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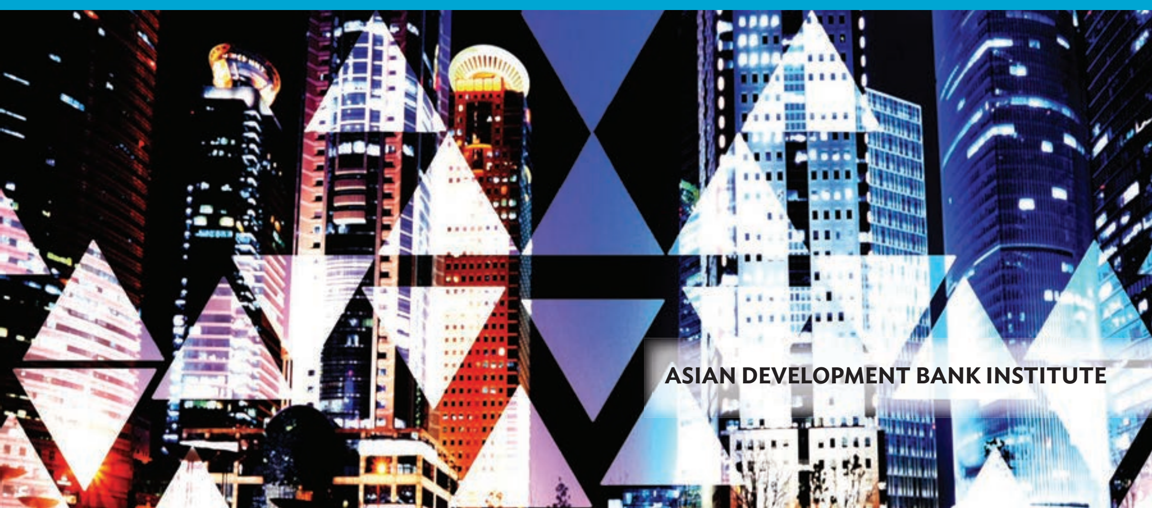
SLOWDOWN IN THE PEOPLE'S REPUBLIC OF CHINA

Structural Factors and the Implications for Asia

Justin Yifu Lin, Peter J. Morgan, and Guanghua Wan



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Structural Factors and the Implications for Asia

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ABBREVIATIONS

AEC	ASEAN Economic Community
ASEAN	Association of Southeast Asian Nations
CES	constant elasticity of substitution
CFA	counter-factual analysis
CFPS	China Family Panel Studies
CGE	computable general equilibrium
CLMV	Cambodia, the Lao PDR, Myanmar, and Viet Nam
CPI	consumer price index
DSGE	dynamic stochastic general equilibrium
ep&c	electronic parts and components
FDI	foreign direct investment
GDP	gross domestic product
GFC	global financial crisis
GMS	Greater Mekong Subregion
IOT	Input–Output Tables
OECD	Organisation for Economic Co-operation and Development
PBoC	People's Bank of China
PPP	purchasing power parity
ppts	percentage points
PRC	People's Republic of China
RoR	Rate of return
s.e.	standard error
TFP	total factor productivity
US	United States
VAR	vector auto regression
WIOD	World Input–Output Database

PREFACE

The People's Republic of China (PRC) has been growing at an unprecedented rate since economic reforms were initiated in 1978, achieving an average annual real gross domestic product (GDP) growth rate of 9.7% over the entire period through 2015. Even more remarkably, there was no marked slowdown of the decadal average growth rates, which stayed within the range of 9%–10% in the three most recent decades. As a consequence, per capita GDP in 2005 purchasing power parity terms reached about $11,300 in 2015, marking a remarkably successful transition from one of the poorest countries to upper middle-income status in just over one generation. In purchasing power parity terms, its share of world GDP rose to 17.9% in 2016 versus 15.6% for the United States.

Moreover, the PRC has become the leading engine of global growth, as it has made the largest contribution to global GDP growth every year since 2001.[1] In 2016, it contributed 1.1 percentage points out of total world growth of 3.1%, 37% of the total. Therefore, it is easy to understand the concern that has arisen over signs that the PRC's strong growth streak recently has run out of steam, showing a steady and marked deceleration since 2010. By 2016, the annual growth rate had fallen to 6.7%, the lowest since 1990, when monetary policy was tightened sharply to reduce inflation. This slowdown, if not reversed, could have significant, and in some cases crucial, implications for many economies, particularly for her major trading partners.

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1 IMF World Economic Outlook Database October 2016. http://www.imf.org/external/pubs/ft/weo/2016/02/weodata/index.aspx (accessed 28 February 2017).

The key question is whether the PRC's economy will continue to slow and be trapped in slow growth, or whether its growth can re-accelerate. This was the theme of two conferences sponsored jointly by the Asian Development Bank Institute (ADBI), the National Natural Science Foundation of China (Project 71133004), and *China & World Economy* journal.[2] A total of 58 papers was submitted or invited and 30 were selected for presentation. These papers focused on the root causes of the current slowdown and, in light of these, assessed the growth potential of the PRC economy, the conditions under which that potential growth could be realized, and the implications for other Asian economies. Not surprisingly, there were both optimistic and pessimistic views on the outlook for the PRC economy. This volume presents some of the most incisive analyses from these conferences.

The pessimistic and optimistic views on the PRC growth divide along several key fault lines, including: the relative contributions of capital and total factor productivity (TFP) to growth; whether or not the factors behind the recent slowdown are mainly structural or cyclical; and what key factors, if any, could enable the return to high GDP growth rates of, say, about 8%. However, there is broad agreement on two points. First, in view of lower trend growth rates in the advanced economies, exports will not contribute as much to growth as before. Second, economic and financial reforms are needed to unlock the growth potential of domestic demand, including financial liberalization, reform of the *hukou* system for internal migration, and adjustment of distorted factor and output prices.

Asia's trading partners need to adjust to the changing environment as well. They need to make greater efforts to diversify their exports away from dependence on the PRC and the developed economies, and to take steps to promote growth of domestic demand.

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2 Implications of a Possible PRC Growth Slowdown for Asia, 25–26 November 2015 in Tokyo, Japan, and Middle-income Trap in Asia and PRC New Economic Normal, 13–14 April 2016, in Beijing, PRC.

Similar to the case of the PRC, the latter can be accomplished mainly by economic reforms, promotion of financial development, promotion of education and innovation, economic upgrading, and steps to improve social safety nets.

We thank Feng Xiaoming and Zhang Zhinan of *China & World Economy* for their substantial support of this project. Yasuyo Sugihara and Ayako Kudo provided able logistic support. Ainslie Smith coordinated the editing of the volume, and Muriel Ordoñez and Jera Beah H. Lego were in charge of production. We also thank Alvin Tubio for typesetting the manuscript, Enid Zafran for compiling the index, and Ian Youngs for designing the cover.

We hope that this volume will contribute to the ongoing dialogue about how economic and financial reforms can contribute to more self-sustainable and inclusive growth in Asia.

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CHAPTER 1

Introduction

Justin Yifu Lin, Guanghua Wan, and Peter J. Morgan

1.1 Introduction

The People's Republic of China (PRC) has been growing at an unprecedented rate since economic reforms were initiated in 1978, achieving an average annual real gross domestic product (GDP) growth rate of 9.7% over the entire period through 2015. Even more remarkably, there was no marked slowdown of the decadal average growth rates, which stayed within the range of 9%–10% in the 3 most recent decades. As a consequence, per capita GDP in 2005 purchasing power parity (PPP) terms reached about $11,300 in 2015, marking a remarkably successful transition from one of the poorest countries to upper-middle-income status in just over one generation.

However, the PRC's strong growth streak recently has run out of steam, showing a steady and marked deceleration since 2010. By 2016, the annual growth rate had fallen to 6.7%, the lowest since 1990, when monetary policy was tightened sharply to reduce inflation. The slowdown has naturally raised worldwide concerns, mainly because the PRC has been acting as the largest engine of global growth for many years, contributing over 30% of global growth every year since 2011.[1] Thus, this slowdown has significant, and in some cases crucial, implications for many economies, particularly for the PRC's major trading partners.

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1 IMF World Economic Outlook Database October 2016. http://www.imf.org/external/pubs/ft/weo/2016/02/weodata/index.aspx (accessed 28 February 2017).

Clearly, the key question is whether the PRC economy will continue to be trapped in slow growth (the so-called "middle-income trap"), or whether its growth can reaccelerate. Not surprisingly, there are both optimistic and pessimistic views on the outlook for the PRC economy. A second important question is how the PRC's slower growth will affect its trading partners, particularly those in Asia. The chapters in this book address both issues.

The pessimistic and optimistic views on PRC growth divide along several key fault lines. First, when using growth accounting approaches to identify the supply-side determinants of growth, i.e., the relative contributions of labor, capital, and total factor productivity (TFP), estimates vary widely depending on the particular data set used. The optimists generally find that the contribution of TFP growth to GDP growth has been large. This implies that the PRC's high growth rates are potentially sustainable because they have not depended on a rapid rise in the capital–output ratio, which would imply a sharp decline in the rate of return to capital. On the other hand, the pessimists tend to find that most of PRC growth can be attributed to capital deepening, which implies a substantial reduction of the return to capital, and hence is likely to limit potential growth going forward.

The second area of disagreement is whether the recent slowdown can be attributed mainly to domestic structural factors or to external and cyclical factors, with pessimists emphasizing the former and optimists the latter. Domestic structural factors include the aging of the population, the diminishing pool of surplus agricultural labor, declining return to capital, economic distortions such as preferential treatment of state-owned enterprises and factor price distortions, and excess capacity. Cyclical factors include mainly the slower growth of the advanced economies in the wake of the global financial crisis of 2007–2009 and the European sovereign debt crisis of roughly 2009–2014.

The third area of disagreement is the basis of comparison for assessing the PRC's growth potential. Pessimists cite the findings of the convergence theory of growth, the so-called "iron law" of convergence, which predicts that growth tends to slow to global average performance in line with the level of per capita GDP. On the other hand, optimists argue that the PRC can follow the path of earlier Asian success stories, including Japan; the Republic of Korea; Singapore; and Taipei,China, which benefited from export-led growth strategies, high rates of savings and investment, and relatively rapid growth of human capital.

The rest of this chapter briefly describes the findings of the individual chapters. Section 1.2 contains various cross-country comparisons with the PRC's experience, especially for those more developed Asian economies that followed a similar development path. Section 1.3 contains analyses of structural factors that are expected to determine the PRC's medium to long-term growth rate. Section 1.4 examines the impacts of slower PRC growth on its Asian trading partners, and Section 1.5 concludes.

1.2 International Comparisons

In Chapter 2, Barro estimates two models of long-term convergence of per capita real GDP. The first uses data on 89 countries from 1960 to 2010. For this model, the results imply a conditional convergence rate of 1.7% per year. The second data set covers a much longer period, 1870–2010, but a smaller sample of only 28 countries. The second model yields an estimated conditional convergence rate of 2.6% per year. Barro argues that the true coefficient on the lagged dependent variable probably is bracketed by these two values. Barro finds the PRC's recent growth rate to be much higher than predicted by his first model described above, and the results imply that the PRC's per capita growth rate is likely to decrease from 8% to a range of 3%–4%. However, he argues that this growth rate over a long period would still be sufficient to enable the PRC to make the transition from middle-income to high-income status. Thus, although these more realistic growth rates are well below recent experience, they would still be a great achievement.

In Chapter 3, Yao compares the experience of the PRC with that of Japan and asks whether the PRC might be subject to the "Japan Syndrome." He finds a number of similarities between the PRC and Japan, including an export-led growth model, upward pressure on the PRC yuan and an aging population. However, he argues that the large internal disparities of income levels in the PRC could contribute to growth if the poorer inland areas converge to the high income levels of the coastal regions. Based on the estimation of a growth equation using cross-country panel data, Yao forecasts that, under reasonable assumptions about the growth rate of the world economy and the PRC's investment rate, the PRC could maintain reasonably high potential growth rates in the next 10 years in the range of 6%–7%.

In Chapter 4, Fukao and Yuan also compare the experiences of the PRC's and Japan's high-speed growth periods and following periods, and derive some lessons from Japan's experience. First, compared with Japan, they find that the PRC's high growth rate was driven more by capital accumulation and less by TFP growth, which would tend to lower the rate of return on capital and might lead to an earlier end of the PRC's high-speed growth period. Second, the fact that the labor-force-age population will decline at an earlier stage of development in the PRC than in Japan will also tend to reduce the rate of return on capital. Taking these factors into account, they conclude that the PRC's high rate of capital investment growth is unsustainable, and recommend that the PRC speed up economic reforms to promote higher growth of TFP.

In Chapter 5, Lee estimates the contribution of various growth factors to the growth rates of the PRC, Japan, and the Republic of Korea. He also estimates a cross-country panel regression for per capita GDP growth using a sample of 75 economies over the period 1960–2010. His estimates of the conditional convergence rate for per capita GDP growth range between 1.7% and 3.4% per year, depending on whether or not country fixed effects are included, a somewhat wider range than Barro's estimate. He attributes the Republic of Korea's recent slowdown to its unbalanced economic structure and estimates that the PRC's potential GDP growth will decline to 5%–6% over the coming decades, unless it significantly improves institutions and policy factors. However, he notes that the Republic of Korea and the PRC share some favorable conditions for more rapid growth than in other developing countries, including strong investment, high trade openness, macroeconomic stability, and continuous improvement of the quality of human resources and institutions. He argues that future reforms and policies might partially offset the growth deceleration due to convergence in the coming decades.

1.3 Structural Factors Affecting the People's Republic of China's Potential Growth Rate

Whether the PRC's economic slowdown since the 2008 financial crisis is a cyclical downturn or a long-run trend has important policy implications. In Chapter 6, Wu finds that, of the PRC's 8.9% average annual GDP growth rate over the period 1980–2012, 7.0 percentage points (ppts) could be attributed to the growth of labor productivity and 1.9 ppts to the rise of hours worked. He finds that the PRC's labor productivity growth was heavily dependent on capital deepening (5.7 ppts) rather than TFP growth (0.8 ppts). Notably, he estimates that TFP growth actually turned negative over 2007–2012, which raises a further question on the PRC's growth sustainability. Another key finding is that industries that are less prone to direct state interventions show faster TFP growth than those controlled by the state. Incorporating the Domar sectoral aggregation scheme, he finds that two-thirds of TFP growth originated from within industries and the remainder can be attributed to a net factor reallocation effect in which labor shifts played a positive role while capital appears to actually have shifted to less-productive sectors. Finally, using a revised Maddison–Wu approach to address the potential flaws in official statistics, he arrives at an annual growth rate estimate of 7.2%, or 1.7 ppts slower than the 8.9% estimate obtained based on PRC industrial productivity data reconstructed using the official national accounts.

Based on provincial panel data, Bai and Zhang in Chapter 7 identify the determinants of productivity and use counter-factual analysis to decompose the causes of the PRC's post-global-financial-crisis slowdown in productivity growth. They find that economic openness has a significantly positive impact on the technical efficiency of production, whereas the income level has a significantly negative effect. Second, they find a significantly negative correlation between the stock of inventory and productivity, and a significantly positive correlation between the employment involvement rate and productivity. Third, the shares of the government sector and fixed investment in GDP both have significantly negative effects on productivity. Lastly, the diminishing late-mover advantage and the growth in investment rate are both major contributors to the current decline in the PRC's productivity. Although the stimulus-induced investment surge during the global financial crisis period effectively offset the negative effects of the crisis on the PRC's growth, it was not conducive to the growth of productivity and consumption. They conclude that the recent economic slowdown does not seem to be a cyclical downturn, and that further reforms are needed to stabilize the PRC's growth.

In Chapter 8, Lin, Wan, and Morgan have the most optimistic view. They argue that the PRC has many positive supply factors that, under favorable circumstances, could support a high potential growth rate. Most importantly, developing countries such as the PRC possess a "latecomer advantage," because they can achieve technological progress through imitation, importing capital goods, integration, and licensing of technology. This capacity can enable the PRC to substantially upgrade its industrial structure. In 2008, the PRC's per capita income in 2005 PPP terms was just over one-fifth that of the United States. Based on the growth experience of Japan;

the Republic of Korea; Singapore; and Taipei,China from the time when their per capita incomes were at similar ratios to that of the United States, they estimate that the PRC has a potential growth rate of roughly 8% through 2028. Also, even though export growth may have slowed, there is still potential for high growth of domestic demand, including investment in urbanization-related investment, infrastructure, industrial upgrading, and environmental improvement. For consumer spending, reform of the *hukou* system could permit freer internal migration toward higher-paying jobs.

Second, they attribute the recent slowdown mainly to cyclical and external factors. This view, of course, does not deny that the PRC faces important structural issues that need to be addressed. In fact, structural reforms are necessary to realize the 8% growth potential. The key challenge is to pace the reforms to achieve positive results while minimizing the short-term deflationary impacts, and to combine them with appropriate macroeconomic policies.

1.4 Implications for Asia

As an increasingly important global and regional economic power, the PRC's growth slowdown may cause large spillover effects to its neighboring economies. Using a multi-sectoral global computable general equilibrium model, in Chapter 9 Zhai and Morgan quantitatively investigate the impacts of a growth slowdown in the PRC for emerging Asian economies through trade linkages. Their results suggest that a growth slowdown of 1.6 ppts in the PRC would bring about a growth deceleration of 0.26 ppts in developing Asia as a whole. However, the impacts vary dramatically by economy within developing Asia, reflecting their differences in economic and trade structure. In most regional economies, the induced growth losses are less than 0.5 ppts. Taipei,China and Hong Kong, China are found to be most vulnerable to a PRC economic downturn, while South Asia is the most isolated from changes in the PRC.

In Chapter 10, Uttama focuses on the impacts of slower PRC growth on the Association of Southeast Asian Nations (ASEAN) countries. Forging closer economic relations between the PRC and ASEAN over the last 2 decades has contributed to building a stronger ASEAN economy. It is particularly important to know how the PRC's foreign direct investment responds to ASEAN's economic performance. He investigates the causal relationship between the PRC's foreign direct investment and economic growth among the 10 ASEAN member countries from 1995 to 2013. Panel unit root tests, a spatial panel vector autoregressive model, and spatial Granger causality are employed as empirical techniques for spatial panel estimation. The empirical results reveal that the PRC's direct investment in ASEAN caused economic growth in ASEAN, and economic growth in ASEAN resulted in the PRC's direct investment in ASEAN. This finding raises potentially interesting external investment policy implications.

In Chapter 11, Thorbecke estimates a gravity model to investigate how slower growth in the PRC can spill over to Asian trading partners through the trade channel. Exports from several East Asian and Southeast Asian countries to the PRC exceed 10% of their gross domestic products. The results indicate that Taipei,China and ASEAN countries are heavily exposed to the PRC because they produce goods for the PRC market and are exposed to developed economies because they ship parts and components to the PRC for processing and re-export to the West. On the other hand, the Republic of Korea is more exposed to a slowdown in developed economies that purchase processed exports from the PRC than to a slowdown in the PRC. Major commodity exporters such as Australia, Brazil, Indonesia, and Saudi Arabia and exporters of sophisticated consumption and capital goods such as Germany and Switzerland are also exposed to a slowdown in the PRC domestic market. The chapter also estimates import elasticities for the PRC. The results indicate that imports for processing into the PRC are closely linked to processed exports from the PRC to the rest of the world and that ordinary imports are closely linked to the PRC GDP. The yuan exerts only a weak impact on imports, however. He concludes by recommending that firms and countries diversify their export bases and their trading partners to reduce their exposures to the PRC and to developed economies.

In Chapter 12, Inoue, Kaya, and Oshige examine the impact of a negative PRC GDP shock on Asian economies by employing the global vector autoregression modeling methodology developed by Pesaran, Schuermann, and Weiner (2004), and Dees, di Mauro, Pesaran, and Smith (2007), using a dataset for 1979Q1 to 2014Q3 for 33 countries. They find that a negative PRC GDP shock impacts commodity exporters such as Indonesia the most, reflecting both demand and terms of trade shocks. Export-dependent countries in East Asian production chains, such as Japan, Singapore, Malaysia, and Thailand, are also severely affected. Moreover, a negative shock to the real GDP of the PRC would not only have an adverse effect on the price of crude oil, as some previous studies have also shown, but also on metals and agricultural prices.

1.5 Conclusions

The debate will go on. However, some aspects are relatively clear. Exports are unlikely to provide a major source of growth for the PRC in the future, given the subdued state of global demand and the PRC's already-large share of global trade. The need to rely primarily on domestic demand underlines the importance of carrying out continued reforms to support growth. These include reform of the *hukou* system to free up internal migration toward higher productivity jobs, reform of the financial system to direct capital resources to the areas of highest return, reform of state-owned enterprises to increase the role of competition, and reforms of distorted pricing mechanisms. Optimists will argue that the good news is that there is still plenty of room to wring out efficiency gains in the economy to support growth, while pessimists will fret about the challenge of overcoming the resistance of vested interests to such reforms so that they can move forward.

In the meantime, Asian economies need to adjust to potentially slower growth in the PRC, although the impacts are not expected to be too great. They need to make greater efforts to diversify their exports away from dependence on the PRC and the developed economies, and to take steps to promote growth of domestic demand. Similar to the case of the PRC, the latter can be accomplished mainly by economic reforms; promotion of financial development, education, and innovation; economic upgrading; and steps to improve social safety nets.

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CHAPTER 2

Economic Growth and Convergence, Applied Especially to the People's Republic of China

Robert J. Barro

The main goal of this chapter is to assess the past and prospective economic growth of the People's Republic of China (PRC). Appraising a single country in isolation is not possible, and I therefore position the PRC within the context of growth experienced by a large number of countries over long periods. More specifically, I use the well-known framework of conditional convergence applied empirically in the form of cross-country growth regressions.[1]

2.1 Conditional Convergence and Cross-Country Growth Regressions

My empirical analysis of the determinants of economic growth relies on two data sets. The first applies to 89 countries observed from 1960 to 2010. An important feature of these data is the availability of information not only on real per capita gross domestic product (GDP) but also on a broad array of explanatory variables—called "X variables"—that help to predict economic growth.

The second data set applies over a much longer period, 1870–2010. For this purpose, I use the long-term data on real per capita GDP constructed recently by Jose Ursúa (2011).[2] These data are particularly

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1 This approach began with Barro (1991).

2 These data, available on my website at Harvard University, cover 42 countries with annual data on real per capita GDP starting at least by 1913.

useful for the estimation of convergence effects. Specifically, well-known econometric problems (Hurwicz 1950, Nickell 1981) in estimating coefficients of lagged dependent variables (central to the gauging of convergence rates) are eased in the presence of long time series. Moreover, it turns out that the 140 years of the second data set is long in this context, whereas the 50 years of the first data set is still too short. Disadvantages of the second data set are the much smaller number of countries with long-term data on real per capita GDP—28 in my context—compared to the 89 in the first data set. In addition, many fewer X variables are available over the long term, even for the countries with information on GDP.

Table 2.1 reports the basic regression results for the two data sets. Column 1 (which comes from Barro [2015, Table 1, column 3]) is for 89 countries observed over 5-year intervals from 1960 to 2010. The dependent variable is the growth rate of real per capita GDP.[3] The right-hand side variables include the 5-year lag of the log of real per capita GDP. The estimated coefficient of this variable gives the conditional convergence rate—for example, the value—0.017 shown in column 1 of the table implies a conditional convergence rate of 1.7% per year. The conditioning variables (X variables) in this particular specification are for life expectancy at birth, total fertility rate, indicators for law and order (rule of law) and democracy, ratios to GDP of investment and government consumption, female and male years of school attainment, the openness ratio (exports plus imports relative to GDP), a measure of changes in the terms-of-trade, and the inflation rate.

The estimation in column 1 uses ordinary least squares and excludes country fixed effects (but has different constant terms for each time period). Barro (2015, Section 4) argues that, particularly for identifying the coefficient on the lagged dependent variable,

3 For some purposes, it might be better to measure growth per worker rather than per person. However, estimates of work force and employment are subject to large measurement errors in developing countries.

the exclusion of country fixed effects is important for minimizing bias of the Hurwicz (1950)–Nickell (1981) type. With country fixed effects excluded, the inclusion of the array of X variables is crucial for minimizing omitted-variables bias. The main results, especially for the conditional-convergence rate, are robust to estimating by two-stage least-squares (with lagged values used as instruments) and to changes in the list of X variables.

A principal finding in Table 2.1, column 1, is that the estimated convergence coefficient, −0.0170 (standard error [s.e.] = 0.0021), is significantly negative and indicates convergence at close to the "iron law" rate of 2% per year. If the other explanatory variables were unchanging, the convergence of real per capita GDP would be toward a level implied by the long-run values of the other explanatory variables (adjusted for a worldwide trend).

The other results indicate significantly positive effects on growth (given initial per capita GDP) from initial life expectancy, the law-and-order (rule-of-law) indicator, the investment ratio, international openness, and improvements in the terms of trade. Negative effects relate to the initial fertility rate and the inflation rate. The estimated impact of the democracy indicator is non-linear; positive at low values but eventually becoming negative. The relation with initial years of schooling is surprisingly weak, perhaps because the variable measures years of education rather than the quality of this education. In general, the results for a particular X variable tend to be sensitive to changes in the list of independent variables. However, the general pattern that emerges robustly is a positive impact on growth from changes that can be construed as favorable for the workings of private markets or for productivity.[4]

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4 The results do not depend much on the observation interval, taken to be 5 years in Table 2.1. The main findings, particularly on the conditional convergence rate, are similar to the variables observed at 10- or 1-year intervals. However, an annual regression is problematic because many of the right-hand side variables are not really observed at an annual frequency.

Table 2.1: Growth Regressions for Cross-Country Panels
(all equations estimated by OLS and include time effects)

	(1) 89 countries 5-year intervals 1960–2010 no country fixed effects	(2) 28 countries 5-year intervals 1870–2010 country fixed effects
Log(lagged per capita GDP)	–0.0170** (0.0021)	–0.0262** (0.0041)
1/(life expectancy at birth)	–3.09** (0.58)	–
Log(fertility rate)	–0.0277** (0.0043)	–
Law-and-order (rule-of-law) indicator	0.0157** (0.0054)	–
Investment ratio	0.031* (0.012)	–
Female school years	0.0024 (0.0014)	–0.0026 (0.0025)
Male school years	–0.0028 (0.0015)	–0.0009 (0.0026)
Government consumption ratio	–0.026 (0.023)	–
Openness ratio	0.0056* (0.0025)	–
Terms-of-trade change	0.117** (0.026)	–
Democracy indicator	0.029 (0.015)	–0.032 (0.019)
Democracy squared	–0.028* (0.014)	0.034* (0.017)
Inflation rate	–0.0180** (0.0042)	–
R-squared	0.33	0.26
s.e. of regression	0.024	0.026
Number of countries; observations	89; 841	28; 727

GDP = gross domestic product, OLS = ordinary least squares, s.e. = standard error.

* Significant at 5% level. ** Significant at 1% level.

Notes to Table 2.1

Column 1:

The sample criterion is to include countries only if they have data starting by the 1970–1975 period for the dependent and independent variables. The countries in the sample appear in Table 2.2. The dependent variable is the annual growth rate of real per capita GDP for the ten 5-year periods: 1960–1965, ..., 2005–2010. Lagged per capita GDP, the reciprocal of life expectancy at birth, the total fertility rate, and female and male years of school attainment for persons aged 15 and over are 5-year lags (for 1960, ..., 2005). The ratios of investment and government consumption to GDP, the openness ratio, the indicator for law and order (rule of law) and the democracy indicator are 5-year averages of values lagged one to five years. The growth rate of the terms of trade and the inflation rate are for the same periods as the dependent variable. Standard errors of coefficient estimates are in parentheses. For calculating standard errors, the error terms are allowed to be correlated over time within countries.

Definitions and sources:

Purchasing power parity-adjusted real per capita GDP is from Penn World Tables (www.pwt.econ.upenn.edu), version 7.0, in 2005 international dollars. Data for 2010 are from version 7.1. Also from version 7.0 are the ratios to GDP of investment (private plus public) and government consumption and the openness ratio (exports plus imports relative to GDP). These ratio variables use current-price information.

Life expectancy at birth and the total fertility rate are from the World Bank's *World Development Indicators* (*WDI*).

The law-and-order (rule-of-law) indicator is from Political Risk Services, *International Country Risk Guide*. The data were converted from seven categories to a 0–1 scale, with 1 representing the highest maintenance of law and order and rule of law.

Average years of school attainment for females and males aged 15 and over at various levels of schooling are from Barro and Lee (2015), with data available at www.barrolee.com. These data are at 5-year intervals.

The terms-of-trade change (growth rates over five years of export prices relative to import prices) is from International Monetary Fund, *International Financial Statistics*, and *WDI*. This variable is interacted with the openness ratio.

The democracy indicator is the political rights variable from Freedom House (www.freedomhouse.org). The data were converted from seven categories to a 0–1 scale, with 1 representing the highest rights. Data on an analogous concept for 1960 and 1965 are from Bollen (1980).

The inflation rate (averaged over 5-year intervals) is calculated from retail-price indexes from the International Monetary Fund, *International Financial Statistics*, and *WDI*.

Column 2:

The sample criterion is to include countries only if they have GDP data starting by 1896 and also have data for most of the period on years of schooling and an indicator of democracy from Polity. This criterion selected 28 countries: Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, the People's Republic of China, Denmark, France, Germany, Italy, Japan, Mexico, the Netherlands, New Zealand, Norway, Peru, Portugal, the Russian Federation, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States, Uruguay, and Venezuela. Standard errors of coefficient estimates are in parentheses. In calculating standard errors of coefficient estimates, the error terms are allowed to be correlated over time within countries.

The dependent variable is the annual growth rate of real per capita GDP for the 28 countries for 28 periods: 1870–1875, 1875–1880, ..., 2005–2010. For the independent variables, the log of lagged per capita GDP, average years of female and male school attainment for persons aged 15 and over, and the Polity indicator are 5-year lags, referring to 1870, 1875, ..., 2005.

Sources: GDP is from "Barro–Ursúa Macroeconomic Data," available at www.rbarro.com/data-sets. The Polity indicator is for democracy less autocracy (converted from a −10 to +10 scale to a 0–1 scale, with 1 representing highest democracy), from Polity IV (www.systemicpeace.org). The data at 5-year intervals since 1950 on female and male average years of school attainment for persons aged 15 and over are as for column 1. Data from 1870 to 1945 at 5-year intervals are estimates described in Barro and Lee (2015).

Table 2.2: Sample of 89 Countries Used in Table 2.1, Column 1

Country	Starting period	Country	Starting period
Argentina	1960–1965	Jordan	1965–1970
Australia	1960–1965	Japan	1960–1965
Austria	1960–1965	Kenya	1960–1965
Belgium	1960–1965	Rep. of Korea	1965–1970
Bangladesh	1965–1970	Sri Lanka	1960–1965
Bahrain	1970–1975	Luxembourg	1960–1965
Bolivia	1965–1970	Morocco	1960–1965
Brazil	1960–1965	Mexico	1960–1965
Botswana	1965–1970	Mali	1965–1970
Canada	1960–1965	Malta	1970–1975
Switzerland	1960–1965	Malawi	1965–1970
Chile	1960–1965	Malaysia	1960–1965
PRC	1960–1965	Niger	1960–1965
Cote d’Ivoire	1960–1965	Nicaragua	1960–1965
Cameroon	1965–1970	Netherlands	1960–1965
Congo, Republic	1960–1965	Norway	1960–1965
Colombia	1960–1965	New Zealand	1960–1965
Costa Rica	1960–1965	Pakistan	1960–1965
Cyprus	1960–1965	Panama	1965–1970
Denmark	1960–1965	Peru	1965–1970
Dominican Republic	1960–1965	Philippines	1960–1965
Algeria	1960–1965	Papua New Guinea	1960–1965
Ecuador	1960–1965	Portugal	1960–1965
Egypt	1960–1965	Paraguay	1960–1965
Spain	1960–1965	Sudan	1970–1975
Finland	1960–1965	Senegal	1960–1965
France	1960–1965	Singapore	1965–1970
Gabon	1965–1970	Sierra Leone	1965–1970
United Kingdom	1960–1965	El Salvador	1960–1965
Germany	1970–1975	Sweden	1960–1965
Ghana	1960–1965	Syria	1970–1975
Gambia	1965–1970	Togo	1965–1970

continued next page

Table 2.2: *Continued*

Country	Starting period	Country	Starting period
Greece	1960–1965	Thailand	1960–1965
Guatemala	1960–1965	Trinidad	1960–1965
Guyana	1970–1975	Tunisia	1965–1970
Honduras	1960–1965	Turkey	1965–1970
Haiti	1960–1965	Taipei,China	1960–1965
Hungary	1970–1975	Tanzania	1970–1975
Indonesia	1965–1970	Uganda	1965–1970
India	1960–1965	Uruguay	1965–1970
Ireland	1960–1965	United States	1960–1965
Iceland	1960–1965	Venezuela	1965–1970
Israel	1970–1975	South Africa	1960–1965
Italy	1960–1965	Zambia	1965–1970
Jamaica	1960–1965		

PRC = People's Republic of China.

Table 2.1, column 2 (which comes from Barro [2015, Table 5, column 4]), shows the results for the long-term panel of 28 countries from 1870 to 2010. Because few X variables are available, the omitted variables problem would seriously impact the estimation of the coefficient of the lagged dependent variable if country fixed effects were excluded. Fortunately, the inclusion of these effects does not produce a large bias of the Hurwicz–Nickell variety when the sample length is 140 years. The main result in column 2 is the estimated coefficient on the lagged dependent variable of −0.0262 (s.e. = 0.0041). That is, conditional convergence appears at 2.6% per year.

Barro (2015, Section 6) argues that the true coefficient on the lagged dependent variable is likely bracketed by the value −0.017 in column 1 (1960–2010) and −0.026 in column 2 (1870–2010). The reasoning is that the column 1 estimate likely reflects some remaining omitted-variables bias (which tends to lower the magnitude of the estimated coefficient), whereas the column 2 estimate likely retains some

Hurwicz–Nickell bias (which tends to raise the magnitude of the estimated coefficient). The iron-law convergence rate of 2% per year falls into the interval between the two point estimates.

2.2 Applying the Global History to the People's Republic of China's Economic Growth

Table 2.3 uses the results from Table 2.1, column 1, to assess actual and model-estimated economic growth for the PRC from 1960 to 2010. In the early parts of the sample, the actual growth rate of real per capita GDP was well below the model-implied value. That is, convergence was occurring at a rate far below the typical cross-country experience. To put it another way, the PRC was so poor in this period that economic growth should have been more rapid, even after taking into account the generally unfavorable nature of the X variables.

Table 2.3: Growth Rates of Real Per Capita GDP in the People's Republic of China—Actual and Model-Fitted Values

Period	Per Capita Growth Rate	Fitted Value	Residual
1960–1965	–0.013	0.040	–0.053
1965–1970	0.017	0.046	–0.029
1970–1975	0.025	0.047	–0.022
1975–1980	0.038	0.060	–0.022
1980–1985	0.061	0.046	0.015
1985–1990	0.024	0.054	–0.031
1990–1995	0.084	0.046	0.038
1995–2000	0.034	0.048	–0.014
2000–2005	0.094	0.051	0.043
2005–2010	0.089	0.042	0.047

GDP = gross domestic product.

Note: The fitted value and residual come from the panel regression in Table 2.1, column 1.

In contrast, Table 2.3 shows that the PRC growth rate tended to exceed the model-implied value since 1990; the residual is substantially positive in three of the last four 5-year periods. Notably, for 2005–2010, the actual per capita growth rate of 8.9% per year was sharply above the fitted value of 4.2%. To put it another way, the PRC has been converging over the last 2 decades toward middle- and upper-income status at a rate far greater than anticipated from the global historical experience (given the values of the PRC's X variables).

Of course, it would be great to attenuate the residuals shown in Table 2.3 by incorporating more explanatory variables, some possibly specific to the PRC. One idea, possibly not already fully reflected in the X variables included in the panel regression, is that the PRC was largely closed to private enterprise and international markets in the early part of the sample, especially until around 1980, and then became much more pro-market (or capitalist?). The challenge would be to model these forces in a consistent way across countries and over time. That is, the suggested route amounts to measuring additional X variables and incorporating them into the regression system. I readily agree that other researchers may do better in this respect than the panel regression reported in Table 2.1, column 1.

It is also possible to use the results from Table 2.1, column 1, to project the PRC's economic growth into the future. For this purpose, I use the values of the PRC's explanatory variables for the most recent year available.[5] The result is a projected growth rate as of 2015 of 3.5% per year (with subsequent growth rates given from a typical convergence process). This projection is sharply below official 5-year forecasts of real GDP growth of around 6%–7% per year (which should be adjusted downward by about 0.5% per year to account for population growth).

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[5] Values for 2014 were real per capita GDP of $12,609 (2011 international dollars), life expectancy at birth of 75.4 years (for 2013), total fertility rate of 1.7 (for 2013), law-and-order (rule-of-law) indicator of 0.58 (0–1 scale), political rights indicator of 0 (0–1 scale), investment ratio of 0.37, government consumption ratio of 0.15, openness ratio of 0.42, years of female schooling of 8.2, years of male schooling of 9.2, inflation rate of 0.020 per year. The future change in the terms of trade was assumed to be zero.

Of course, consistent with the model's underestimation of PRC economic growth in the 2000s (as shown in Table 2.3), the model may be underpredicting growth from 2015 on. But it is unlikely that the PRC's growth rate can deviate in the long run from the results predicted by international experience within a conditional-convergence framework. In particular, it is not possible for the PRC's per capita GDP growth rate to exceed 6% per year in the long run.

2.3 Convergence Success Stories across the World

The PRC through 2014 can be viewed as a convergence success story, in the sense that the strong economic growth over a sustained period led to a level of real per capita GDP that can be characterized as middle income. To put the PRC accomplishment into international perspective, I calculated all the convergence success stories in the world based on reasonable, though slightly arbitrary, criteria. Specifically, I propose that one criterion for a convergence success is a doubling or more of real per capita GDP from 1990 to 2014 (implying per capita growth of at least 2.9% per year). Secondly, I define a middle-income success as attainment of a level of real per capita GDP in 2014 of at least $10,000 (on a purchasing power parity basis in 2011 international dollars).[6] An upper-income success requires a level of real+ per capita GDP in 2014 at least twice as high; that is, at least $20,000.

Table 2.4 shows the cases of middle- and upper-income successes. Aside from the PRC, the middle-income successes comprise Indonesia, Peru, Thailand, and Uruguay. (Uruguay was a surprise; a possible explanation is the extensive migration of high human-capital people away from Argentina, which has been following strikingly anti-market policies.) One additional country that almost made this list is Costa Rica (average per capita growth rate since 1990 of 2.8% per year).

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6 The data for 2014 are from World Bank, *World Development Indicators*.

Table 2.4: Convergence Success Stories—Middle-Income and Upper-Income Successes

Country	Real per Capita GDP, 1990 (2011 US dollars)	Real per capita GDP, 2014 (2011 US dollars)
Middle-Income Successes		
PRC	1,500	12,600
Indonesia	4,500	10,000
Peru	5,300	11,400
Thailand	6,400	13,900
Uruguay	9,800	19,900
Almost met criteria for middle-income success:		
Costa Rica	7,300	14,200
Upper-Income Successes		
Chile	9,200	22,000
Ireland	22,500	46,600
Republic of Korea	12,100	33,600
Malaysia	10,200	23,800
Poland	10,100	24,000
Singapore	34,300	79,000
Taipei,China[a]	13,700	37,900
Almost met criteria for upper-income success:		
Hong Kong, China	27,000	52,600

GDP = gross domestic product, PRC = People's Republic of China, US = United States.

[a] Data are from the national accounts of Taipei,China.

Notes: The definition of a convergence success is, first, that real per capita GDP has to at least double from 1990 to 2014 (per capita growth rate of at least 2.9% per year). Second, a middle-income success has to reach a level of per capita GDP in 2014 of at least $10,000 in 2011 US dollars. An upper-income success has to reach at least $20,000.

The upper-income successes comprise seven economies: Chile; Ireland; the Republic of Korea; Malaysia; Poland; Singapore; and Taipei,China (Hong Kong, China almost made this list, with an average per capita growth rate since 1990 of 2.8% per year). Some of these upper-income successes—Singapore; Hong Kong, China; and Ireland—are now among the world's richest economies.

One way to think about convergence is to ask what characteristics of economies underlie the attainment of middle- or upper-income convergence success. For example, for the PRC, one might emphasize the opening up to international markets and capitalism in the late 1990s. For India (not yet rich enough to make the middle-income list in Table 2.4), one might focus on the partial relaxation of socialistic restraints and other governmental regulations since the mid-1980s. However, this approach does not really differ from the one pursued in the form of cross-country growth regressions in Table 2.1, column 1. The only difference is that some basic changes in country institutions can, perhaps, be identified qualitatively, but cannot be quantified in the form of X variables that apply across countries and over time.

A view that seems to have gained popularity recently at the World Bank and elsewhere is the "middle-income trap." For a survey and a largely skeptical analysis of this phenomenon, see Bulman, Eden, and Nguyen (2014). According to the trap hypothesis, the successful transition from low- to middle-income status is often followed by barriers that impede a further transition to upper income. My view is that this idea is a myth. Moving from low- to middle-income status, as with the success stories in the upper part of Table 2.4, is challenging. In particular, according to the criteria applied in the table, this status requires at least a doubling of real per capita GDP from 1990 to 2014. The required average per capita growth rate of 2.9% per year, sustained over 24 years, is well above the typical experience (featuring an average per capita growth rate around 2.0% per year). Conditional on having achieved middle-income status, the further transition to upper-income status requires another extended period of well-above-average economic growth. Again, this transition is challenging, but there is no evidence that this second transition (conditional on having achieved the first goal) is more difficult than the first. In this sense, a middle-income trap is not different from a lower-income trap.

2.4 Cross-Country Dispersion of Per Capita GDP

The concept of convergence discussed thus far pertains to whether countries that are poorer (in absolute terms or in relation to their own steady-state position) tend to grow faster than richer ones. In Barro and Sala-i-Martin (1991), this concept is called β-convergence and is distinguished from another form (σ-convergence) that relates to a possible tendency for the cross-sectional dispersion of per capita GDP to decline over time. This dispersion can be measured in proportionate terms by the cross-sectional standard deviation of the log of per capita GDP for a group of economies.

If all countries have the same steady-state per capita GDP, then the existence of β convergence tends to reduce the cross-sectional dispersion over time. However, if individual country shocks are present, these shocks tend to raise dispersion. With purely idiosyncratic country shocks, the cross-sectional variance tends to approach a value that depends positively on the variance of the shocks and negatively on the rate of β convergence. The cross-sectional variance tends to fall over time if it starts above its steady-state value, but otherwise tends to rise over time (even though β convergence is present). If the sample comprises a large number of countries that have existed with fixed underlying parameters for a long time, the cross-sectional variance will tend at any point in time to be close to its long-run value, and the dispersion will be roughly stable over time.[7]

More generally, countries differ in their long-run or steady-state levels of real per capita GDP, and the X variables included in Table 2.1, column 1, hold constant part of these long-term differences.

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7 The notion that a tendency for the poor to grow faster than the rich implies a negative trend in dispersion or inequality is a fallacy; in fact, it is Galton's Fallacy (Galton [1886, 1889], Quah [1993], Hart [1995]), which Galton applied to the distribution of heights across a population. For generations of an extended family, height has positive persistence but tends to revert to the population mean, thereby constituting a form of β convergence. Nevertheless, the dispersion of heights across the overall population typically changes little over time.

In this context, the measured cross-country dispersion of the log of real per capita GDP will tend toward a value that is increasing in the long-term dispersion of the log of steady-state real per capita GDP. If a shock occurs (such as the incorporation of the PRC and India into the world economy around 1980) that lowers the steady-state dispersion, the actual dispersion will tend to decline gradually following the shock toward this reduced steady-state dispersion.

The long-term data on real per capita GDP used in Table 2.1, column 2, can be used to study the long-run evolution of cross-country dispersion. Figure 2.1 applies to the longest feasible sample, 1870–2010, for which 25 countries (20 of which subsequently became Organisation for Economic Co-operation and Development members) have annual data on real per capita GDP. The countries are listed in the note to the figure. Dispersion is measured by the standard deviation across countries of the log of real per capita GDP. The black line weights countries equally, and the gray line weights by population (thereby corresponding under some conditions to the dispersion of income for persons rather than countries).

The black line (equally weighted) in Figure 2.1 shows small changes over time. The range is from 0.56 in 2010 to 0.71 in 1946. The main movement away from the mean of 0.65 associates with World War II—the standard deviation rose from 0.62 in 1938 to 0.71 in 1946. During this crisis period, shocks had a high spatial correlation and affected groups of countries differentially, thereby violating the assumption of purely idiosyncratic country shocks.[8] Otherwise, the main finding is that the cross-sectional standard deviation of the log of per capita GDP has been remarkably stable since 1870 around its mean of 0.65.

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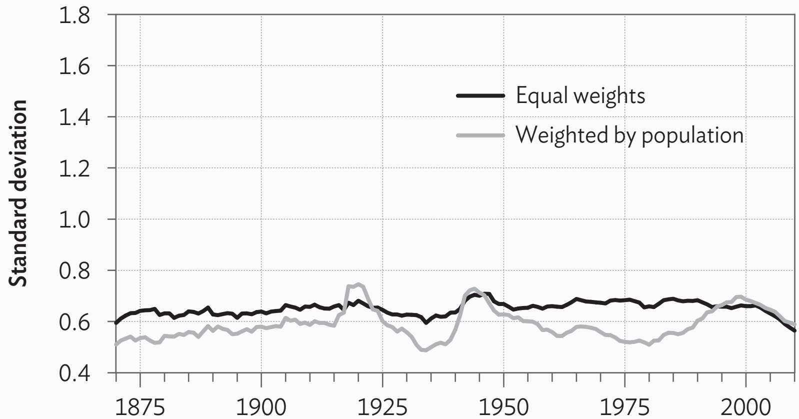
8 Similarly, in Barro and Sala-i-Martin (1991, Figure 4), the large dispersion of per capita personal income across the US states in 1880 reflects the differential impact of the Civil War on the South versus the North. However, across the US states, the long-run standard deviation for the log of per capita personal income was only around 0.2, much smaller than that across countries.

Figure 2.1: Cross-Country Dispersion of the Log of Real Per Capita GDP —25 countries, 1870–2010



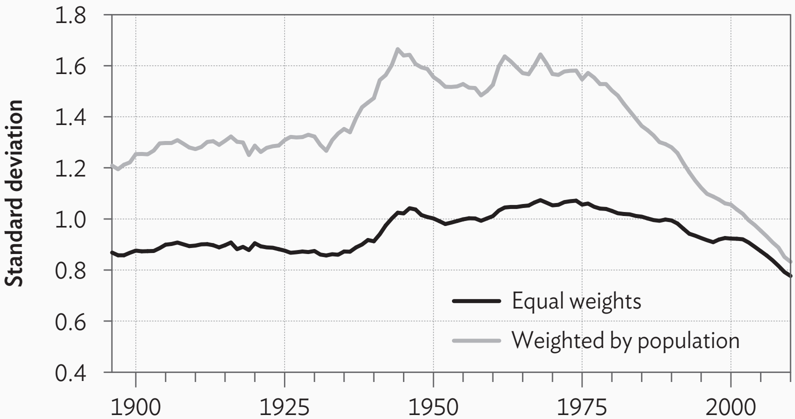
GDP = gross domestic product.

Note: The 25 countries included are Australia, Austria, Belgium, Brazil, Canada, Chile, Denmark, Finland, France, Germany, Iceland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, the Russian Federation, Spain, Sri Lanka, Sweden, Switzerland, the United Kingdom, the United States, and Uruguay. The graphs show the cross-sectional standard deviation of the log of real per capita GDP. The black series has equal weights; the gray series weights each country by population. The source of data (which also includes data on population) is given in the notes to Table 2.1, column 2.

The gray line (population weighted) tells a similar story, except that this measure of dispersion is more sensitive to the major crises in the Russian Federation (a relatively poor country with a large population) during the world wars and the 1990s. In 2010, the population-weighted standard deviation of 0.59 is close to the equally weighted value of 0.56.

Figure 2.2 extends to a larger sample by using the 34 countries with GDP data starting at least by 1896. This sample is less subject than the 25-country group used before to the sample-selection problem of tending to include countries that were rich toward the end of the sample. The note to the figure lists the countries. Most importantly, this extension adds the world's two largest countries by population—the PRC and India.

Figure 2.2: Cross-Country Dispersion of the Log of Real Per Capita GDP —34 countries, 1896–2010



GDP = gross domestic product.

Note: The 34 countries included are Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, the People's Republic of China, Denmark, Egypt, Finland, France, Germany, Iceland, India, Indonesia, Italy, Japan, Mexico, the Netherlands, New Zealand, Norway, Peru, Portugal, the Russian Federation, Spain, Sri Lanka, Sweden, Switzerland, Turkey, the United Kingdom, the United States, Uruguay, and Venezuela. The graph shows the cross-sectional standard deviation of the log of real per capita GDP. The black series has equal weights; the gray series weights each country by population. The source of data (which also includes data on population) is given in the notes to Table 2.1, column 2.

The dispersion measured by the black line (equally weighted) in Figure 2.2 is higher than that in Figure 2.1 because the expansion of the sample brings in several countries with per capita GDP well below the mean. Compared to Figure 2.1, the black graph in Figure 2.2 shows more substantial changes over time, with the standard deviation starting at 0.87 in 1896 and rising during the Great Depression and World War II to 1.04 in 1946. That is, the years from the early 1930s through the mid-1940s exhibit a "great divergence," which persists through the mid-1970s. From there on, the standard deviation falls from 1.07 in 1974 to 0.78 in 2010. The decline of dispersion in this last phase reflects particularly the strong growth in developing countries, including the

PRC, India, and Indonesia.[9] Possibly, in the long run, the standard deviation in this 34-country sample will fall toward the average value of 0.65 found in Figure 2.1 because the added developing countries seem to be joining the richer group selected in Figure 2.1 (by the criterion of having GDP data back to 1870).

The gray line (population weighted) in Figure 2.2 starts with higher dispersion than the black line (equally weighted) because the largest countries by population, the PRC and India, begin far below the world mean for per capita GDP. The trend in the population-weighted series is similar to that for the equally weighted series in exhibiting a great divergence from the early 1930s through the 1940s and persisting up to the mid-1970s. Thereafter, the dispersion falls sharply, going from 1.58 in 1974 to 0.83 in 2010. This recent trend, highlighted in terms of the world distribution of income by Sala-i-Martin (2006), reflects particularly the strong growth in the PRC since the late 1970s and in India since the mid-1980s.

2.5 Concluding Observations

The PRC's growth rate of real per capita GDP has been remarkably high since around 1990, well above the rates predicted from international experience in a conditional-convergence framework. Although country growth rates can deviate above or below their predicted values for some time, no country, including the PRC, can escape the "iron law of convergence" forever. Therefore, the PRC's per capita growth rate is likely to decline soon from around 8% per year to a range of 3%–4%.

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9 In this respect, the sample selection criterion in Figure 2.1 (25 countries having GDP data back to 1870) understates σ convergence since the mid-1970s compared to that in Figure 2.2 (34 countries having GDP data back to 1896). The long-term results in Baumol (1986, Figure 1) were the reverse—with the restriction of the sample to 16 countries with data from Maddison (1982) back to 1870 tending to overstate σ convergence. See DeLong (1988).

Economic growth at a 3%–4% per capita rate is sufficient when sustained over 2–3 decades to transition from low- to middle-income status (which the PRC has already accomplished) and then from middle- to high-income status (which the PRC is likely to achieve). Thus, although these realistic growth rates are well below recent experience, they would actually be a great accomplishment.

Perhaps the biggest challenge is that the likely prospects for the PRC's per capita growth rates are well below the values of 5%–6% per year implied by official forecasts.[10] Thus, the future may bring major political tensions in reconciling economic dreams with economic realities. Rather than sticking to unreasonably optimistic projections (or, even worse, yielding to a temptation to manipulate the national-accounts data), the PRC's leaders would be better off reducing the growth expectations held inside and outside the government.

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[10] According to Economist Intelligence Unit (2015), the PRC government's official forecast as of December 2015 implied by the most recent 5-year plan was for an average annual real GDP growth rate around 6% from 2016 to 2020.With population growth of about 0.5% per year, this projection corresponds to a per capita growth rate around 5.5% per year.

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CHAPTER 3

Will the People's Republic of China Be Able to Avoid the Japan Syndrome?

Yang Yao

3.1 Introduction

The People's Republic of China (PRC) had been experiencing record growth rates before the 2008 global financial crisis. While the crisis halted growth in most parts of the world, the PRC managed to keep growing at respectable rates with the help of a major stimulus package. Since 2010, however, the PRC's economy has been on a path of steady slowdown. Its performance in 2014 was particularly worrisome, leading many to assume that the PRC might follow Japan's path after the 1973 oil crisis. This path was characterized by two steep drops in the growth rate. One occurred immediately after the oil crisis when Japan's growth dropped from an average annual rate of 9.0% between 1951 and 1973 to 3.5% between 1974 and 1993.[1] The other one occurred after the real estate bubbles burst in 1993; Japan's economy has seen virtually no growth since then when measured in yen terms. In the meantime, Japan has embarked on a path of secular deflation. The first drop was clearly related to the adjustment to the world market after the oil crisis. While the causes of the second drop are still being debated, the slowdown of domestic demand caused by a fast-aging population and continuous appreciation of the yen are likely to have been the main reasons for it.

1 Based on the purchasing power parity figures provided by Penn World Table 8.0.

In the media, Japan's experience has been aptly dubbed the "Japan Syndrome."[2] The PRC has closely followed the export-led growth model Japan adopted before the oil crisis; the trade surpluses that resulted from adoption of this model forced the PRC yuan to appreciate. Worse than Japan, the PRC population has started to age and per capita income in the PRC is much lower than in Japan. It is a legitimate question, therefore, whether the global financial crisis, with some delay, would be the point when the PRC began to get caught up in the Japan Syndrome.

However, one key difference between the PRC and Japan may help the PRC do better than Japan—the PRC's size. The PRC is a much bigger country than Japan, in terms of both population and territory. There are tremendous geographical disparities in the PRC, and income is far less equally distributed than in Japan. The PRC's growth so far has been mostly generated by the coastal provinces; inland provinces have lagged far behind. This can be a problem itself for the country, but the forces of convergence also imply that inland provinces can have higher growth rates than coastal provinces. As a result, the growth rate for the whole country may be higher than what Japan was able to achieve between 1974 and 1993. The challenge for the PRC, though, is how to stimulate domestic demand to allow it to achieve its full growth potential.

This chapter will first describe the symptoms of the Japan Syndrome and provide an analysis of its causes. It will then compare the PRC to Japan and show that the possibility of the PRC getting caught up in the syndrome is real. Next it will present evidence for inland provinces' potentials to sustain relatively high growth rates in the medium term. Lastly, a quantitative study will be provided to further compare the PRC's and Japan's potential growth rates against the world's average growth experience between 1988 and 2014. This comparison will

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2 "The Japan Syndrome" was first used by Jon Woronoff in his 1986 book *The Japan Syndrome: Symptoms, Ailments and Remedies*. Woronoff argued that Japan's economic success was threatened by poor economic policies and planning, among other reasons, and was in danger of falling behind its competitors. This was different from the meaning that more recent authors have given to the phrase.

highlight how lack of demand has constrained Japan's growth and how that may happen in the PRC. The chapter concludes by summarizing the results and discussing the measures the PRC may take to stimulate domestic demand.

3.2 The Japan Syndrome

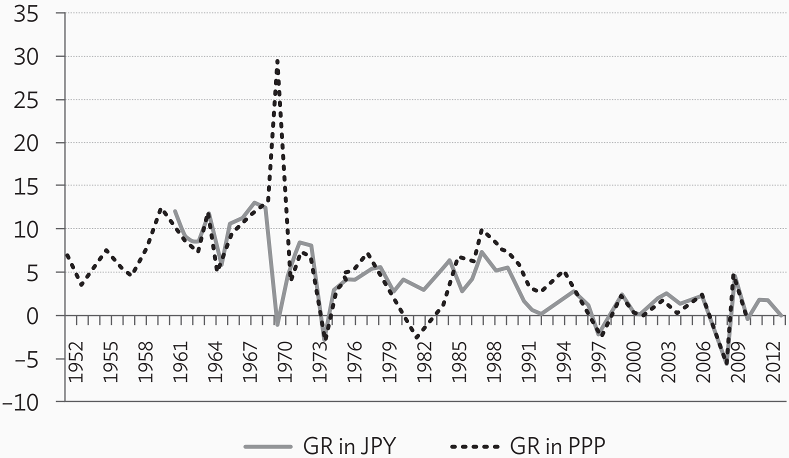
The Japan Syndrome is characterized by three symptoms: (i) the growth rate of gross domestic product (GDP) experiences cliff drops after a prolonged period of high growth; (ii) the economy enters a period of secular deflation after the economy stops growing; and (iii) a long period of bullish markets leads to asset bubbles that finally burst and are followed by a long period of declining asset prices. This section will first provide evidence of those symptoms and explanations by relating them to two major factors: (i) substantial adjustment to the world market; and (ii) a fast-aging population.

3.2.1 The Symptoms

Japan is the pioneer of the export-led growth model. In the aftermath of World War II when most catching-up countries adopted the standard recommendation of the day to institute import-substitution policies, Japan managed superfast growth in the 1950s and 1960s by promoting exports while maintaining a fixed exchange rate between the yen and the United States (US) dollar. The collapse of the Breton Woods system forced the yen to appreciate against the dollar in the early 1970s, but this did not stop Japan's growth. The average growth rate (in 2005 constant US dollar terms) of Japan's economy was 9.0% between 1951 and 1973. The real blow came after the 1973 oil crisis when Japan's economy experienced two cliff drops in its growth rate. Next, we rely on Figure 3.1 to proceed with our discussions. The figure presents three series of data for Japan's growth rates. "GR in JPY" are real growth rates calculated from GDP figures measured in constant Japanese yen, and "GR in purchasing power parity (PPP)" are real growth rates calculated from GDP figures measured in constant PPP dollars.

The series "GR in PPP" covers the period 1952–2011, and the other series covers the period 1961–2014.

Figure 3.1: Japan's Gross Domestic Product Growth Rates in Yen and Purchasing Power Parity (%)



GR = growth rate, PPP = purchasing power parity.

Sources: Figures measured in PPP are from Penn World Table 8.0; figures measured in Japanese yen and US dollar are from World Development Index.

The first cliff drop of Japan's growth rate occurred immediately after the oil crisis. The world market was severely hit by the crisis and demand for Japanese products declined. In most years of the 1950s and 1960s, Japan had trade deficits despite its reliance on exports. But this turned to surplus in 1969 and in 1972 its trade surplus was 52 billion dollars, or 1.67% of its GDP.[3] The oil crisis reversed this trend; in the 3 years from 1973–1975 Japan had deficits again. The deficit was particularly large in 1974 when it reached $65 billion and when the size of Japan's economy shrank by 1.2% in yen, 4.0% in PPP, and 8.1% in US dollars. Although Japan's exports recovered after 1975, growth was never restored to the level of the pre-crisis years; the oil crisis caused a permanent

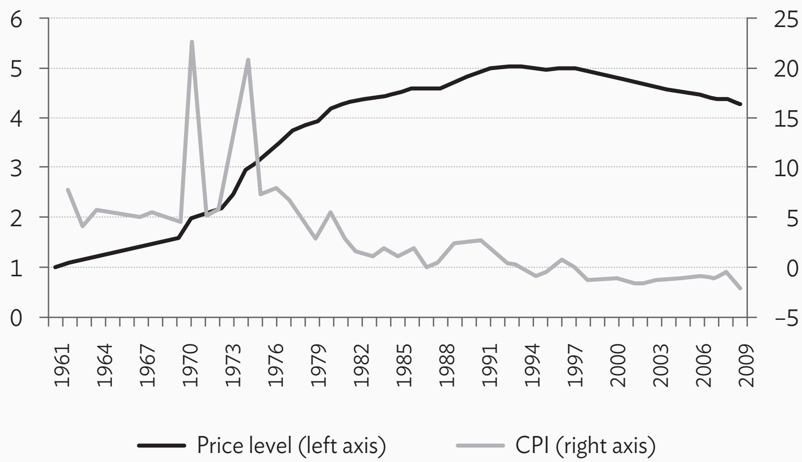
3 Data provided by World Development Index.

structural adjustment to Japan's pattern of growth. Between 1974 and 1993, Japan's average growth rate fell to 3.7% in yen and 3.5% in PPP. Those rates, of course, were better than those of most other countries in the world at the time. The US economy was in a period of painful adjustment; Europe was trying desperately to deal with the problems caused by the welfare state; and Latin America was in deep trouble caused by the sovereign debt crisis. The only group of countries/region that could beat Japan's growth were the East Asian Tigers and several other newly industrializing Asian countries. Japan became a world leader of innovation during this period when "Japan No. 1" was a catchphrase. Indeed, because of the continuous appreciation of the yen against the dollar and inflation in Japan, the Japanese economy grew by an annual average 12.9% between 1974 and 1993 when measured in dollar terms. As a result, Japan gained tremendous purchasing power in the world market during this period.

The second cliff drop occurred in 1993 when Japan's real estate bubble burst and domestic prices stopped rising. In the 21 years from 1994–2014, Japan's economy only managed to grow by a total of 18%, or an average 0.8% each year, when measured in yen. The figures based on PPP and current dollars are even worse—both are 0.7% each year. During this period, the yen continued to appreciate against the dollar, averaging 0.7% per year (2.2% if the period of Abenomics, 2012–2014, is not included). Therefore, the low average growth rate in current dollar terms was mainly caused by deflation in Japan.

In addition to the two cliff drops of the growth rate, the Japan Syndrome is also characterized by two phenomena that are related to consumer and asset prices. Figure 3.2 presents data for Japan's domestic consumer price level and its rate of change (CPI) between 1961 and 2010. In this period of half a century, three phases can be distinguished in terms of the development of Japan's consumer prices. The first was the 1960s and 1970s. In the 20 years from 1961–1980, the average CPI was 7.5%. Japan was a typical catching-up country in this period; the Balassa–Samuelson effect was clearly functioning to drive up Japan's domestic prices when its income gap with the US was quickly narrowed. The second phase was from 1981–1995 when Japan embarked on a path of secular slowdown. During this period, Japan's domestic price level managed to grow at an average of 1.7% per year. The last phase was from 1995 onward. Between 1995 and 2010, Japan experienced a period of deflation, as the domestic price level declined by 1.0% each year. During this period, 1997 was the only year when the CPI was positive.

Figure 3.2: Japan's Path from Inflation to Deflation

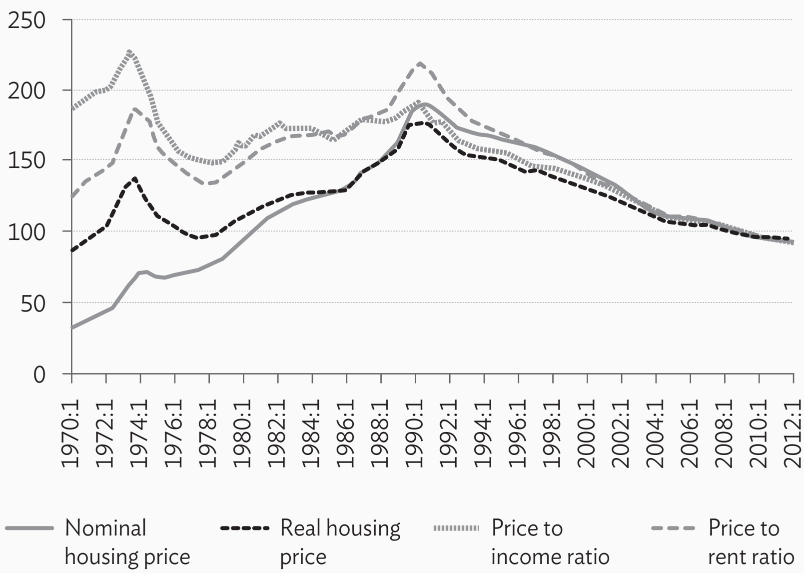


CPI = consumer price index.

Source: World Development Index.

Asset prices have seen similar movements. Figure 3.3 presents four series of quarterly data for Japan's housing market since 1970. They are, respectively, nominal housing prices, real housing prices (relative to consumer prices), price to income ratio, and price to rent ratio, all using 2010 as the benchmark. As the first series shows, nominal housing prices in Japan increased virtually without interruption in the 1970s and 1980s. The real price shot up in 1973, but then quickly dropped to converge to the path of nominal prices. The price to income ratio and price to rent ratio also shot up in 1973. Overall, they fluctuated at high levels in the 1970s and 1980s. All four series reached their peaks in the first quarter of 1991, and turned downward after that. It is remarkable that all four series declined at very similar rates and, after 2005, they virtually converged to the same rate. After the long period of secular decline, Japan's nominal housing prices have fallen back to their early 1980s level. Real housing prices have decreased further to their level of the early 1970s. As a result, housing has become much more affordable to ordinary Japanese families. From 1970–1990, the average price to income ratio was 177. By the end of 2013 it had declined to 91, which means that the purchasing power of an ordinary Japanese family in the housing market increased by 94.5%.

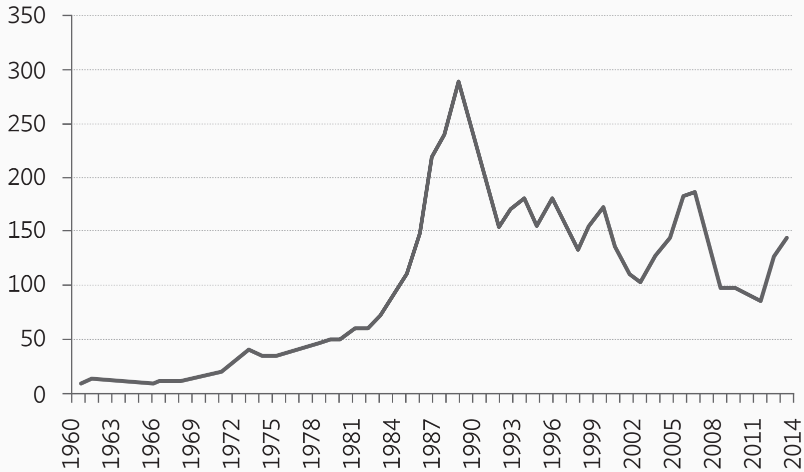
Figure 3.3: Prices of Japan's Housing Market (2010 = 100)



Source: OECD Statistics.

Figure 3.4 presents the price index of the Japanese stock market. The housing bubble at the end of the 1980s was accompanied by a huge bubble in the stock market. The only difference was that the stock market bubble burst 2 years earlier than the housing bubble.

Figure 3.4: Japan's Stock Price Index (2010 = 100)



Source: OECD Statistics.

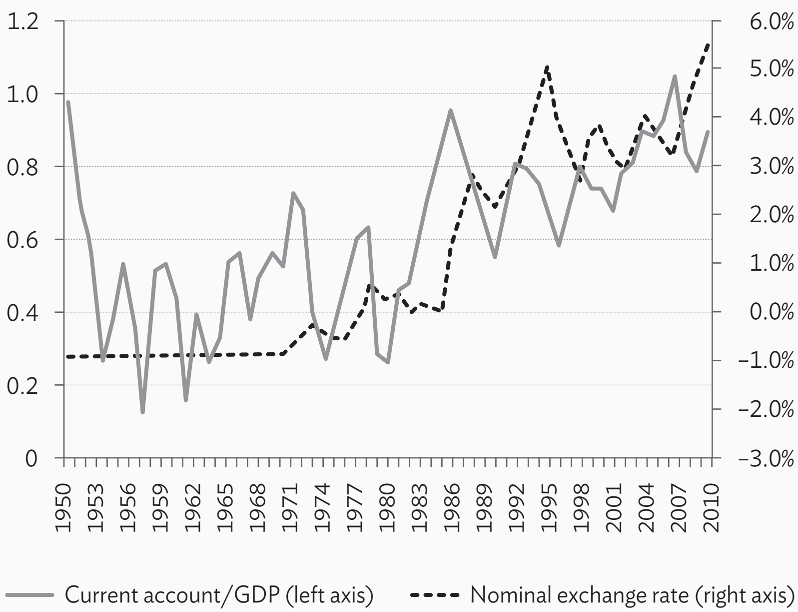
Stock prices reached their highest level in 1989 and dropped by 40% in the next 4 years. Except for the 2 years before the global financial crisis and the recent years of Abenomics, the Japanese stock market has been on a downward path.

3.2.2 Causes

The first cliff drop of Japan's growth rate was clearly related to the oil crisis that forced the world market to undergo a major adjustment. Japan's export-led growth could have lasted a bit longer had there not been the Crisis. But even in that case Japan's growth would have ultimately been brought down by its loss of competitiveness and rising wages. What the Crisis did was to accelerate the transition in a more dramatic manner.

The asset bubbles were the results of a combination of increasing current account surpluses, fast appreciation of the yen, and excessively easy monetary policy. Figure 3.5 presents two series of data—one for the nominal exchange rate and the other for the current account balance as a percentage of GDP. The exchange rate is the indirect quote against the US dollar (dollars for 100 yen). Before 1980, Japan's current account balance fluctuated around zero and after 1980 it was never negative. It saw two relatively long periods of one-sided growth—one between 1980 and 1986 and the other between 2001 and 2007. The first period triggered the Plaza Accord that called for Japan to substantially revalue the yen. Between 1985 and 1995, the yen appreciated by 154% against the dollar. Persistent and rising current account surpluses led to fast accumulation of wealth; fast appreciation of the yen then hugely increased the purchasing power of this wealth. While part of the wealth was spent on foreign goods and services, a large chunk of it was turned into demand for housing and stock shares in Japan's domestic markets and asset bubbles were a natural consequence.

Figure 3.5: Current Account Balance and Exchange Rate in Japan



Note: The exchange rate is dollars for 100 yen.

Source: World Development Index.

Many analysts blame Japan's central bank for creating and blowing up the asset bubbles. Japan's central bank may have mismanaged the interest rate policy—initially it set low interest rates attempting to offset the contracting effects of the yen's appreciation, and subsequently when asset bubbles were forming it raised the interest rate too fast. But the formation of the bubbles was unlikely to be avoided, as without them it would have been difficult for the country to digest the sudden and big increase of purchasing power. But bubbles burst eventually and the sudden interest rate hike probably just made this happen more quickly.

The second cliff drop of Japan's growth rate occurred after its asset bubbles burst. Between the two cliff drops, Japan still benefited from the forces of convergence. But the bursting of the asset bubbles triggered the end of convergence. After that, according to the neoclassical growth model, Japan should have embarked on a steady growth path, with a per capita GDP rate of growth equal to its rate of technological progress. Should Japan have had similar economic institutions and a demographic structure comparable to that of the US, Japan's economy could have grown at a similar rate. But this was clearly not the case and the gap in per capita income between the two countries has risen since 1993.

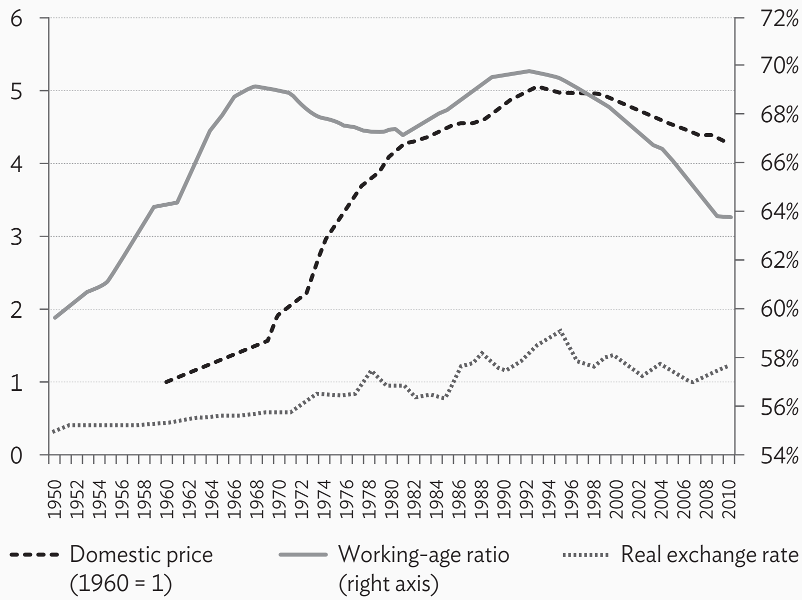
Japan's economic institutions are clearly less geared toward gaining high economic efficiency than those of the US. In particular, the Japanese labor market was much less flexible than the US labor market. Job remuneration is much more egalitarian in Japan than in the US, although labor market flexibility has increased markedly in recent years due to the increased share of part-time employment and dispatched workers. The Japanese economy is also much more regulated than the US economy and Japan does not have the kind of super-efficient financial market the US has. Those are the impediments that prevent Japan from becoming as innovative as the US.

What really distinguishes Japan from the US is its demography. While the US population is growing at a healthy rate, the Japanese population is shrinking and aging quickly. This may have been one of the main causes that have set the two countries apart in the last quarter century. One piece of evidence is the contrast between Japan's per capita GDP and per worker output. Japan's growth record after 2000 was one of the worst among the major industrial countries when measured by per capita GDP; however, it was one of the best when measured by per worker output (Weinstein 2013). This contrast shows that Japan's growth potential has been constrained by the declining size of its labor force.

On the demand side, aging probably is also a drag on the Japanese economy because it limits the growth of domestic demand. Figure 3.6 presents Japan's working-age ratio against its domestic price level and real exchange rate. Since 1980, Japan's domestic price level and real exchange rate have moved closely in line with its working-age ratio. The working-age ratio reached its highest point in the early 1990s and has since declined quite substantially. It is probably not a coincidence that both the domestic price level and the real exchange rate also began to decline at that time. The current old generation holds most of the wealth created in the 1970s and 1980s. They are now slowly selling off the assets they accumulated when they were young. Because of the size of this population, asset markets, particularly the housing market, are subject to downward pressures, which largely explains the secular decline of asset prices in Japan. Comparatively speaking, this generation of old people in Japan is wealthier than its counterparts in other industrial countries, but its consumption is limited. This asymmetry between wealth and consumption limits the growth of consumption in Japan, which puts downward pressures on the consumer goods market and, as a result, domestic prices decline.

In summary, aging may have constrained Japan's economic growth on both the supply and demand side, but it is unclear which side has constrained growth more. Further below in our quantitative study, we will show that Japan has underperformed against its growth potentials since 1993, indicating perhaps that the demand side has constrained growth more severely.

Figure 3.6: Impacts of Aging on Domestic Prices and the Real Exchange Rate in Japan



Note: The exchange rate is dollars for 100 yen.

Source: World Development Index.

3.3 A Comparison between the PRC and Japan

The PRC resembles Japan in several respects. First, the PRC has followed Japan's export-led growth model to develop its economy and has accumulated a large amount of wealth through this model. Second, as in Japan, the wealth created by the export-led growth model is held mostly by the generation that is the largest among the age cohorts. Third, the PRC's domestic consumer and asset prices have followed Japan's path before 1993 and so have the PRC's nominal and real exchange rates. So there are good reasons to worry that the PRC would also be affected by the Japan Syndrome. The PRC's case may even be worse than that of Japan because the PRC faces more serious challenges in its demographic transition. The PRC has begun its path of aging at a much lower income level than Japan; the age cohort that owns large parts of the wealth created by the export-led growth model accounts for a larger share of the population in the PRC than in Japan. This section will provide detailed information for the above comparisons and highlight the demographic challenges the PRC faces on its future growth path.

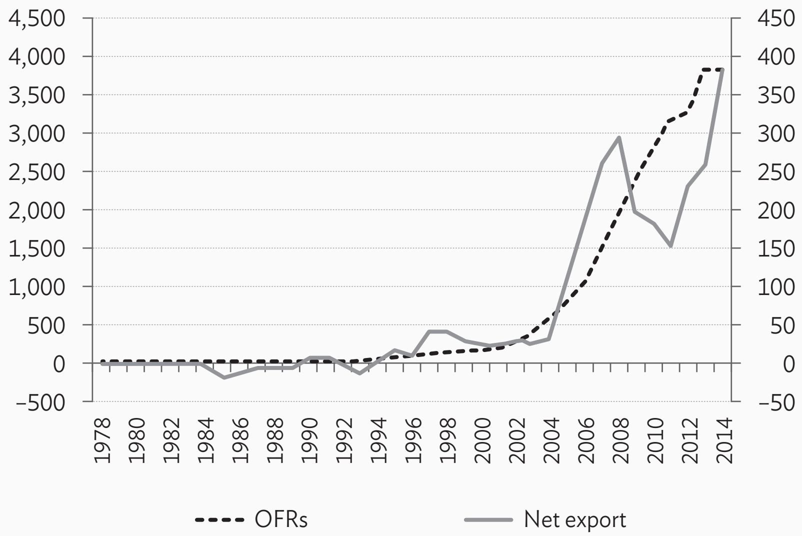
3.3.1 The PRC's Export-led Growth Model and its Impacts

The PRC began to adopt the export-led growth model in the early 1980s, but it was only after 2001, when it joined the World Trade Organization (WTO), that the PRC began to enjoy large benefits from this model. Exports grew at a respectable rate before 2001 (averaging 17% per year in the 1990s), but this was dwarfed by the growth between 2001 and 2008 when the PRC's exports grew five-fold and began to enjoy persistent and large trade surpluses (Figure 3.7). To maintain the fixed exchange rate, the PRC's central bank (People's Bank of China, PBoC) had to buy the foreign currencies brought into the country through trade surpluses and the PRC accumulated a huge amount of official foreign reserves as a result. Official foreign reserves reached their highest level in 2014, when they were $3.8 trillion, the equivalent of Germany's GDP.

Persistent trade surpluses inevitably result in an appreciation of the yuan. Before 1994 when the PRC unified its official and market exchange rates, the yuan depreciated against the dollar. Between 1994 and 2005, the yuan was pegged to the dollar. However, it had already begun to experience real appreciation before the PBoC began to allow the yuan to appreciate against the dollar (Figure 3.8).

Despite the PBoC's sterilization operations, money supply has kept growing, putting upward pressure on the PRC's domestic prices (Figure 3.9). There was a period of modest deflation after the Asian financial crisis. Since 2003, the domestic price level has continued to increase and by 2014 it was 50% higher than in 2003. It was comparable to Japan's rate in the period 1964–1974, when it was 58%.

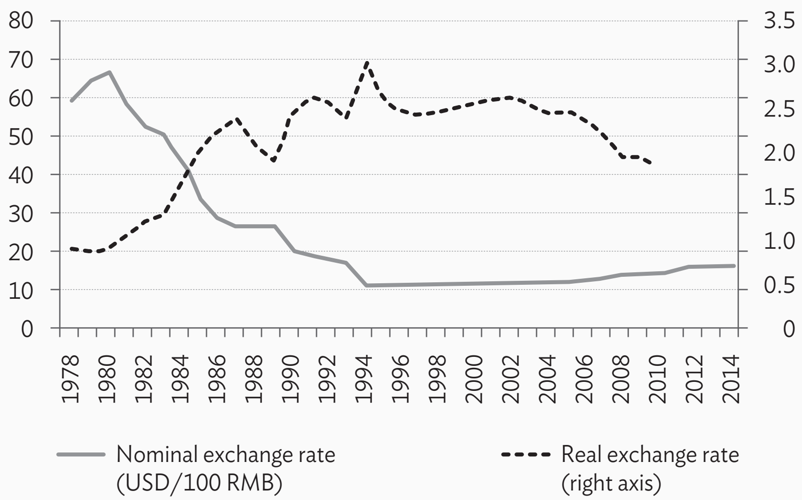
Figure 3.7: People's Republic of China's Trade Surpluses and Official Foreign Reserves



OFRs = official foreign reserves.

Sources: People's Bank of China, China Statistical Yearbook.

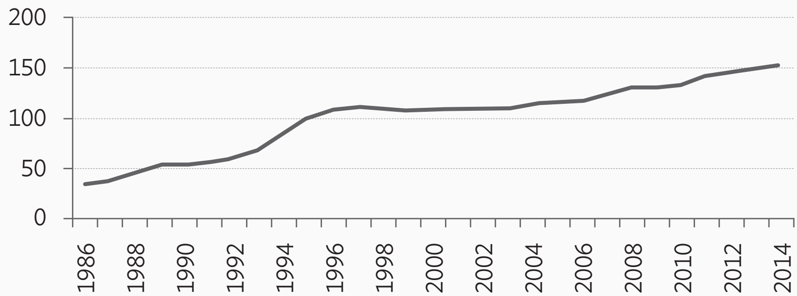
Figure 3.8: People's Republic of China's Nominal and Real Exchange Rates



Note: The real exchange rate equals the nominal exchange rate (indirect quote)/PPP.

Source: Penn World Table 7.1.

Figure 3.9: People's Republic of China's Domestic Price Levels (1995 = 100)

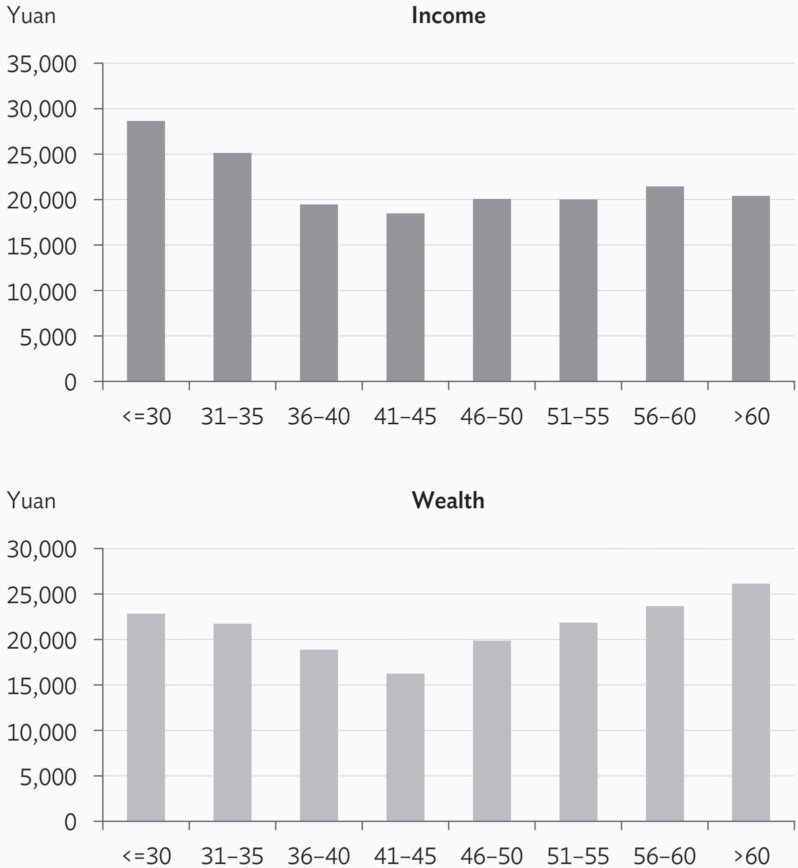


Source: China Statistical Yearbook.

3.3.2 The Age Profiles of Income and Wealth and Their Impacts

Until very recently, income and wealth distribution had been worsening, a deterioration that had started with the beginning of economic reform in the late 1970s. The top 10% of families account for 34% to 43% of total household income and about 60% of the total stock of household wealth (China Family Panel Studies [CFPS] 2013). Income and wealth are not evenly distributed across age cohorts either. Figure 3.10 presents the per capita annual income and the stock of wealth by age cohorts in urban PRC in 2012 using household data provided by the CFPS, a nationally representative and longitudinal survey carried out by Peking University. In the figure, families are divided into eight groups by the age of the household head: 30 and below, 31–35, 36–40, 40–45, 45–50, 50–55, 56–60, and above 60. It was a surprising finding that the age profiles of both income and wealth are U-shaped. In the case of per capita income, the youngest households whose heads were 30 years old or younger (born in or after 1982) were the richest, and the age cohort of 41–45 years old (born between 1967 and 1971) were the poorest. The latter cohort also had the smallest stock of wealth. Starting with this cohort, the stock of wealth increased monotonically when the household head was getting younger or getting older. However, the oldest cohort (born before 1952) had the highest stock of wealth.

Figure 3.10: Distributions of Income and Wealth by Age Cohorts (2012)



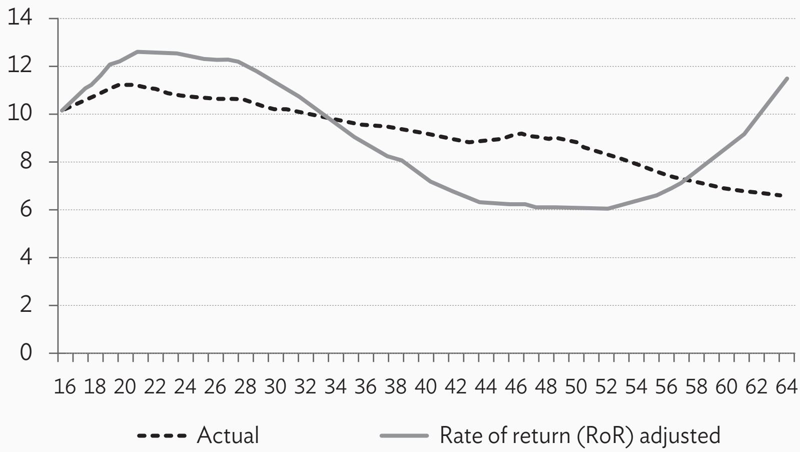
Source: CFPS (2012).

The age profile of income is likely to have been a result of the distribution of education and its rate of return in the population. Figure 3.11 presents the distribution of the actual years of schooling and the rate of return (RoR)-adjusted years of schooling in urban PRC based on data provided by CFPS 2010.[4] People younger than 30 years of age had advantages

[4] The RoR-adjusted years of schooling is the actual years of schooling weighted by each age cohort's rate of return to education.

over older people on both fronts: they were more educated and their education brought them higher returns. As a result, their RoR-adjusted years of schooling were higher than their actual years of schooling. This largely explains why they earned the highest income among all age cohorts. On the other hand, people between age 36 and age 58 had lower rates of return to education so their RoR-adjusted years of schooling were lower than their actual years of schooling.[5] However, older people in this group benefited from their greater experience and earned more than younger people in the same group.

Figure 3.11: Actual and Rate of Return-adjusted Years of Schooling (2010) by Age



Source: Yao and Cui (2015).

The age profile of wealth was a result of the combination of education and life accumulation. Young people accumulated wealth from their higher levels of income, and older people did it by saving more of their income and saving longer.

5 This group of people either was wholly educated or completed their primary education between 1960 and 1980 when the PRC was stranded by political and social turmoil. The quality of education was lower than in other periods of time.

It is noteworthy that the PRC's birth rates increased dramatically in the 15 years after the Great Famine of 1959–1961. The baby boomers born during this period (36–50 years by 2012), as the figures above show, are today the poorest among all age cohorts. This is clearly shown in Table 3.1, which compares the population share of each cohort with its share of income and wealth in 2012. The cohort of people younger than 30 accounted for 42.66% of the PRC's urban population, but owned 50.87% of total urban income and 44.39% of total urban wealth. Their dominance was evident. In contrast, the three cohorts between 36 and 50 years old were the underdogs. Their shares of population were substantially higher than their shares of income and wealth. The oldest cohort (older than 60), though, had a disproportionally higher share of wealth.

Table 3.1: Shares of Population, Income, and Wealth by Age Cohort

	Population	Income	Wealth
<=30	42.66	50.87	44.39
31–35	7.46	7.81	7.35
36–40	9.32	7.54	8.04
41–45	9.10	6.98	6.70
46–50	7.18	5.99	6.49
51–55	6.17	5.16	6.13
56–60	5.80	5.19	6.26
>60	12.30	10.46	14.64

Sources: CFPS (2012), Census 2010.

Judged by the facts presented above, the PRC's future problems will probably be different from those Japan faces at present. In Japan, the decline of housing prices probably has been caused to a greater extent by excessive supply released by the aging population. In the PRC, it would be caused to a greater extent by lack of demand if housing prices were to drop, because young people will already have accumulated a substantial stock of wealth. Demand for consumer goods will also fall in the PRC because of aging, and its decline is likely to be more severe than in Japan, for two reasons. First, the PRC is aging faster than Japan did between 1974 and 1993. The share of the PRC population over 65 years of age was 8.9% in 2010, equivalent to Japan's level in 1982, although the PRC's per-capita GDP in 2010 was equivalent to Japan's in 1968. Second, the PRC's future old generation, the baby boomers who are now between 40 and 55 years old, own disproportionally smaller stocks of wealth. This will constrain their consumption because they largely depend on their stocks of wealth to finance their consumption. Therefore, the PRC's aging problem is likely to place a more severe constraint on economic growth than Japan's.

In summary, because the PRC has followed Japan's export-led growth model and faces more severe aging problems than Japan, it is reasonable to conclude that the PRC will not be able to avoid the Japan Syndrome. There is a high probability that the PRC's growth in the medium term will be similar to Japan's growth pattern between 1973 and 1993 until the country reaches its steady state. However, it remains a question whether the PRC's growth rates will drop to the levels seen in Japan between 1973 and 1993. The next section will show that the PRC's large geographic size will help to raise the PRC's growth rates above Japan's.

3.4 The PRC's Advantages over Japan

The PRC is larger than the whole of Europe in terms of both population and territory. It is a diverse country comprising provinces/regions at different stages of development. This allows the PRC to benefit from the forces of convergence, enabling it to sustain a longer period of catching up. This section will present data to show that the PRC's large regional disparities may help the PRC maintain higher growth rates than Japan's average of 3.5% between 1973 and 1993.

Regional disparities are large in the PRC. While Shanghai, the most advanced provincial unit in the PRC, has reached an annual income of $15,000 per person, Guizhou, the poorest province in the PRC, has barely managed to reach one-seventh of Shanghai's level. This disparity is larger than Shanghai's gap with New York City. In themselves, regional disparities are a problem for the PRC; viewed in light of the neoclassical growth theory of convergence, they can also be sources of higher sustained growth for the PRC.

Figure 12 presents data for the PRC's regional disparities in terms of economic development. The country is divided into three regions: East, Central, and West.[6] Panel A presents the average per capita GDP of each region during 1997–2014. While the gap between the Central region and the West has been small, their gap with the East has been growing larger and larger. In 2014, the average per capita GDP in the East was 1.8 times the average per capita GDP in the Central region and the West. However, there are reasons to believe that this gap was smaller than the real number because inland provinces tend to exaggerate their growth rates. It is probably easier to get a more accurate picture by comparing the three regions' economic structures. By the standard results about structural change, the share of the primary sector declines, the share of services increases, and more people live in the city as income increases in a country/region. Panels B, C, and D of Figure 3.12 provide comparisons of three indicators among the three regions.

Panel B presents the primary sector's share of value added in regional GDP. It declined continuously in all three regions from 1997 to 2014. By 2014, in the East it was barely above 5%, but it was still above 10% in the other two regions, the equivalent of the figure for the East in 1997. That is, inland provinces lagged the coastal provinces by 17 years.

6 The East includes, from south to north, Guangdong, Fujian, Zhejiang, Shanghai, Jiangsu, Shangdong, Tianjin, Beijing, and Liaoning; the Central includes, from north to south, Helongjiang, Jilin, Shanxi, Hebei, Henan, Hubei, Anhui, Jiangxi, Hunan, and Hainan; the West includes the rest of the provinces/autonomous regions.

Figure 3.12: Regional Disparities in the People's Republic of China

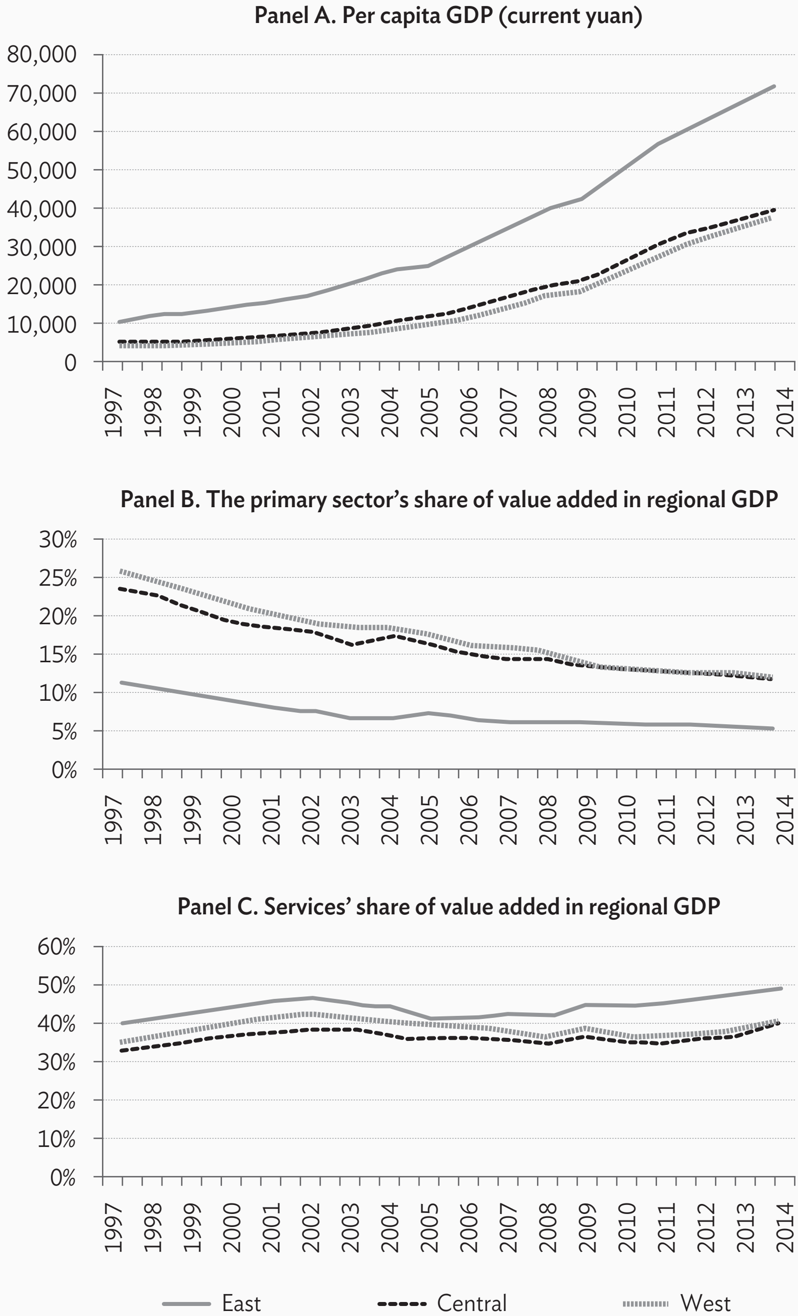


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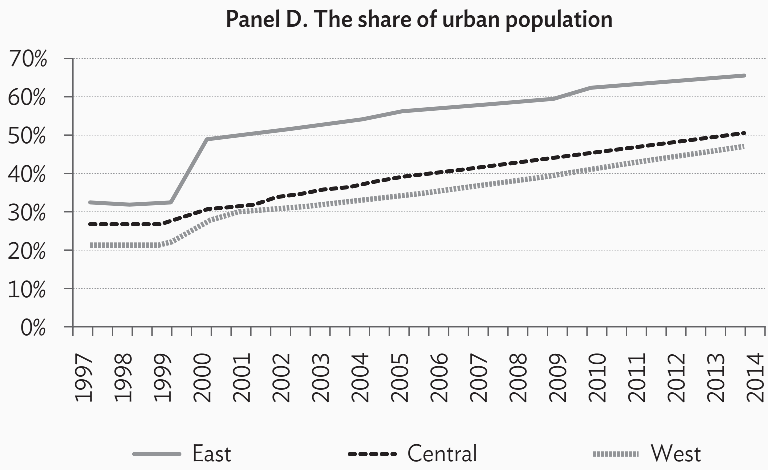
Figure 3.12: *Continued*



GDP = gross domestic product.

Source: China Statistical Yearbook.

This is confirmed by the service sector's share of value added in regional GDP, shown in Panel C. There were noticeable gaps between the East and the other two regions throughout the whole period, and they increased from 2005. By 2014, the share of service value added was already 50% in the East, but it only reached 40% in the other two regions, equivalent again to the level that the East had reached in 1997. Lastly, Panel D presents data for the share of urban population. The East has led the other two regions throughout the whole period. By 2014, 66% of people lived in cities in the East, while less than 50% of people did so in the other two regions. The level of urbanization in the Central region and the West only reached the level of the East at the end of the 1990s.

In summary, the inland provinces lagged the coastal provinces by 15 to 17 years in terms of economic structure. While growth in the coastal provinces may slow substantially, the forces of convergence will allow relatively high growth rates to be sustained in inland provinces. In the last 15 years, the coastal provinces have been able to grow at an annual rate of around 10%. Export growth may have contributed

2.4 percentage points.[7] Therefore, if inland provinces are able to follow coastal provinces' growth trajectory, they can be expected to grow at an average rate of 7.6% in the next 15 years even if exports do not play a major role in promoting growth. As a result, the potential growth rate of the PRC's overall GDP can be sustained at a relatively high level.

3.5 A Quantitative Study

This section provides a further comparison between the PRC and Japan using a framework of cross-country growth experience.[8] Specifically, a growth equation is estimated based on panel data of 103 countries in the period 1985–2014. The growth determinants include capital formation, labor supply, and indicators of technological progress. Based on the estimated growth equation, the growth potential of a country in a particular year can be estimated and compared with its actual growth rate. This comparison is useful for judging whether aging has constrained Japan's growth from the supply side or from the demand side. We can also see whether the PRC has performed better than its growth potential or underperformed. In addition, we can forecast the PRC's future growth rates based on several scenarios.

We start with the following standard growth equation in a panel framework:

$$\ln y_{it} = \alpha + \beta \ln y_{it-1} + (\ln X_{it})\Gamma + v_i + v_t + e_{it} \quad (1)$$

where y_{it} is the per capita GDP of country *i* in year *t*, X_{it} is a set of growth determinants, v_i is country *i*'s fixed effect, v_t is year *t*'s fixed effect, e_{it} is an i.i.d. error term, and α, β, and Γ are parameters to be estimated.

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7 More than 80% of the PRC's exports are from the nine coastal provinces. Between 2001 and 2014, the PRC's exports grew at an average annual rate of 18%. Exports' contribution to the PRC's GDP was between 11% and 15%. So the contribution of exports to GDP growth was between 2 percentage points and 2.8 percentage points. The figure used in the text is the average.

8 This section is based on Chen and Yao (2015).

In X_{it}, we include capital stock per capita, dependency ratio, infant mortality rate, college enrollment rate, and research productivity. The role of per capita capital stock is obvious. The dependency ratio is meant to capture a country's potential labor supply. The infant mortality rate is a measure of a country's level of medical services, and thus can serve as a proxy for health human capital. The last two variables, that is, the college enrollment rate and research productivity, are meant to capture a country's capability of technological progress (research productivity is measured by the number of papers published per researcher).

Taking the differences between two consecutive years, we can transform Equation (1) into a form of growth rates:

$$\hat{y}_{it} = \beta y_{it-1} + \widehat{X_{it}}\Gamma + \Delta v_t + \Delta e_{it} \qquad (2)$$

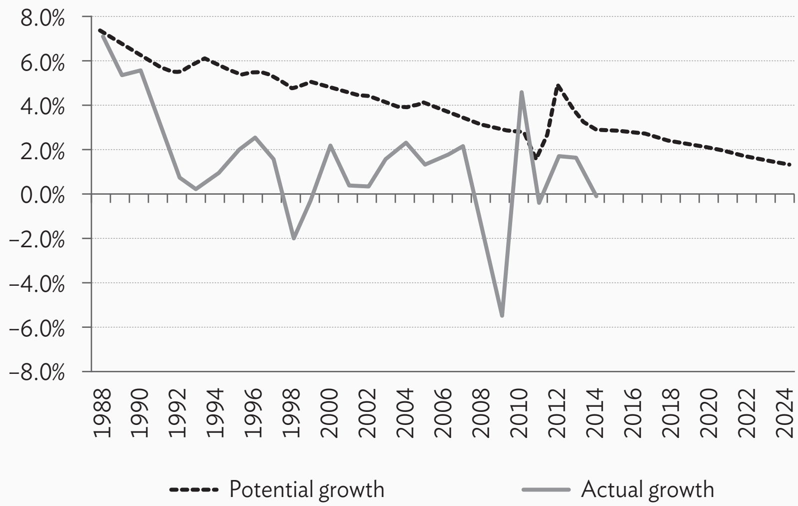
Then the potential growth rate of country *i* in year *t* can be estimated by its expected long-term growth rate:

$$\hat{y}^*_{it} = \widehat{X_{it}}\Gamma' + \overline{\Delta v_t{}'} \qquad (3)$$

where $\Gamma' = \Gamma / (1-\beta)$, and $\Delta v_t{}' = \Delta v_t / (1-\beta)$. Note that $\overline{\Delta v_t{}'}$ is the world average growth rate. It was 3.8% in the sample period. Thus defined, the potential growth rates of a country are obtained by assuming that the country grew similar to a hypothetical country that represents the world average growth experience.

Equation (1) is estimated by a standard fixed-effect model. The results can be found in the Appendix. Then, based on the results of the fullest model (3) in the Appendix, the potential growth rates of Japan and the PRC in the sample period and beyond are calculated using Equation (3). Figure 3.13 compares Japan's actual growth rates and its potential growth rates. Except for 1988 and 2010, Japan underperformed in relation to its potential growth rate by large margins between 1988 and 2014. Because the potential growth rate is estimated from the supply side, taking into account Japan's worsening demography and slower growth of capital formation in this period, those margins are likely to have been created by a lack of sufficient demand in the country, to which aging has greatly contributed.

Figure 3.13: Japan's Actual and Potential Growth Rates



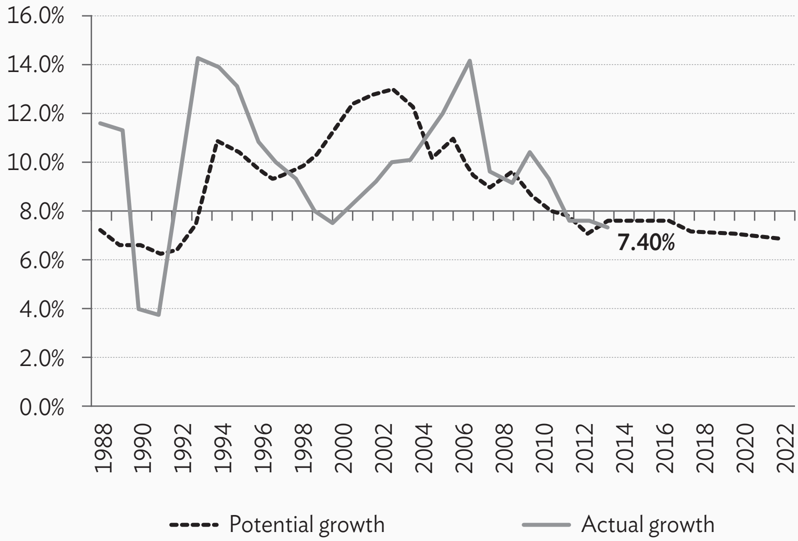
Notes: The world average growth rate of 3.8% in the sample period is used in the estimation of the potential growth rates. The potential growth rates beyond 2014 are obtained by assuming that the trends of variables in the sample period would continue.

Source: Author.

Figure 3.14 then presents the same comparison for the PRC. Except for 1990 and 1991 and in the period 1998–2003, the PRC achieved or performed above its potential growth rate. This pattern is consistent with the PRC's business cycles. The PRC was in recession in 1990 and 1991 as well as in the period 1998–2003.[9] In 1990 and 1991, domestic demand declined; in 1998–2003, international demand declined.

[9] The PRC's recession in 1990 and 1991 was caused by the 1989 Tian'anmen protests. Its recession between 1998 and 2003 was caused by the Asian financial crisis.

Figure 3.14: People's Republic of China's Actual and Potential Growth Rates



Notes: The world average growth rate of 3.8% in the sample period is used in the estimation of the potential growth rates. The potential growth rates beyond 2014 are obtained by assuming that the trends of variables in the sample period will continue.

Source: Author.

The boom between 1992 and 1997 was created by an acceleration of domestic investment; the boom between 2004 and 2008 was largely created by international demand. The PRC's actual growth outperformed its potentials in 2010 and 2011 mostly because the PRC conducted a large-scale stimulus plan. In more recent years, its actual growth converged with its potential rates.

Note that the world average growth rate is a big component of the potential growth rate. In the above two figures, the sample average of 3.8% is used. If the world average growth rate declines by 1 percentage point, then the potential growth rate declines by the same amount. The growth rate of capital stock is also an important determinant. Table 3.2 presents the forecast potential growth rates for the PRC in the period 2015–2024 under three scenarios of capital stock growth, assuming that world growth will be maintained at 3.8%.

Table 3.2: Forecast Growth Rates for the PRC (2015–2024) (%)

Growth of Capital Formation	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Average
Growth as before (8.7%)	7.5	7.6	7.6	7.2	7.2	7.1	7.0	7.0	6.9	6.8	7.2
Growth as in 2014 (7.5%)	7.4	7.5	7.4	7.0	7.0	6.9	6.8	6.8	6.7	6.6	7.0
Growth like Japan: 1974–1993 (5.4%)	7.1	7.1	7.1	6.7	6.6	6.6	6.5	6.5	6.4	6.5	6.7

Source: Author.

The first scenario assumes that capital stock will grow at the average rate of the period 1988–2014, which amounts to an average of 7.2% for the period 2015–2024. The second scenario assumes that capital stock will grow at the rate of 2014, resulting in a lower average growth rate of 7.0%. The third scenario assumes that capital stock will grow at the same rate as Japan in the period 1974–1993, which further lowers the average growth rate to 6.7%. Those forecasts, however, critically depend on the world average growth rate. For example, if the world average were to grow at the rate predicted by the International Monetary Fund for 2015, i.e., 3.1%, then average growth under the three scenarios would fall to 6.5%, 6.3%, and 6.0%, respectively.

Based on the discussion in the previous section, it is reasonable to believe that the PRC would maintain faster capital formation than Japan in the period 1993–2014. Therefore, even if world growth remained as low as predicted by the International Monetary Fund for 2015, the PRC's potential growth in the next 10 years would be between 6.0% and 6.5%. The challenge for the PRC is to maintain sufficient domestic demand against the headwind of unfavorable demographic changes.

3.6 Conclusion

The PRC's large size is likely to help the country to achieve higher potential growth rates than those achieved by Japan from 1974–1993. Our quantitative study has confirmed this conclusion. The major lesson the PRC can learn from Japan's growth experience is that stimulating domestic demand is key for the country to achieve its growth potential after it transits from an export-led growth model to a domestically oriented growth model. The export-led growth model has helped the PRC reach the goal of catching up fast, but the global financial crisis has forced the PRC to abandon this model. Now the country faces the problems that Japan has faced since the oil crisis. The PRC's challenge is probably bigger than that faced by Japan, mainly because the PRC's aging problem is more acute than that of Japan between 1974 and 1993. The PRC's population is not only aging faster than Japan's, but it is also aging at a lower level of per capita income. This means that the PRC's domestic demand can be weaker than Japan's. The PRC's real estate prices are already very high and the stock market has experienced several rounds of boom and bust in the last 15 years. The PRC's PPI has been below zero since early 2012 and its CPI has also been close to zero.[10] To avoid the secular deflation that Japan has experienced since 1993, the PRC has to find ways to stimulate domestic demand. In this regard, several measures will help.

First, accelerating the pace of urbanization will greatly increase domestic consumption. The PRC's pace of urbanization has clearly lagged its pace of industrialization. Even according to the official statistics, agriculture only employs a quarter of the country's labor force. The real number is likely to be smaller. However, 45% of people are still living in the countryside. The discrepancy has been created by the lack of resident status, or *hukou*, on the part of migrant workers.

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[10] It has probably already been negative if housing prices are included in the price basket. Most scholars believe that housing consumption is under-represented in the price basket.

Because they do not have *hukou* in the recipient city, they cannot bring their families with them. As a result, migrant workers do not live like urban dwellers. The average urban dweller consumes 2.57 times as much as the average rural dweller. If migrant workers can obtain local *hukou* and bring their families with them, their consumption will increase.

Second, postponing retirement ages will not only increase the supply of labor, but also increase consumption. At present, blue-collar female workers can retire at the age of 50, and blue-collar male workers and white-collar female workers can retire at the age of 55. This is much lower than any other country in the developed world. One of its consequences is that people begin to rely on their retirement salaries and accumulated wealth to sustain their living at an early age, which inevitably reduces the growth of consumption.

Third, there is still much room for the PRC to improve its infrastructure, particularly in inland provinces. Cities need more roads, subways, public utility facilities, and green spaces; villages need to be either consolidated so modern amenities can be introduced or receive more investment to improve people's quality of life. Currently, there is a tendency to reject further investment on the basis that the rate of return to capital is declining. But this decline is probably one of the consequences of recession, not a consequence of a structural shift toward low rates of return to capital. In fact, the PRC government needs to encourage more investment to fight recession.

Fourth, reforms to lift to service sector entry barriers will also boost domestic consumption. The service sector has already overtaken over the manufacturing sector to become the largest contributor to the PRC's growth. But job certificates, licensing, and administrative approvals hinder the development of a more vibrant service sector.

In summary, to realize its growth potential, the PRC must take bold measures to offset the strong headwind of demographic change. In this regard, the PRC government's reform agenda is on the right track.

Accelerating the pace of urbanization and removing service sector entry barriers are among Premier Li Keqiang's top priorities. The central government has geared up its fiscal policy to stimulate investment in the country and increasing the retirement ages is on the government's working agenda.

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APPENDIX

Estimation Results

Variables	(1) $ln(y_t)$	(2) $ln(y_t)$	(3) $ln(y_t)$
$ln(y_{t-1})$	0.887***	0.891***	0.873***
	(0.00840)	(0.00943)	(0.0125)
$ln(\text{Capital Stock per capita})_t$	0.00701	0.00263	0.0198*
	(0.00795)	(0.00896)	(0.0114)
$ln(\text{Dependency ratio})_t$	–0.0965***	–0.104***	–0.0784***
	(0.0123)	(0.0134)	(0.0159)
$ln(\text{Infant Mortality rate})_t$	–0.0454***	–0.0274***	–0.0227**
	(0.00599)	(0.00711)	(0.00912)
$ln(\text{College Enrollment rate})_t$		0.00715	0.0151***
		(0.00462)	(0.00581)
$ln(\text{Research Productivity})_t$			0.00321
			(0.00299)
Constant	1.441***	1.279***	1.142***
	(0.0911)	(0.0917)	(0.110)
Observations	2,617	1,948	1,310
Number of Countries	106	105	102

ln = natural logarithm.

Source: Author.

CHAPTER 4

The People's Republic of China's Slowdown: Lessons from Japan's Experience and the Expected Impact on Japan's Economy

Kyoji Fukao and Tangjun Yuan

4.1 Introduction

The recent slowdown of economic growth in the People's Republic of China (PRC) has attracted worldwide attention. In this chapter, we examine what lessons can be derived for the PRC from Japan's high-speed growth era and examine the economic impact of the PRC's slowdown on the economies of Japan and other major developed countries.

The PRC's economic growth has been characterized not only by its speed and the fact that it has lasted for a long period, but also by extremely rapid capital accumulation and low total factor productivity (TFP) growth in most sectors, such as heavy and chemical industries and services (Wu 2015). Moreover, because of the one-child policy, the PRC's demographic transition has proceeded much more quickly than in other developing economies and the growth of the PRC's working age population has been slowing down in recent years. From a theoretical perspective, rapid capital accumulation coupled with slow TFP and labor input growth will result in a decline in the rate of return on capital through the diminishing marginal product of capital. If a country continues with rapid capital accumulation with very low rates of return on capital, then sooner or later it will experience a deterioration in firms' balance sheets and mounting bad loans in the banking sector. The recent decline in investment and slowdown of economic growth in the PRC can probably be regarded as a consequence of the diminishing marginal product of capital.

The PRC's experience is not unique and, in fact, shares some important parallels with Japan's high-speed growth era and its aftermath. Just like the PRC, Japan, in the period from 1955 to 1970, achieved sustained unprecedented rates of growth based on rapid capital accumulation, but subsequently suffered from the diminishing marginal product of capital. This means that Japan's experience potentially holds important lessons for the PRC.

To accomplish satisfactory economic growth over the next decades, the main driver of economic growth in the PRC needs to switch from capital accumulation to TFP growth. To achieve an acceleration of TFP growth, the PRC will need to reform its state-owned firms, which dominate industries such as the heavy and chemical industries and public services, and liberalize its financial markets, service industries, etc. The PRC also needs to increase its domestic consumption and reduce its high gross saving–GDP ratio and gross investment–GDP ratio.[1] Would the success of this huge economic transformation of the PRC be good news for Japan? We do not know the exact answer yet. As Wolf (2015) has recently pointed out, exports to the PRC from some developed economies such as Japan, Germany, and the Republic of Korea mainly consist of investment goods and advanced materials, as well as parts and components that are used as inputs in the production of investment goods. For such economies, the PRC's transformation might have a large negative impact. The main goal of this chapter is to examine this issue in detail.

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1 If the PRC were able to raise its current account surplus—GDP ratio substantially, the PRC would be able to reduce its gross investment—GDP ratio without reducing its gross saving–GDP ratio. However, since the world economy is suffering from a shortage of final demand and the PRC's economy by now accounts for a sizeable share of the global economy, this is an unrealistic scenario.

In this age of global value chains, to correctly assess the impact of the PRC's transformation, it is necessary to take account not only of the direct effects—a decline of exports to the PRC—but also of indirect effects such as a decline of exports to other countries caused by the decline of exports from these other countries to the PRC. To take these indirect effects into account, we use the World Input–Output Database (WIOD).[2]

In addition to the high gross saving–GDP (and high gross investment–GDP) ratio, another characteristic of the PRC's recent economic development is the very low and declining labor income share. Moreover, these characteristics are closely related. On the one hand, since most of the capital income is earned by richer households, a higher capital income share makes the income distribution more unequal, and since poorer households cannot save much, a higher capital income share raises the gross saving–GDP ratio. On the other hand, since capital goods are more capital intensive than consumption goods, a decline in the gross saving–GDP ratio (and gross investment–GDP ratio) would increase the labor income share and therefore could mitigate the PRC's income inequality problem. The WIOD contains data on the labor income share in each sector in each country, so that we can examine this second relationship (whether a decline in the gross investment–GDP ratio would increase the labor income share). Since the income distribution problem is such an important issue for the PRC economy, we will examine this as well.

The structure of the chapter is as follows. In Section 4.2, we present an overview of the problem of the PRC's high gross investment–GDP (and high gross saving–GDP) ratio and the sources of economic growth.

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2 The WIOD was developed in a joint project of Groningen University and other European universities with financial support from the European Commission. The WIOD covers 35 industries in each of the 41 countries (including the rest of the world) for 1995 to 2011. The WIOD consists of 35 times 41 input–output tables, the final demand of each category (consumption, gross investment, and government expenditure) of each country for the output of the 35 industries of each of the 41 countries, and gross value added and its composition (labor income, gross current surplus, and indirect tax and subsidies). For more details about the database, see Timmer et al. (2015).

We also compare the PRC's present situation with Japan's experience during the high-speed growth era and the aftermath. Next, in Section 4.3, we estimate the economic impact of the PRC's slowdown and hypothetical economic transformation on Japan, the United States (US), and Germany, using the WIOD. In Section 4.4, we then examine the relationship between the labor income share and the gross investment–GDP ratio in the PRC. Finally, Section 4.5 summarizes our results.

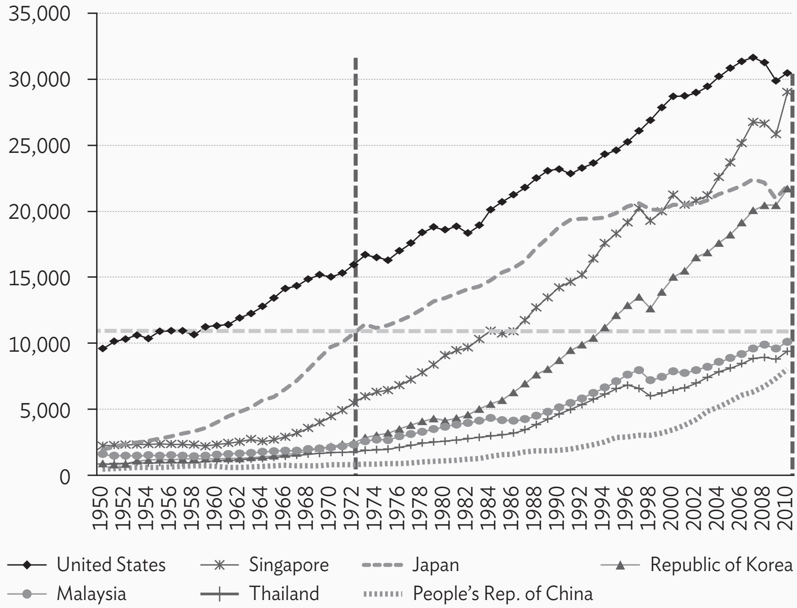
4.2 The PRC's High-speed Growth and Lessons from Japan's Experience

In this section, we present an overview of the problem of the PRC's high gross investment–GDP (and high gross saving–GDP) ratio and the sources of economic growth. We also attempt to derive some lessons for the PRC from Japan's past experience by comparing the PRC's present situation with Japan's high-speed growth era and the period that followed.

Figure 4.1 shows the purchasing power parity (PPP)-based per capita GDP (in 1990 international Geary–Khamis US dollars, GK$) of various East Asian economies and the US. Unfortunately, data used for the construction of the figure are available only until 2010, but extrapolating the path of the PRC's PPP-based per capita GDP, the level in 2015 likely is more than 30% higher than in 2010. This means that it probably is somewhere in the region of the level indicated by the dotted horizontal line, which represents Japan's PPP-based per capita GDP in 1972. In other words, in terms of PPP-based per capita GDP, the PRC's present development level is comparable with that of Japan in the early 1970s.

Figure 4.1 also shows that Japan's per capita GDP growth slowed down substantially after 1970, which marked the end of Japan's high-speed growth era. To examine why Japan's per capita GDP growth slowed down after 1970, Table 4.1 presents a breakdown of the sources of growth of Japan's economy. Specifically, the top part shows the growth

Figure 4.1: PPP-based GDP per Capita: Major East Asian Countries and the United States (1990 int. GK$)



GDP = gross domestic product, GK$ = Geary–Khamis US dollars, int. = international, PPP = purchasing power parity.

Source: Groningen University, Maddison Project Database.

rate of Japan's GDP and factor inputs, while the middle part shows the supply-side sources of GDP growth based on a growth accounting analysis.[3] The contribution of each term is derived by multiplying the input growth of a factor with the cost share of that factor (for example,

3 In Table 4.1, TFP growth for the period before 1970 is based on the macro-level data of Broadberry, Fukao, and Zammit (2015). On the other hand, TFP growth after 1970 is derived as the Domar-weighted sum of industry-level TFP growth based on the JIP Database 2015. When a factor of production moves from a sector where the price of that factor is low to a sector where the price of that factor is high, GDP will usually increase. In the case of the approach using Domar weights, a GDP increase caused by such resource reallocation is regarded as the contribution of factor quality improvements. On the other hand, in the case of the analysis based on macro-level data, such a GDP increase is regarded as a result of TFP growth. Therefore, if such resource reallocation was common in Japan, there is a risk that we overestimate the decline in TFP growth from the 1960s to the 1970s. For more details on this issue, see Wu (2015).

Table 4.1: Decomposition of Japan's GDP Growth (annual rate, %)

		1955–1970	1970–1990	1990–2012
Real GDP growth	c+d+e	8.4	4.4	0.9
Growth rate of labor input	a	2.0	1.6	0.0
Growth rate of capital service input	b	11.0	6.2	1.9
Contribution of labor input growth	c	1.3	1.1	0.0
Contribution of man-hours growth		1.0	0.4	–0.5
Contribution of labor quality improvement		0.3	0.7	0.5
Contribution of capital service input growth	d	4.3	1.9	0.7
TFP growth	e	2.8	1.4	0.2
Growth rate of labor efficiency (Harrod-neutral technical progress)	f	4.6	2.1	0.4
Rate of natural growth	a+f	6.6	3.7	0.3

GDP = gross domestic product, TFP = total factor productivity.

Sources: Data for the period after 1970 are taken from the JIP Database 2015. Data for the period up to 1970 are taken from Broadberry, Fukao, and Zammit (2015).

the cost share of labor is about 60%). Since Japan's growth trend further decelerated around 1990, we divide the post-war period into three sub-periods: 1955–1970, 1970–1990, and 1990–2012. The table shows that the contribution of all three sources of economic growth—that is, increases in labor and capital input as well as TFP growth—declined after 1970. Specifically, the middle part of the panel shows that the deceleration in capital service input growth (row D) made the largest contribution to the slowdown in GDP growth overall, accounting for 2.4 percentage points. This is followed by the contribution of the deceleration in TFP growth, which accounted for 1.4 percentage points. Finally, the slowdown in labor input growth had only a relatively small effect, accounting for 0.2 percentage points of the decline in GDP growth.

The reason that the slowdown in labor input growth had a comparatively small impact is that the slowdown in man-hour input growth, which was caused by the ending of baby boomers' inflow into the labor market, was partly canceled out by the acceleration in labor quality growth reflecting the spread of higher education and the accumulation of skills among the employed.

Meanwhile, the slowdown in TFP growth after 1970 reflects certain areas Japan having managed to catch up with advanced economies. For example, in the production of important exports such as TV sets and audio equipment, Japan's TFP level had almost reached the level of the US by the early 1970s (Jorgenson, Kuroda, and Nishimizu 1987; Jorgenson, Nomura, and Samuels 2015). At the same time, Japan faced increasingly serious trade friction with other developed economies, and firms from the US and Europe became more cautious in providing technology to Japanese firms through licensing. As a result, in areas where Japan was still lagging behind, it became more difficult for firms to continue catching up through licensing, reverse engineering, etc.

As for the slowdown in capital accumulation, a number of reasons can be identified. First, if, as in the standard neoclassical growth model (Solow 1956) with Harrod-neutral (labor augmenting) technical progress, the economy is on a balanced growth path, the growth rate of capital service inputs will be equal to the natural rate of growth, which is the sum of the growth rate of labor input plus the growth rate of the efficiency of labor due to Harrod-neutral technical progress. When technical progress is Harrod-neutral, the growth rate of the efficiency of labor is equal to the growth rate of TFP multiplied by the inverse of the cost share of labor. Comparing the 1955–1970 and 1970–1990 periods, the growth rate of labor input declined by 0.4 percentage points (row A in Table 4.1) and the growth rate of the efficiency of labor declined by 2.5 percentage points (row F). Therefore, the natural rate of growth declined by 2.9 percentage points. On the other hand, the growth rate of capital service input declined by 4.8 percentage points between the two periods. Therefore, about 60% (2.9/4.8 = 0.60) of the total slowdown of capital service input growth can be explained by the decline of the natural rate of growth.

Second, if the economy is in a convergence process to the above-mentioned balanced growth path from an initial point with small capital stock, the growth rate of capital will stay higher than the natural rate of growth until the economy reaches the neighborhood of the balanced path. During this process, as the capital–GDP ratio increases, the rate of return on capital declines through the diminishing marginal product of capital, and the growth rate of capital service inputs will gradually slow down. As Table 4.1 shows, the natural rate of growth in the three periods, 1955–1970, 1970–1990, and 1990–2012, was 6.6%, 3.7%, and 0.3%, respectively. On the other hand, the (annual average) capital service input growth rate was 11.0%, 6.2%, and 1.9%. Therefore, Japan seems to have been in a convergence process until around 1990 and we can probably explain part of the decline in capital service input growth by this convergence mechanism with a diminishing marginal product of capital.

Third, if energy input and capital service input are close complements, the jump in energy prices as a result of the first oil shock in 1973 may have reduced the rate of return on capital and hence the rate of capital accumulation. After the first oil shock, the international competitiveness of most of Japan's heavy and chemical industries, which heavily relied on both energy and capital services as inputs, deteriorated and their output share in the economy declined.

In both the second (convergence process) and third explanation (first oil shock), the decline in the rate of return on capital plays a key role. Figure 4.2 shows how the gross rate of return on capital and the ratio of capital services to GDP (the capital coefficient) have changed over time in Japan. As can be seen, the gross rate of return on capital dropped in the early 1970s and never returned to the level of the high-speed growth era. This fact is consistent with our two explanations.[4]

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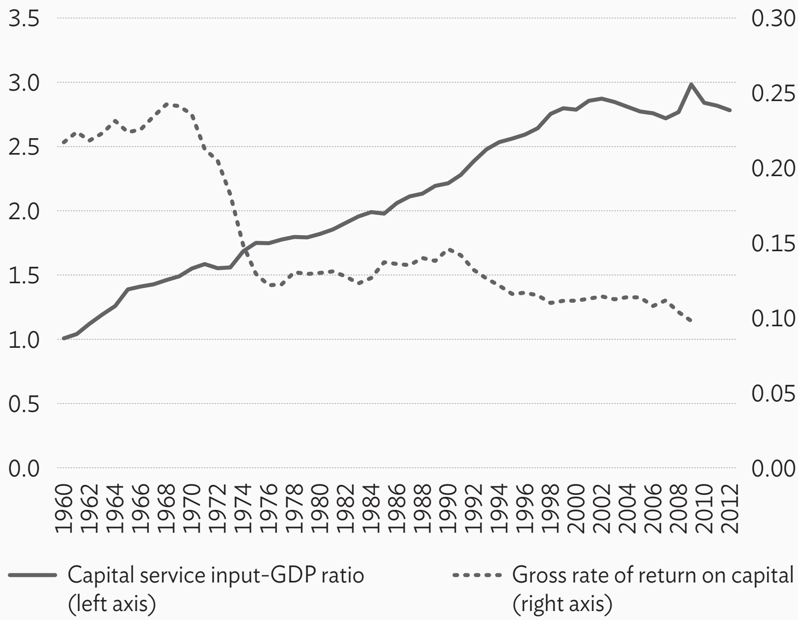
[4] However, we should point out that before 1970 there was no declining trend in the gross rate of return on capital. In other words, the engine of Japan's high-speed growth era did not fade away slowly as the convergence mechanism predicts, but stopped abruptly as a result of several severe external shocks such as the large appreciation of the yen triggered by the Nixon shock (1971) and the first oil shock.

Figure 4.2: Capital Coefficient and Gross Rate of Return on Capital in Japan



GDP = gross domestic product.

Notes: The capital service input–GDP ratio is calculated as (real capital stock [in 2000 prices]) × (capital quality index [2000 = 1])/(real GDP [in 2000 prices]).

Sources: EU KLEMS ISIC Rev. 4 Rolling Updates; JIP Database 2015; and Broadberry, Fukao, and Zammit (2015).

Next, let us compare the PRC's present situation with Japan's high-speed growth era. Table 4.2 shows the results of a decomposition analysis of the PRC's GDP growth. The top half of the table is based on Wu (2015). Since Wu decomposed labor productivity growth, not GDP growth, we cannot directly compare Wu's results with our results on Japan (Table 4.1). Therefore, to compare the PRC and Japan, we estimated the bottom half of Table 4.2 from the information in the top half assuming that both the labor and the capital cost share in the PRC have been 50% for the whole period. We will discuss cost shares in the PRC in more detail in Section 4.4.

Table 4.2: Decomposition of the PRC's GDP Growth (annual rate, %)

	1980–1991	1991–2001	2001–2007	2007–2010	1980–2010
A					
			Growth rate		
Real GDP growth	7.7	9.2	11.2	10.3	9.2
Growth rate of value added per hour worked	4.9	7.4	9.7	9.5	7.1
Growth rate of hours worked	2.8	1.8	1.6	0.8	2.0
			Contribution		
Growth rate of value added per hour worked	4.9	7.4	9.7	9.5	7.1
Contribution of capital deepening	3.5	5.2	7.6	10.1	5.6
Contribution of labor quality improvement	0.1	0.4	0.5	1.2	0.4
TFP growth	1.4	1.8	1.6	–1.8	1.2
B					
Real GDP growth	7.7	9.2	11.2	10.3	9.2
Growth rate of labor input	2.9	2.1	2.1	2.0	2.4
Growth rate of capital service input	9.8	12.6	17.3	22.2	13.5
Contribution of labor input growth	1.4	1.1	1.0	1.0	1.2
Contribution of man-hours growth	1.4	0.9	0.8	0.4	1.0
Contribution of labor quality growth	0.0	0.2	0.2	0.6	0.2
Contribution of capital service input growth	4.9	6.3	8.6	11.1	6.7
TFP growth	1.4	1.8	1.6	–1.8	1.2
Growth rate of labor efficiency (Harrod-neutral technical progress)	2.8	3.6	3.1	–3.6	2.5
Rate of natural growth	5.7	5.7	5.2	–1.6	4.9

PRC = People's Republic of China, GDP = gross domestic product, TFP = total factor productivity.

Sources: Panel A is from Table 7 of Wu (2015), while panel B was calculated by the authors.

Before comparing the two countries' growth patterns, we should stress that the PRC's rapid economic growth started from a very low income level. The PRC's per capita GDP in 1980 was GK$1,061, which is equivalent to only 38% of Japan's per capita GDP in 1955 (GK$2,771). Further, the PRC's rapid growth went on for a much longer period (3 decades) than Japan's high-speed growth era (about 15–20 years). As already seen above, through this prolonged high-speed growth, the PRC's per capita GDP in 2015 reached a level on par with Japan's in the early 1970s.

When we compare the PRC's era of prolonged high-speed growth (1980–2010) with Japan's high- speed growth era (1955–1970), several additional differences become apparent. First, the PRC's growth rate of capital inputs (13.5%) was substantially higher than that of Japan (11.0%). Second, the PRC's TFP growth rate (1.2%) was much lower than that of Japan (2.8%). And third, the PRC's growth rate of labor inputs (2.4%) was slightly higher than that of Japan (2.0%).[5]

Because of the slower TFP growth, the PRC's natural rate of growth (4.9%) was much lower than that of Japan during the high-speed growth era (6.6%). However, quicker capital accumulation made the PRC's actual GDP growth rate (9.2%) higher than Japan's (8.4%). These differences mean that the PRC's capital coefficient (capital service input–GDP ratio) grew much quicker than Japan's. Specifically, the PRC's capital coefficient increased 103% during the 16 years from 1991 to 2007; on the other hand, Japan's capital coefficient increased by only 48% during the 15 years from 1955 to 1970.

As already explained, when the capital coefficient increases, the rate of return on capital declines through the diminishing marginal product of capital, and the growth rate of capital service inputs will gradually decline. This mechanism might lead to the end of the PRC's high-speed growth, which has been driven by extremely rapid capital accumulation. In fact, as shown in Figure 4.3, since about 2010 the rate of return on capital has started to decline substantially in all manufacturing subsectors.

Another factor that will further hamper the PRC's capital accumulation in the near future is demographic developments. As already mentioned, probably as a result of the one-child policy, the annual growth rate of the PRC's working age population has been declining rapidly and is now approaching zero. According to the United Nations' median projection,

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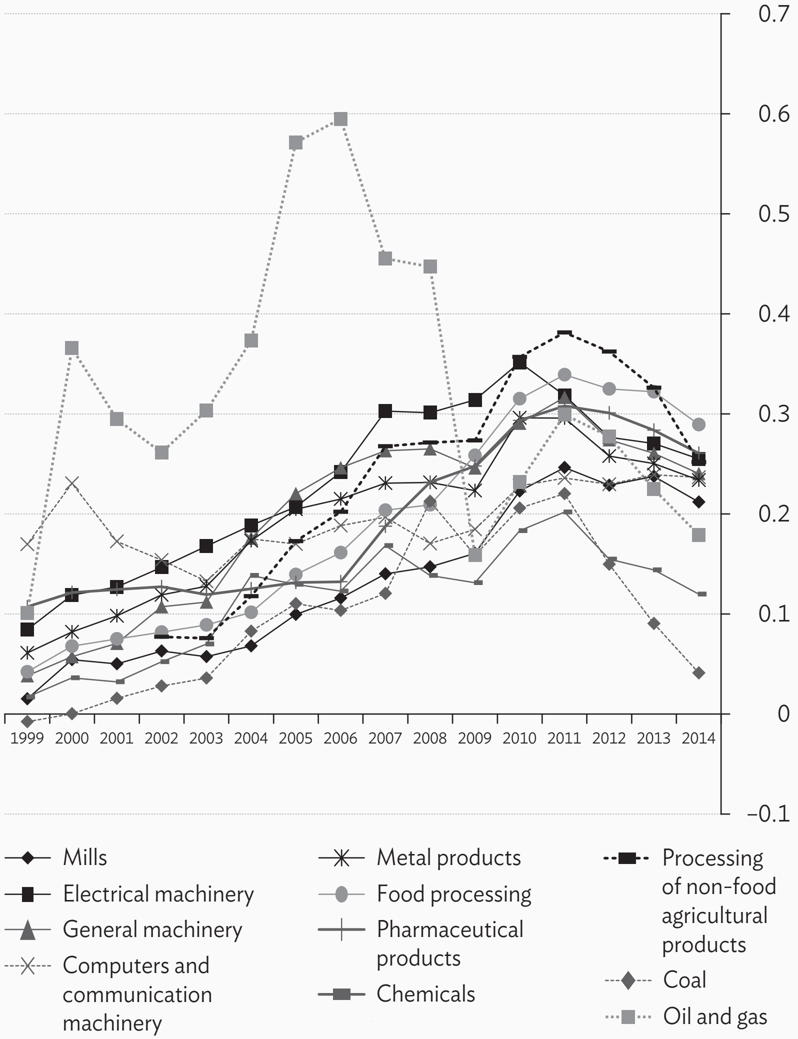
5 Neither the data used in Table 4.1 for Japan for the period 1955–1970, nor the data used in Table 4.7 for the PRC for the period 1980–2010 are based on Domar-weighted TFP. Therefore, the two results are comparable (on this issue, see footnote 3).

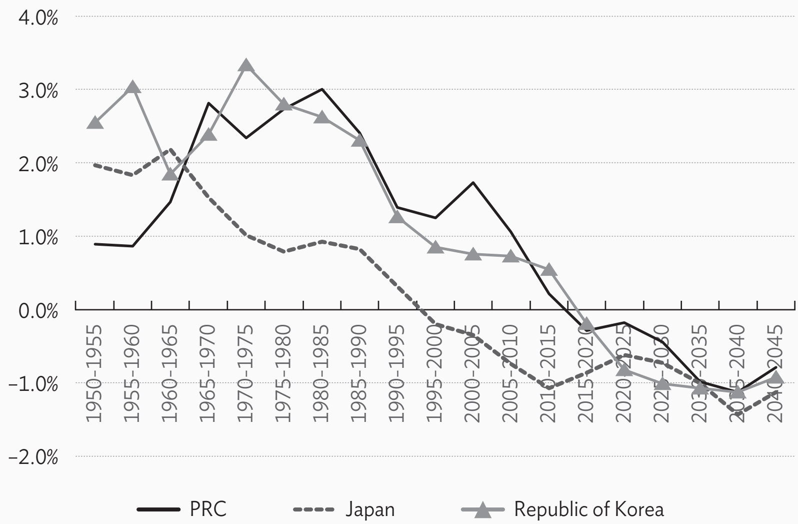
Figure 4.3: Gross Rate of Return on Capital in the People's Republic of China's Manufacturing Sector: By Subsector



Source: Authors' calculation based on the CEIC Database.

the growth rate of the working age population will continue to decline and turn negative (Figure 4.4). In the case of Japan, the annual growth rate of the working age population became negative only at the end of the 1990s. In other words, in terms of the level of economic

Figure 4.4: Estimates and Median Projections of Annual Average Growth Rate of Working Age Population (Aged 15 to 64): the PRC, Japan, and the Republic of Korea



PRC = People's Republic of China.

Source: United Nations, World Population Prospects, the 2015 Revision, downloaded from: http://esa.un.org/unpd/wpp/Download/Probabilistic/Population/.

development as measured by per capita GDP, the decline in labor input will start much earlier in the PRC than in Japan. This demographic factor will also reduce the rate of return on capital, through the diminishing marginal product of capital.

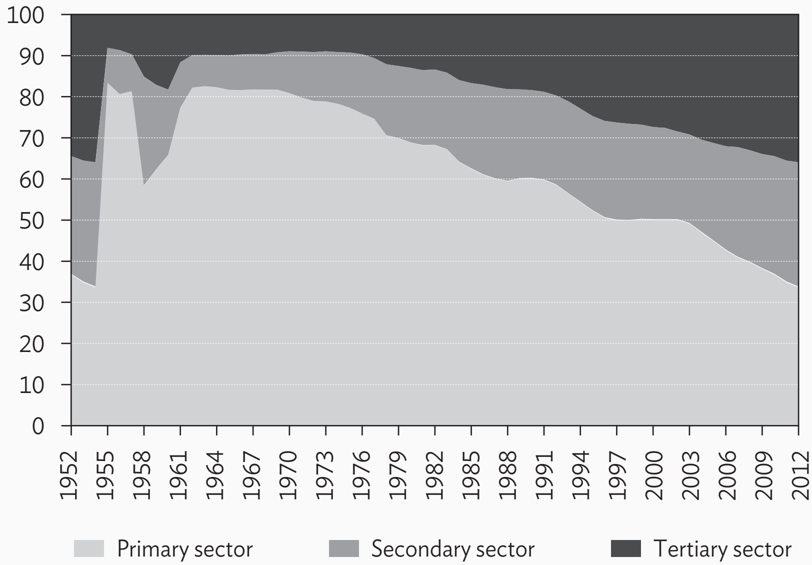
Taking these factors into account, it will likely be very difficult for the PRC to maintain the growth pattern on which it has relied so far, which is overly dependent on capital accumulation. Moreover, even to achieve satisfactory economic growth of 4% or 5%, the PRC desperately needs to accelerate TFP growth.

As Wu (2015) has shown, the TFP growth of leading export sectors, such as electric machinery, has been relatively high. However, the TFP growth of other sectors, especially the heavy and chemical industries and public services, which are dominated by state-owned firms, has been extremely low. This means that there is probably a lot of room for the PRC to accelerate TFP growth by reforming its state-owned firms. Another positive factor is that in comparison with Japan in the early 1970s, there is a huge technology gap between the PRC and countries at the world technology frontier such as the US. As Figure 4.1 shows, in 1970, Japan's per capita GDP (PPP adjusted) was 65% of that of the US, while the PRC's current per capita GDP (PPP adjusted) is still only 30% of the US level. This suggests that there likely is still substantial scope for the PRC to catch up technologically.

It could also be argued that since a large share of workers in the PRC are still engaged in the primary sector, there is considerable room for the PRC to increase labor input in the non-primary sector through structural change. Figures 4.5 and 4.6 compare the share of labor input by sector in the PRC and Japan. The figures indicate that even after the rapid decline of the primary sector labor input share from 2003 to 2012, the share of workers in the PRC's primary sector in the total number of workers is still around 30%, which is almost the same level as that in Japan during the high-speed growth era. If labor moves from the labor- and land-intensive primary sector to the capital-intensive secondary sector, capital accumulation can continue without resulting in diminishing returns on capital.

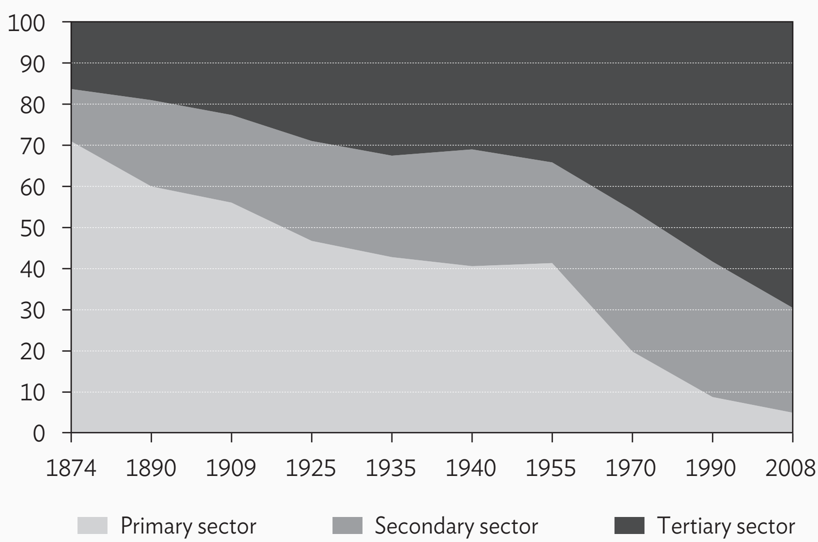
However, as Figure 4.7 shows, probably as a result of the rapid change in industrial structure in the 2000s, the labor productivity gaps between the primary and the secondary sector and between the primary and the tertiary sector have narrowed. This means that the incentive for workers to move from the primary sector to the other two sectors has declined substantially. Taking account of the fact that many of those remaining in the primary sector are aged and unskilled and that there still exists a large gap in the consumer price level (including house rents) between rural areas and cities (Fukao and Yuan 2012), structural change is likely to slow down soon.

Figure 4.5: Share of Labor Input by Sector: People's Republic of China



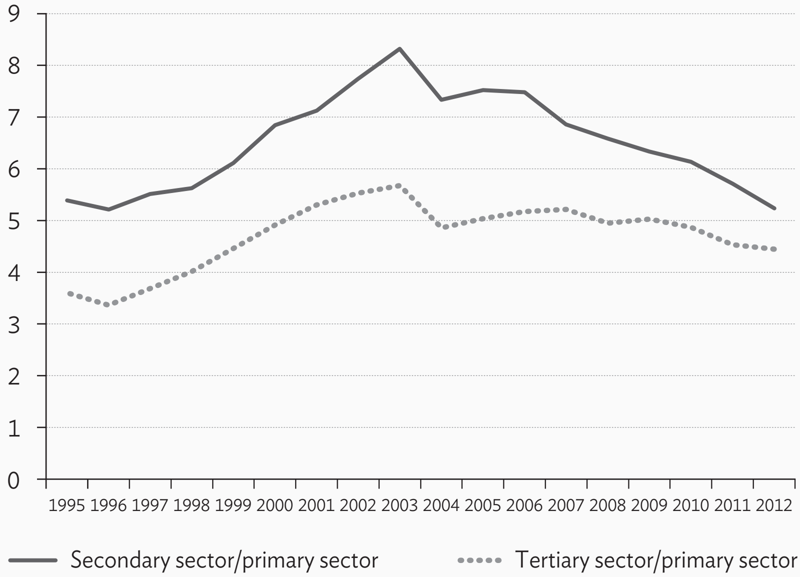
Source: China Statistical Yearbook.

Figure 4.6: Share of Labor Input by Sector: Japan



Source: Fukao et al. (2015).

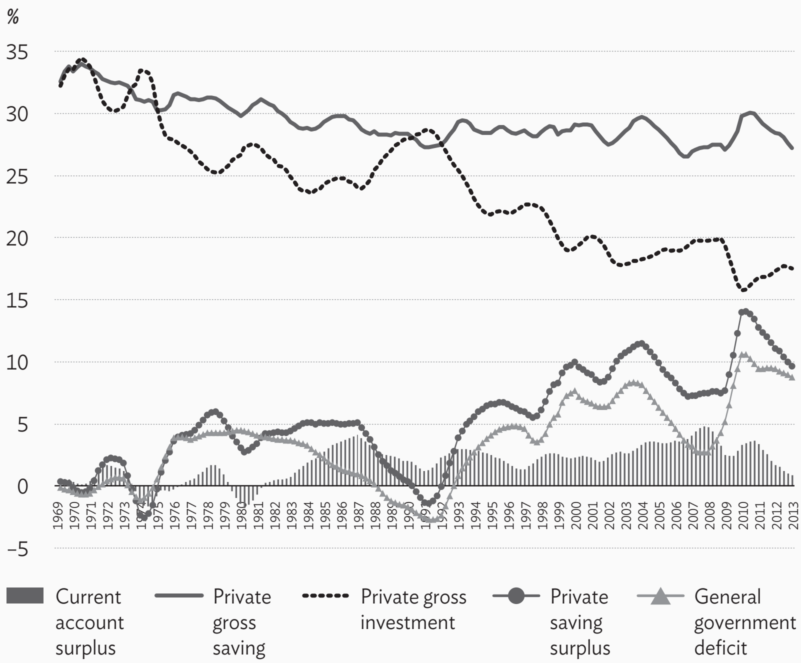
Figure 4.7: Relative Labor Productivity between Sectors: People's Republic of China



Source: China Statistical Yearbook.

Suppose that the PRC succeeds in switching from economic growth based on extremely rapid capital accumulation to economic growth based on structural reforms and TFP growth. Would this be enough to ensure the PRC's prosperity? Japan's experience suggests that the answer is no. A slowdown in economic growth based on capital accumulation implies that gross investment declines. In countries like Japan and the PRC, where the private saving rate is very high, this change will create a large positive saving–investment surplus in the private sector (private saving surplus). The private excess saving will be either invested abroad (current account surplus) or borrowed by the government (general government deficit). However, according to Keynesian economics, if intended private saving is greater than the intended current account surplus plus the intended government deficit, there arises an excess supply of goods. In this case, a reduction in GDP, through a reduction in excess private saving, restores balance in the goods market.

Figure 4.8: Japan's Saving–Investment Balance: Relative to Nominal Gross Domestic Product (Four-quarter Moving Average)



Note: The data were compiled by Kono of BNP Paribas Japan.

Sources: Annual Report on National Accounts 2013 and Annual Report on National Accounts of 2009, Economic and Social Research Institute, Cabinet Office.

Despite Japan's exceptionally high private gross saving rate when compared with other advanced economies, it did not experience any excess saving until the 1970s due to extremely high investment during the high-speed growth era (Table 4.1). However, as can be seen in Figure 4.8, from the beginning of the 1970s Japan's economy started to experience chronic excess saving. This is due to the large decline in private investment.

Comparing the 1955–1970 and 1970–1990 periods, Japan's natural rate of growth declined by 2.9 percentage points (Table 4.1). This change reduced the growth rate of capital service input on the balanced growth path by 2.9 percentage points. Since the nominal capital stock–nominal GDP ratio in 1973 was 2.0 (EU KLEMS ISIC Rev. 4 Rolling Updates), this slowdown of capital accumulation lowered the investment–GDP ratio by 5.8 percentage points. In addition to this, the convergence process and the increase of energy prices also must have lowered the investment–GDP ratio.

The lower part of Figure 4.8 shows how much of the private saving surplus was used for investment abroad (current account surplus) or for financing of the government (general government deficit). The figure shows that during most of the period the largest part of excess saving went to the government deficit. The only exceptions are the mid-1980s, when Japan recorded large current account surpluses as a result of "Reaganomics" from the late 1980s to early 1990s, when there was active private investment during the "bubble economy," and the export-driven boom during 2006–2008.

Open economy macroeconomics (see, e.g., Obstfeld and Rogoff 1996) suggests that when there is a large private saving excess in an economy with free international capital flows, then—assuming neoclassical adjustment mechanisms where goods and factor prices as well as the real exchange rate adjust flexibly to achieve full-employment equilibrium—the excess supply of domestic goods should be resolved through a large depreciation of the domestic currency and an increase in the current account surplus. In this situation, the exchange rate that achieves full-employment equilibrium can be called the "equilibrium real exchange rate" in the same sense as the "equilibrium real interest rate" is the interest rate that achieves full employment in a closed economy. But in the case of Japan, because of trade frictions with the US and appreciation of the yen, this mechanism did not work most of the time after 1970.[6]

Figure 4.9 compares the gross investment–GDP and gross saving–GDP ratios of the PRC, the Republic of Korea, and Japan. The figure shows that both Japan and the Republic of Korea experienced a high gross

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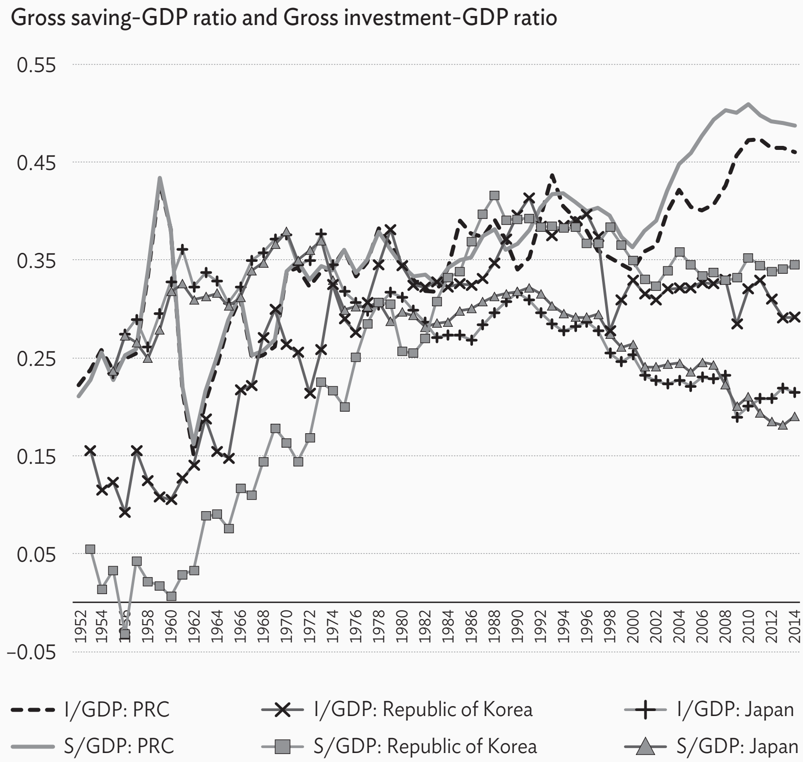
6 For more details on this issue, see Fukao et al. (2016).

investment–GDP ratio during their respective high-speed growth eras and a substantial decline thereafter. However, the PRC's recent gross investment–GDP ratio is much higher than that observed in Japan's and the Republic of Korea's high-speed growth eras. For example, Japan's average gross investment–GDP ratio in the period 1960–1969 was 34%, while the Republic of Korea's average in the period 1988–1997 (the decade before the Asian Currency Crisis) was 38%. In contrast, the PRC's average gross investment–GDP ratio in the period 2005–2014 was 44%.

Figure 4.9: Gross Saving/GDP and Gross Investment/GDP in the PRC, the Republic of Korea, and Japan



PRC = People's Republic of China, GDP = gross domestic product, I = gross investment, S = gross saving.

Sources: The Republic of Korea and Japan: each country's SNA statistics; the PRC: CEIC Database.

Since the PRC's very rapid capital accumulation is not sustainable, the PRC will experience a huge decline in the gross investment–GDP ratio; and since the PRC's saving rate is extremely high, the PRC will face a serious excess saving problem. One solution to the excess saving problem would be an expansion of the current account surplus, which is shown by the vertical gap between gross saving (S)/GDP and gross investment (I)/GDP in Figure 4.9. However, since the world economy is suffering from a shortage of final demand and the PRC's economy by now accounts for a sizeable share of the global economy, it will be difficult for the PRC to resolve the excess supply of domestic goods through a large depreciation of the yuan and an increase in the current account surplus.

Another solution to the excess saving problem would be a reduction of the private saving rate. In Japan, many economists, based on the life cycle hypothesis, thought that with the aging of the population, Japan's saving rate inevitably would fall rapidly and the excess saving problem would soon be resolved. For example, Horioka (2008) expected that Japan's household saving rate would rapidly fall to zero or even turn negative by around 2010. As can be seen from Figure 4.10, the actual household saving rate, more or less in line with Horioka's prediction, has fallen considerably. However, as if to offset that decline, the corporate saving rate has increased rapidly, and as a result the private saving rate has remained unchanged at around 25%.[7] As in Japan's case, the PRC's private saving is characterized by large saving in the corporate sector. Therefore, how corporate saving can be cut to reduce private saving will be a key issue for the PRC. We will discuss this issue in more detail in Section 4.4.

To sum up the analysis of this section, it seems that the PRC's high-speed growth based on rapid capital accumulation is not sustainable and the PRC needs to increase its TFP growth. The PRC will also face a serious excess saving problem as capital accumulation slows.

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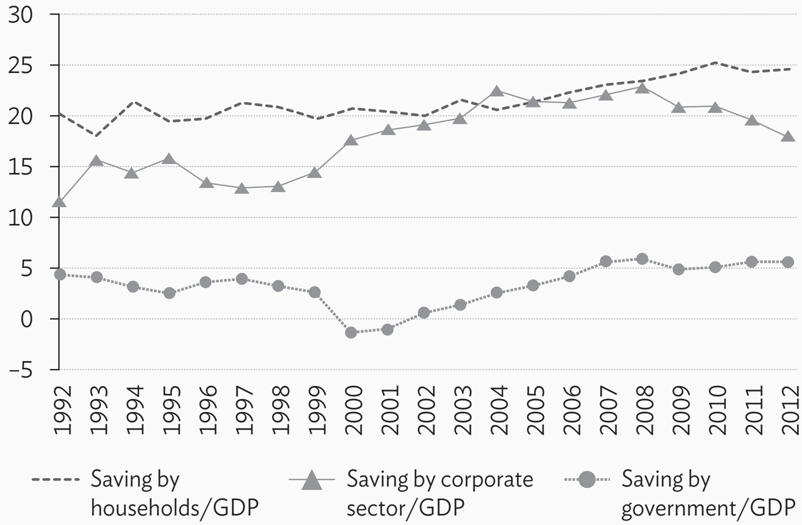
[7] For more details on this issue, see Fukao et al. (2016).

Figure 4.10: Japan's Household and Corporate Saving Relative to Nominal GDP (%)



GDP = gross domestic product.

Notes:

1. Corporate saving is the sum of the saving of non-financial corporate firms and that of financial institutions.
2. The benchmark year for the data before 1994 is 2000. The benchmark year for the data after 1994 is 2005.

Sources: Annual Report on National Accounts 2013 and Annual Report on National Accounts of 2009, Economic and Social Research Institute, Cabinet Office.

4.3 Impact of the PRC's Slowdown and Structural Reforms on Developed Economies

As seen in the previous section, to maintain rapid economic growth, it is not sufficient for the PRC to further increase final demand through greater private and public investment as in the wake of the global financial crisis. Such policies would reduce the return on capital and exacerbate the bad loan problem and the deterioration of firms' balance sheets. To achieve sustainable growth, the PRC needs to switch from investment-based growth to consumption-based growth. Moreover, on the supply side, the PRC needs to switch from growth based on capital deepening to growth based on improvements in TFP. However, as mentioned, such structural reforms may potentially have a negative impact on the export of investment goods from Japan and other countries. In this section, we examine this issue using the WIOD.

We assume that relative to global production capacity final demand in the world economy is weak and global output therefore is determined by the demand side. We also assume Leontief-type low substitutability among factor inputs. Let $\boldsymbol{f}$ denote a global final demand vector (when there are n countries and m industries, $\boldsymbol{f}$ is a column vector of $n \times m$ elements), where each element denotes total final demand for the output of each sector in each country. For example, the elements from the first to the mth element of $\boldsymbol{f}$ denote the total final demand for the output of each sector of country 1. Similarly, the $m+1$th to the $2 \times m$th elements denote the total final demand for the output of each sector in country 2. The $i \times m+j$th element of $\boldsymbol{f}$ is the sum of all countries' household consumption demand, government consumption demand, and capital formation demand (fixed capital formation plus investment in inventories) for the output of sector j in country i. Similarly, let $\boldsymbol{q}$ denote a gross output vector (a column vector of $n \times m$ elements). Further, let $\boldsymbol{A}$ denote the input coefficient matrix (a matrix of $n \times m$ rows and $n \times m$ columns). The element in the $i \times m+j$th row and the $i' \times m+j'$th column of $\boldsymbol{A}$ denotes the intermediate input from sector j in country i necessary to produce one unit of sector j' output in country i'. Then we have the following demand–supply relationship:

$$\Delta \boldsymbol{q} = \boldsymbol{A} \Delta \boldsymbol{q} + \Delta \boldsymbol{f}$$

where Δ denotes the difference in each vector under two different scenarios.

The difference in the gross output vector $\boldsymbol{q}$ caused by the difference in final demand, $\Delta \boldsymbol{f}$, in two scenarios is determined by the following equation:

$$\Delta \boldsymbol{q} = (\boldsymbol{I} - \boldsymbol{A})^{-1} \Delta \boldsymbol{f}$$

where $\boldsymbol{I}$ denotes the unit matrix of $n \times m$ rows and $n \times m$ columns and $(\boldsymbol{I} - \boldsymbol{A})^{-1}$ denotes the Leontief inverse matrix. Moreover, the difference in the number of workers in each sector of each country caused by the difference in final demand, $\Delta \boldsymbol{f}$, is determined by

$$\Delta \boldsymbol{e} = \boldsymbol{Z} \Delta \boldsymbol{q} = \boldsymbol{Z}(\boldsymbol{I} - \boldsymbol{A})^{-1} \Delta \boldsymbol{f}$$

where $\boldsymbol{e}$ is an employment vector (a column vector of $n \times m$ elements) where each element denotes the total number of workers in each sector of each country. $\boldsymbol{Z}$ denotes the labor input coefficient matrix (the diagonal matrix of $n \times m$ rows and $n \times m$ columns). The diagonal element in the $i \times m+j$th row and the $i \times m+j$th column of $\boldsymbol{Z}$ denotes the numbers of workers required for producing one unit of gross output in sector j of country i.

We compare the following three scenarios regarding the PRC's final demand in 2020 and economic growth from 2015 to 2020.

(1) *The Optimistic Scenario*
The International Monetary Fund (2015) forecasts that the PRC's real GDP will grow at an annual rate of 6.2% during the period 2015–2020. In this scenario, we assume that this growth is accomplished without structural reforms and all of the PRC's final demand components—that is, household consumption demand, government consumption demand, and capital formation demand (fixed capital formation plus investment in inventories)—for the output of each sector j in country i will increase during the period 2015–2020 at an annual rate of 6.2% in real terms.

(2) *The Slowdown Scenario*
Without structural reforms, the PRC's economic growth might slow down substantially. In this scenario, we assume that all of the PRC's final demand components will increase at an annual rate of 4.0% in real terms during the period 2015–2020.

(3) *The Structural Reforms Scenario*

We assume that the PRC succeeds in carrying out structural reforms and that the share of household consumption in total domestic absorption (household and government consumption plus gross capital formation) increases from the level recorded in 2011, 36.0% to 56.2%. Further, the share of gross fixed capital formation in total domestic absorption declines from the level recorded in 2011, 47.0% to 26.9%. We assume that the share of government consumption and the share of inventory investment in total domestic absorption will not change over time (i.e., they remain at the 2011 levels of 13.8% and 3.1%, respectively). These assumptions mean that the share of gross capital formation (gross fixed capital formation plus inventory investment) in domestic absorption declines from 50.1% (47.0% + 3.1%) to 30.0% (26.9% + 3.1%) and the share of household and government consumption in domestic absorption increases from 49.9% to 70.0%.[8] We also assume that within each of the PRC's final demand components (household and government consumption, gross fixed capital formation, and inventory investment), the share of demand for the output of each industry in each country remains constant. As in the optimistic scenario, we assume that the PRC's total domestic absorption increases at an annual rate of 6.2% in real terms. Unlike in the optimistic scenario, here we assume that economic growth is accomplished not by rapid capital accumulation but by other factors such as TFP growth.

The most recent version of the WIOD covers the period 1995–2011. To compare the economic impact of the three scenarios for the period 2015–2020, we prepared data for 2015 through extrapolation. We assumed that during the period 2011–2015, each of the PRC's final demand components (household and government consumption, gross fixed capital formation, and inventory investment) increased at the same rate as GDP, 7.4% in real terms. We obtained this GDP growth rate from the estimation by the International Monetary Fund (2015).

8 In Japan, the average share of gross capital formation in total domestic absorption during the period 1975–1984 was 31.1%. Therefore, here we are assuming that the PRC's share of gross capital formation in total domestic absorption will decline to a level slightly lower than Japan's value during this period.

We assumed that during the period 2011–2015, within each of the PRC's final demand components (household and government consumption, gross fixed capital formation, and inventory investment) the share of demand for the output of each industry in each country remained constant. We also assumed that the input coefficient matrix A and the labor input coefficient matrix Z did not change from 2011 to 2015.

Table 4.1 reports our results. The first row, *a*, compares the impact on the total employment in Japan, the US, and Germany in 2020 between the optimistic scenario and the slowdown scenario. The negative impact of the PRC's slowdown is greatest in the US. The downward shift in the PRC's average growth rate from 6.2% to 4.0% during the period 2015–2020 will reduce employment in the US by 211,000 persons in 2020. The negative impact on Japan's employment, a decline of 204,000, is smaller than that on the US, but the difference is only 7,000. The impact on Germany, a decline of 174,000, is substantially smaller than that on the other two countries. This order regarding the size of the negative impact (US, Japan, and Germany) is the same as that regarding the amount of total exports to the PRC. However, the difference between the US and Japan in the impact is much smaller than that in the amount of exports. Part of the reason probably is that a large share of US exports is produced in less labor-intensive sectors such as agriculture. Another factor is that Japan exports a huge amount of materials, parts, and components to other Asian countries, which are used as inputs in the production of goods exported from these Asian countries to the PRC.

The second row, *b*, compares the impact on employment in the three countries between the optimistic scenario and the structural reform scenario. A decline in the gross capital formation–GDP ratio as a result of structural reforms in the PRC would have a much larger impact on Japan and Germany than on the US. In Japan, employment would decline by 302,000, followed by 225,000 in Germany, and 135,000 in the US. The reason is that Japan and Germany tend to export investment goods as well as materials, parts, and components, which are used for the production of investment goods in the PRC and other Asian countries. On the other hand, the US mainly exports consumption goods such as iPhones and food to the PRC.

The last row, *a–b*, compares the impact on employment in the three countries between the structural reform scenario and the slowdown scenario. The results show that Japan and Germany would suffer more from structural reforms in the PRC than from a slowdown in growth. In the case of Japan, the employment decline brought about by structural reforms would be 1.5 times greater than the employment decline caused by a growth slowdown. Similarly, in the case of Germany, the employment decline due to structural reforms would be 1.3 times greater than the employment decline caused by a growth slowdown. Meanwhile, in the case of the US, the employment decline triggered by structural reforms would be about 40% smaller than the employment decline caused by a growth slowdown.

Next, let us consider the impact of PRC structural reforms on Japan's economy by sector. Figure 4.11 compares the impact on each sector's employment in Japan between the structural reform scenario and the optimistic scenario. The total decline in employment would be 302,000, as seen in row *b* of Table 4.3.

The largest decline in employment would occur in investment goods sectors such as basic and fabricated metal, machinery not elsewhere classified, and electrical and optical equipment. Renting of machines and equipment and other business activities would also be hit hard. In each of these four sectors, employment would decline by more than 40,000. The total employment decline in the four sectors would be 199,000, making up about two-thirds of the overall estimated decline in employment in Japan. On the other hand, some consumption goods sectors, such as textiles and textile products; food, beverages and tobacco; and agriculture, hunting, forestry, and fishery, would benefit from the PRC's reforms. However, the positive impact is very small compared to the negative impact in the investment goods sectors.

Figure 4.11: Economic Impact of the People's Republic of China's Slowdown and Economic Reforms on Japan in 2020: by Sector

Source: Authors' calculation based on WIOD.

Table 4.3: Economic Impact of the PRC's Slowdown and Economic Reforms on Japan, the United States, and Germany in 2020 (thousand workers)

		Japan	United States	Germany
a	Impact of growth slowdown in 2020: Slowdown scenario (GDP growth rate = 4%, I/GDP = 0.501) minus optimistic scenario (GDP growth rate = 6.2%, I/GDP = 0.501)	−204	−211	−174
b	Impact of structural reforms: Structural reform scenario (GDP growth rate = 6.2%, I/GDP = 0.3) minus optimistic scenario (GDP growth rate = 6.2%, I/GDP = 0.501)	−302	−135	−225
b-a	Comparison between structural reforms and slowdown: Slowdown scenario (GDP growth rate = 4%, I/GDP = 0.501) minus structural reform scenario (GDP growth rate = 6.2%, I/GDP = 0.3)	−98	76	−51

PRC = People's Republic of China, GDP = gross domestic product, I = gross capital formation (gross fixed capital formation plus inventory investment).

Source: Authors' calculation based on WIOD.

4.4 Relationship between the Labor Income Share and the Gross Saving–GDP Ratio in the PRC

Next, let us examine the relationship between the labor income share and the gross saving–GDP ratio in the PRC. As Figure 4.12 shows, the PRC's labor income share has declined over the past 2 decades and is now at a very low level. Since most capital income is earned by richer households, a higher capital income share makes the income distribution more unequal. In addition to the high gross saving–GDP (and high gross investment–GDP) ratio, the very low and declining labor income share is another notable characteristic of the PRC's recent economic development. As discussed in Section 4.1, these two characteristics are closely related. Since the income distribution problem is an important issue in the PRC, we analyze this relationship in this section.

Figure 4.12: Labor Income Share in the People's Republic of China

GDP = gross domestic product.

Source: People's Republic of China's GDP Statistics.

Low-income households cannot afford to save much, while capital income will be either distributed mostly to richer households or saved as retained earnings within firms. In the PRC, because of the increase in the capital income share and firms' low dividend payout ratio, corporate sector saving increased substantially in the 2000s (Figure 4.13). Taking these factors into account, we can probably conclude that the low labor income share has contributed to the high gross saving–GDP ratio.[9] This relationship of the macro saving function can be expressed by the SS line in Figure 4.14. In this figure, the horizontal axis denotes the labor income share and the vertical axis denotes the gross saving rate of the macro economy.

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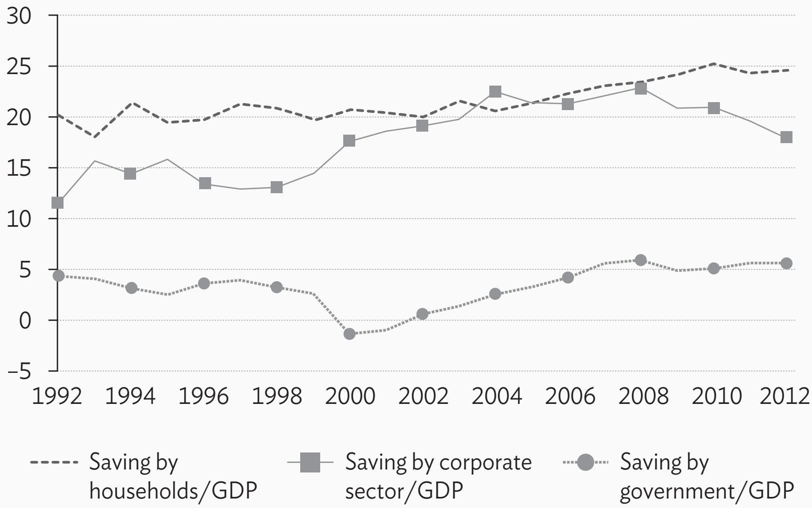
9 On the relationship between income distribution and the macro saving rate, see Kalecki (1971) and Pyo (2015). Using household survey data, Jin, Li, and Wu (2011) have shown that an increase of income inequality also raises the average household saving rate.

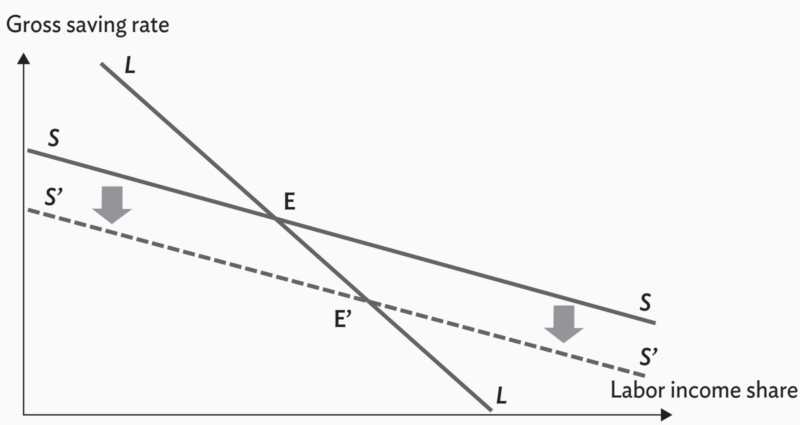
Figure 4.13: Gross Saving of Each Sector/GDP



GDP = gross domestic product.

Source: People's Republic of China's GDP Statistics.

Figure 4.14: Simultaneous Determination of the Gross Saving Rate and the Labor Income Share



Note: See text about the meaning of lines and points.

On the other hand, since capital goods are more capital intensive than consumption goods, a decline in the gross saving–GDP ratio (and gross investment–GDP ratio) will increase the labor income share and might mitigate the PRC's income inequality problem. This relationship can be expressed by the *LL* line in Figure 4.14.

In Figure 4.14, both lines are downward sloping. We assume that the *LL* line is steeper than the *SS* line. The intersection of the two lines, point *E*, denotes the equilibrium level of the gross saving rate and the labor income share. An important fact this figure suggests is that the gross saving rate and the labor income share are mutually dependent on each other. For example, if the government were to introduce a tax on saving and the macro saving function shifts downward from *SS* to *S'S'*, the equilibrium would move from point *E* to point *E'*. When the *LL* line is downward sloping, the decline in the saving rate will be greater than the downward shift of the *SS* line. In addition, the tax to reduce the gross saving rate has the side effect of raising the labor income share. Similarly, if the government were to introduce policies that shift the *LL* line to the right, such as policies to expand labor-intensive sectors, this would not only increase the labor income share but also reduce the gross saving rate. These phenomena occur because of a virtuous cycle in which a decline in the gross saving rate reduces the labor income share and a decline in the labor income share reduces the gross saving rate.

How much this virtuous cycle mechanism works depends on the slopes of the two lines. While it is beyond the scope of this chapter to quantitatively examine the slope of the *SS* curve, we can examine the slope of the *LL* curve using the WIOD.

The WIOD contains data on the labor income–gross output ratio and the capital income–gross output ratio for the year 2008 in each of the PRC's sectors. Assuming that these ratios remain constant during 2008–2020, we can calculate how much the macro-level labor income share would differ between the optimistic scenario and the structural reform scenario. Moreover, this difference can be regarded as the impact of the decline in the gross capital formation–GDP ratio (and the gross saving–GDP ratio) as a result of the structural reforms. Conducting this calculation, we find that a decline in the gross capital formation–GDP ratio from 50.1% to 30.0% would raise the labor income share by only 1.2 percentage points.[10]

This result suggests that the *LL* line in Figure 4.9 is almost vertical and a shift in the gross saving function (*SS* curve) would not change the labor income share substantially.

4.5 Conclusions

After presenting an overview of the problem of the PRC's high gross investment–GDP (and high gross saving–GDP) ratio and the sources of economic growth, we derived some lessons for the PRC from Japan's past experience by comparing the PRC's present situation with Japan's high-speed growth era and the period that followed. Based on this analysis, we estimated the economic impact of the PRC's slowdown and hypothetical economic transformation on Japan, the US, and Germany, using the WIOD. We also examined the relationship between the labor income share and the gross investment–GDP ratio in the PRC.

Our main lessons derived from Japan's past experience are as follows. First, because of the slower TFP growth, the PRC's natural rate of growth (4.9%) was much lower than that of Japan during the high-speed growth era (6.6%). However, quicker capital accumulation made the PRC's actual GDP growth rate (9.2%) higher than Japan's (8.4%). These differences mean that the PRC's capital coefficient (capital service input–GDP ratio) grew much quicker than Japan's. When the capital coefficient increases, the rate of return on capital declines through the diminishing marginal product of capital, and the growth rate

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10 According to Yue, Li, and Sicular (2010), wage rates in industries in which large firms dominate the market are quite high. If a decline in the saving rate were to reduce the size of such industries, this might mitigate income inequality.

of capital service inputs will gradually decline. This mechanism might lead to the end of the PRC's high-speed growth, which has been driven by extremely rapid capital accumulation.

Second, the annual growth rate of the PRC's working age population has been falling rapidly and is now approaching zero. Moreover, according to the United Nations' median projection, the growth rate of the working age population will continue to decline and turn negative. In the case of Japan, the annual growth rate of the working age population became negative only at the end of the 1990s. In other words, in terms of the level of economic development as measured by per capita GDP, the decline in labor input will start much earlier in the PRC than in Japan. This demographic factor will also reduce the rate of return on capital, through the diminishing marginal product of capital.

Taking these factors into account, it will likely be very difficult for the PRC to maintain the growth pattern on which it has relied so far, which is overly dependent on capital accumulation. Moreover, even to achieve satisfactory economic growth of 4% or 5%, the PRC desperately needs to accelerate TFP growth. But switching from economic growth based on extremely rapid capital accumulation to economic growth based on structural reforms and TFP growth would not be enough to ensure the PRC's prosperity. A slowdown in economic growth based on capital accumulation implies that gross investment declines. In countries like Japan and the PRC, where the private saving rate is very high, this change will create a large positive saving–investment surplus in the private sector (private saving surplus). The PRC will face a serious excess saving problem as capital accumulation slows. For prosperity, the PRC needs to reduce its private saving rate.

Next, we estimated the economic impact of the PRC's slowdown and hypothetical economic transformation on Japan, the US, and Germany, using the WIOD. We compared the following three scenarios regarding the PRC's final demand in 2020 and economic growth from 2015 to 2020: (i) an optimistic scenario (GDP growth rate = 6.2%, I/GDP = 0.501), (ii) a slowdown scenario (GDP growth rate = 4%, I/GDP = 0.501), and (iii) a structural reform scenario (GDP growth rate = 6.2%, I/GDP = 0.3). Our analysis suggests that Japan and Germany would suffer more from structural reforms in the PRC than from a slowdown in growth. Meanwhile, in the case of the US, the employment decline triggered by structural reforms would be much smaller than the employment decline caused by a growth slowdown. In the structural reform scenario, the largest decline in employment in Japan would occur in investment goods sectors such as basic and fabricated metal, machinery not elsewhere classified, and electrical and optical equipment. Renting of machines and equipment and other business activities would also be hit hard. The total employment decline in the four sectors would be 199,000, making up about two thirds of the overall estimated decline in employment in Japan.

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CHAPTER 5

The Republic of Korea's Economic Growth and Catch-Up: Implications for the People's Republic of China

Jong-Wha Lee

5.1 Introduction

The Republic of Korea has had a remarkable economic performance since the early 1960s, achieving per capita income of $27,000 to become the world's eighth-largest trading nation.[1] However, the economy's recent growth performance has been rather disappointing. Gross domestic product (GDP) growth averaged only 4.1% during 2000–2010, marking a significant drop from the average of 7.9% achieved during 1960–2000. Moreover, from 2011 to 2015, the Republic of Korea's GDP growth averaged only 3%. The Organisation for Economic Co-operation and Development (OECD) (2014a) has projected a further decline in the country's growth rate to around 2% in the coming decade.

Some researchers argue that the Republic of Korea's strong economic performance is an outcome of factor accumulation rather than efficiency improvement (e.g., Krugman 1994), while others attribute the growth largely to "good fundamentals," including a high savings rate, strong human capital, maintenance of good institutions, high trade openness, and prudent fiscal and monetary management (e.g., Radelet, Sachs, and Lee 2001; De Gregorio and Lee 2004). In particular, trade

1 Gross national income per capita in 2014 is from World Bank (2015).

openness, driven by outward-looking development strategy, has often been emphasized as a key growth factor, as it has provided access to inexpensive imported intermediate goods, larger markets, and advanced technologies, thereby contributing to rapid productivity growth of the Republic of Korea's manufacturing industries. The government has also played an important role in promoting export-oriented industrialization, as export-oriented policies designed to offer performance-based incentives for exporters have facilitated continuous upgrading of Republic of Korea firms' comparative advantage in global markets.[2]

It is debated whether the Republic of Korea's current slowdown is an indication of a permanent drop in its growth potential. Some scholars believe that the Republic of Korea's economic downturn will be exacerbated, eventually leading to a situation comparable to Japan's "lost decades" (Cho 2014). Others, however, consider that the dynamic forces that have enabled the Republic of Korea's fast growth—in particular, manufacturing exports—remain vibrant; thus, the Republic of Korea can continue its strong growth trajectory aided by appropriate policies (Sharma 2012).

This study investigates the Republic of Korea's growth performance and assesses the country's future growth prospects. The changes in the country's per capita income and growth rates over the past 5 decades are discussed and compared with Japan. This study also assesses changes in the gap of per worker output between the Republic of Korea and United States (US) over time, and analyzes the extent to which the gap is explained by differences in factor inputs and total factor productivity (TFP). In addition, the study adopts a general framework of cross-country analysis, putting the Republic of Korea's experience in a global context, discussing the major factors that enabled the Republic of Korea

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2 It remains controversial to what extent industrial policy that targets specific industries has contributed to overall economic growth. The developmental state view, such as that of Amsden (1992), argued that selective government policies attempted to "pick winners." In contrast, the World Bank (1993) asserted that government intervention conformed to the market, rather than replaced the market, using a pragmatic and flexible approach. Lee (1996) showed that targeting specific industries was often harmful to productivity growth of the overall economy.

to achieve strong growth over a half-century yet caused the recent growth slowdown. Further, the study adopts more detailed industry-level data of the Republic of Korea's economy to assess the imbalance between the manufacturing and services sectors, and compares the Republic of Korea's sector performance with those of the US and Japan.

Thereafter, the study assesses the implications of the empirical findings from the Republic of Korea's experience for the growth performance and prospects of the People's Republic of China (PRC).

The PRC's economic performance since the 1980s has been astonishing—its economy has grown more than 9.5% annually. However, its economy, too, is now slowing; it grew only 6.9% in 2015, the lowest since 1990, and is predicted to grow more slowly in the coming years. Considering the PRC's influence on the world economy, the future of its growth is of concern to many. This study analyzes PRC economic growth in the context of global standards as well as the Republic of Korea's experience. It discusses the changes in the gap of per worker output between the PRC and the US over time and compares the performance of the PRC with that of the Republic of Korea for an equivalent period. It also suggests policy measures that the PRC could adopt to sustain strong growth.[3]

5.2 The Republic of Korea's Economic Growth and Catch-Up

5.2.1 The Experience of the Republic of Korea

During the past half-century, the Republic of Korea's economy has shown impressive growth, with average annual GDP growth rate surpassing 7.1%, raising the level of real per capita GDP in international

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3 Japan's experiences, in particular the bursting of an asset bubble and long-term stagnation since the early 1990s, can be also useful for PRC policymaking. However, the PRC's per capita output, as well as economic structure, lags over 40 years behind those of Japan, which makes difficult to compare the two economies and draw useful policy implications for the PRC.

prices almost 26 times (Table 5.1). Average GDP growth rates accelerated to 7.5% in the 1960s, 8.6% in the 1970s, and 9.3% in the 1980s, but the impressive performance was interrupted by the 1997/98 Asian financial crisis. This sudden crisis had a devastating effect on the Republic of Korea's economy, with real GDP falling by almost 7% in 1998, due to the huge, sudden reversal of short-term capital flows triggered by international investor panic (Radelet, Sachs, and Lee 2001). Structural problems underlying the economy, including under-supervised financial systems and an overleveraged corporate sector, also led to the accumulation of vulnerabilities that set the stage for the crisis and amplified its shock to the economy.

The Republic of Korea managed to recover rapidly from 1999—faster than anyone had expected. However, there seems to have been a permanent decline in growth potential, as the average GDP growth rate remained at 4.1% over 2000–2010.

The global financial crisis in 2008–2009, which evolved from the US subprime mortgage crisis, also seriously affected the Republic of Korea's economy through spillovers from global trade and financial markets.

Table 5.1: Economic Growth in Selected Countries, 1960–2010

	GDP per Capita			Average Annual GDP Growth					
Country	1960	2010	2010/ 1960	1960–1970	1970–1980	1980–1990	1990–2000	2000–2010	1960–2010
Republic of Korea	1,078	27,578	25.59	7.45 [4.82]	8.58 [6.83]	9.28 [7.90]	6.33 [5.65]	4.07 [3.60]	7.14 [5.76]
Japan	4,795	30,916	6.45	9.66 [8.62]	4.37 [3.25]	4.53 [4.00]	1.12 [0.84]	0.74 [0.68]	4.08 [3.48]
United States	15,254	42,371	2.78	4.11 [2.84]	3.19 [2.26]	3.18 [2.20]	3.37 [2.28]	1.52 [0.58]	3.07 [2.03]
PRC	1,057	8,426	7.97	3.24 [0.92]	6.03 [4.15]	8.87 [7.34]	9.92 [8.89]	9.95 [9.40]	7.61 [6.14]

GDP = gross domestic product, PRC = People's Republic of China.

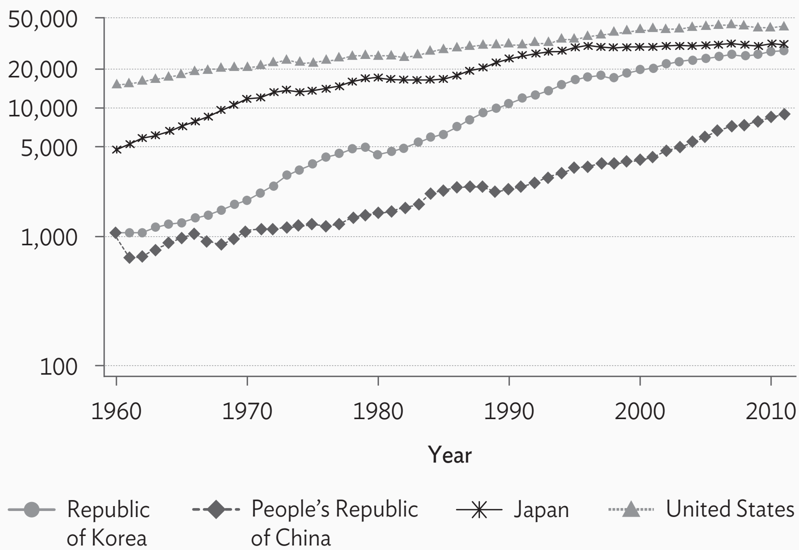
Note: Per capita GDP levels and growth rates are based on the international prices of 2005 (adjusted for purchasing power parity), which are based on the Penn-World Table 8.1.

Source: Feenstra, Inklaar, and Timmer (2015)

The country's GDP growth rate dropped to 0.3% in 2009. Although the Republic of Korea managed the global financial crisis relatively well, showing the fastest recovery among OECD members, its economy still has not yet resumed its pre-crisis growth rates.

Over the past half-century, due to the Republic of Korea's strong growth performance, its economy has experienced a fast catch-up to developed economies in per capita output and income (Figure 5.1).[4] The Republic of Korea has achieved the high-income level in a half-century, with per capita income of $27,578 purchasing power parity (PPP) in 2010. In 1960, it was still a lower-middle income country, with a per capita GDP of only $1,078 PPP.

Figure 5.1: Trends in per Capita Gross Domestic Product in Selected Economies (purchasing power parity international dollar, 2005 constant prices)



Source: Feenstra, Inklaar, andTimmer (2015).

[4] For an international and intertemporal comparison, this study uses data on per capita GDP at PPP international dollars from the Penn-World Table 8.1 in Feenstra, Inklaar, and Timmer (2015).

Japan has also experienced a significant growth slowdown since early 1990s. The bursting of asset bubbles in the 1990s left Japan's financial system and private sector saddled with a huge debt overhang. During its "lost decades," Japan suffered from deflation and economic stagnation due to its dysfunctional financial system and lack of private demand. Consequently, the gap in per capita GDP between Japan and the Republic of Korea has narrowed rapidly, and has been close to zero in recent years.

In the last 35 years, since Deng Xiaoping embarked on economic opening and reforms, the PRC has shown astounding output growth of more than 9.5% annually. It has rapidly narrowed its per capita output gap with developed economies. Yet despite this stellar performance, the country's per capita output continues to lag behind those of developed economies. The GDP per capita in 2011 was $8,850 PPP, which is comparable to the Republic of Korea's 1988 level (i.e., $9,137 PPP) and Japan's 1968 level (i.e., $9,527 PPP). The PRC is thus more than 20 years behind the Republic of Korea and more than 40 years behind Japan.

Figure 5.2 shows the evolution of per capita GDP levels of the three Asian economies relative to the US over time. The values are 5-year averages, matched with average GDP growth rates in the corresponding period.[5] The Republic of Korea's sustained growth contributed to narrowing the gap in its per capita GDP with the US, as it experienced a very rapid catch-up to the US in per capita output. The value of per capita output increased from approximately 10% of the US value in 1960 to more than 60% in the late 2000s.

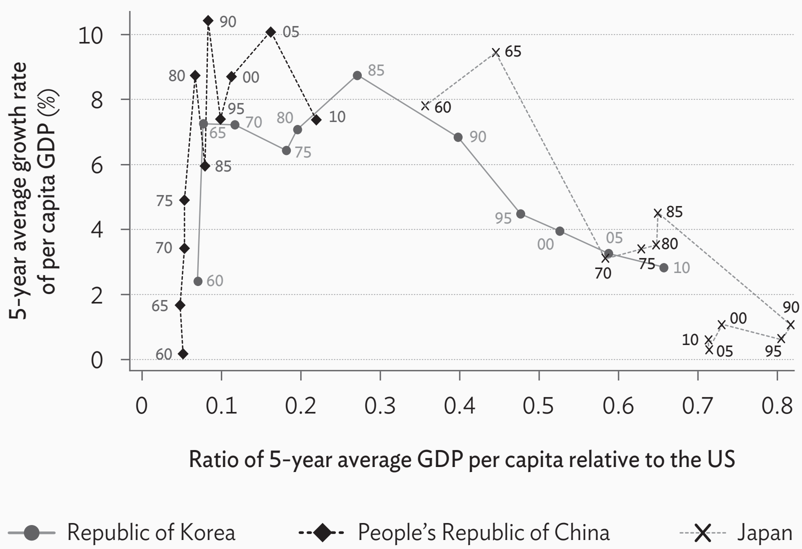
Figure 5.2 shows that the pace of the catch-up slowed as the Republic of Korea economy narrowed its per capita income gap compared to that of the US. While income per capita in the Republic of Korea was less

5 The underlying data are the adjusted PPP values from the Penn-World Table 8.1 in Feenstra, Inklaar, and Timmer (2015). For 2012, 2013, and 2014, the values are estimated from information on real GDP growth rates from IMF (2015).

than 20% of the US average in the 1970s and 1980s, annual per capita GDP growth reached only 7%–8%. By the time the Republic of Korea reached 50% of US per capita income in 2000, its annual growth rate had slowed to 3%–4%.

The Republic of Korea's experience resembles that of Japan. Japan's annual per capita GDP growth dropped from 8.6% in the 1960s to 3%–4% in the 1970s and 1980s as its per capita income jumped from about 40% to over 60% of the US level over the period (Figure 5.2).

Figure 5.2: Per Capita Income Level and Growth Rates of the People's Republic of China, the Republic of Korea, and Japan Relative to the United States



GDP = gross domestic product, US = United States.

Note: The figure shows the period average of relative per capita income and its growth rates over the corresponding 5 years. For 5-year periods, 60 indicates 1960–1964, ..., and 10 indicates 2010–2014. The data from 2012 to 2015 are from IMF (2015).

Source: Author's calculations based on data from Feenstra, Inklaar, and Timmer (2015) and IMF (2015).

The evolution of per capita income and growth rates over time can be explained by the conditional convergence theory. Conditional convergence of per capita (or per worker) output is predicted by an extended version of the neoclassical growth model, as described by Barro and Sala-i-Martin (2004). A country with a low initial per capita output relative to its own long-run (or steady-state) potential level of per capita output grows faster than a country with a higher level of per capita output. The basic concept is that the farther a country is located from its steady-state output or income level, the greater the gap of reproducible physical and human capital stock and productivity (i.e., technology) from its long-run levels. The gap of existing physical and human capital from steady-state levels offers the chance for a rapid catch-up via high rates of physical and human capital accumulation, which are encouraged by higher rates of return on investment.
In addition, the greater technology gap stimulates faster productivity improvement via the diffusion or imitation of technology from more technologically developed economies. Therefore, the lower the initial level of per capita output relative to the steady state, the higher the subsequent growth.

5.2.2 Catch-Up and Convergence in Output and Productivity

This subsection assesses the role of factor accumulation and productivity increase in the evolutionary process of the gap in income between two countries. The aggregate production function is used, and the level of per worker output is decomposed into productive inputs, including physical and human capital, and TFP based on the development accounting approach (Hall and Jones 1999).[6]

A simple Cobb–Douglas production function is assumed:

$$Y = AK^{(1-\alpha)}(hL)^{\alpha}, \quad (1)$$

[6] Lee (2005) adopted the same methodology to analyze the Republic of Korea's catch-up process over 1970–2000.

where Y is value-added output (GDP), K is physical capital, L is the number of workers, h is human capital per worker, and A is TFP. The labor share of output is given by α, which varies across countries and over time.

At the per worker level, the production function can be written as

$$y = Ak^{(1-\alpha)}h^{\alpha} \tag{2}$$

To assess how much of the gap in y is explained by differences in the two productive inputs, k and h, and in the TFP, the ratio of per worker output between two countries, i and j, is expressed as

$$y_i/y_j = (\overline{k_1}/\overline{k_j})(\overline{h_1}/\overline{h_j})(A_i/A_j), \tag{3}$$

where $\overline{k} = k^{(1-\alpha)}$, $\overline{h} = h^{\alpha}$.

Equation (3) enables the decomposition of the differences in per worker GDP between two countries into the differences in the physical capital–labor ratio, human capital per unit of labor, and TFP. Note that this framework relies on several simplifying assumptions. The estimate of TFP, which is an unobservable "residual," may incorporate many elements other than productivity, such as natural resources and business cycle factors. The distinction between factor accumulation and technology (i.e., productivity) increase is often ambiguous, because A, k, and h are not independent of each other.

The US is considered a reference country (j) in equation (3). Thus, the value of each term in equation (3) indicates the level of per worker output, physical capital per worker, human capital per worker, and TFP of the Republic of Korea (i) relative to that of the US.

To conduct the decomposition of output, data on GDP and physical capital stock are collected from the Penn-World Table 8.1 (Feenstra, Inklaar, and Timmer 2015). Labor shares are assumed to be 0.6 across countries and over time. The working-age population, sourced from the

United Nations (2015), is used as a measure for the number of workers. The available cross-country sources of labor force or employees are less reliable than those of the working-age population.

Human capital per worker is measured by the sum of the shares of workers across all education categories weighted by their relevant productivity, measured by relative wage rates (Barro and Lee 2015). The relative wage rate of a worker with schooling is calculated by assuming a constant marginal return rate to an additional year of schooling of 10%, which is the world average (Psacharopoulos 1994).

Table 5.2 presents the evolution of the gap in per worker output between the Republic of Korea and the US over time, while assessing the sources of the Republic of Korea's catch-up to the US. The Republic of Korea experienced a very rapid catch-up in per worker output over time. The value of per worker output increased from 8% of the US value in 1960 to 61% in 2010. The output catch-up process is associated with strong catch-up in physical and human capital accumulation and TFP. Physical capital shows the fastest expansion: the level of physical capital stock per worker in the Republic of Korea relative to that of the US increased tremendously from 7% in 1960 to 78% in 2010. This contrasts with the increase in the relative levels of human capital per worker from 60% to 97%, and TFP from 31% to 68% over the same period.

In addition, Table 5.2 shows that the pace of productivity catch-up slowed during 2000–2010. Indeed, the relative level of productivity decreased, although only marginally from 70% to 68% during this period. Note that this could have been caused by not only the slowdown of the Republic of Korea's productivity growth, but also the relatively high growth rates of productivity of the US economy in the early 2000s.

Table 5.2 also details the sources of Japan's catch-up in per worker output over time. For example, in 1960, the value of per worker output in Japan was only 29% of the value in the US, but rose to 78% in 2010. As in the Republic of Korea, in Japan, physical capital accumulation showed the fastest growth in this catch-up process.

Table 5.2: Output per Worker and Its Components: Ratio to United States Values, 1960–2010

Country	Year	Per Worker Output	Physical Capital per Worker	Human Capital per Worker	Total Factor Productivity
Republic of Korea	1960	0.08	0.07	0.60	0.31
	1970	0.11	0.10	0.64	0.38
	1980	0.20	0.15	0.69	0.53
	1990	0.33	0.24	0.81	0.67
	2000	0.47	0.45	0.88	0.70
	2010	0.61	0.78	0.97	0.68
Japan	1960	0.29	0.17	0.83	0.66
	1970	0.50	0.37	0.75	0.88
	1980	0.69	0.69	0.76	0.93
	1990	0.73	0.78	0.83	0.90
	2000	0.74	1.03	0.87	0.80
	2010	0.78	1.15	0.92	0.78
People's Republic of China	1960	0.07	0.02	0.50	0.47
	1970	0.06	0.02	0.50	0.39
	1980	0.06	0.03	0.52	0.37
	1990	0.07	0.04	0.54	0.35
	2000	0.09	0.09	0.59	0.34
	2010	0.17	0.20	0.61	0.44

Notes: Data on output and physical capital stock are sourced from Feenstra, Inklaar, and Timmer (2015), and data on the working-age population are sourced from the United Nations (2013). Human capital per worker is measured by the weighted sum of the shares of workers multiplied by the relative wage rates across all education categories. Relative wage rates are constructed assuming that the rates of return to an additional schooling year are constant at 10%.

Source: Author's calculations.

The level of physical capital stock per worker in Japan relative to that of the US increased from 17% in 1970 to 115% in 2010, contrasting with a moderate increase in the level of productivity from 66% to 78% of the US over the same period. Yet the pace of Japan's catch-up in per worker output has slowed since 1990. The level of per worker output in Japan relative to the US increased only marginally from 73% in 1990 to 78%

in 2010, probably due to the decline in productivity. The relative level of productivity in Japan deteriorated from 90% in 1990 to 80% in 2000 and further to 78% in 2010. By contrast, the relative levels of physical capital stock and human capital stock per worker continued to increase over the same period.

In addition, Table 5.2 shows that there is a significant difference in the levels of per worker output between the PRC and the three developed economies in the study. In 2010, the value of per worker output in the PRC was only 17% of that value in the US, comparable to the Republic of Korea's 1980 level (i.e., 20%).[7] The PRC's physical capital stock per worker level (20%) in 2010 relative to the US level is comparable to the Republic of Korea's level in the 1980s. The PRC's relative productivity level (44%) in 2010 is lower than that of the Republic of Korea in 1980.

Equation (3) can be transformed by taking logs to express the log difference in per worker output of the Republic of Korea with the US as an additive sum of three components:

$$\ln\left(\frac{y_{US}}{y_K}\right) = \ln\left(\frac{\overline{k_{US}}}{\overline{k_K}}\right) + \ln\left(\frac{\overline{h_{US}}}{\overline{h_K}}\right) + \ln\left(\frac{A_{US}}{A_K}\right) \tag{4}$$

Figure 5.3 shows the gap of per worker output and its sources at 10-year intervals from 1960 to 2010. In 1960, US per worker output was about 12.5 times the Republic of Korea's per worker output, which are decomposed into differences in per worker capital, human capital, and TFP.

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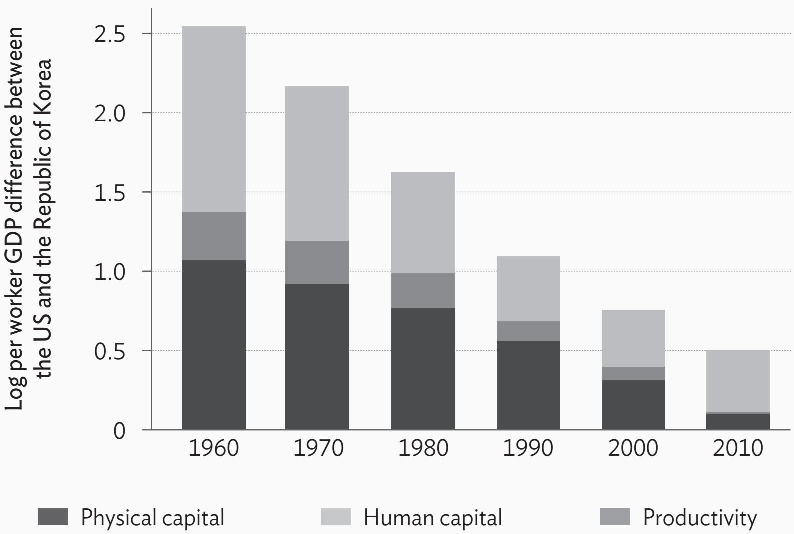
[7] Considering that the PRC has grown much faster than the US over the past 5 years, the value of per worker output in the PRC in 2015 is estimated to be approximately 23% of that value in the US. Note that the gap in per worker output of the PRC with the US is much larger than that in per capita output, because the PRC has a larger share of workers in total population than the US.

Figure 5.3: Change in the Gap of per Worker Output and Its Components between the Republic of Korea and the United States, 1960–2010



Note: The gap is expressed as the log difference in the value of each term between the United States and the Republic of Korea.

Source: Author's calculations based on equation (4).

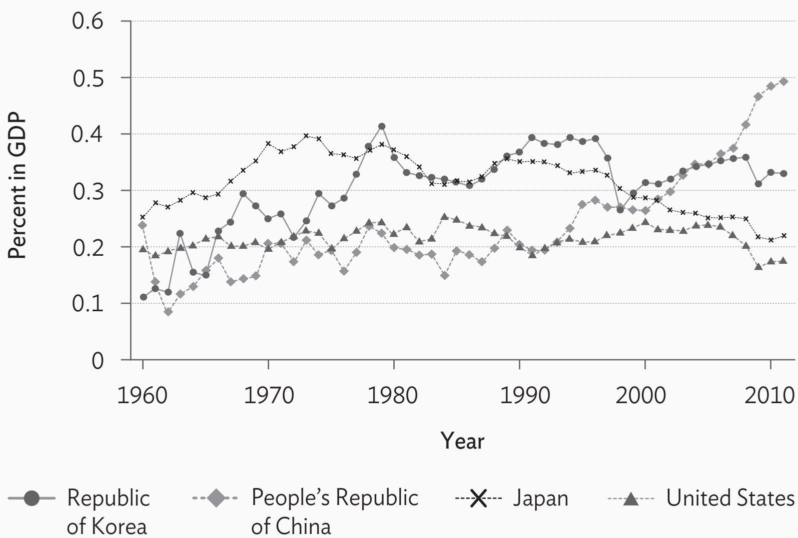
The income gap between the Republic of Korea and US continued to decrease over the past half-century. Over time, the gaps in physical capital and human capital per worker also decreased rapidly. By contrast, the productivity gap decreased only until 2000, and then increased. Currently, the productivity gap is the principal source of the income gap. If the Republic of Korea's productivity level is upgraded from the current 64% to 80% of that of the US, the Republic of Korea's per worker output would jump to 76% of that of the US, with gaps in the relative levels of physical capital and human capital per worker in 2010.

The results of development accounting explain that the Republic of Korea requires productivity improvement to further catch up to the US. During the Republic of Korea's fast catch-up phase of development, factor accumulation played an important role. Consequently, the

Republic of Korea now faces a much smaller gap in physical and human capital stock from both its long-run potential and US levels. Thus, according to the prediction of conditional convergence, the Republic of Korea economy will experience slower factor accumulation than it did in previous decades.

In terms of physical capital accumulation, the Republic of Korea has maintained very high investment rates throughout its catch-up process. The real investment–real GDP ratio continued to increase over time, from 10% of GDP in the early 1960s to close to 40% during the 1990s prior to the Asian financial crisis (Figure 5.4). The ratio dropped significantly during the crisis, recovered gradually to 35%, and then declined again.

Figure 5.4: Investment Rates of the People's Republic of China, Japan, the Republic of Korea, and the United States, 1960–2014



GDP = gross domestic product.

Source: Feenstra, Inklaar, and Timmer (2015).

The low investment rates relative to the pre-crisis level may suggest a permanent negative occurrence.[8] The rate of return of capital declined, as indicated by the Republic of Korea's low real interest rate. The permanent depression of investment would have negative consequences for the Republic of Korea economy's catch-up pace.

In addition, Figure 5.4 depicts investment rates for Japan and the PRC. Japan's investment rates increased to 40% in 1973, prior to the oil shock that began in the same year. In recent years, this has slowed to 20%. The PRC's investment rates continued to increase gradually over the 1960s, 1970s, and 1980s, and more rapidly from the early 1990s. The PRC currently invests almost 50% of its GDP, which is disproportionate compared to the historical experiences of Japan and the Republic of Korea.

Concerning the accumulation of human capital, the Republic of Korea's performance has been remarkable. Figure 5.5 shows that education expanded significantly over the past half-century. The number of average years of schooling increased from only 4.1 years in 1960 to 12.0 years in 2010. As a result, the gap in the average educational attainment between the Republic of Korea and the US narrowed substantially. The Republic of Korea's dramatic catch-up reflects the rapid increase in school enrollment rates for all education levels. Considering that enrollment ratios at secondary and tertiary levels will not increase much beyond current levels—which are among the highest in the world—the speed of the Republic of Korea's human capital accumulation will eventually decelerate.[9]

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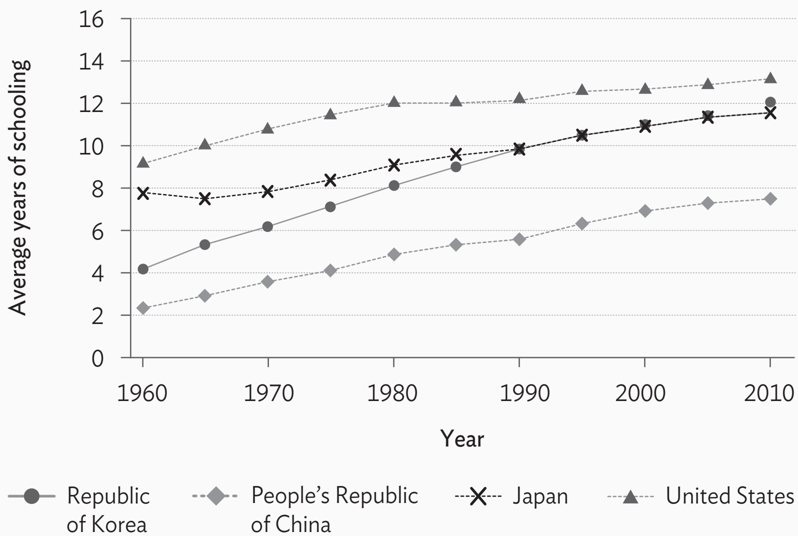
8 Barro and Lee (2003) suggested that, based on broad international evidence, a financial crisis typically has a persistent adverse effect on investment. In addition, they found that the 1997/98 Asian financial crisis has had a long-term negative impact on investment in the Republic of Korea's economy.

9 The number of average years of schooling does not take into account the differences in the quality of schooling and measurement of skills obtained on the job. Thus, the Republic of Korea could continue to improve the quality of its human resources to catch up to the US. See the discussion of educational quality and adult skills in Barro and Lee (2015).

Figure 5.5: Trends of Average Schooling Years of Total Population Aged 15 Years and Over, 1960–2010



Source: Barro and Lee (2013).

5.3 Determinants of Economic Growth and the Republic of Korea's Catch-Up

5.3.1 Cross-Country Analyses of Economic Growth

This section applies the framework of cross-country analyses of economic growth to investigate the major factors that explain the Republic of Korea's growth and catch-up experience over the past half-century.

The conditional convergence theory implies that each country has its own steady-state levels of per worker output to which it is converging.

The basic framework is expressed as

$$Dy_{it} = f(y_{it}, y_i^*) \quad (5)$$

where Dy_{it} is country *i*'s per worker GDP growth rate in period *t*, is the country's per worker output, and y_i^* its own long-run (or steady-state) level of *y*. Dy_{it} is inversely related to *y*, indicating conditional convergence of per worker output to its own steady-state level over time. In the cross-country context, countries with higher per worker output would grow slower than those with lower per worker output when controlling for the variables influencing the steady-state level. Consistent with the production function, the dependent variable is expressed as the growth in per worker output rather than per capita output. Note that the per capita output growth rate is calculated by the per worker output growth rate added to the growth rate of the share of the working-age population to the total population.

The long-term level of per worker output depends on various external environmental and policy variables. In the extended neoclassical growth model, the steady-state level of per worker output is determined by investment rate, population growth, and human capital (Mankiw, Romer, and Weil 1992). Previous theoretical and empirical studies consider institutions and policy factors as other important determinants of long-run per worker output. These factors include government consumption, institutional quality, macroeconomic stability, trade openness to the world economy, and democracy (Barro and Lee 1994, Barro and Sala-i-Martin 2004).

The empirical framework can be represented by a reduced form, such as[10]

$$Dy_{i,t} = \beta_0 + \beta_1 \log(y_{i,t}) + \beta_2 X_{i,t} + \varepsilon_{i,t}, \qquad (6)$$

where *Xi* denotes an array of the variables that influence country *i*'s steady-state level of per worker output.

[10] The specification and data follow those of Barro and Lee (2015), with the updated national accounts data from the Penn-World Table 8.1 in Feenstra, Inklaar, and Timmer (2015).

The regression of equation (6) applies to a panel set of cross-country data for 75 countries over ten 5-year periods from 1960 to 2010: 1960–1965, 1965–1970, 1970–1975, 1975–1980, 1980–1985, 1985–1990, 1990–1995, 1995–2000, 2000–2005, and 2005–2010. The panel is unbalanced, with 713 observations in total. This system of 10 equations is estimated by adopting instrumental variable (IV) estimation techniques to control for the endogeneity of explanatory variables. Instruments are mostly lagged values of the explanatory variables. The estimation results from the IV panel estimation with and without country-fixed effects are presented. The exclusion of country-fixed effects can cause bias of the estimates; however, the fixed-effects technique eliminates information from cross-section variations and could exacerbate measurement errors, especially if the timing of relationships is not known (Barro and Lee 2015).

The representative set of the explanatory variables, X_i, includes investment, fertility, and human capital as fundamental growth factors. The stock of human capital is measured by the average years of schooling for the population aged 15–64 years. In addition, the regression includes the reciprocal of life expectancy at birth as a measure of the health of workers in an economy. Five other variables are included to control for institution and policy variables: government consumption, overall maintenance of the rule of law, inflation rate, trade openness, and democracy. A measure for changes in the terms of trade is included as an exogenous factor.[11] In addition, the regressions include period dummies to control for common shocks to per worker GDP growth in all countries.

Summary statistics of the variables for 1965–1970 and 2005–2010 for the PRC, the Republic of Korea, Japan, the US, and the world are presented in the Appendix.

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11 A measure of financial crisis was also considered as an independent variable, but it is statistically insignificant. As discussed in footnote 9, the impact of financial crisis on growth can occur through its adverse effect on investment.

Table 5.3: Cross-Country Panel Regressions for per Worker Gross Domestic Product Growth Rate

Regression	(1)	(2)
Log (per worker GDP)	–0.0230*** (0.00236)	–0.0343*** (0.00352)
Investment/GDP	0.0364** (0.0162)	0.0353* (0.0208)
Log (total fertility rate)	–0.0246*** (0.00445)	–0.0185*** (0.00622)
Average years of schooling	–0.00352* (0.00183)	–0.00552** (0.00243)
Average years of schooling squared	0.000292** (0.000122)	0.000365** (0.000158)
1/Life expectancy	–3.275*** (0.662)	–2.157** (0.990)
Trade openness	0.00616** (0.00302)	0.00702 (0.00601)
Government consumption/GDP	–0.00954 (0.0127)	–0.00697 (0.0153)
Rule of law index	0.0184*** (0.00572)	0.0115 (0.00806)
Inflation rate	–0.0163* (0.00942)	–0.0272** (0.0132)
Democracy index	0.0402** (0.0181)	0.0249 (0.0224)
Democracy index squared	–0.0380** (0.0164)	–0.0200 (0.0203)
Growth rate of terms of trade	0.0665** (0.0262)	0.0588** (0.0264)
Country fixed effect	no	yes
Period dummies	yes	yes
Number of economies, observations	75,713	75,713

GDP = gross domestic product.

Notes:

1. The system has 10 equations, corresponding to 1960–1965, 1965–1970, 1970–1975, 1975–1980, 1980–1985, 1985–1990, 1990–1995, 1995–2000, 2000–2005, and 2005–2010. The sample consists of 75 economies. The system is estimated by adopting instrumental variable (IV) estimation techniques. Instruments are mostly lagged values of the explanatory variables. The dependent variables are the growth rates of per worker GDP.
2. Standard errors are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

continued on next page

Table 5.3: *Continued*

Notes: (Continuation)

3. The specification and data closely follow those in Barro and Lee (2015), but use the updated national accounts data from the Penn-World Table 8.1 in Feenstra, Inklaar, and Timmer (2015).
4. Per worker GDP levels and growth rates are based on 2005 international prices (adjusted for purchasing power parity).
5. The investment ratio is the ratio of real investment (private plus public) to real GDP.
6. The government consumption measure is the ratio of real government consumption to real GDP, based on the Penn-World Table 8.1. They are averaged over the period.
7. Schooling data are the average years of schooling for the population aged 15–64 years from Barro and Lee (2013).
8. Life expectancy at birth and the fertility rate are from World Bank (2015).
9. The rule of law index, expressed on a 0–1 scale, with 1 being the most favorable, is based on the maintenance of the rule of law index in PRS Group (2015).
10. The inflation rate is the growth rate over each period of a consumer price index.
11. The trade openness variable is the ratio of exports plus imports to GDP.
12. The democracy index, expressed on a 0–1 scale, with 1 being the most favorable, is based on the indicator of political rights compiled by Freedom House (2015).
13. The growth rate of the terms of trade is the change of export prices to import prices over the period.

Column 1 of Table 5.3 presents the regression results of equation (6) without country-fixed effects. The negative estimate of the coefficient on the first explanatory variable, the log of per worker GDP at the start of each period, reveals a strong conditional convergence effect. The estimated speed of conditional convergence is about 2.3% per year, implying that a country at half of the per worker output level of another country tends to grow by 1.6 percentage points (= 2.3 x ln[2]) faster than the richer country, assuming the same level of long-term per worker output.

The investment rate has a positive and statistically significant effect on growth. The log of the total fertility rate is significantly negative. The estimated coefficient on the reciprocal of life expectancy at birth is negative and highly significant, indicating that better health is associated with higher economic growth.

The regression result shows the nonlinear relationship between human capital stock and growth, as discussed in Barro and Lee (2015).

The coefficients on average years of schooling and its square term are negative and positive, respectively, although only the square term is marginally statistically significant. The pattern of the coefficients demonstrates that the growth rate increases with the level of educational attainment only when the society has attained 6.0 average years of schooling. Hence, only countries that have accumulated human capital above a certain threshold are able to experience higher GDP growth induced by an increase in educational attainment for given values of the other explanatory variables.

The regression results show that government policies and institutions play a significant role in determining economic growth. A subjective measure of the extent of maintenance of the rule of law is significantly positive. Increased openness to international trade is a positive determinant for growth, although the estimated coefficient is marginally significant.

The level of democracy has a nonlinear relationship with growth, as found by Barro (1996). The coefficients on the indicator of democracy and its square term are positive and negative, respectively, and both coefficients are jointly statistically significant. The pattern of the coefficients on the indicator of democracy and its square term indicates that the GDP growth rate increases with political freedom at low levels of democracy but decreases with democracy once the society has attained a certain level of political freedom. The threshold level is 0.53. The nonlinear relation suggests that autocracy can have negative effects on growth if a leader uses his or her power to steal the nation's wealth, but more democracy above the threshold level can also retard growth if it promotes income-redistributive policies, rather than pro-growth ones, in systems of majority voting.

Inflation, an indicator of macroeconomic instability, has a negative effect on growth, but the estimated coefficient is not statistically significant. The government consumption–GDP ratio is statistically insignificant. A higher growth rate of the terms of trade (i.e., export prices relative to import prices) has a strong, positive effect on economic growth.

In summary, the regression results in column 1 show that per capita GDP growth has strong relationships with the initial per capita GDP level, investment, fertility, the quality of human resources, rule of law maintenance, trade openness, and democracy.

Column 2 of Table 5.3 adds country-fixed effects. The results are similar to those of column 1. The estimated coefficient on the log of per worker GDP remains statistically significant. The estimated speed of conditional convergence increases to about 3.4% per year. Since the unobserved country-specific factors that influence the steady-state value of per worker output are likely to have positive relationships with current per worker GDP, the omitted variables tend to bias upward the estimated effect of lagged per worker GDP on growth. Consequently, the inclusion of the country-fixed effects tends to lower the convergence rate below zero.

The results with country-fixed effects show that some economic policy and institutional factors, such as rule of law and trade openness, become statistically insignificant. In contrast, the estimated coefficient on inflation becomes statistically significant.

5.3.2 The Republic of Korea's Economic Growth in Comparative Perspective

The growth regressions imply that the Republic of Korea has grown faster than high-income countries by many factors, including convergence, due to the low level of per worker output relative to its long-term level as well as favorable environmental and policy factors influencing the long-term potential level of per worker output, y_i^*, to which the Republic of Korea has been converging.

The Republic of Korea's relatively favorable environment and policy factors have facilitated faster catch-up to the developed economies than other developing countries with the same level of per worker output over the transition to a higher steady-state level of per worker output. Note that these factors could affect both the rate of factor accumulation and of productivity growth.

The cross-country regression results allow analysis of the growth performance of the Republic of Korea relative to that of the US. The point estimates of the parameters in the regressions of Table 5.3 are used for simple accounting that breaks down the fitted values of growth rates for each country into the contributions from each explanatory variable. Although the residual errors in individual country growth rates are substantial, it is worthwhile to examine the differences in the explanatory variables that generate the differences in the fitted growth rates. The accounting results can be used to explore the sources of the differences in the fitted growth rates between the Republic of Korea and the US.[12]

Table 5.4 presents the results of the accounting exercise in this study. The basic regression can account for a substantial part of the growth differences between the Republic of Korea and the US over time. The predicted growth rates of the Republic of Korea are higher than those of the US over the period. Growth rate differentials are shown by the averages over three subperiods: 1960–1980, 1980–2000, and 2000–2010. The results in panel A of Table 5.4 are based on the estimates in column (1) of Table 5.3; the estimated growth rate differentials are 2.0, 2.6, and 3.1 percentage points for each subperiod, while the actual differences are 4.0, 3.9, and 2.9 percentage points. Therefore, the model underestimates the Republic of Korea's relative growth performance in the earlier subperiods.

The cross-country regressions represent the "average" relationships applied to all countries across time. Some individual countries undoubtedly differ in terms of the magnitude of the relationships, and in terms of the list of the most important variables affecting growth.

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12 Using the same technique, De Gregorio and Lee (2004) compared the economic performance of East Asian economies relative to those in Latin America, and showed that the better growth performance of East Asia is largely attributable to "fundamental growth factors," including high savings rates, strong human capital, high trade openness, maintenance of good institutions, and prudent fiscal and monetary management.

Table 5.4: Contributions to Growth Differentials between the Republic of Korea and the United States, 1960–1980, 1980–2000, and 2000–2010 (%, annual average)

	1960–1980	1980–2000	2000–2010	(2000–2010)
Without Country-Fixed Effects (A)				
Difference in				
Actual growth	0.0395	0.0387	0.0294	
Predicted growth	0.0195	0.0259	0.0309	(100.0%)
Initial income	0.0484	0.0294	0.0165	(53.3%)
Investment rate	0.0023	0.0046	0.0041	(13.2%)
Fertility	−0.0122	0.0022	0.0132	(42.8%)
Schooling	−0.0070	−0.0070	-0.0030	(−9.6%)
Life expectancy	−0.0070	−0.0028	0.0004	(1.3%)
Government consumption	−0.000029	−0.000023	−0.000189	(−0.6%)
Rule of law	−0.0092	−0.0082	−0.0021	(−7.0%)
Inflation rate	−0.0014	−0.0003	−0.0001	(−0.4%)
Democracy	0.0069	0.0062	0.0021	(6.6%)
Openness	0.0010	0.0019	0.0023	(7.3%)
Terms of trade	0.000002	−0.0002	−0.0022	(−7.0%)
With Country-Fixed Effects (B)				
Difference in				
Actual growth	0.0395	0.0387	0.0294	
Predicted growth	0.0501	0.0402	0.0356	(100.0%)
Initial income	0.0721	0.0439	0.0245	(68.9%)
Investment rate	0.0023	0.0045	0.0040	(11.1%)
Fertility	−0.0092	0.0017	0.0099	(27.8%)
Schooling	−0.0044	−0.0062	−0.0029	(−8.0%)
Life expectancy	−0.0046	−0.0018	0.0003	(0.7%)
Government consumption	−0.00002	−0.00002	−0.00014	(−0.4%)
Rule of law	−0.0058	−0.0051	−0.0013	(−3.8%)
Inflation rate	−0.0024	−0.0005	−0.0002	(−0.6%)
Democracy	0.0016	0.0020	0.0008	(2.3%)
Openness	0.0012	0.0022	0.0026	(7.3%)
Terms of trade	0.000002	−0.0002	−0.0019	(−5.4%)

Note: The predicted per capita growth rates in panels A and B are based on the estimation results of columns 1 and 2 in Table 5.3, respectively.

The accounting result indicates that while the basic set of explanatory variables explains most of the differences in growth rates between the Republic of Korea and the US, there are other unexplained factors that made the Republic of Korea grow faster than other countries in the sample, in particular, in the 1970s and 1980s.

The accounting exercise in Table 5.4 breaks down the predicted differences separately into the contributions from the 11 explanatory variables. The result shows that the lower income level of the Republic of Korea compared to that of the US led to higher growth over the whole period because of the convergence effect. However, the magnitude of the convergence effect became smaller over time as the Republic of Korea caught up to the US in per capita income: this effect declined from 4.8 percentage points a year over 1970–1990 to 2.9 percentage points a year in 1980–2000, and then 1.7 percentage points a year in 2000–2010.

While the convergence effect is an important factor explaining the Republic of Korea's growth performance, the rest of the explanatory variables also influenced a significant part of the growth difference. For example, during 2000–2010, the model predicts an average growth rate for the Republic of Korea that is 3.1 percentage points per year higher than that of the US. The convergence effect explains a difference of 1.7 percentage points, while the rest of the factors influencing growth explain the remainder (1.4 percentage points).

The exercise shows that higher investment rates in the Republic of Korea explain about 0.2–0.5 percentage points, and trade openness accounts for about 0.1–0.2 percentage points in growth differentials over the whole period. The gap between the Republic of Korea and the US in terms of human resources (i.e., schooling and life expectancy) contributes to lowering the growth of the Republic of Korea relative to that of the US by 1.4 percentage points over 1960–1980. However, as the Republic of Korea experienced improvements in human resources, the human resources variables explain a smaller difference of 0.3 percentage points in 2000–2010.

In addition, the Republic of Korea has improved institutional quality, which has contributed positively to growth. The relatively low level of the rule of law variable accounts for about 0.8–0.9 percentage points of slower growth of the Republic of Korea relative to the US over 1960–2000. However, this drops to only 0.2 percentage points in 2000–2010. The Appendix shows the values of the variables in 1965–1970 and 2005–2010 for the Republic of Korea and the US. The Republic of Korea has caught up rapidly to the US in human resources, policy, and institutional variables from 1970 to 2010.

The Republic of Korea had higher fertility rates in earlier periods, but now has lower fertility rates than the US. The change in the fertility gap between the Republic of Korea and the US is predicted to contribute positively to the higher growth of the Republic of Korea with a net effect of 1.3 percentage points over 2000–2010. Note that the estimated positive effect of fertility is applied to per worker GDP growth rates rather than per capita GDP growth rates. While the decrease in fertility has a positive effect on per worker (or per capita) output growth by lowering population growth and raising the steady-state per worker output, it eventually has a negative effect on per capita output growth when it leads to a decline in the working-age population.

An interesting prediction is that improvement in democracy contributes negatively to the catch-up in recent decades in the Republic of Korea. The Republic of Korea’s level of democracy indicator is slightly lower than the critical level of 0.53 in the 1970s and then increases above the critical level in 1989 (0.533). Thereafter, the nonlinear relationship between democracy and growth works unfavorably for the Republic of Korea’s catch-up to the US in per capita income.

Panel B of Table 5.4 presents the predicted growth rates that are based on the estimates in column 2 of Table 5.3. The estimated growth rate differentials are 5.0, 4.0, and 3.6 percentage points for each subperiod. Therefore, the model overestimates the Republic of Korea’s actual growth rate differentials in all subperiods. The effect of the difference of per worker output levels between the two countries on subsequent growth differentials becomes much larger in panel B than in panel A due to the larger convergence estimate. The predicted effects of the differences in other environment and policy variables—human resources, investment, fertility, rule of law, inflation, democracy, and trade openness—on growth differentials between the Republic of Korea and the US are broadly similar to those in panel A.

For the Republic of Korea, the ratio of the working-age population to total population is expected to decline from 73.1% in 2010 to 70.6% in 2020, and further to 62.3% in 2030 (United Nations 2013). The decline in the working-age population ratio has additional negative effects on per capita GDP growth of −0.3% in 2010–2020 and −1.3% in 2020–2030 (Table 5.5).

Table 5.5: Population and Working-Age Population Growth for the People's Republic of China, Japan, the Republic of Korea, and the United States (per year, %)

Country	Growth	1960–1970	1970–1980	1980–1990	1990–2000	2000–2010	2010–2020	2020–2030	2030–2040
Republic of Korea	GRp	2.63	1.75	1.38	0.68	0.47	0.57	0.39	−0.19
	GRw	2.12	3.07	2.47	1.00	0.66	0.22	−0.87	−0.95
	GRw–GRp	−0.51	1.31	1.09	0.33	0.19	−0.35	−1.26	−0.76
Japan	GRp	1.03	1.11	0.53	0.28	0.07	−0.12	−0.41	−0.51
	GRw	1.86	0.90	0.87	0.06	−0.54	−0.93	−0.70	−1.23
	GRw–GRp	0.82	−0.21	0.34	−0.22	−0.6	−0.81	−0.29	−0.72
United States	GRp	1.27	0.93	0.97	1.09	0.94	0.73	0.64	0.49
	GRw	1.50	1.57	0.97	1.18	1.05	0.31	0.05	0.41
	GRw–GRp	0.24	0.64	−0.01	0.09	0.11	−0.43	−0.59	−0.09
People's Republic of China	GRp	2.32	1.88	1.53	1.03	0.56	0.62	0.09	−0.15
	GRw	2.14	2.54	2.56	1.34	1.45	−0.07	−0.31	−1.06
	GRw–GRp	−0.18	0.66	1.03	0.31	0.89	−0.69	−0.40	−0.91

GRp = population growth, GRw = working-age population growth.

Source: Author's calculations based on the United Nations (2013).

Overall, the Republic of Korea's historical experience of economic growth and catch-up to the US is largely attributed to the Republic of Korea's favorable growth factors. Relatively low per worker output level, high investment rate, strong human capital, high trade openness, maintenance of good institutions, and low inflation have contributed to strong growth. Since the Republic of Korea's rapidly growing economy has continued to narrow the gap with the US in per capita income and levels of environmental and institutional variables, it has inevitably encountered a slowdown in growth potential.

5.4 Sector Productivity and Economic Growth in the Republic of Korea

The Republic of Korea's remarkable economic transformation since the early 1960s has been characterized by fast industrialization and strong economic growth, with the manufacturing sector being a key growth driver. In the early 1960s, the Republic of Korea shifted its economic policy focus from import substitution to export orientation, to support industrialization and economic growth. Export-oriented policies, designed to provide incentives to export firms based on their performance, were effective in pushing the pace of change in comparative advantage. The exposure to international export markets and performance-based government support stimulated efficiency improvement and faster productivity growth in manufacturing industries, which successfully underwent diversification stages. The numbers of goods produced expanded along with quality upgrades of existing products. Exporters were able to build up their comparative advantage in labor-intensive manufacturing and then to move to more capital- and technology-intensive industries, including electronics, machinery, automobiles, ships, chemicals, and information and communications technology products.

Overall, the Republic of Korea's export-oriented growth strategy has worked in its favor, enabling the country to sustain strong growth and transform into a more technologically developed economy.

However, the strategy has also made the country vulnerable to external shocks. The Republic of Korea economy came to rely increasingly on external demand to drive growth. Exports accounted for about 56% of GDP in 2014 from 15% in 1970 and 34% in 2002. As during the global financial crisis, overreliance on external demand has made the Republic of Korea susceptible to the economic recession in industrial countries as well as drop in global demand.

An imbalance between the Republic of Korea's manufacturing and services sectors is another outcome of its export-promotion strategy that encouraged more investment in manufacturing than in services. Despite the size of the Republic of Korea's services sector, which employs 76% of the country's workers, the sector's contribution to overall economic growth is small, owing to its low productivity. Value added per worker in the services sector remains just 48% of that in the manufacturing sector. Table 5.6 shows value added per worker for nine sectors, including four services industries for the PRC, the Republic of Korea, Japan, and the US in 2010.

Within the services sector, the levels of labor productivity across services industries are diverse. In general, labor productivity is relatively high in the transport, storage, and communications industry and the finance, insurance, real estate, and business services industry (Table 5.6). In contrast, the wholesale and retail trade, hotels, and restaurants industry has shown a lower productivity level relative to the manufacturing sector. It is notable that the finance, real estate, and business services industry had higher labor productivity than the manufacturing sector in the PRC, Japan, and the US, but had lower productivity in the Republic of Korea in 2010.

The annual labor productivity growth in the services sector was only 1.6%, which is significantly lower than that in the manufacturing sector of 7.7% for 1980–2010 (Table 5.7). The average annual growth in per worker value added dropped from 2.5% during 1980–1990 to an annual average of 1.2% during 1990–2000 and 1.1% during 2000–2010. The Republic of Korea services industries, including finance, real estate, and business services as well as community and government services, have shown negative or zero growth of per worker value added over all subperiods.

The lower productivity growth of the stagnant services sector relative to the manufacturing sector has been well known since the seminal study of Baumol (1967). Hence, the fact that the Republic of Korea services sector has had relatively lower productivity growth than the country’s manufacturing sector is not extraordinary. However, the differentials in labor productivity (i.e., per worker value added) and growth rates in labor productivity between the two sectors have been much larger in the Republic of Korea compared to other industrialized economies.

Table 5.6: Ratio of Each Sector’s per Worker Value Added to Manufacturing per Worker Value Added in 2010

Industry	Republic of Korea	Japan	People’s Republic of China	United States
Agriculture, hunting, forestry, and fishing	0.24	0.22	0.18	0.55
Manufacturing	1.00	1.00	1.00	1.00
Services	0.48	0.94	0.64	0.64
Wholesale and retail trade, hotels, and restaurants	0.25	0.60	0.56	0.38
Transport, storage, and communications	0.61	1.00	1.06	0.83
Finance, real estate, and business services	0.83	1.55	1.79	1.25
Community and government services	0.47	0.84	0.31	0.48
Others	0.74	0.95	0.83	0.82
Mining and quarrying	1.99	1.14	1.82	2.44
Electricity, gas, and water	3.64	6.41	2.70	2.90
Construction	0.59	0.72	0.50	0.48
Aggregate economy	0.58	0.91	0.58	0.68

Notes: Japan uses 2009 values for 2010. For international comparison, the relative level of per worker value added is calculated using nominal value added.

Sources: World KLEMS, http://www.worldklems.net; Asia KLEMS, http://asiaklems.net; and RIETI. China Industrial Productivity (CIP) 3.0 Database. http://www.rieti.go.jp/en/database/CIP2015/index.html

Table 5.7: Growth Rate of per Worker Value Added by Sector (%)

Industry	1980–1990	1990–2000	2000–2010	1980–2010
Republic of Korea				
Agriculture, hunting, forestry, and fishing	7.02	5.58	4.73	5.78
Manufacturing	7.58	9.94	5.47	7.66
Services	2.45	1.22	1.13	1.60
Wholesale and retail trade, hotels, and restaurants	4.90	1.34	2.56	2.94
Transport, storage, and communications	3.72	5.14	4.13	4.33
Finance, real estate, and business services	–0.55	–1.05	–1.37	–0.99
Community and government services	–0.20	–0.08	–1.06	–0.45
Others	5.54	2.09	1.20	2.94
Mining and quarrying	5.12	14.84	–2.07	5.96
Electricity, gas, and water	11.40	10.08	3.20	8.23
Construction	5.21	0.80	0.59	2.20
Aggregate economy	5.54	4.14	2.56	4.08
Japan				
Agriculture, hunting, forestry, and fishing	3.92	2.33	1.34	2.57
Manufacturing	3.25	1.48	2.00	2.25
Services	1.39	0.45	0.26	0.71
Wholesale and retail trade, hotels, and restaurants	2.02	1.41	–0.53	1.02
Transport, storage, and communications	2.43	0.96	1.93	1.77
Finance, real estate, and business services	–0.09	0.05	–0.81	–0.27
Community and government services	0.16	–0.61	0.47	–0.01
Others	2.91	–2.30	0.66	0.42
Mining and quarrying	1.94	–0.42	–1.98	–0.09
Electricity, gas, and water	6.16	2.69	2.39	3.79
Construction	2.53	–3.41	0.37	–0.19
Aggregate economy	2.43	0.63	0.72	1.28
People's Republic of China				
Agriculture, hunting, forestry, and fishing	2.34	2.73	4.14	3.09
Manufacturing	10.64	19.51	14.54	15.04
Services	–0.70	–1.33	5.78	1.32
Wholesale and retail trade, hotels, and restaurants	–16.02	–2.76	8.64	–2.95
Transport, storage, and communications	0.87	4.83	11.22	5.80

continued on next page

Table 5.7: *Continued*

Industry	1980–1990	1990–2000	2000–2010	1980–2010
Finance, real estate, and business services	11.02	3.41	−3.00	3.56
Community and government services	−2.35	−8.90	2.63	−2.89
Others	−1.31	−0.19	4.78	1.17
Mining and quarrying	−3.65	6.39	1.43	1.56
Electricity, gas, and water	6.63	−8.75	12.46	3.34
Construction	−3.87	−1.93	3.38	−0.70
Aggregate economy	4.72	7.25	9.94	7.39
United States				
Agriculture, hunting, forestry, and fishing	8.67	3.33	2.54	4.85
Manufacturing	4.07	4.82	4.12	4.34
Services	0.34	1.16	1.32	0.94
Wholesale and retail trade, hotels, and restaurants	3.29	3.76	1.29	2.78
Transport, storage, and communications	1.40	2.09	3.59	2.36
Finance, real estate, and business services	−1.56	0.78	2.32	0.51
Community and government services	−0.12	−0.36	0.01	−0.15
Others	0.24	−0.73	−1.25	−0.58
Mining and quarrying	6.36	1.67	−3.46	1.52
Electricity, gas, and water	−0.26	1.26	2.08	1.03
Construction	−0.55	−0.45	−3.03	−1.34
Aggregate economy	0.98	1.45	1.33	1.25

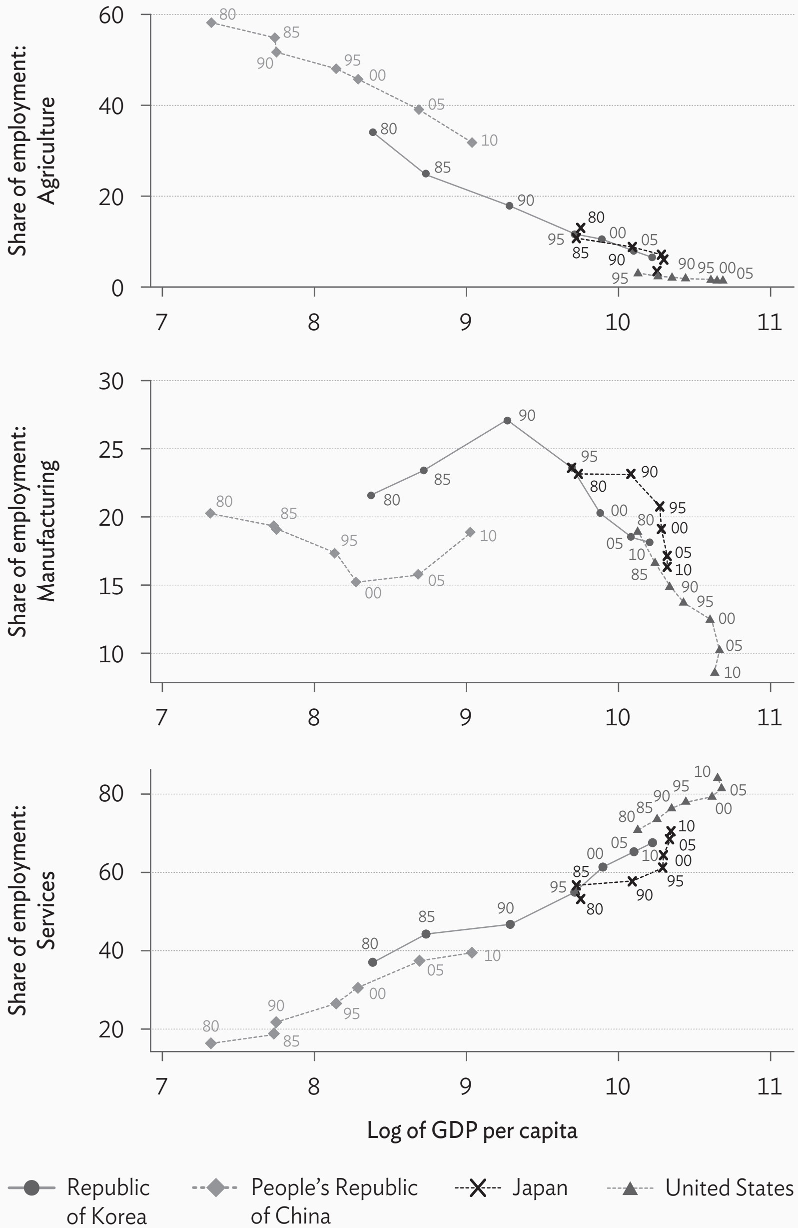
Notes: Data from the People's Republic of China are from 1981 to 2010, and data from Japan are from 1980 to 2009.

Sources: World KLEMS, http://www.worldklems.net; Asia KLEMS, http://asiaklems.net;and RIETI. China Industrial Productivity (CIP) 3.0 Database. http://www.rieti.go.jp/en/database/CIP2015/index.html

Figure 5.6 confirms the stylized pattern of structural change in the literature.[13] An increase in GDP per capita is associated with a decrease in agriculture employment and an increase in employment

[13] See Chenery (1960); Herrendorf, Rogerson, and Valentinyi (2014); and Lee and McKibbin (2014).

Figure 5.6: Sector Shares of Employment, 1980–2010 (%)



GDP = gross domestic product.

Sources: Author's calculations based on sector employment data from World KLEMS, http://www.worldklems.net; Asia KLEMS, http://asiaklems.net;and RIETI. China Industrial Productivity (CIP) 3.0 Database. http://www.rieti.go.jp/en/database/CIP2015/index.html. GDP data are from Feenstra, Inklaar, and Timmer (2015).

in the services sector. The manufacturing employment share shows hump-shaped changes. The PRC has been following the stylized pattern, although it had a larger share of employment in the agriculture sector and a smaller share in the manufacturing sector in 2010, compared to the Republic of Korea and Japan in the 1980s.

It is clear that there have been major employment shifts toward the services sector in selected Asian economies over 1980–2010. In the Republic of Korea, the share of employment in the services sector increased dramatically from 37.0% in 1980 to 67.5% over 1980–2010. This share increased in Japan from 53.1% to 70.2% over the same period. In the PRC, the employment share of the services sector increased over the same period from 16.4% to 39.3%.

The low labor productivity of the services sector relative to the manufacturing sector tends to hamper overall productivity growth. Lee and McKibbin (2014) showed a negative relationship between the overall labor productivity growth rate of an economy and the employment share of its services sector.

A key to the Republic of Korea's further growth is to rebalance its economy through diversification of growth sources. A new growth strategy should entail productivity increases in services industries. Structural reforms to stimulate productivity growth in the services sector are essential for sustained long-term growth. One of the effective ways to raise productivity is developing modern services industries, including health care, education, telecommunications, business processing, and legal and financial services (Eichengreen and Gupta 2013). Lowering product regulations and barriers to foreign direct investment would promote more competition and boost new technology innovation. Enhancing services sector productivity is important for the Republic of Korea to obtain a second growth driver that could propel strong, sustainable growth in the future.

5.5 Implications for the People's Republic of China's Sustained Growth

As discussed, the Republic of Korea's economy, like those of other developing countries, started its conditional convergence and catch-up process with low initial per worker output relative to its own long-run (or steady-state) potential, which provided the opportunity for faster capital accumulation and technology diffusion. Good environmental and policy factors, such as a high investment rate, strong human capital, trade openness, and improved institutions, guided the economy toward a higher level of long-run steady state compared to other economies, enabling the Republic of Korea to realize its strong potential for catching up. For this successful catch-up, the Republic of Korea's manufacturing- and export-oriented growth strategy played a critical role. International trade provided large external markets for Republic of Korea products and facilitated imitation and adoption of advanced technologies. Continuous product diversification and technology upgrading in the manufacturing sector also characterized the Republic of Korea's economic development.

The PRC economy has also grown fast over the last 35 years, as it transformed from a controlled socialist economy to a market-oriented economy. During this period, the PRC has shown strong output growth, which averaged more than 9.5% annually, and rapidly narrowed its per capita income gap with the Republic of Korea, Japan, and the US. Its unprecedented economic growth since the 1980s reflects a strong convergence effect fueled by economic reform and opening. In addition, abundant human resources, high savings and investment rates, and prudent macroeconomic management have contributed to the strong growth. The PRC's economic power continues to rise, making it the largest economy in the world. Its share of world GDP in PPP terms is projected to reach about 17% in 2015, exceeding that of the US and European Union (IMF 2015). Advancing from upper middle-income to high-income status, the PRC now strives to develop more technologically sophisticated industries.

Although its economy has grown rapidly and its per capita income gap has diminished, the PRC showed increasing average growth rates until recent years. This acceleration of economic growth in the takeoff stage of development also occurred in the Republic of Korea until 1990 and in Japan until 1970 (Figure 5.2). The PRC caught up fast to the US in terms of per worker output and per capita income. In 1980, the value of per worker output in the PRC remained only 6% that of the US, which rose to 17% in 2010.

Although the PRC has caught up to developed economies very fast, a significant development gap still exists between the PRC and developed economies. The PRC's average per capita income level relative to the US in 2010–2014 is lower than the Republic of Korea's level in 1990 and Japan's level in 1970.

Physical capital accumulation has contributed most significantly to the PRC's catch-up process, as it did for the Republic of Korea. The level of physical capital stock per worker in the PRC relative to that of the US increased significantly from 3% in 1970 to 20% in 2010. By contrast, the relative level of productivity increased at a modest rate from 39% to 44% of the US over the same period. Because the current levels of physical capital accumulation, human capital stock, and TFP relative to the US are comparable to the Republic of Korea's levels in the 1970s and 1980s, the PRC must have significant room to catch up to the US in per worker output by increasing factor accumulation and productivity growth. Economic growth can remain strong; however, it will eventually decelerate.

In fact, the PRC economy is currently experiencing a slowdown. The PRC recorded a 6.9% GDP growth rate in 2015, the slowest since 1990, and it is expected to continue slowing. The International Monetary Fund (2016) forecasted a growth rate of 6.3% in 2016 and 6.0% in 2017. The reduced return on investment has lowered physical capital accumulation, as it cannot continue to maintain the unprecedented level of investment ratio over 45%. In addition, labor inputs have dropped due to fertility decline and population aging.

With limited institutional and innovative capability, the PRC is struggling to maintain strong technological progress.

For the PRC to continue catching up and to achieve a level of development comparable with that in the Republic of Korea, Japan, or the US, a faster growth rate is required in the coming decades, which is why it is important for the PRC to learn from the early development experiences of the Republic of Korea. In particular, the PRC's growth strategy over the next 2 decades should be designed by analyzing the experiences of the Republic of Korea's economy and learning from its successes and failures. Specifically, understanding the role of convergence, technology, institutions, and the manufacturing and services sectors in driving sustained economic growth could help guide PRC economic policies.

Forecasting the PRC's mid- and long-term growth is a debate among scholars and policy makers.[14] The discussion focuses mostly on interpreting the country's growth experience in a global and historical context. For instance, Pritchett and Summers (2014) argued that the PRC's growth could slow to 2%–4% over the next 2 decades, as the PRC will probably succumb to the historically prevalent growth pattern of "regression to the mean." One critical assumption of this view is that the PRC will follow the average pattern of historical experiences across all the world's economies. On the other hand, Lin (2015) suggested that the PRC has the potential to grow 8% for another 20 years by rapidly narrowing its technology and per capita income gap with those of the US through technological imitation and adaptation through leveraging a "latecomer advantage."

Based on the experience of the Republic of Korea as well as a broad sample of countries over time, a decline of the PRC's growth potential seems inevitable due to the diminishing pace of convergence. If the estimated convergence effect from the cross-country regression prevails, the PRC's per worker GDP growth is expected to decline

14 The discussion in this paragraph is from Lee (2015).

by 1.6 to 2.4 percentage points when its per worker GDP doubles. The PRC's per worker GDP growth rate was 8.5% over 2000–2010, raising per worker GDP by about 2.26 times over the period. Hence, the convergence effect implies that a smaller per worker GDP gap would lower the per worker GDP growth rate to 5.7%–6.6% in 2010–2020, assuming other environmental and policy variables remain unchanged. Since the working-age population growth rate is estimated to be –0.1% in 2010–2020, the GDP growth rate would also decline to 5.6%–6.5%. The PRC's per capita GDP growth rate would decline further to 5.0%–5.9% by considering its total population growth of 0.6% during 2010–2020.

The PRC's actual per worker GDP growth rate is estimated to be about 7.3% between 2010 and 2015, exceeding the growth estimate. However, the increase in per worker GDP level over the previous 5 years will exert downward pressure on output growth in the coming years. Table 5.5 shows that the working-age population growth rate will decline from –0.1% in 2010–2020 to –0.3% in 2020–2030. Both the convergence effect and working-age population decline would cause a slowdown of GDP growth in the coming decade. It would be difficult for the PRC to maintain over 6% for GDP growth in the coming decade without significant improvements in institutions and policy factors.

These forecasts are broadly consistent with views that predict a "soft landing" of the PRC economy (e.g., Lee and Hong 2012, World Bank 2013, Cai and Lu 2013, Perkins 2015). Lee and Hong (2012) predicted that the PRC's average potential per worker GDP growth would decline to about 6.1% over 2011–2020 and 5.0% over 2021–2030 under the baseline scenario, which assumes a steady improvement in human capital but no serious policy and institutional reform. This prediction was based on the conditional convergence framework using cross-country growth regression analysis, in which physical capital accumulation, human capital accumulation, and TFP growth are estimated separately and then combined to produce long-run GDP forecasts. In addition, this study showed considerable growth gains of policy reforms in the alternative scenario: when the PRC significantly improves education, research and development stock growth, and maintenance of rule of law, the PRC could achieve average potential per worker GDP growth of about 7.0% over 2011–2020 and 6.2% over 2021–2030.

There are significant gaps in human capital and quality of institutions between the PRC and developed economies (Appendix), indicating that the PRC could stimulate economic growth by more educational investment and institutional reform. The government has been carrying out structural reforms aimed at labor market flexibility and human capital development, privatization of state-owned enterprises, and liberalization of the finance sector. The success of these reforms will improve environmental and policy variables and support productivity growth, thereby offsetting the convergence effect.

In addition, the future of the PRC's growth hinges on policies to promote continuous technological innovation and industrial upgrading, which could contribute to productivity increases in both the manufacturing and services sectors. Increased research and development investment and its more efficient allocation could also stimulate productivity growth.[15] Policies aimed at strengthening the research capacity of domestic firms and protection of intellectual property rights could stimulate innovative activities.

PRC authorities are pushing on with rebalancing from an investment and export-driven economy to a domestic consumption and services-based economy. Effective rebalancing is critical to move the economy to a sustainable growth path, especially under great uncertainties in the global economy. Due to its bigger size, the PRC will have more challenges maintaining its export-led growth than the Republic of Korea.

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[15] According to OECD (2014b), gross domestic expenditure on research and development in 2012 was $257 billion in the PRC. It predicted that the PRC will be the world's top research and development spender by around 2019.

However, premature switching from exports to the domestic sector may hamper overall productivity growth. Reallocating resources from a productive export-oriented industry to a highly unproductive services industry could cause a permanent decline in the economy's productivity (Kim, Lee, and McKibbin 2014; Lee 2015).

There are significant gaps in the labor productivity level and growth between the manufacturing and services sectors in the PRC. The average annual growth in per worker value added in the services sector was only 1.3% per year for 1980–2010, which is significantly lower than the manufacturing sector's 15.0%. The annual growth rates in per worker value added increased to 5.8% during 2000–2010 from an annual average of –0.7% during 1981–1990 and –1.3% during 1990–2000. PRC services industries—in particular, the wholesale and retail trade, hotels, and restaurants industry and the transport, storage, and communications services industry—showed strong, positive growth of per worker value added in the recent decade. However, the finance, real estate, and business services industry showed negative growth. Sector data are subject to measurement errors because of data constraint at industry level. As discussed by Maddison (2007) and Wu (2014), the official GDP estimates for the "nonmaterial services" are highly likely to be exaggerated.

Hence, the PRC should pursue successful rebalancing along with improved productivity growth. Rebalancing policies alone are unlikely to increase average output growth substantially in the PRC. Enhancing productivity is critical for achieving higher economic growth over the long run (Kim, Lee, and McKibbin 2014). The PRC's growth strategy over the next 2 decades still necessitates continuous upgrading in manufacturing and export industries while improving domestic services industries. Improving productivity and achieving more balanced growth will require careful long-term strategies.

The government has implemented structural change and growth-enhancing polices in gradual and pragmatic ways (Naughton 2007). It has started with rural reform using a dual-track strategy.

Markets were first opened in some selected coastal areas and then expanded to other areas. In addition, the government has adopted incremental managerial reform instead of rapid privatization of state-owned enterprises. At a later stage, the government ended its dual-track strategy and adopted more rapid restructuring and downsizing of state-owned enterprises. The economy has made a successful transition from a command economy to a market economy while achieving rapid economic growth. In addition, the PRC has maintained macroeconomic stability as well as political and social stability.

Currently, the PRC faces difficult challenges to continue its reforms. It needs to continue reforms in the factor markets of labor, finance, and land. Furthermore, it must continue to restructure state-owned enterprises and increase domestic competition, especially in the services sector by overcoming pressures from vested interest groups. Yao (2013) asserted that the country's authoritarian government was able to adopt the right growth-enhancing polices at critical points because it was not unduly swayed by any interest group. Since the economy has become bigger and more unpredictable, government interventions would probably not work as they did before.

5.6 Conclusion

The recent growth slowdown of the Republic of Korea's economy reflects its diminishing mid- and long-term growth potential due to convergence and structural factors. As argued by the convergence theory, a fast-growing country eventually grows more slowly, encountering difficulties in maintaining the same fast rates of human and physical capital accumulation and technological progress.

The Republic of Korea's recent growth slowdown is also attributable to its unbalanced economic structure. Export-oriented policies have caused the Republic of Korea to depend overly on manufacturing exports for growth. Increased imbalance between the manufacturing and services sectors hampers the productivity growth of the overall economy. Due to its low productivity growth, the contribution of the services sector to overall economic growth is small, despite its increasing size. Moreover, owing to overdependence on external demand, the Republic of Korea’s economy has become prone to risk from global economic cycles, as demonstrated by its experience during the recent global financial crisis. External demand may not assure the Republic of Korea of a continued market for its exports in the post-crisis global environment, in which the recovery of developed economies remains sluggish and the PRC economy—the Republic of Korea’s largest trading partner—begins to slow rapidly. The Republic of Korea needs structural reforms and productivity growth, particularly in its services sector, for more balanced and sustained growth.

Like the Republic of Korea, the PRC’s economic slowdown is an inevitable trend, partly an outcome of its earlier success. The PRC has narrowed its income gap continuously from its long-run potential over time; according to the prediction of conditional convergence, economies with higher initial income can expect slower growth. The PRC’s average potential GDP growth will decline to 5%–6% over the coming decade, unless it significantly improves institutions and policy factors. The slowdown could be accelerated if policy makers make major mistakes in handling domestic weaknesses and political transformation.

The data indicate that the Republic of Korea and the PRC have had more favorable conditions for rapid growth than other developing countries by maintaining strong investment, high trade openness, and macroeconomic stability, and by improving the quality of human resources and institutions continuously. The future of economic growth in the Republic of Korea and the PRC hinges critically on reforms and policies that could contribute to increasing productivity, at least partially offsetting the growth deceleration due to convergence in the coming decades.

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APPENDIX

Table 5A: Summary of Key Variables for the World, the People's Republic of China, Japan, the Republic of Korea, and the United States, 1965–1970 and 2005–2010

	Republic of Korea	Japan	PRC	United States	World
1965–1970					
Per worker GDP growth	0.072	0.090	0.015	0.018	0.032
Per worker GDP in 1965	2,354	10,626	1,721	30,046	8,977
Investment/GDP	0.237	0.317	0.153	0.208	0.191
Fertility rate in 1965	5.157	2.139	5.872	2.913	5.173
Schooling in 1965	5.676	7.796	3.400	10.416	4.108
Life expectancy in 1965	56.820	70.200	51.290	70.220	58.170
Trade openness	0.165	0.186	0.018	0.096	0.363
Government consumption	0.147	0.162	0.164	0.143	0.166
Rule of law index	0.500	1.000	0.500	1.000	0.576
Inflation	0.117	0.053	0.040	0.042	0.062
Democracy index	0.474	0.951	0.117	0.946	0.643
Terms of trade	0.002	−0.001	0.002	0.001	0.002
2005–2010					
Per worker GDP growth	0.029	0.010	0.095	−0.002	0.019
Per worker GDP in 2005	34,012	46,378	8,059	64,366	23,361
Investment/GDP	0.345	0.244	0.394	0.212	0.227
Fertility rate in 2005	1.076	1.260	1.668	2.054	2.771
Schooling in 2005	12.272	12.124	8.020	13.011	8.531
Life expectancy in 2005	78.43	81.930	72.170	77.340	70.450
Trade openness	0.722	0.374	0.312	0.283	0.662
Government consumption	0.128	0.171	0.217	0.113	0.174
Rule of law index	0.833	0.833	0.750	0.833	0.642
Inflation	0.030	−0.001	0.029	0.022	0.051
Democracy index	1.000	1.000	0.000	1.000	0.738
Terms of trade	−0.032	−0.009	−0.001	0.001	0.006

GDP = gross domestic product, PRC = People's Republic of China.

Notes: For the world, the figures are unweighted averages of the sample of the 75 economies that are used in the regressions in Table 5.3. See the notes to Table 5.3.

CHAPTER 6

On the Sustainability of the People's Republic of China's Growth Model—A Productivity Perspective*

Harry X. Wu

6.1 The Sustainability Debate Revisited

The substantial slowdown of the economy of the People's Republic of China (PRC) in the wake of the global financial crisis (GFC) of 2008–2009 has heated up the long debate about the sustainability of the PRC's growth model. Despite the government's unprecedented stimulus package, the official statistics, though often suspected of exaggerating the real growth performance especially at times of crisis (Wu 2014a), show that the PRC's pace of growth nearly halved from an annual average 13.5% in 2005–2007 to around 7% in 2013–2015 (NBS 2016: 58–59). Economists have been divided on the nature of the slowdown, the choice of macroeconomic policy, and the potential growth rate of the PRC economy.

* The productivity part of this chapter (Sections 6.3–6.4) is a preliminary update of my earlier paper using the same methodology (Wu 2016). The updated total factor productivity estimates are presented in the Reserve Bank of Australia China Conference, Australian National University China Update 2016, Asia KLEMS Taipei Conference, and Asian Development Bank Institute PRC Conference, as well as seminars at University of Western Australia, University of Science and Technology Hong Kong, Australian National University, Peking University, Shanghai Jiaotong University and Nankai University. Section 6.5 revises and updates my earlier work on reassessing the PRC's gross domestic product growth (Wu 2013, 2014, and 2014b). I am indebted to helpful comments from Xuehui Han, Yiping Huang, James Laurenceson, Peter Robertson, John Simon, Ligang Song, Rod Tyers, Yong Wang, Wing Thye Woo, and Yanrui Wu. What is reported in this chapter are interim results of China Industrial Productivity (CIP)/China KLEMS Database Project, supported by Research Institute of Economy, Trade and Industry's Asian Industrial Productivity Program and the Institute of Economic Research of Hitotsubashi University. The usual disclaimers apply.

One camp from a short-run perspective, represented by Justin Lin, former chief economist of the World Bank, believes that the PRC's current slowdown is largely *cyclical* and caused by the prolonged recession of the world economy following the 2008–2009 global financial crisis (GFC) and therefore has nothing to do with the sustainability of the PRC's growth (Lin 2015, 2016; Zhang 2013). The other camp from a medium- to long-run perspective, perhaps represented by Shijin Liu, the former deputy head of the Development Research Center under the State Council, argues that it is natural for the PRC to slow down after a long period of rapid industrialization that resulted from structural changes, as also experienced by the PRC's East Asian counterparts at similar stages of development. In other words, the nature of the PRC's slowdown is *structural* rather than cyclical and it can affect the sustainability of growth if no proper measures are taken (Liu et al. 2011; Liu 2013).

Not surprisingly, the two camps have come up with different policy recommendations. While admitting that the PRC economy still suffers from institutional deficiencies that cause market distortions, the "cyclical camp" maintains that the fundamentals determining the PRC's fast growth pre-crisis have not changed and the PRC's growth potential is much larger than that of its East Asian counterparts at similar stages of development, as suggested by the PRC's per capita gross domestic product growth (GDP) relative to that of the United States (US). Therefore, a timely and more effective policy choice should be focused on the expenditure side through what might be labeled "sector-selective Keynesian" or "beyond Keynesian" policies (Lin 2016) focusing on investment in urbanization especially to improve urban infrastructures that are in short supply (Lin 2015, 2016; Zhang 2013).

In contrast, based on the growth rates of catch-up economies in history and a seemingly observable relationship between per capita income and the consumption of major commodities and consumer durables, the "structural camp" considers the PRC's slowdown inevitable and irreversible, which is consistent with the view of the PRC's "new normal." It warns of the danger of further investment aimed at bringing the economy back to the previous fast growth track that arguably no longer exists, especially if based on the so-called "middle income trap" conjecture. It therefore prescribes a comprehensive package of reform measures to shift the PRC to a new growth model that relies more on market-driven innovation rather than on government-mobilized inputs (Liu et al. 2011: 40–45).

Standing out in this debate, Wu Jinglian, a renowned PRC economist and "reform policy adviser" who has made significant contributions to the PRC's market-oriented reforms since the mid-1980s (Naughton 2013), maintains that it is the extensive nature of the PRC's growth model caused by government's heavy involvement in resource allocation that has forced the PRC to slow down (Wu, J. 2013). This view is well in line with his seminal work that criticizes the PRC's growth model for relying heavily on extensive expansion of inputs rather than efficient and innovative use of inputs, and is hence unsustainable (Wu J. 2005, 2008). Wu Jinglian called for rethinking policy choices facing the current difficulties in a production function framework and emphasizes the importance of total factor productivity (TFP) growth instead of resorting to any type of Keynesian short-run stimulus policy as suggested by the "cyclical camp." Nonetheless, Wu Jinglian's view on the nature of the PRC's growth model also distinctly differs from that of Liu et al. (2011) who argued that despite the institutional deficiencies, the PRC model was efficient and even superior to other models during its high-growth period (Liu et al. 2011: 39).

Indeed, the question of the PRC's growth sustainability cannot be properly answered without considering the PRC's productivity performance, which has been largely missing in the debate. The government's heavy involvement has (so far) successfully solved the PRC's growth problem, but it remains unclear to what extent and in which sectors this has taken its toll on the economy's efficiency and productivity. It is, however, very challenging to accomplish a productivity analysis that is appropriate for addressing the problem of the PRC economy. There are two major challenges. One is how to properly account for the role of the government in a standard production function framework and the other is how to evaluate and interpret TFP estimates, which are sensitive to both input and output data, when official statistics, especially the output accounts, could be flawed due to data manipulations by growth-motivated local governments (Maddison and Wu 2008; Wu 2013, 2014a, 2014b). Facing these challenges, I adopt the following empirical strategy in this study.

Taking up the first challenge, I conduct an economy-wide productivity analysis across industries to explore the effect of state interventions following my earlier work (Wu 2016; Wu, Shea, and Shiu 2015). This industry perspective is indispensable because government policies are often industry-specific and individual industries with different degrees of the government interventions may affect other industries through the input–output linkages of the economy. To this end, we need both an appropriate methodological framework that is able to account for the industry origin of the aggregate productivity performance, and industry-level productivity accounts data that are constructed as coherent parts of the national input and output accounts to satisfy the methodological requirement.

Methodology-wise, I adopt the Jorgensonian aggregate production possibility frontier framework incorporating Domar weights to account for contributions of individual industries to the growth of aggregate inputs and output (Jorgenson, Ho, and Stiroh 2005). This approach relaxes most of the restrictive assumptions of the widely used aggregate production function approach in which all industries are assumed homogenous and subject to the same value-added function and the same input and output prices. Data-wise, I use the China Industrial Productivity (CIP) database that is constructed based on the principle of the methodology (for details of the CIP data construction, see Wu 2015; Wu and Ito 2015; Wu, Yue, and Zhang 2015). However, the data construction focuses mainly on dealing with inconsistencies in the official industry statistics, assuming that there were no data manipulations. This is mainly because of the lack of alternative information at this level of detail that is independent of the official industry accounts.

Regarding the second challenge of the possible politically motivated data manipulations, I evaluate the official estimate of the PRC's GDP growth rate with a revised Maddison–Wu approach to an alternative measure of the PRC's real output at the aggregate level (Maddison and Wu 2008; Wu 2013, 2014a, and 2014b). Using the recently released PRC 2012 input–output tables weights as the latest benchmark, I first revise and update Wu's previous work on the alternative GDP growth estimates, and then compare the results with those obtained using official GDP statistics.

The rest of the chapter is organized as follows. Section 6.2 discusses the role of government in the PRC economy from an industry perspective. Section 6.3 briefly introduces the methodology and the CIP database. Section 6.4 reports and interprets the empirical results on TFP. To evaluate the official aggregate GDP growth rates, Section 6.5 provides updated Maddison–Wu alternative estimates and discusses their implications for the TFP estimates obtained without challenging the official output statistics. Finally, Section 6.6 concludes this study.

6.2 Sectoral Productivity Growth and the Role of the Government

Despite a series of reforms over the past 3 decades, the PRC government still intervenes heavily in the economy. Unlike in the planning period that relied on centralized, comprehensive, and mandatory controls through state ownership, local governments have been playing an important role in the reform era under a "regional decentralized authoritarian" regime (Xu 2011). The driving force is growth competition among localities in a quasi market environment. Since all efforts made by local governments are indexed by the rate of local GDP growth and assessed by upper authorities as political performance, officials are highly motivated to engage in "growth tournaments" with their peers of other localities (Li and Zhou 2005). Consequently, their relentless search for new growth engines has resulted in increasing government interventions in resource allocation and business decisions (Huang 2012; Wu and Shea 2008; Xu 2011).

To explore the role of government, we may consider distinguishing industries that are subject to different types of government interventions, directly and indirectly. One important change since the reform is that government interventions are no longer all-encompassing as in the central planning era that completely ignored the market. They have, however, become more industry-specific through either subsidization or administrative interference or some combination of both. Subsidies can be made in direct or indirect forms. Indirect subsidies intend to reduce the producer cost of inputs, including energy, land, environment, labor, and capital (Huang and Tao 2010). By contrast, direct subsidies come with administrative interferences aiming to compensate for output losses. Administrative interferences serve the state interests or government strategic plans through controlling or influencing output prices and business operations ranging from managerial personnel to the choice of technology.

We may argue that whether or to what extent the government uses administrative interference or different types of subsidization depends on the distance of an industry from the final demand, especially the international market. Indirect subsidies have been mainly used by local governments to promote export-oriented manufacturers that make semi-finished and finished goods. Most of these downstream industries are labor-intensive and therefore crucial for the PRC to timely reap its demographic dividend. However, the government tends to directly get involved in upstream industries such as energy and primary input materials that are deemed strategically important in supporting downstream industries.

Considering the behavior of enterprises in such a policy environment and its implications for efficiency improvement and productivity growth, we may conjecture that industries that are mainly supported by indirect subsidies could be more efficient and productive than those receiving direct subsidies. In the former case, enterprises may still behave like market competitors although their competitiveness is arbitrarily enhanced. Upstream industries are traditionally dominated by state-owned enterprises and do not conform to the PRC's comparative advantage. Their assumed "strategic importance" gives them strong bargaining power in negotiating for government support. In return, they have to accept controls from the authorities. This distorts their behavior and disincentivizes their effort for efficiency and innovation.

Following this discussion, to explore the impact of government interferences on the PRC's productivity performance we categorize the 37 industries in the CIP database into eight groups guided by degrees of government intervention, either directly or indirectly (see Wu 2016). First, the 24 CIP industries of the industrial sector are categorized into three large groups: "energy", including coal mining, crude oil and gas extraction, petroleum, and utilities; "commodities and primary input materials (C&P)", such as basic metals, chemicals, and building materials; and "semi-finished and finished goods (SF&F)", such as apparel, electrical equipment, and machinery. Industries of "SF&F", as well as part of "C&P", have been the key drivers of the PRC's post-reform growth. According to their "distances" from the final demand, the "energy" group is located upstream, followed by "C&P", and finally "SF&F" being the closest to the final consumer market. The "SF&F" group will thus as conjectured be least inclined to direct government interventions.

The non-industrial sectors are divided into five groups, though their "location" of the production chain cannot be easily defined. The agricultural sector not only serves the final demand but also increasingly provides intermediate inputs to food processing and manufacturing industries and as such can be an important channel for indirect policies. Construction also delivers both investment and consumer goods. Services are divided into three groups with Services I consisting of state-monopolized services of important intermediate input industries such as financial intermediaries, transportation, and telecommunication services; Services II covering the rest of market services which include both business and consumer service providers; and Services III denoted by typical "non-market services", including government administration, education, and healthcare.

6.3 A Brief Note on Methodology and Data

Methodology

Following Wu (2016), this chapter adopts Jorgenson's APPF framework incorporating the Domar aggregation scheme to account for the industry origin of the PRC's aggregate growth and productivity performance (Jorgenson 1966; Jorgenson, Gollop, and Fraumeni 1987; Jorgenson, Ho, and Stiroh 2005). The APPF approach relaxes stringent assumptions of the widely used aggregate production function (APF) approach that for all (underlying) industries "value-added functions exist and are identical across industries up to a scalar multiple" and "the aggregation of heterogeneous types of capital and labor must receive the same price in each industry" (Jorgenson et al. 2005), and hence is closer to the PRC reality with heavy government interventions and institutional deficiencies that cause market imperfections.

The Domar-aggregation-incorporated APPF approach is briefly introduced here (refer to Wu [2016] for details). The basic idea is that the gross output of an economy as shown in the national accounts is coherently made up of the costs of individual industries economy-wide, including all production factors and intermediate inputs. The inputs of, or services provided by, heterogeneous labor and asset types (production equipment and structures) at the industry level should be measured in constant quality using the user cost approach. The industry-level TFP growth can then be estimated using industry accounts data that are specifically constructed for this approach (such as the CIP data as introduced next). Moreover, incorporating the Domar aggregation scheme, the contribution of industries to the aggregate productivity performance is measured by taking into account that individual industries not only affect other industries, but also are affected by other industries through economy-wide input–output links and the reallocation of factors (Domar 1961, Hulten 1978).

In an oversimplified way, we define the weighted growth of capital services, labor services, and intermediate materials as $\bar{v}_j^K \Delta \ln K_j$, $\bar{v}_j^L \Delta \ln L_j$, and $\bar{v}_j^M \Delta \ln M_j$ for industry j, respectively, where $\bar{v}_j^K$, $\bar{v}_j^L$, and $\bar{v}_j^M$ are two-period averages of the nominal weights in gross output, and $v_j^K + v_j^L + v_j^M$ = 1. Then, the growth of TFP, denoted as v_j^T, can be expressed as:

$$v_j^T = \Delta \ln Y_j - \bar{v}_j^K \Delta \ln K_j - \bar{v}_{jt}^L \Delta \ln L_j - \bar{v}_j^M \Delta \ln M_j \qquad (1)$$

By introducing the Domar weight for j, defined as a ratio of j's share in total value added (w_j) to the value-added proportion of j's gross output (v_j^V), and through further manipulations to arrive at the value-added concept for productivity growth, the aggregate TFP growth can be expressed as:

$$v^T = \left(\sum_j \frac{\bar{w}_j}{\bar{v}_j^V} v_j^T \right) + \left(\sum_j \bar{w}_j \frac{\bar{v}_j^K}{\bar{v}_j^V} \Delta \ln K_j - \bar{v}_K \Delta \ln K \right) + \left(\sum_j \bar{w}_j \frac{\bar{v}_j^L}{\bar{v}_j^V} \Delta \ln L_j - \bar{v}_L \Delta \ln L \right) \qquad (2)$$

in which the first source of the aggregate TFP growth is the Domar-weighted TFP growth from within industries, and the second and third source is the reallocation effect of capital and labor on the aggregate TFP growth, respectively. Productivity gains of the aggregate economy may exceed the average productivity gains across industries because flows of factors allow gains in successive industries to augment one another. The same logic can explain productivity losses.

The CIP Database

This study has benefited from a newly constructed economy-wide, industry-level data set in the ongoing CIP Project (for details, see Wu 2015; Wu and Ito 2015; Wu, Yue, and Zhang 2015). The KLEMS principles,[1] which are in line with the Jorgensonian APPF approach,

1 KLEMS is used as an acronym for **K**(C)apital, **L**abor, **E**nergy, **M**aterials, and **S**ervices that are used to produce any product. By the same token, the gross output of an industry equals the total costs of KLEMS and the gross output of an economy equals the sum of the costs of KLEMS of all industries. See O'Mahony and Timmer (2009) for an introduction of the European Union-KLEMS database.

are followed in the CIP data construction. This also implies that the industry-level data are coherently linked to the PRC national production and income accounts statistics.

Conceptual, classification, and coverage consistencies are strictly followed in the data construction. Some features of the CIP data should be noted. For the classification of industries, CIP adopts the 2002 version of the PRC Standard Industrial Classification (CSIC/2002) and reclassifies the economy into 37 industries. The reconstruction of the nominal national accounts is based on different versions of the official national accounts compiled under the Material Product System prior to 1992 and the United Nations System of National Accounts afterwards. The PRC's SNA input–output accounts, available for every 5 years since 1987, and a Material Product System input–output table for 1981 converted to a SNA-type table, are used to construct a time series of PRC input–output accounts for the period 1981–2012 (Wu and Ito 2015).

The nominal input–output accounts are deflated by industry-level producer price index (PPI), constructed using official PPIs for the agricultural and industrial sectors and the consumer price index (CPI) or its components for service industries (Wu and Ito 2015). However, the work reported in this chapter still uses the single deflation approach assuming changes in input prices are the same as changes in output prices, similar to the practice of the PRC national accounts, rather than the theoretically-sound double-deflation approach due to the lack of price data.[2]

For the required labor data, following earlier studies by Wu and Yue (e.g., 2012) that focus on the industrial sector only, CIP establishes economy-wide employment series in both numbers employed and hours worked, and weighted by matching compensation matrices for 37 industries. "Workers" refers to the entire workforce including (not distinctively) employers, employees, and self-employed workers, cross-classified by industry, gender, age, and education (Wu, Yue, and Zhang 2015).

2 See Wu and Ito (2015) for very preliminary growth estimates at industry level using the double deflation approach.

CIP reconstructs the annual flows of investment for the industrial sectors using official gross capital stock data at historical costs. But it has to adopt the official investment series for the non-industrial sectors. The results are yet to be reconciled with the national accounts gross fixed capital formation data. Industry-specific investment deflators are constructed using the PPIs of investment goods industries and nominal wage index of construction workers (Wu 2015). The industry-specific depreciation rates are estimated based on industry-specific asset service lives and declining balance values used in the US national accounts following Hulten and Wykoff (1981; also see Wu 2015).

6.4 Empirical Results

Sources of Growth in the APPF Framework

We now examine the PRC's aggregate TFP performance in the APPF framework. The results are summarized in Table 6.1. The PRC economy achieved a real output growth of 8.94% per year in 1980–2012. The "SF&F" group was the top growth contributor before the GFC. It was followed by Services II (market). In the wake of the crisis, "SF&F" was marginally overtaken by Services II. On average from 1980–2012, "SF&F" contributed over one-quarter of the real output growth, Services II 20%, and agriculture, "C&P" and Services I (state monopoly) together nearly 40%. The estimated aggregate TFP growth is 0.83% per year. However, the TFP performance was highly unstable over time, with the highest growth achieved in 1991–2001 (1.63%) and the worst in 2007–2012 (–2.06%).

Of the 8.94% annual output growth rate for the entire period, the contribution of capital input was 6.71%, labor input 1.40%, and TFP 0.83%. This means that 64% of the real value-added growth relied on capital input, 27% on labor input, and 9% on TFP growth. The contribution of capital input increased from 46% in the 1980s to 71% post-World Trade Organization (WTO) and nearly 100% in the wake of the GFC. On the other hand, the contribution of labor input declined from 38% in the 1980s to 19% post-WTO. This trend reversed following the crisis and the contribution of labor input rose back to 26%, largely attributed to quality improvement rather than hours worked. The contribution of the quality of capital was insignificant on average.

Table 6.1: Growth in Aggregate Value-added and Sources of Growth in the People's Republic of China, 1980–2012
(Contributions are share-weighted growth rate in %)

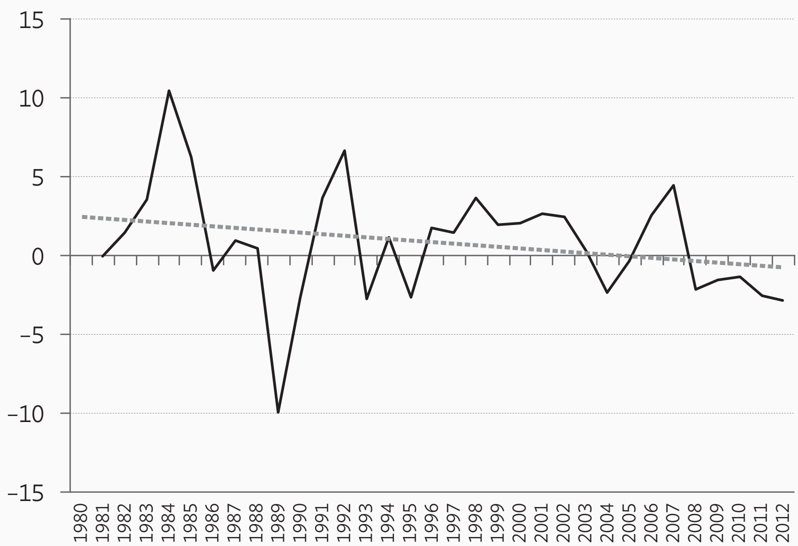
	1980–1991	1991–2001	2001–2007	2007–2012	1980–2012
	Industry contributions to value-added growth				
Value–added growth due to (%)	7.61	9.04	11.00	9.23	8.94
– Agriculture	1.75	1.18	0.50	0.65	1.17
– Construction	0.38	0.64	0.68	0.73	0.58
– Energy	–0.06	0.33	0.74	0.30	0.27
– Commodities and primary materials	0.90	1.49	1.57	1.31	1.28
– Semi-finished and finished goods	1.87	2.65	2.72	2.01	2.29
– Services I	0.92	0.64	1.47	1.20	0.98
– Services II	1.45	1.74	2.39	2.35	1.86
– Services III (Non-market)	0.39	0.37	0.94	0.67	0.53
	Factor contributions to value-added growth				
Value-added growth due to (%)	7.61	9.04	11.00	9.23	8.94
– Capital input:	5.00	6.15	8.63	9.30	6.71
– Stock	5.00	6.22	8.71	9.30	6.75
– Capital quality (composition)	–0.01	–0.07	–0.08	0.00	–0.04
– Labor input:	1.39	1.26	1.19	1.98	1.40
– Hours	1.34	0.88	0.71	0.34	0.92
– Labor quality (composition)	0.05	0.38	0.48	1.65	0.48
– Aggregate TFP	1.22	1.63	1.19	–2.06	0.83

TFP = total factor productivity.

Source: Author's estimates.

Using the empirical results, Figure 6.1 shows that the PRC's TFP growth was not sustained but followed a declining trend over the period 1980–2012. The PRC's first TFP drive was observed from the early to mid-1980s associated with the PRC's successful agricultural reform and the kick-off of nation-wide industrial reforms, yet it was short-lived. Then, the growth of TFP significantly slowed down before it collapsed sharply as a result of the 1989 political crisis. The post-crisis TFP recovery was short. The only period that saw a stable and sustained TFP growth was the one from 1996 to 2002. The PRC's post-WTO period, nonetheless, only saw a short resurgence of TFP growth over 2006–2007, which was interrupted by the GFC. There has been no sign at all that the decline in TFP will be reversed any time soon.

Figure 6.1: Growth of Total Factor Productivity in the People's Republic of China: An APPF Approach (1980 = 100)



APPF = aggregate production possibility frontier.

Source: Constructed based on results shown in Table 6.1.

Table 6.2 presents the results of a decomposition of the PRC's aggregate value added per hour worked into changes in capital deepening, labor quality, and TFP. This enables us to separate the contribution of hours worked from the contribution of genuine labor productivity improvement and its sources. The PRC economy benefited significantly from the increase in hours worked attributable to the so-called "demographic dividend." This, however, declined over time from an average 2.83% per year in 1980–1991 to an average 0.73% per year in 2007–2012. Although value added per hour worked increased from 4.78% to 8.50% per year, it appeared to be increasingly relying on capital deepening from 3.51% to 8.91% per year. More importantly, the growth of labor productivity was not necessarily in line with the pace of capital deepening if comparing the results for 2007–2012 with those for 2001–2007, suggesting serious disequilibrium and misallocation of resources that was likely caused by increasingly overinvestment.

Table 6.2: Decomposition of Aggregate Labor Productivity Growth in the People's Republic of China
(Contributions are weighted growth in %)

	1980–1991	1991–2001	2001–2007	2007–2012	1980–2012
			Growth Rates		
Value-added growth (APPF)	7.61	9.04	11.00	9.23	8.94
– Value added per hour worked	4.78	7.29	9.44	8.50	7.02
– Hours	2.83	1.75	1.57	0.73	1.93
			Factor Contributions		
Value-added per hour worked	4.78	7.29	9.44	8.50	7.02
– Capital deepening	3.51	5.28	7.77	8.91	5.71
– Labor quality	0.05	0.38	0.48	1.65	0.48
– TFP growth	1.22	1.63	1.19	–2.06	0.83

APPF = aggregate production possibility frontier, TFP = total factor productivity.

Source: Author's estimates.

The Industry Origin of Aggregate TFP growth

To explicitly account for differences across industries and their impact on the PRC's aggregate TFP performance, we now introduce Domar weights in the exercise, following the studies on the US economy by Jorgenson, Ho, and Stiroh (2005). The results presented in the first line of Table 6.3 are the same as those presented in Table 6.1 and Table 6.2. As expressed in Equation (2), using Domar weights the aggregate TFP growth rate can be decomposed into three additive components (in percentage points): (i) the change of Domar-weighted aggregate TFP; (ii) the change of capital reallocation; and (iii) the change of labor reallocation. Let us start with the first component in Table 6.3, which is the most important finding of the study.

Table 6.3: Domar-weighted TFP Growth and Reallocation Effects in the People's Republic of China Economy
(Growth in % per year and contribution in percentage points)

	1980–1991	1991–2001	2001–2007	2007–2012	1980–2012
Aggregate TFP growth	1.22	1.63	1.19	−2.06	0.83
1. Domar-weighted TFP growth[a]	0.60	1.72	0.54	−2.10	0.52
– Agriculture	0.99	0.75	0.82	0.68	0.83
– Construction	−0.05	0.12	0.29	0.04	0.08
– Energy	−0.76	−0.24	−0.32	−0.49	−0.47
– Commodities and primary materials	−0.50	0.77	0.20	−0.27	0.07
– Semi-finished and finished goods	0.30	1.35	0.50	−0.35	0.57
– Services I (market monopolies)	0.25	−0.59	0.28	−0.02	−0.05
– Services II (market)	0.31	−0.42	−0.79	−0.97	−0.33
– Services III (non-market)	0.06	−0.03	−0.43	−0.71	−0.18
2. Reallocation of K	0.28	−0.09	−1.03	−0.01	−0.12
3. Reallocation of L	0.35	0.01	1.68	0.06	0.44

K = capital input, L = labor input, TFP = total factor productivity.

[a] Subcategories are also additive.

Source: Author's estimates following equation (2).

From 1980–2012, the PRC's average annual TFP growth estimated by the Domar weights was 0.52%, much slower than the aggregate TFP growth of 0.83%, implying a net factor reallocation effect of 0.44, which will be discussed further below. Table 6.3 also shows the contribution of each industrial group to the Domar-weighted annual TFP growth. The highest contributor to the Domar-weighted aggregate TFP growth was agriculture with a contribution of 0.83 ppts. The second-highest contributor was the "SF&F" group (0.57), followed by construction (0.08). The worst performer was the "energy" group (−0.47), followed by Services II (−0.33), and Services III (−0.18). Such a sharp contrast in TFP performance across industry groups can also be observed over different sub-periods, which clearly suggests that treating individual industries homogenously when evaluating growth can substantially distort our view of the productivity performance of the PRC economy.

A closer examination of sub-periods against a background of policy regime shifts may shed light on the role of the government. The agricultural sector benefited most from reforms in the 1980s, especially the decollectivization of farming and deregulations pertaining to rural township-village enterprises. It contributed 0.83 ppts to the Domar-weighted TFP growth at an average 0.52% per year in 1980–2012. Surprisingly, even in the latest period that was affected by the GFC, it was still the most important contributor (0.68 ppts) to the Domar-weighted TFP growth (−2.10% per year). While its share in nominal GDP declined over the same period (see Table 6.1), its contribution to the Domar-weighted TFP growth remained high. This is suggestive of a process in which the agricultural sector is still releasing capital (including land) and labor that have a marginal productivity below the sector's average. By shedding these "surplus" factors, the average productivity with which factors are used is still growing. But clearly this cannot be a long-run source of growth as this structural shift is temporary. Future growth must come from the manufacturing and services sectors.[3]

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3 I am indebted to Marcel Timmer for a discussion on the role of PRC agriculture in the productivity performance of the aggregate economy.

The period 1991–2001 saw the most rapid TFP growth at an average 1.63% per year by Domar weights despite the impact of the Asian financial crisis (1997–1998) and the subsequent deflation period of 1998–2003 (see footnote 7). The "SF&F" group was the most important contributor (1.35 ppts), followed by the "C&P" group (0.77 ppts), thanks to unprecedented state sector reforms and opening up to foreign trade and direct investment, which allowed markets to play an increasingly important role in resource allocation. The productivity performance of the construction industry also turned positive for the first time (0.12 ppts) and even the productivity decline of the "energy" group slowed substantially to −0.24 from −0.76 ppts in the previous period (1980–1991).

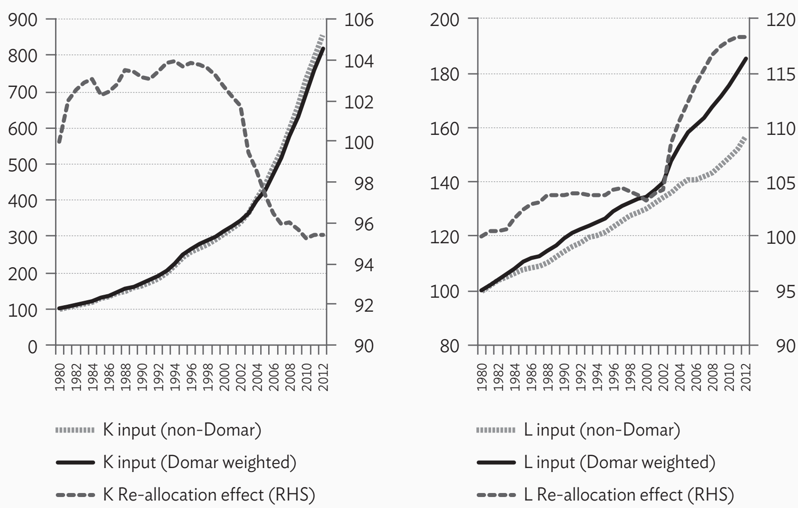
Nevertheless, I find that the PRC's accession to the WTO at the end of 2001 was accompanied by a slowdown rather than an acceleration of TFP growth, which was an average 0.54% per year from 2001–2007, less than one-third of the 1.72% achieved in 1991–2001. This puzzling result may be somewhat supportive of observed increasing interventions by local governments throughout the 2000s aiming to promote local urbanization and heavy industrialization (see Wu J. 2008). Table 6.3 shows that in 2001–2007, while the contribution of "SF&F" and "C&P" to TFP growth fell from 1.35 to 0.50 ppts and from 0.77 to 0.20 ppts, respectively, the contribution of construction and state monopolized Services I (transportation, telecommunication, and financial services), both pushed and engineered by the government, increased from 0.12 to 0.29 ppts and from −0.59 to 0.28 ppts, respectively.

In the wake of the GFC, despite a CNY4 trillion stimulus package adopted by the central government that was further accompanied by CNY18 trillion projects driven by local governments' financing vehicles, the PRC's TFP growth turned to negative, declining by an annual average −2.10% from 2007–2012. Since most of the projects concentrated on infrastructural development, construction continued to benefit though with nearly zero TFP growth. For the same reason, Services I suffered least (−0.02) among those negatively affected by the productivity decline. However, the most recent development shows that while the effect of the unprecedented government injection quickly abated after 2012, there are increasing signs that the PRC's surplus capacity in manufacturing is rising and may take many years to be restored.

The Effect of Factor Reallocation

The slower Domar-weighted TFP growth (0.52%) compared to the aggregate TFP growth (0.83%) implies that over 60% of the aggregate TFP growth can be attributed to the productivity performances of individual industries and less than 40% to the reallocation of capital and labor. Following Equation (9), I show in Table 6.3 that this effect consists of a positive labor reallocation effect of 0.44 ppts and a negative capital reallocation effect of –0.12 ppts. Figure 6.2 presents indices of these effects.

Figure 6.2: Domar and Non-Domar Weighted Factor Input Indices and Reallocation Effects



K = capital input, L = labor input, RHS = right-hand side.

Source: Author's estimates following equation (2).

It should be noted that such a magnitude of reallocation effect is typically not observed in market economies. For example, based on their empirical work on the US economy in 1977–2000, Jorgenson, Ho, and Stiroh (2005) showed that, first, the reallocation effect was generally negligible and, second, if it was non-negligible for some sub-periods, the capital and labor reallocation effects generally moved in opposite directions. Jorgenson, Gollop, and Fraumeni (1987) also reported the reallocation of capital that was typically positive and the reallocation of labor that was typically negative for the US economy for the period 1948–1979. This is because capital grew more rapidly in industries with high capital service prices, hence high returns on capital, whereas labor grew relatively slowly in industries with high marginal compensation.

In the case of the PRC, the much larger magnitudes and unexpected signs of capital and labor reallocation effects have two important implications. First, individual industries indeed face significantly different marginal factor productivities suggesting that there are barriers to factor mobility, which cause misallocation of resources in the economy. The reverse of this finding is that corrections to the distortions can potentially be productivity-enhancing, which might be good news in terms of much-talked-about and long-awaited structural reforms.

I find that the effect of labor reallocation remained generally positive over time. This suggests that the labor market was much less distorted than the capital market benefitting from increasing labor mobility along with reforms. Notably, the post-WTO period experienced the most significant gain from labor reallocation (1.68 ppts in 2001–2007), which could be driven by the rapid expansion of export-oriented, labor-intensive industries that was in line with the PRC's comparative advantage.

The case of capital reallocation is different. The early reform period was the only period that saw a positive effect of capital reallocation (0.28 ppts in 1980–1991) due to partial removal of the distortions inherited from the central planning period. However, the effect subsequently turned negative following the PRC's WTO entry

(−1.03 ppts in 2001–2007), probably as a result of the enhanced role of the government that was behind the resurgence of the state sector in upstream industries.

Nevertheless, the results for the post-crisis period (from 2008 to 2012, as covered by our data) deserve greater attention. As shown in Table 6.3, during this period the reallocation effect in both capital and labor became close to zero, a distinct contrast to the earlier period, i.e., 0.06 compared to 1.68 ppts in the case of labor and −0.01 compared to −1.03 ppts in the case of capital. This probably reflects that the actual PRC growth performance could be much worse than that suggested by the official statistics because the reallocation of primary factors became much less active than before, which will be investigated in the following section.

6.5 What If the Official GDP Growth Estimates are Flawed?

As explained in the introduction, the CIP project does not challenge the official estimates of real output. Due to a lack of alternative data at the industry level, we had to use the official input–output aggregates as “control totals” to construct the output of individual industries. But what if the “control totals” are flawed? In the literature, upward-bias hypotheses about the official estimates of the PRC’s GDP growth and related empirical studies to explore supportive evidence can be found. They either focus on the total economy based on price level (Wu 2000, Woo 1998, Ren 1997, Jefferson et al. 1996), food consumption (Garnaut and Ma 1993), and energy consumption (Adams and Chen 1996); or on real output at the sectoral level, especially the industrial sector (Maddison 1998, 2007; Maddison and Wu 2008; Rawski 1993; Woo 1998; Wu 2002, 2007, 2013) and the so-called “non-material services” (Maddison 1998, 2007; Maddison and Wu 2008; Wu 2014b).[4]

[4] The concepts of “material” and “non-material” services are borrowed from the Marxian dogma that only material production is considered productive. The former includes commercial trade (wholesale, retail, hotels, and catering), transportation, and telecommunication services, whereas the latter includes banking and financing, real estate, business services, education, healthcare, culture and entertainment services, and government services.

In this section, I propose a revised Maddison–Wu approach incorporating the newly released PRC Input–Output Tables (IOTs) for 2012 (DNEA 2015) and integrating industrial production indices based on different IOT weights by the Fisher indexing method to obtain an alternative estimate for the PRC's industrial GDP growth from 1980 to 2015. This is a further development from my last revision (Wu 2013, 2014b). Together with an alternative estimate for the growth of the PRC's "non-material services," which will also be discussed in this section, we can assess the official growth estimates and investigate if there are potential flaws, and hence their implications for our TFP estimates using the CIP data that fully adopt the official output statistics.

An Alternative Estimation of the PRC's Industrial GDP Growth

As widely believed, the upward bias of official industrial GDP estimates is caused by both methodological and institutional problems (Wu 2013). It methodologically refers to the "comparable price system" adopted in the early 1950s together with the adoption of the Soviet-style national accounts, known as the Material Product System, which introduced segmented price weights with overlong intervals in growth indexing,[5] therefore underestimating price changes while exaggerating real growth rates (Maddison 2007; Wu 2002, 2013). This problem can be well explained by the Gerschenkron effect (Gerschenkron 1951): a comparison of two economies for real output growth, weighted at base-year prices, can be expected to be biased upwards because the price movements are inversely related to the quantity movements when the normal demand relationship is held. This is also known as "substitution bias" in the index number theory. The longer the time span, the stronger the upward bias.

The upward bias in the industrial output statistics is also caused by institutional deficiencies. There are two major sources of such bias with one related to the "price manuals" used in the practice of the

[5] In the "comparable price system" there were five sets of "constant prices" that were used over time based on 1952, 1957, 1970, 1980, and 1990, respectively. The 1990 "constant prices" were used for the period 1990–2002 (Wu 2013).

"comparable price system" up to the early 2000s and the other a result of the inter-regional growth competition engineered by GDP-motivated local officials starting in the early 1990s. The "price manuals" were designed to measure the price change of a product relative to an official "constant price" in a base year. However, due to the impossibility of covering most products and their technical details and the overlong intervals between the official "constant prices", this practice provided leeway for enterprises to overstate their real output. For example, enterprises tended to over-report their products in constant prices when the products were not listed in the given price manual and to exaggerate their output of "new products" because newly invented products are allowed to be valued in current prices as if in real terms (Rawski 1993, Woo 1998). Local governments tended to turn a blind eye to such practices because they had political incentives to show faster growth, which was related to the second major source of the upward bias as explained below.

The post-reform PRC economy is administrated under a "regional decentralized authoritarian" regime, as well explained in Xu (2011). This regime is also responsible for data manipulations. Since all efforts of local governments are indexed by the rate of local GDP growth and assessed by upper authorities as political performance, officials are highly motivated to engage in a "growth tournament" with their peers of other localities (Li and Zhou 2005). This politicizes not only their efforts to maximize growth, but also their data as the evidence for their "actual" growth performance.

Most studies that assessed the reliability of the official growth estimates focused on the aggregate economy. The Maddison–Wu commodity-index approach was the first of its kind for the PRC; it followed earlier studies that assessed the Soviet Union's real industrial production performance (e.g., Gerschenkron 1947, Bergson 1961). It is designed to bypass the problematic or unavailable official price deflators to detect the underlying trend of real industrial growth over different periods (Maddison 1998, 2007; Wu 1997, 2002, 2007, 2013; Maddison and Wu 2008).

The initial version of the Maddison–Wu approach relies on simple volume movements of major industrial commodities or commodity groups weighted by the PRC's 1987 IOTs (Wu 1997) and were adopted in Maddison's earlier work on the PRC's long-run growth (Maddison 1998). The subsequent revisions of this approach substantially improved the estimates by using more information on commodity prices (Wu 2002, 2007) and by introducing multiple input–output table weights for grouping and indexing (Wu 2011, 2013). Especially, by incorporating all available input–output tables, two major problems have been tackled, that is, single-benchmark price weighting that creates substitution bias and fixed value-added ratios to convert gross output index to value-added index that assumes a fixed input–output relationship overtime. Using all available PRC IOTs (for 1987, 1992, 1997, 2002, and 2007), my latest estimates in 2013 not only provided stronger support for the upward-bias hypothesis, but also confirmed the Maddison–Wu conjecture in 2008 that official GDP estimates tended to smooth out high volatility and to cover up external shocks.

In my previous estimate, converting the gross output index into a value-added index required that two significant assumptions be made. First, the post-2007 gross output index was weighted using the 2007 IOTs. Hence, it could not adequately capture the post-2008 GFC structural impacts. Second, the post-2007 industry-level value-added ratios were assumed to follow the annual change of the ratio from the 2002 to the 2007 IOTs. With the recent release of the PRC's 2012 IOTs, a further revision and update is in order. I first construct a new 2012 IOT weights-based gross output index and link it with the previous five gross output indices weighted by the earlier IOTs using the Fisher index approach. This produces a better multi-weights index for the new estimate that captures changes over the post-GFC period. I then interpolate industry-level value-added ratios between 2007 and 2012, which means that the final value-added index is now anchored on six IOT benchmarks ending in 2012 rather than five and ending in 2007.

Although concentrating on the period 1980–2012, to match the latest official GDP estimates we still need to make a proper assumption for the value-added ratios over the period after the 2012 benchmark, i.e., 2013 to 2015. Two options are considered: one assumes that the value-added ratios for 2013 to 2015 remained the same as those of 2012, and the other assumes that the value-added ratios changed following the annual average rate of change between the 2007 and 2012 IOTs. The first option is less realistic due to the increase in labor compensation in recent years following the implementation of the PRC's *Labor Law* in 2006. I therefore choose the second option.

My new estimates using the revised Maddison–Wu approach are presented in Table 6.4 in the average annual growth rate of the sub-periods that match the previous tables. The new estimates are also compared to the official estimates and to those derived from the China Industrial Productivity (CIP)/capital, labor, energy, materials, and services (KLEMS) database that also use the official national accounts as "control totals." The new estimates lend strong support to our previous conclusion that the official industrial GDP estimates tended to smooth out volatility and covered up the impact of external shocks. For the entire period 1980–2012 that matches the current CIP database, my estimate of the annual growth of the PRC's industrial GDP is 8.1% compared to the official rate of 11.5% and the CIP/KLEMS approach-derived rate of 9.7%. Nevertheless, for the post-WTO period 2001–2007, my estimate is even higher than that of the official rate and the CIP/KLEMS-reinterpreted "official" rate. But for other sub-periods, my alternative measures give much slower growth rates than those of the other two estimates in Table 6.4.

The full series of all estimates in the comparison as presented in Figure 6.3 reveals the external (including political) shocks to PRC industry that are not, or are not sufficiently, shown in the official statistics. Specifically, the classic recessions found in my work for 1989, 1990, and 1998, as well as for the most recent year 2015, have disappeared completely in the official estimates. The year 1989 is somewhat exceptional because the estimate using the CIP/KLEMS

Table 6.4: People's Republic of China's Industrial GDP Growth: Official versus Alternative Estimates (% per year)

	1980–1991	1991–2001	2001–2007	2007–2012	2012–2015	1980–2012	1980–2015
Official/NBS	10.1	13.4	12.3	10.0	6.7	11.5	11.1
CIP/KLEMS	7.1	11.2	12.3	9.3	n.a.	9.7	n.a.
Maddison–Wu	5.3	8.2	12.7	8.7	2.5	8.1	7.6

PRC = People's Republic of China; CIP/KLEMS = China Industrial Productivity (CIP)/capital, labor, energy, materials, and services (KLEMS) database; GDP = gross domestic product; NBS = National Bureau of Statistics.

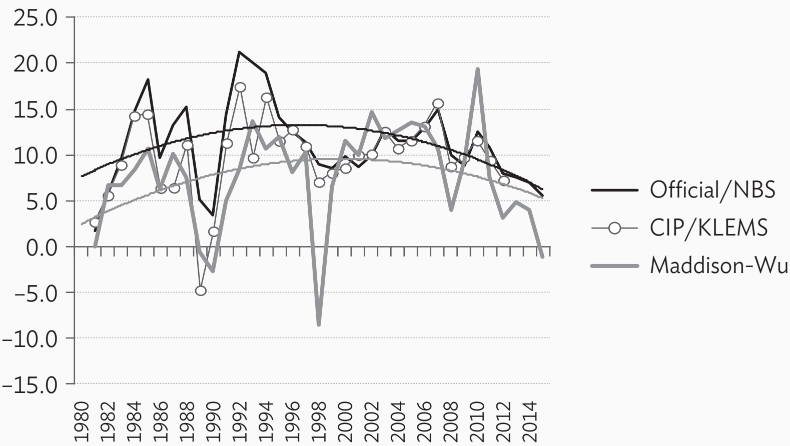
Sources: The official estimates are available in the latest issue of *China Statistical Yearbook* (NBS, 2015 with update), the CIP/PRC KLEMS estimates are also based on official statistics and used in the productivity analysis are introduced in Section 6.4, and the estimates using the Maddison–Wu approach is discussed in this section.

approach, which is also based on the official data, arrives at a decline of −4.8%, even more severe than that of my alternative estimates. Besides, the positive impact of Deng Xiaoping's call for bolder reforms in 1992 does not appear to be as strong as suggested by the official statistics. But the negative impact of the GFC in 2008 is more pronounced using the Maddison–Wu approach. I show that GDP growth in 2008 slowed to 3.9% rather than staying at 9.9% officially or 8.7% using the CIP/KLEMS approach. I also find some periods experiencing faster growth than that suggested by the official statistics, especially from 2000 to 2006 covering most of the post-WTO export-driven growth period and from 2009 to 2010 due to the government's unprecedented stimulus package in the wake of the GFC.

An Alternative Estimation of the PRC's "Non-Material Services"

Maddison (1998 and 2007) argued that the official growth estimates for "non-material services" were highly likely to be exaggerated because its implied labor productivity growth, an annual average 5.1% from 1978–2003 (Maddison 2003), was too strong to be credible.

Figure 6.3: People's Republic of China's Industrial GDP Growth: Official versus Alternative Estimates



CIP/KLEMS = China Industrial Productivity (CIP)/capital, labor, energy, materials, and services (KLEMS) database, GDP = gross domestic product.

Source: See Table 6.4.

He separated "non-material services" from "material services" (see footnote 5 for classification) not because the latter are more reliable than the former, but because the former are easier to examine due to their labor-intensive nature and hence very slow labor productivity growth rate, as well observed in the literature.

Indeed, the US from 1948 to 1989, and Organisation for Economic Co-operation and Development countries from 1973 to 1979, only achieved an annual labor productivity growth of between 0% and 1% in these services (see Griliches 1992, van Ark 1996). In Wu (2014b), I also show that latecomer economies such as the Republic of Korea are not exceptional. By controlling for the stage of development from $2,000 to $8,000 per capita GDP in 1990 purchasing power parity terms, the growth of "non-material services" in the Republic of Korea in the period 1970–1990 was almost zero (in fact −0.1% per year) compared to the official estimate of the PRC's 6.2% per year in the comparable period 1993–2012.

Based on the empirical trends observed in developed economies, Maddison proposed a "zero labor productivity growth" axiom, which was used in his re-estimation of the PRC's GDP by "non-material services" (Maddison 2007). This means that he assumed that the value-added growth was the same as the employment growth in those services. He consequently arrived at an annual GDP growth rate of 5.5% for the period 1978 to 2003, approximately half of the official estimate of 11%. This adjustment lowered the official aggregate GDP growth by 0.9 ppts.

After a careful investigation, I confirmed Maddison's hypothesis for the pre-reform period up to 1983, skipping the earlier post-war recovery period and the shocks brought by the socialization (semi-nationalization of private enterprises) and the Great Leap Forward campaign and its catastrophic aftermath periods, i.e., that there was indeed zero labor productivity growth observed from the mid-1960s to the early 1980s. This suggests that the PRC's abnormally fast labor productivity growth in "non-material services" is basically a new phenomenon of the reform period, especially following the early 1980s. This could be caused by insufficient measure of price changes and thus exaggerated the real output. Besides, it may also be caused by considerably underestimated initial level of those services due to distorted pricing under central planning aiming to shift resources from "unproductive" activities such as "non-material services" to productive activities such as manufacturing.

My recent work in Wu (2014b) is a substantial revision of the earlier work in Maddison and Wu (2008). It involves three major tasks: (i) reconstructing a more consistent employment series for "non-material services" by tackling structural breaks and adding missing military personnel (as part of government services); (ii) taking into account the reform effect that corrected the previous distortions undervaluing those services by assuming 1% labor productivity growth per year from 1981 and another 1% growth per year 1992 to capture the effect of deeper reforms in the state sectors; and (iii) incorporating annual labor productivity variations from the trend growth shown in the official statistics. In the present study, considering labor price distortions may have been gradually offset by service market liberalizations, I have dropped the assumption of additional 1% labor productivity growth from 1992.

The alternative estimates for the value added of "non-material services" are presented in Table 6.5 in annual average growth rates for the whole period and its sub-periods. The time series estimates are shown in Figure 6.4. Besides, the annual average growth rates of the "non-material service" employment are also provided in Table 6.4 to derive implied labor productivity growth rates for the same periods. In both GDP and labor productivity growth, the alternative estimates are compared with the official aggregate estimates and the estimates derived from the CIP database using the KLEMS approach that adopts the official industry statistics controlled by the national accounts. For the entire period 1980–2012, the alternative estimates show that the PRC's value added in "non-material services" grew at 4.8% per year, much slower than the official estimate of 11.6% and the estimate of 9.0% by the CIP/KLEMS approach.

Considering the employment growth over the same period, the alternative GDP growth rate implies that the PRC's labor productivity in "non-material services" would grow at 0.9% per year if using the alternative estimates for value added, which would be more than 10 times the labor productivity growth achieved by the Republic of Korea in 1970–1990 at –0.1% per year (Wu, 2014b); if using the official GDP estimates or the CIP data, however, it would show an astonishing growth rate of either 7.7 or 5.0% per year.

Table 6.5 shows that the average growth paces over the sub-periods are also distinctly different between these estimates, and our alternative estimates appear to be most volatile. Nevertheless, if judged by the implied labor productivity growth, the official estimates and the CIP-adjusted official estimates appear to be much more volatile than our alternative estimates. A comparison of all three estimates for the period 1980–1991 may further help reveal the implausibility of the official GDP statistics for those services. The official estimates and the

Table 6.5: Growth of GDP, Employment, and Labor Productivity in the People's Republic of China's "Non-material Services" (% per year)

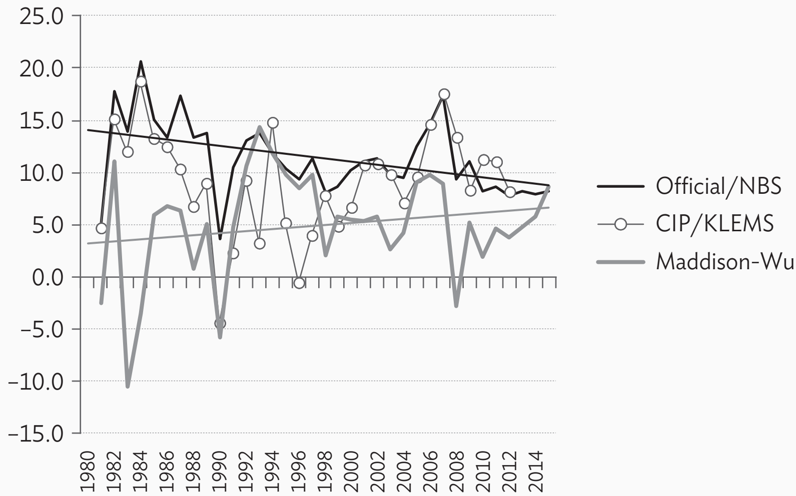
	1980–1991	1991–2001	2001–2007	2007–2012	2012–2015	1980–2012	1980–2015
GDP Growth							
Official/NBS	13.1	10.7	12.5	9.0	8.1	11.6	11.3
CIP/KLEMS	9.1	6.2	11.6	10.4	n.a.	9.0	n.a.
Maddison–Wu	1.7	8.3	6.7	2.5	6.3	4.8	5.0
Employment Growth							
NBS adjusted	1.6	6.7	4.4	3.2	5.8	3.9	4.1
Implied Labor Productivity Growth							
Official/NBS	11.5	4.1	8.1	5.8	2.3	7.7	7.2
CIP/KLEMS	7.5	−0.1	7.2	7.3	n.a.	5.0	n.a.
Maddison–Wu	0.1	1.7	2.4	−0.6	0.5	0.9	0.9

PRC = People's Republic of China; CIP/KLEMS = China Industrial Productivity (CIP)/capital, labor, energy, materials, and services (KLEMS) database; GDP = gross domestic product; NBS = National Bureau of Statistics.

Sources: See Table 6.4 for GDP estimates. See Wu (2014b) for employment estimates.

CIP-adjusted official estimates show a very rapid GDP growth over this period at 13.1 and 9.1% per year, respectively, compared to only 1.7% per year obtained by our alternative estimates. Such a rapid shift to those services suggested by the official statistics does not seem to be reasonable when the economy still focused on reforming the agricultural sector and revitalizing the ailing manufacturing industries. Initial deregulations in rural township and village enterprises and open up to foreign direct investment concentrated in labor-intensive manufacturing rather than services. Strict state controls over labor migration via the *hukou* (internal passport) system were still in force, leaving limited room for the growth of services in cities. Besides, the official and CIP-adjusted official estimates-implied labor productivity growth at 11.5 and 7.5% per year are also too high to be true.

Figure 6.4: **People's Republic of China's "Non-material Services" GDP Growth: Official versus Alternative Estimates** (% per year)



CIP/KLEMS = China Industrial Productivity (CIP)/capital, labor, energy, materials, and services (KLEMS) database; GDP = gross domestic product; NBS = National Bureau of Statistics.

Source: See Table 6.5.

It is worth a close look at the dynamics of the three series as presented in Figure 6.4. Like the case of the industrial output growth, the Maddison–Wu estimates demonstrate greater volatility than the others especially the official aggregate series. Shocks are apparently much more pronounced in our results than others. Notably, shocks in 1990 and 2008 had stronger impact on the "non-material services" than on the industrial sector (Figure 6.3). Nonetheless, the most severe shock in those services appears to be in 1983 when the earlier agricultural reform effect began to be exhausted. Interestingly, the CIP/KLEMS approach picks up some sharp declines in the 1990s that are never observed in the two aggregate measures of the official and the Maddison–Wu, suggesting that measures emphasizing the role of industries are more sensible. Finally, something interesting emerges by adding a trend line to the official estimates and to the alternative estimates, respectively. It shows that the official series follows a declining trend while my series tracks a rising trend. Compared to the former, the latter appears to be more plausible showing a clear shift of the economy from manufacturing to services.

Re-estimated GDP Growth and its Implication for TFP Growth

Taking into account our estimates for the industrial and "non-material services" sectors as described above, incorporating Maddison's work on agriculture (which only has a minor effect on the official growth rate; Maddison, 1998), and accepting official estimates for "material services" and construction (this admittedly is a strong assumption that requires further scholarly work to verify), we can now reconstruct an aggregate GDP index for the PRC economy. Table 6.6 presents the average growth rates of the alternative GDP growth estimates for the whole period and the sub-periods and Figure 6.5 presents the annual changes derived from this GDP index. Both show comparisons with the official estimates and CIP/KLEMS approach-derived estimates.

Table 6.6: People's Republic of China's GDP Growth: Official versus Alternative Estimates (% per year)

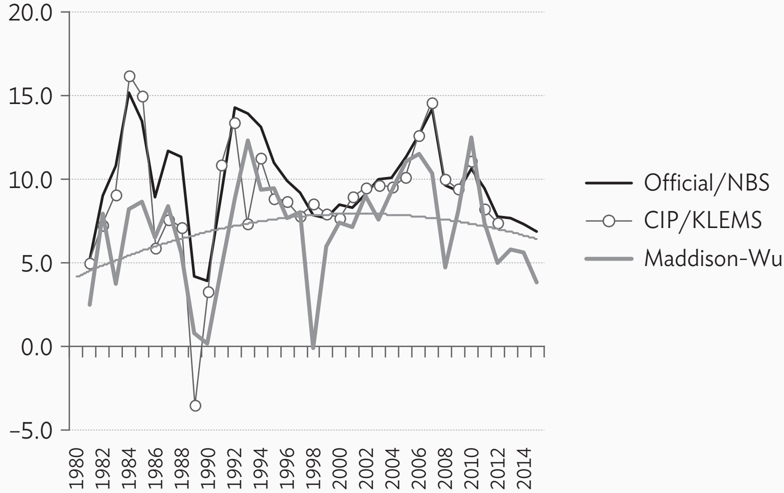
	1980–1991	1991–2001	2001–2007	2007–2012	2012–2015	1980–2012	1980–2015
Official/NBS	9.4	10.4	11.2	9.3	7.3	10.0	9.8
CIP/KLEMS	7.6	9.0	11.0	9.2	n.a.	8.9	n.a.
Maddison–Wu	5.2	7.6	9.8	7.5	5.1	7.2	7.0

CIP/KLEMS = China Industrial Productivity (CIP)/capital, labor, energy, materials, and services (KLEMS) database; GDP = gross domestic product; NBS = National Bureau of Statistics.

Sources: See Table 6.4, Maddison and Wu (2008), and Wu (2014a).

Over the entire period from 1980 to 2012, our alternative estimates arrive at an annual average 7.2 per year growth rate compared with the official estimate of 10.0% per year. It appears that this difference is mainly caused by the more profound downside impacts of external shocks as exhibited in our estimates. The smoother movement of the official estimates suggests a systematic upward bias in the official handling of the data that considerably covered up the external shocks on the economy.

Figure 6.5: People's Republic of China's GDP Growth: Official versus Alternative Estimates (% per year)



CIP/KLEMS = China Industrial Productivity (CIP)/capital, labor, energy, materials, and services (KLEMS) database; GDP = gross domestic product; NBS = National Bureau of Statistics.

Source: See Table 6.6.

The implication of this exercise for the PRC's TFP growth is in no way straightforward however. One cannot simply use the alternative estimates to adjust the growth of value-added and hence the growth of TFP in Tables 6.1–6.3 because of the lack of industrial details. But it is suggestive to any growth accounting study using the official data without seriously handling the potential flaws that if holding all the input factors constant, the estimated TFP growth is surely upward biased.

6.6 Concluding Remarks

The question about the PRC's growth sustainability cannot be easily answered without analyzing the economy's productivity performance. Using the newly constructed CIP database, this study adopts the Jorgensonian aggregate production possibility frontier framework, incorporating with the Domar aggregation approach, to examine the sources of growth in the PRC economy for the reform period 1980–2012. This methodology provides a highly appropriate analytical tool for investigating the industry origin of aggregate productivity and the effect of resource reallocation across industries in the PRC economy.

In this study I show that the PRC achieved an aggregate TFP growth of 0.83% per year for the entire period 1980–2012. As industry-weighted aggregate GDP growth was 8.9% per year over the same period, TFP growth only accounted for about 9.3% of the output growth. This estimate is apparently much smaller than the estimates of almost all previous studies using the aggregate production function approach. For example, the contribution of the TFP growth was about 40% in Bosworth and Collins (2008) and in Perkins and Rawski (2008). Compared to the work by Cao et al. (2009) applying a similar approach to the PRC for the period 1982–2000, my finding is only about one third of their estimate at 2.51% per year, which could be caused by differences in data construction in terms of measurement, coverage, and classification (e.g., I have 11 service sectors whereas Cao et al. put all services in one sector).

At the industry group level, as conjectured, industry groups less prone to government intervention, such as "SF&F" manufacturers, tend to have better TFP performance than those subject to direct government interventions, such as the "energy" group. However, the fact that the "SF&F" group maintained a positive TFP growth while the "energy" group experienced a persistent TFP decline may suggest the existence of "cross-subsidization" between upstream and downstream industries in which the government plays different roles to serve its strategy.

This is further supported by the findings on the factor reallocation effect, which shows that capital might be significantly misallocated in the PRC economy.

A TFP estimate is questionable if output is mismeasured. Using a revised Maddison–Wu alternative GDP approach and also updating the earlier Maddison–Wu estimates with the PRC's recently available 2012 Input–Output Tables, this study also conducts an exercise to estimate an alternative GDP growth for the PRC. It confirms the earlier findings in Maddison and Wu (2008) and in Wu (2002 and 2013) that the official estimates tend to exaggerate the growth in the 1990s and smooth out the growth volatility in the 2000s. Especially, it shows that external shocks to the PRC are more pronounced and the PRC's recent slowdowns are more significant than what was suggested by the official estimates. Therefore, other things being equal, my TFP estimates in this study may have still overstated the PRC's true productivity growth.

To better address the PRC's future growth one has to not only investigate the industry origin of the PRC's growth and productivity performance taking into account that industries may face different factor costs, but also bear in mind that the official output accounts may be distorted to reduce macro volatility and to disguise external shocks. In my view, a sensible projection for the PRC's growth in the near future, say the next 5 years, needs to consider both the PRC's "potential growth rate" that may be maintained over the projected period and reform scenarios that could improve the PRC's productivity performance. For the first consideration, I would take the revised Maddison–Wu annual compound GDP growth rate of 5.1% for the period 2012–2015 as a proxy for the "potential growth rate" (Table 6.6). Figure 6.5 shows that the Maddison–Wu estimate for 2015 is only 3.8% (compared to the official estimate of 6.9%), substantially below the potential rate. For the second consideration, if the TFP growth for 2015 is indeed –2.0% as estimated in Table 6.2 for the period 2007–2012, reforms that could stop the TFP decline or maintain a zero-TFP growth would sustain the growth at around 5%

per year. Nevertheless, the PRC's potential growth would be faster if more productivity-enhancing reforms are able to turn the PRC's TFP growth to something positive.

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CHAPTER 7

Is the People's Republic of China's Current Slowdown a Cyclical Downturn or A Long-term Trend? A Productivity-Based Analysis

Chong–En Bai and Qiong Zhang

7.1 Introduction

The People's Republic of China's (PRC) economy has shown visible signs of slowdown since 2008. The annual real gross domestic product (GDP) growth rate dropped from an annual average 10.54% between 2000 and 2007, to 9.70% in 2008. Though the government stimulus triggered a pullback from 2009's record low, this rebound proved to be short-lived: the growth rate slumped again in 2011. Over the period 2011–2015, the annual growth rate for the PRC economy stood at a mere 7.84%, even below that (10.03%) between 1978 and 2007.[1]

The causes of this striking slowdown and the PRC's economic outlook have been the subject of much contention. Some blame the lower growth on the financial crisis and the debt problems facing the eurozone, expecting the PRC economy to be back on its high-growth track once the residual impact of the crisis fades. Others point to the accumulated structural issues underlying the development mode of the past decade, arguing that high-speed growth is unsustainable and predicting a shift towards a "lower gear" or a "New Normal" scenario.

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1 The growth rates are calculated based on real GDP data in 2005 prices (among which the GDP for 2015 is a preliminary estimate), with original data from the PRC National Bureau of Statistics (NBS) website.

A good understanding of the forces behind the PRC's economic growth prior to the financial crisis is essential to this debate. Neoclassical growth theory suggests that economic growth is driven by labor (an increase in a well-educated and well-trained workforce), capital, and productivity. According to our analysis (which will be discussed in detail later), the annual productivity growth (residual of output growth minus growth rates of factor inputs) reached 3.55% between 1978 and 2007, much higher when compared with the rate of 1.97% over the period 2008–2014. Clearly, the PRC's productivity growth dipped in the wake of the financial crisis. The massive stimulus package and the discretionary macro-economic policies, which led to a boost in investment, had clearly played a huge role from 2008 to 2014.

Our analysis further reveals that the economic slowdown since 2008 is a result of the decrease in both labor and productivity growth rates. The cause of the former is readily explained by an aging population and more than 2 decades of widening coverage of compulsory education. A better understanding of what has led to the latter, therefore, is central to understanding the current slowdown in the PRC and the forecast of its future performance.

As such, this chapter first constructs provincial panel data between 1978 and 2014 based on a growth accounting model. To forecast the PRC's growth, it examines three aspects—technical efficiency, factor utilization efficiency, and allocative efficiency—to explain the regional and temporal productivity variations during this period. It then uses counterfactual analysis to reveal the causes of the PRC's productivity variations in recent years and recursively simulate the effects of a policy-promoted investment boom on growth. The chapter finds that, first, economic openness has a significant positive impact on the technical efficiency of production, whereas income level has a significant negative effect as implied by convergence theory. Second, a significant negative correlation is observed between the stock of inventory and productivity through the latter's influence on effective factor usage, while the opposite is observed between labor force involvement rate and productivity. Third, through effects on the efficiency of resource allocation, government size, and investment rate both have significant negative effects on productivity. Lastly, we conclude that the diminishing late-mover advantage and the growth in investment rate are all major contributors to the decline in the PRC's productivity since the financial crisis. Moreover, although the stimulus-induced investment surge has effectively offset the negative effects of the financial crisis on the PRC's growth, it is not conducive to productivity and consumption. The current economic slowdown does not seem to be a cyclical downturn that may soon be reversed. Indeed, further reforms are needed to stabilize the PRC's growth.

The main contribution of this chapter is as follows. First, it offers a comprehensive estimate of the PRC's national and provincial total factor productivity (TFP) over the period of 1978–2014 based on comparable data.[2] More specifically, it follows the principle of considering under-utilization of factors as efficiency loss and differentiates between the amount of inputs and their production efficiency as much as possible when assessing the TFP. Second, it determines the impact of technical factor utilization, and allocative efficiency on the TFP with provincial panel data, which can help to simultaneously consider provincial and year fixed effects. The former is closely related to regional, specific time-invariant characteristics over years, whereas the latter reflects the cyclical effects on all provinces during the same period. Results from the panel can then be applied to reveal long-run effects of referred determinants on TFP when short-run cyclical shocks are controlled. Third, after assessing the annual labor resource level in different provinces, the chapter adopts two methods to calculate the TFP: one considers human capital stock, which is a measure of the quality-adjusted labor force, as labor input; the other takes only the working-age population into account, but considers human capital as a determinant of factor utilization efficiency. Finally, it performs a counter-factual analysis (CFA) to analyze the PRC's post-crisis productivity variations to predict its long-term growth rate.

2 The PRC's provincial administrative units, which consist of provinces, municipalities, and autonomous regions, are labeled as "provinces" in this article for simplicity.

It answers the question of whether the PRC's economic slowdown since the 2008 financial crisis is a cyclical downturn or a long-run trend.

It is worth mentioning that there are a variety of ways to estimate TFP, each with unique advantages and disadvantages. One strand uses upstream output as downstream input to capture the productivity transferred across supply chains and considers only the actual number of factors entering the production process. This method yields very accurate results only when stringent data requirements are met—a condition that is hard to satisfy in the current PRC. Another downside of this approach is that it does not distinguish between the potential and actual input usage. In this chapter, we evaluate the comprehensive utilization efficiency of potential human and physical capital input throughout the entire production process. We also consider under-utilization as efficiency loss, so the transfer from potential to actual input usage, and from actual input usage to final output are all included in the calculation. To investigate the factors determining productivity, we quantitatively compare comprehensive variation across provinces over time, taking into account province-specific characteristics during a given period and controlling possible effects of cyclical shocks. We believe that this is the best approach under data availability constraints.

The remainder of the chapter includes the following sections. Section 7.2 briefly summarizes the research on TFP, its estimation procedures, and the factors that determine its growth. Section 7.3 describes the analysis framework. Section 7.4 explains the selection of indicators and data handling, and then applies the orthogonal decomposition method to identify effects of such indicators on productivity. Sections 7.5 and 7.6 break down the causes of the post-crisis fluctuation in productivity and recursively simulate the effects of policy-induced investment boom on growth using a CFA. The final part concludes.

7.2 Literature Review

This section surveys two lines of literature: one on TFP and its estimation methods; the other on elements that impact productivity.[3]

7.2.1 TFP and Estimation Methods

The term total factor productivity (TFP) has its origin in a 1766 article by Quesnay, which mentioned the word "productivity" for the first time, referring to the output generated per unit of input. Its conceptual framework was later established in Tinbergen's 1942 international comparison. By linking the increase in output that cannot be explained by increase in input to TFP, Solow (1957) set up the grounds for productivity measures in his neo-classical residual growth model. Abramovitz (1956) referred to TFP as a "measure of our ignorance," pointing to the various sources of productivity growth that cannot be explained by the factor inputs. His work spawned a series of studies aiming to expand Solow's model, taking into account the measurement issue Abramovitz raised and relating the resulting TFP to technological progress with commonly held beliefs.[4] However, Solow's TFP measures remain to date the most widely used methods in the literature.

Domestic scholars started to take notice of the PRC's TFP starting in the early 1980s, with Shi, Qin, and Chen (1985) one of the earliest examples. Systematic application of growth accounting theories and methods to measure technological advancement in the PRC, however, did not begin until the 1990s. Today, there are many studies on related topics. Generally speaking, most of them have focused on estimating TFP growth rates. Studies seeking to understand the change in TFP are relatively scarce.

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3 Detailed discussion of this section can be found in Bai and Zhang (2014).

4 Included among these studies are Denison (1967, 1972), Jorgenson and Griliches (1967), and Christensen and Jorgenson (1969, 1970).

Methodology is a central concern in obtaining TFP growth estimates. Theorists in this field are typically preoccupied with the merits of different production functions (i.e., which one more accurately describes the input–output production process) and uncovering their interlinkages. Empiricists, on the other hand, devote a large amount of effort to inferring the production process from input/output data. Several approaches are widely accepted in empirical studies, including Solow's 1957 growth accounting method, Farrell's 1957 deterministic production frontier, Aigner, Lovell, and Schmidt's 1977 stochastic production frontier, Charnes, Cooper, and Rhodes' 1978 data envelopment analysis, and Caves, Christensen, and Diewert's 1982 Malmquist productivity index. All the available methods have pros and cons. However, the growth accounting method is perhaps the most appropriate for explaining the change in TFP (Barro and Sala-i-Martin 1995, Barro 1999).

Another issue is how to measure factor input; more specifically, how to calculate the physical capital stock and whether to take human capital into account when considering labor input. Research studying the PRC's TFP often centers on assessing the physical capital stock; most such studies use Goldsmith's 1951 perpetual inventory method (PIM). Yet a major point of contention exists with respect to the assumptions of the initial physical capital stock and the depreciation rate (Ren and Liu 1997). In addition, opinions are divided as to whether or not different types of capital should be first assessed separately and then added to the total physical capital stock (Bai, Hsieh, and Qian 2006, 2007) or not (Zhang and Zhang 2003; Zhang, Wu, and Zhang 2004; Perkins and Rawski 2008).

One of the thorniest issues confronting scholars studying TFP is how to introduce human capital into the growth accounting model. It is indeed widely acknowledged that human capital accounts for an impressive economic rise (Mankiw, Romer, and Weil 1992). However, to date, no consensus has emerged on the definition of human capital. The work of Chen, Lu, and Jin (2004) is one of the first PRC scholarly forays into this field. An even more complex issue concerns the impact of human capital on growth. Scholars distinguish between the roles of human capital as a factor of production, and one that affects the growth rate of TFP (Benhabib and Spiegel 1994, Wei and Zhang 2010), both through domestic innovations (Romer 1990a) and by facilitating technological adoption and catch-up (Nelson and Phelps 1966). In the former, the benefit of human capital is measured as a production process input, whereas in the latter its growth effects operate through input utilization efficiency.

7.2.2 Factors Affecting Productivity

Empirically speaking, the estimates of TFP are sensitive to the choice of method, researchers' selection of indicators to proxy the input-output process, and possible measurement errors in the original data. Although work devoted to the systematic decomposition of TFP growth is scarce, scholars have looked at various areas in their attempt to explain the change in TFP.

Many early studies sought to identify the source of TFP growth. For example, Arrow (1962) observed that productivity gains are achieved through learning-by-doing and spillovers. Romer (1990b), on the other hand, labeled firms' research and development as a major source of TFP growth. Other scholars further noted that increasing economic integration has facilitated technological spillovers through foreign direct investment (MacDougall 1960) and trade (Grossman and Helpman 1991, He 2007).

The allocation of production factors is of primary interest to scholars studying the PRC's TFP. As Jones (2011) noted, income differences across countries associated with resource misallocation are one of the most important developments in the growth literature of the last decade. Scholars including Banerjee and Duflo (2005) and Restuccia and Rogerson (2008) have made attempts theoretically and empirically to prove the linkage between misallocation and the income gap between low-income countries and their industrialized peers. Many believe that reforms and policy adjustments aiming to correct resource misallocation in the PRC have the capacity to unlock the country's huge growth potential (Hsieh and Klenow 2009; Brandt,Van Biesebroeck, and Zhang 2012; Luo, Li, and Shi 2012).

7.3 Theoretical Framework and Analysis

This section offers first an explanation on how national and provincial TFP growth rates are estimated, followed by an introduction on ways of orthogonally decomposing TFP growth into several factors and an assessment of their marginal effects.

7.3.1 Methodologies for TFP Estimation

Of the many TFP estimation methods, the growth accounting approach is well suited for exploring the factors influencing TFP. More specifically, this approach assumes a production function reflecting the relationship between the output Y, physical capital stock K, and human capital stock H, which takes the form of $Y = AK^{\alpha}H^{1-\alpha}$, where α is the capital income share, and A the TFP. From the above production function, we have $g_A = g_Y - \alpha g_K - (1 - \alpha)g_H$, which implies that TFP growth rate (g_A) can be obtained once the growth rates of output (g_Y), physical (g_K) and human capital stock (g_H), as well as the capital income share, are known.

We can rewrite the production function as $Y = A^{\frac{1}{1-\alpha}}\left(\frac{K}{Y}\right)^{\frac{\alpha}{1-\alpha}}H$ ($\frac{K}{Y}$ is the capital output ratio), from which we get $g_A = (1-\alpha)g_Y - \alpha g_{\frac{K}{Y}} - (1-\alpha)g_H$.

Thereby we can compute TFP growth rate for given measures of output growth rate, capital–output growth rate ($g_{\frac{K}{Y}}$), human capital growth rate, and share of capital income. This chapter adopts the second approach since the neoclassical growth model implies a constant capital output ratio at steady state. This approach assumes that the parallel growth in physical stock (accumulated by investment, which is part of output) to that of output is assured by TFP (otherwise one would assume that decreasing marginal product would reduce investment and accumulation of physical capital stock). In that sense, it would be better to attribute the growth in output resulting from such induced growth in physical capital to the TFP. The physical capital only augments economic growth when it grows faster than output, which means changes in capital output ratios or shifts of the growth path.

7.3.2 Determinants of TFP

TFP measures the portion of output not explained by the amount of inputs used in production. As such, the level of TFP (and, by extension, the efficiency of an economy's factor utilization) is determined by how intensely the inputs are utilized in production and how much output is generated per unit of input. In the latter, productivity gains can be attributed to technological progress and a range of other changes including economic, political, regulatory, and cultural developments. Regardless of the source, productivity growth is either reflected as an overall boost (technical efficiency) or an average increase via reallocation (allocative efficiency).[5]

We hence model TFP growth as a function of three groups of determinants: (i) variables that will improve technical efficiency and, in turn, boost overall productivity (hereafter Group 1 determinants); (ii) variables that will boost factor utilization (Group 2 determinants); and (iii) variables that will boost factor allocation (Group 3 determinants). The equation is expressed as follows:

$$tfp_{it} = \underbrace{\left(\phi_1 TE_{1,it} + \phi_2 TE_{2,it} + \cdots\right)}_{Group1 \quad determinants} + \underbrace{\left(\varphi_1 EU_{1,it} + \varphi_2 EU_{2,it} + \cdots\right)}_{Group2 \quad determinants} + \underbrace{\left(\gamma_1 AE_{1,it} + \gamma_2 AE_{2,it} + \cdots\right)}_{Group3 \quad determinants} + \Gamma X + \varepsilon_{it} \qquad (1)$$

5 For example, factors flow from less to more productive sectors, or, in extreme cases, the least productive sectors are weeded out.

7.3.3 Data Source and Indicators

This section first discusses how we estimate the annual provincial TFP, and then explains our choice of indicators for the aforementioned three groups of determinants.

7.3.3.1 Provincial TFP

The first step in growth accounting exercises is to compute the capital income share, human capital stock, and output and physical capital stock in real terms using the most recent data. The detailed procedure works as follows.

Annual Real Gross Regional Product (GRP) by Province (At 2005 Constant Price)

Provincial Gross Regional Product (GRP) data from 1978 to 2014 (previous year = 100) are compiled from the *China Compendium of Statistics over Sixty Years* for 1978–1992, and from the PRC's National Bureau of Statistics (hereafter "NBS website" if no other specification of the data source is provided) for 1993–2014. Since the price base changes every year, these figures do not form a homogeneous time series. We therefore recalculate them in 2005 prices and then adjust for inflation to obtain the provincial time series for real GRP at a constant 2005 price.[6]

Annual Capital Income Share by Province

Growth accounting literature (e.g., Chen et al. 1988, Chow 1993, Chow and Li 2002) traditionally estimates the aggregate production function from which the share of capital income is derived. We find that this approach may not be applicable here for two reasons.

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6 Principally speaking, so long as a single, fixed base year is chosen, price variation across provinces will have little effect on the final results. However, given the continuous adjustment made to the official data, the effect of provincial TFP determinants may not be accurately measured if we use time series expressed in prices of the previous year. As such, we pick 2005 as the fixed benchmark year, as opposed to the typical choice of 1952 or 1978, although our robustness analysis shows that choosing a different reference year (such as 1978) has no significant impact on the results.

First, such an approach produces a fixed share of capital income, which is empirically unlikely given that the time series we chose spans 36 years. Second, empirical investigations of aggregate production may be theoretically flawed as they treat capital as an independent variable (because the change of capital is closely associated with the rate of return, which, in turn, is largely affected by productivity). As Perkins and Rawski (2008: 6) observed, "in China and other nations that experience major economic or institutional reforms, the growth of capital is itself in part the result of acceleration in TFP growth."

Here we compute the capital income share based on data of output structure accounted in income approach. We exclude net production tax from the capital income share calculation because the taxable amount includes income from both capital and labor inputs,[7] expressed as follows:

$$\alpha_{it}=\frac{\text{depreciation on fixed assets}_{it}+\text{operating surplus}_{it}}{\text{compensation of employees}_{it}+\text{depreciation on fixed assets}_{it}+\text{operating surplus}_{it}}$$

It is worth mentioning that the growth accounting method allows for the calculation of TFP only when the capital income share is fixed. However, it may be far-fetched to claim a constant provincial annual share of capital income (e.g., using the average of the annual capital income shares as a proxy) over a very long horizon (1978–2014) of rapid transformation. Such an assumption ignores the change in income distribution within and across provinces over time. For this reason, we only assume that the current year's capital income share is the same as that of the previous year. In other words, we use the mean of the capital income share of the *t* th and (*t* – 1)th year to calculate *t* th year's TFP growth rate for the *i* th province.

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[7] This is a simplified assumption when detailed data on the tax burden of capital as well as labor are not available.

Annual Human Capital Stock by Province

The lack of a large-scale survey on educational attainment poses a challenge to directly measuring the provincial stock of human capital. In this chapter, we opt to construct time-series of stocks of educational attainment for the provincial working-age population. We begin with the time-series estimates of age-specific population structure and average educational attainment years. Next, we obtain the total years of education of the population in working age following UN standards (aged 15–64) by taking a weighted sum of the average years of schooling (weights are assigned to different age groups based on their size), which then is used as a proxy for human capital stock.[8] The details of this procedure are presented below.

Step 1: Construct provincial population age structure. To date, the PRC government has conducted only six censuses and several population sampling surveys, the provincial age structure details of which are not disclosed to the public. While many demographic and sociological studies have attempted to present an accurate portrait of national population age structure, far fewer such endeavors have been made provincially. We believe that the dynamics of provincial population change over time are well described by the Markov process in which a given individual will either die (exit the economy), or move into the group one year older; at the same time, a group aged zero will be formed by newborns. In the absence of interprovincial migration,[9] it is feasible to infer historical and future patterns of provincial population age composition based on relevant data of a given year and every year's

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8 An alternative case that considers working-age people to be those aged 20–60 delivers very similar results, which, though not reported for space limitation, are available upon request.

9 This assumption can be readily accepted when estimating national population structures since the number of emigrants and immigrants is negligible when compared with the PRC's domestic population. However, it may not be feasible to apply such an assumption provincially. Nonetheless, we make such a simplified assumption for two reasons. One is that detailed annual data on age-specific migrants (or more specifically, age-specific migrants by education levels) is not publicly available. The other is that migration (reallocation of population) itself may influence factor utilization efficiency and therefore should be included as a determinant of productivity. Consequently, here we make this assumption when estimating human capital stock, while adding variables of migration as determinants of productivity later.

birth rate and age-specific mortality rates. Here we use the age-specific rates of mortality estimated by assuming

$$d_{a,\mathrm{i,t}} = d_{\mathrm{i,t}} \bullet \frac{d_{a,\mathrm{i,2000}}}{d_{\mathrm{i,2000}}}$$

where $d_{\mathrm{i,t}}$ and $d_{a,\mathrm{i,t}}$ are the mortality rate of the whole population and that of the population group aged *a* in province *i* in year *t*, respectively; $d_{\mathrm{i,2000}}$ and $d_{a,\mathrm{i,2000}}$ are the corresponding rates for the year 2000. The basic concept underlying the above assumption is that the possibility of death for any particular individual in a given year is affected both by their age and specific risk factors present in that year (reflected in that year's crude death rate).

Step 2: Estimate provincial age-specific education attainment.[10] We first measure the average years of schooling received by the working-age population (aged 15–64) based on individual data from the 2005 population census (the sample contains about 2.48 million people). Take, for example, the population group aged 35, which is denoted by $Educyear35_{it}$; for any province *i* at any time *t*, we assign the number of average years of schooling for all individuals aged 35 from 2005 survey data as the realized value of $Educyear35_{it}$ in 2005, that for all individuals aged 36 as the realized value of $Educyear35_{it}$ in 2004,[11] that for all individuals aged 37 as the realized value of $Educyear35_{it}$ in 2003,[12] and so forth. Similarly, we get realized values of $Educyear35_{it}$ between years 2006 and 2014 from the 2010 census data.

10 We assume an education system where an individual starts school at 6 years old, receives 6 years of primary and 3 years of secondary education, 3 years of high school, 2 years of junior college or 4 years of undergraduate, and then 2 years of graduate education. Also, graduates from a certain educational level obtain all years of that level, while dropouts and those who have completed schooling without earning a diploma or alternative credential of that level obtain half the years (or, equivalently, assuming uniform distribution of dropouts for that education level). Since school students are not classified as economically active, they are excluded thusly: individuals aged 20 with high school education when surveyed in 2005, for example, should be students between 1991 and 2003; hence, we exclude them when calculating average education attainment for the years before 2003.

11 Individuals aged 35 in 2004 form the group aged 36 in 2005 if they live for another year; in this sense, the group aged 36 in 2005 is the best representative of the group aged 35 in 2004.

12 Individuals aged 35 in 2003 become 37 in 2005 if they survive.

For all other age groups between 15 and 64 of each province, we estimate their average years of schooling in a similar way.[13]

Annual Physical Capital Stock by Province

Following Bai, Hsieh, and Qian (2006, 2007), we use the PIM to measure the annual provincial physical capital stock. We first compute the annual provincial physical capital stock (at 2005 constant price) for construction and installation, and that for equipment separately and then add them up to obtain the aggregate annual provincial physical capital stock.[14]

Figure 7.1 shows the distribution of the provincial TFP growth rates from 1978 to 2014 (frequencies are shown on the left vertical axis, with the corresponding fitted kernel density shown on the right vertical axis).

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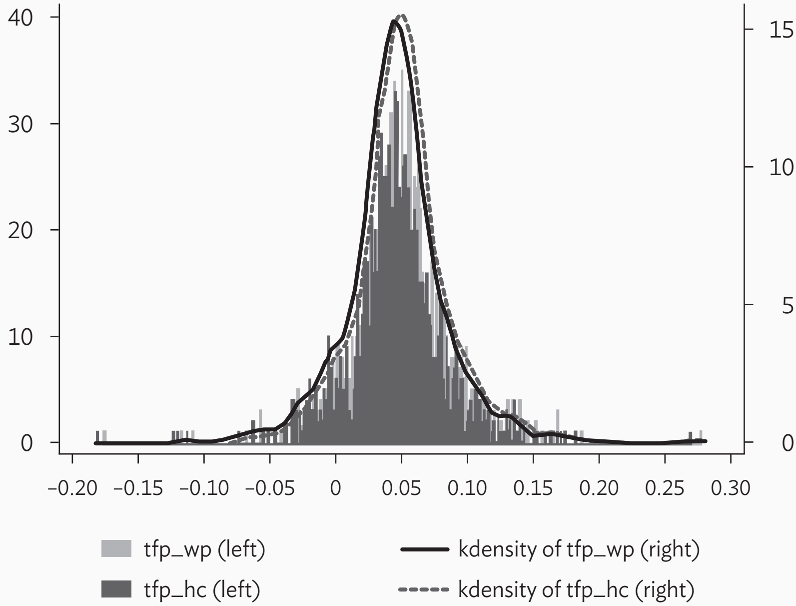
13 Note that here we actually assume no re-education experience for all individuals—no individual receives any further education once they start working. We believe it is an acceptable scenario for older people (e.g., aged 30 and above). Younger people (e.g., aged between 15 and 16), however, are far more likely to re-enroll some years after dropping out or pursue a higher level of education. That is, the average years of schooling of individuals aged 18 when surveyed in 2005 may be longer than that of individuals aged 15 in 2002 (though the former is the best representative of the latter). Nevertheless, we still make such assumptions for the following three reasons. First, the 15–64 age group is classified as working-age by the United Nations, and the commonly used dependency ratios are subsequently defined. This implicitly assumes that individuals over 15 do not re-enter the education system; otherwise this group will be excluded from the labor force (not willing to work). Second, the idea that individuals enter the work force at age 15 is roughly consistent with the PRC's education pattern. Most in the PRC start primary school at age 6, move on to secondary school at age 12, and then attain secondary education (compulsory) at age 15. Third, if we know the average age when people in each province start working (e.g., age 18), we can easily apply the aforementioned analysis to a different definition of working age (e.g., aged 18 to 64). In other words, we make such a simplified assumption owing to data limitations, but it can be readily modified when more data are available.

14 See Bai, Hsieh, and Qian (2006, 2007) for more details. We update Bai, Hsieh, and Qian's estimates with the latest data from the NBS website and most recently published yearbooks. Note that instead of summing the capital stock of construction and installation and that of equipment as done by Bai, Hsieh, and Qian (2006, 2007), we alternatively estimate the physical capital stock directly with annual aggregate investment data. We prove that these two approaches are theoretically equivalent if the deflator used for aggregate investment is the weighted harmonic mean of the deflators of construction and installation investment and equipment investment. However, they may be empirically different since the price index of aggregate investment includes those that can be grouped neither into construction and installation nor equipment.

Figure 7.1: Distribution of the Provincial TFP Growth Rate, 1978–2014



hc = human capital, TFP = total factor productivity, wp = working age population.

Sources: The China Compendium of Statistics; The Demographic Data Assembly of the People's Republic of China; Almanac of China's Population; County Level of Population Statistics in the People's Republic of China; National Bureau of Statistics of China (stats.gov.cn/English).

Results when human capital is included (with human capital stock as an input, tfp_{hc}) and excluded (with the working age population in the 15–64 range as an input, tfp_{wp}) are both displayed in the figure.[15] The growth rates of TFP (written as $\{tfp_{it}\}$, which reflects the change in overall productivity) obtained with or without a human capital variable are quite similar. As such, we start with tfp_{hc} and use tfp_{wp} (where human capital is additionally considered as a utilization efficiency determinant) as a robustness check in the following analysis.

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15 We compare our estimates of these two series with those obtained by other scholars such as Perkins and Rawski (2008) and find them to be very similar despite the differences in data, estimating methods, and indicators. Only some minor differences exist in terms of years of beginning (possibly due to different assumption of initial physical capital stock) and ending (possibly due to data later modified by the NBS).

7.3.3.2 Factors of Changes in Productivity

As mentioned previously, the “residual” TFP measures the portion of output not explained by the amount of tangible, and therefore quantifiable, inputs used in production. As such, the growth of TFP can be attributed either to a raise in aggregate productivity (potential productivity), or an increase in input utilization rate, or more efficient allocation of factor input between different production sectors. In this chapter, we denote the three groups of determinants as “technical efficiency,” “utilization efficiency,” and “allocative efficiency,” respectively.

Specifically, Group 1 determinants (technical efficiency) act on the utilization of capital and/or labor inputs in different sectors simultaneously. Institutional quality (e.g., rule of law), technological progress (neutral, labor-augmenting, and capital-augmenting) and openness to the world economy are some well-studied examples. Economic catch-up (or “convergence”) as reflected in income levels relative to the world frontier also falls in this category.

We introduce Group 2 determinants (utilization efficiency) for the following two reasons. First, although it is the flow of services from the capital stock and the people employed that make active contributions to the output, under-utilization of available capital and labor resource is in itself a loss of efficiency, which therefore should be captured by the estimated TFP. Hence, to fully separate the effects of the amount and the utilization efficiency of inputs, we recommend estimating TFP by considering all physical capital stock (whether used or not) and the entire working-age population (whether employed or not) as production inputs. Second, given that the demand-side factors influence the short-term utilization efficiency of inputs and the supply-side factors affect the amount of long-run available resources, it is only natural that we seek to separate the effects of the latter from the former.

Group 3 determinants (allocative efficiency) are well explored in the misallocation literature. Resource reallocation often affects factor utilization, given the productivity gap between, for example, government and households, state-owned enterprises (SOEs) and non-SOE firms, urban and rural areas, different industries, and investment goods and consumer goods sectors.[16] As the "reform dividends" literature (among other researches) observed, reallocation has been a major source of economic growth since the PRC's reforms. Therefore, even when sector-specific productivity remained constant, structural reforms could enhance overall productivity by changing the relative weight of different economic sectors. By choosing appropriate indicators such as government size, the share of state ownership, urbanization progress, and the weights of the primary and the tertiary sectors in the economy, it is possible to measure the effects of resource reallocation resulting from structural reforms.

We identified two major indicators associated with Group 1 determinants: (i) provincial income level (the catch-up indicator [CUI]), which measures the catch-up effect, defined as the natural logarithm of relative provincial lagged real GRP per capita to lagged real GDP per capita of the US (written as *L.* ln *relativeGRP*);[17] and (ii) the degree of foreign trade dependence, which reflects the level of openness and trade orientation of a provincial economy and its capacity to capture technology spillovers, defined as the ratio of exports and imports to GRP (written as *ftd*). Imports and exports data used to

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16 Significant productivity differences among these sectors are well documented in the literature.

17 The PRC provincial GRP and US national GDP are both valued in 2005 prices in US dollars. We first get the annual US$/yuan bid and ask rates based on data of the PRC's GDP respectively valued in yuan and US$ (both are in 2005 prices) from the UN data website. The data of provincial GRP per capita valued in yuan are then accordingly converted into those in US$. The annual GDP per capita data in 2005 prices for the US are calculated with data of GDP (from the UN data website) divided by data of aggregate population (from the OECD website). This means we always assume the US as the productivity frontier. Some may prefer to consider another CUI to be the productivity level for each province relative to the US. For simplicity's sake, we here follow Lucas (2009) to consider the CUI of relative income levels. The results with the alternative CUI of relative productivities, which are not presented here, though are available upon request, are similar.

calculate this indicator are expressed in US dollars (US$),[18] and thus need to be converted into yuan (CNY). We make this conversion by first obtaining the annual US$/yuan bid and ask rates based on national layer data (the NBS website provides annual data on total imports and exports both in US$ and yuan).[19]

Group 2 determinants include variables that affect the level of output generated per unit of input through effective usage. We select two indicators. The first indicator is the provincial inventory stock, which measures the accumulation of non-productive capital, defined as the ratio of inventory stock to GRP (written as *inventory*). We adopt an approach similar to that used to calculate the physical capital stock to assess the real inventory stock in 2005 prices. Data needed are gathered from the NBS website and the *China Compendium of Statistics 1949–2008*. The second indicator is the labor involvement rate, which measures the proportion of working-age population active in production, defined as the percentage of employed persons aged 15–64 (written as *lir*). This indicator can be derived by multiplying the proportion of economically active persons (or labor force) in the working-age population (the labor participation rate [LPR]) with that of employed persons in labor force (the so-called employment rate). In our opinion, the former mainly reflects the health status and working willingness of the PRC working-age population, whereas the latter mainly indicates how active they are in the economy; their products, here termed as the labor involvement rate, therefore show comprehensively the efficiency of potential labor input to actual labor input. Data on the total number of employed persons come mainly from the *China Compendium of Statistics 1949–2008*, complemented

18 The NBS website has published two data series of exports and imports since 1993: one is recorded according to the jurisdictions where the domestic firms are registered, while the other is classified by the commodities' region of origin and destination. We carefully compare these two series with data from the *Compendium of Statistical Data and Materials on 50 Years of New China* and find that the former is more comparable with the compendium data and therefore choose it for combining the final series between 1978 and 2014.

19 It is worth mentioning that the way of obtaining the annual US$/yuan bid and ask rates for converting imports and exports are slightly from the way of those for converting provincial GRP. This is because we think the former is mainly related to tradable goods, whereas the latter is used for all goods (including tradable and non-tradable ones).

by information from provincial statistical yearbooks, statistical bulletins of human resources and social security development, and statistical bulletins of national economic and social development.

We only introduce human capital intensity *princomp_hc* as a third indicator when tfp_{wp} is used as a dependent variable. Human capital intensity as a composition factor is defined as the weighted average of age-specific education attainments of the working-age population, which can be calculated using the Principal Component Analysis (PCA) method. Specifically, we use the principal component as a proxy for human capital intensity.

The indicators for the Group 3 determinants include government size, the weight of SOEs in the economy, investment rate, industrial structure, urbanization, and migration. Government size and the weight of SOEs in the economy are two variables that measure the influence of government intervention on TFP growth. Investment rate measures the factor utilization difference between investment goods sectors and consumer goods sectors. Industrial structure measures the productivity gap between different economic sectors. Urbanization and migration measures the effects of factor mobility.

Government size is defined as the ratio of local government revenue to provincial GRP (written as *govsize*).[20] Annual local government revenue data (in current prices) are collected from the NBS website (local government budgets and expenditures sector).[21]

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20 Measuring government size can be a daunting task. Some recommend the use of the ratio of local government expenditure to provincial GRP as a proxy. This method is not considered here for two reasons. First, these two measures are very similar since local government income approximately equals local government expenditure for all provinces in all years. The second is that part of the central government spending, such as funding for certain agricultural irrigation projects, targets only one or several provinces, and thus should be included into the local government expenditure of the benefiting provinces. Such detailed data are not publicly available and exploration in this area, though meaningful, is beyond the scope of this chapter. Therefore, we choose to ignore the nuances for simplicity.

21 Measuring the impact of non-budgetary expenditures (which also play a significant role in boosting local economic growth) on TFP, though important, is well beyond the scope of this chapter, due to the lack of comparable datasets.

Provincial GRP (in current prices) data for the period 1993–2014 come from the NBS website; those for the period 1978–1992 come from the *China Compendium of Statistics 1949–2008*.

The economic weight of SOEs (written as *soe*) is defined as the ratio of investment in fixed asset by SOEs to the aggregate investment in fixed asset.[22] Data for the period 1978–2004 are sourced from the *China Compendium of Statistics 1949–2004*; those for the period 2005–2014 come from the NBS website.

Investment rate (written as *inv_rate*) is defined as the ratio of aggregate capital formation to provincial GRP. Data for the period 1993–2014 come from the NBS website; those for the period 1978–1992 come from the *China Compendium of Statistics 1949–2008*.

Industrial structure includes the "weight of the primary sector" (written as *prim*) and the "weight of the third sector" (written as *third*). The former is defined as the share of value added of the primary sector in provincial GRP. The latter is defined as the share of value added of the third sector in provincial GRP. Data for the period 1993–2014 come from the NBS website; those for the period 1978–1992 come from the *China Compendium of Statistics 1949–2008*.

Urbanization is defined as the growth rate of the share of urban population in total population (written as *urgr*). Data of the share of urban population for the period 2000–2014 are from the NBS website; data for the period 1978–1999 are collected from the *China Compendium of Statistics 1949–2008*.

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22 An alternative is to define the economic weight of SOEs as their proportion of industrial output out of total industrial output. Both indicators only partly represent the relative size of SOEs in the PRC economy (measuring only the size of investment, in the former case, and the industrial output, in the latter, by firms large enough to be surveyed).

Migration includes the rate of entrance (written as *migratein*) and the rate of exit (written as *migrateout*),[23] both of which measure the effect of interregional labor mobility on TFP growth. Data for these two indicators, which could at least partially correct the bias of assuming the lack of migration among provinces previously when calculating provincial human capital stock, come from several sources: those for the period 1978–1984 are from *The Demographic Data Assembly of the People's Republic of China 1949–1984*; those for 1985–1991 are correspondingly collected from various issues of *Almanac of China's Population* for years between 1986 and 1991; those for 1992–2010 are from various issues of *County Level of Population Statistics in the People's Republic of China* for years from 1992 to 2010.

Table 7.1 presents the summary statistics for all aforementioned variables.

7.3.3.3 Determinants' Effects on the TFP Growth

Given that the Hausman test confirms fixed effect models are better than random effect ones, we further use them to orthogonally decompose the above potential determinants on TFP growth rate in the following analysis.

We also test the stationarity of residuals in the fixed-effect regression to ensure that the estimates are reliable and co-integration relationship exists between the TFP growth rate and the potential determinants.[24]

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23 Note that both indicators contain inter- and intra-provincial migration. A much more reasonable way is to establish three indicators to distinguish between intra-provincial migration rate, immigration rate, and emigration rate. Unfortunately, we do not have access to the relevant data.

24 Commonly used Levin-Lin-Chu (LLC; 2002), IPS (Im, Pesaran, and Shin 2003), and Hadri (2000) tests can all be applied to unit root tests on panel data. The null hypothesis is that some panels contain unit roots for the LLC test, all panels contain unit roots for the IPS test, and all panels are stationary for Hadri test, respectively. However, the LLC and Hadri tests require strictly balanced panels, which is not satisfied here since observations for certain indicators are missing in some provinces in some years.

Table 7.1: Summary Statistics and Unit Root Tests for Key Variables

		Obs.	Mean	Std.	Min.	Max.
TFP growth rate	tfp_hc	1,106	0.046	0.037	–0.181	0.270
	tfp_wp	1,106	0.050	0.037	–0.176	0.279
L.lnrelativeGRP		1,147	–3.461	0.570	–4.686	–1.757
ftd		1,109	0.228	0.337	0.001	1.912
inventory		1,147	0.650	0.331	0.072	2.740
lir		1,144	0.746	0.093	0.373	0.981
princomp_hc		1,147	–0.033	6.212	–21.251	21.693
govsize		1,136	0.104	0.065	0.006	0.620
soe		1,137	0.581	0.227	0.114	1.000
inv_rate		1,140	0.453	0.151	0.138	1.304
prim		1,147	0.219	0.126	0.005	0.606
third		1,147	0.341	0.098	0.087	0.779
urgr		1,138	0.033	0.090	–0.652	0.903
migratein (‰)		993	17.907	7.165	1.980	61.250
migrateout (‰)		963	15.812	6.847	2.720	66.020

hc = human capital, obs = observations, std = standard error, TFP = total factor productivity, wp = working age population.

Sources: The China Compendium of Statistics; The Demographic Data Assembly of the People's Republic of China; Almanac of China's Population; County Level of Population Statistics in the People's Republic of China; National Bureau of Statistics of China (stats.gov.cn/English).

On the basis of the tests suggested by Wooldridge (2003), we find that the fixed-effect regression continues to suffer from auto-correlation problems. We therefore report Newey–West standard deviations.

The tfp_{hc} Approach

The first part (columns 1–4) of Table 7.2 presents the results when we adopt the tfp_{hc} approach, i.e., estimating TFP growth rate when human capital is treated as a quality multiplier to adjust labor force.

Column 1 includes all potential variables of the above three groups of determinants and shows how technical efficiency-related indicators, namely, income level *L.lnrelativeGRP* and degree of foreign trade

Table 7.2: Determinants of TFP Growth Rate

	tfp_hc				tfp_wp		
	1978–2014			2001–2014	1978–2014		2001–2014
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
L.lnrelativeGRP	−0.075***	−0.075***	−0.066***	−0.065**	−0.097***	−0.080***	−0.067**
	(0.013)	(0.013)	(0.011)	(0.028)	(0.015)	(0.012)	(0.028)
ftd	0.028***	0.028***	0.027***	0.007	0.026***	0.026***	0.007
	(0.009)	(0.009)	(0.008)	(0.013)	(0.009)	(0.008)	(0.013)
inventory	−0.020**	−0.020**	−0.012	0.000	−0.023**	−0.011	−0.003
	(0.009)	(0.009)	(0.008)	(0.020)	(0.010)	(0.008)	(0.020)
lir	0.081***	0.081***	0.074***	0.063	0.083***	0.071***	0.053
	(0.028)	(0.027)	(0.023)	(0.039)	(0.028)	(0.023)	(0.040)
princomp_hc					0.008***	0.005***	0.006
					(0.002)	(0.002)	(0.004)
govsize	−0.108**	−0.108**	−0.113***	−0.083	−0.108**	−0.102**	−0.084
	(0.046)	(0.045)	(0.041)	(0.162)	(0.046)	(0.041)	(0.149)
soe	0.002	0.002			−0.000		
	(0.014)	(0.014)			(0.014)		
inv_rate	−0.052	−0.052**	−0.049***	−0.068***	−0.100	−0.031*	−0.053***
	(0.073)	(0.023)	(0.016)	(0.014)	(0.072)	(0.018)	(0.017)
inv_rate square	−0.000				0.060		
	(0.060)				(0.063)		
prim	0.009	0.009	−0.029	−0.393***	0.027	−0.010	−0.363***
	(0.045)	(0.045)	(0.039)	(0.098)	(0.046)	(0.040)	(0.104)
third	−0.039	−0.039	−0.055	−0.109**	−0.055	−0.071*	−0.128**
	(0.041)	(0.041)	(0.033)	(0.045)	(0.044)	(0.037)	(0.054)
urgr	0.012	0.012	0.014	0.009	0.009	0.012	0.010
	(0.011)	(0.011)	(0.010)	(0.016)	(0.010)	(0.010)	(0.017)
migratein	0.000	0.000			0.000		
	(0.000)	(0.000)			(0.000)		
migrateout	−0.000	−0.000			−0.000		
	(0.001)	(0.001)			(0.001)		
Province effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	939	939	1,095	432	939	1,095	432
IPS test	0.000	0.000	0.000	0.000	0.000	0.000	0.000

hc = human capital, TFP = total factor productivity, wp = working age population.

Note: (i) The Newey–West standard deviations are in parentheses. (ii) *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. (iii) For the Im-Pesaran-Shin (IPS) test, we report the P-values.

Sources: The China Compendium of Statistics; The Demographic Data Assembly of the People's Republic of China; Almanac of China's Population; County Level of Population Statistics in the People's Republic of China; National Bureau of Statistics of China (stats.gov.cn/English).

dependence (*ftd*) both have a statistically significant impact on TFP growth. The estimated coefficient on the former variable has the expected negative sign, as convergence to the productivity frontier naturally entails a slowdown of TFP growth in the larger economy. The coefficient on the latter variable has the expected positive sign, confirming the common belief that learning and adaptation of advanced technology associated with, and facilitated by, a high level of openness raise productivity.

The utilization-efficiency indicators, that is, the relative size of inventory stock (*inventory*) are found to have an expected negative impact on tfp_{hc}; whereas the labor involvement rate (*lir*) is found to have an expected, significantly positive effect on tfp_{hc}. Indeed, an increase in inventory stock implies a decrease in the amount of output entering the production process, whereas a higher labor involvement rate means more working-age people entering the work force.

Allocative-efficiency indicators such as government size (*govsize*) have a significant negative effect as expected, whereas the economic weight of SOEs (*soe*) appears to have an insignificant effect. Slightly inconsistent with the commonly held belief, the results shown in column 1 suggest that state ownership may not necessarily reduce efficiency. One possible explanation is the choice of indicator. We proxy the weight of SOEs in fixed asset investment by SOEs to that in the whole economy. Moreover, the insignificance of the corresponding efficiency may be a result of two opposing effects. As Bai et al. (2000) observed, SOEs have positive spillover effects. Such positive impacts on the economy could be offset by the well-documented negative impacts associated with monopolies and resource under-utilization. The observed insignificance may also be a result of the synchronous relationship influenced by a third factor (i.e., economic prosperity): an expansion of the state-owned economy and growth in productivity would be simultaneously observed during the economic boom.

Results of the investment rate (*inv_rate*), along with its square terms to show possible non-linear effects, indicate an insignificant inverted

U-shape effect on tfp_{hc}. The estimated coefficients for industrial structure (*prim* and *third*), migration (*migratein* and *migrateout*), and urbanization (*urgr*) turn out to be statistically insignificant.

The statistically insignificant estimate of the square term of investment rate (*inv_rate*) then suggests the omission of this variable in column 2. Moreover, given the missing migration data (*migratein* and *migrateout*) for certain years (mainly since 2011) and the imperfect representation for the economic weight of SOEs (*soe*), together with the insignificant impact of these three indicators (their estimated coefficients are close to zero), we recalculate the estimates when excluding these indicators. The results are shown in column 3. Clearly, the estimated coefficients in columns 2–3 are close to their counterparts in column 1, except for statistically significant estimates for the variable *inv_rate*.

For an economy undergoing dramatic transformation, the PRC may have experienced significant structural changes within the time horizon under investigation (1978–2014). In other words, a certain determinant's effect on tfp_{hc} may vary over time. An example is how "investment" could play a different role in different development stages: early on, investment (on infrastructure in particular) served to promote resource reallocation and productivity growth; however, it could prove to be detrimental in later stages when over investment leads to a consumption imbalance. Hence in column 4 we focus on the 2001–2014 time period, which can be conveniently divided into two intervals of the same length before and after the 2008 crisis. We find similar values for the estimated coefficients. Under this approach, however, the degree of foreign trade dependence (*ftd*), relative size of inventory stock (*inventory*), labor involvement rate (*lir*), and government size (*govsize*)collectively have an insignificant impact on tfp_{hc}; whereas the two indicators for industrial structure (*prim* and *third*) both have significantly negative impact.[25]

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25 This implies lower productivity growth rates for the primary and tertiary industries. While the former is naturally expected, the latter may be partly due to its inclusion of some sectors with lower productivity such as public administration and social service institutions.

The tfp_{wp} Approach

As previously discussed, human capital can be both viewed as a factor and a utilization efficiency determinant. Results obtained using the first approach are displayed in the first part of Table 7.2 (columns 1–4). The following section discusses results obtained when adopting the second approach. In other words, tfp_{wp} is turned into an explained variable and human capital intensity (*princomp_hc*) is entered as the utilization-efficiency variable. Results are shown in the second part of Table 7.2 (columns 5–7).

Clearly, human capital intensity (*princomp_hc*) has a significant, positive impact on TFP growth tfp_{wp}. In addition, although the effects of individual indicators on the TFP growth rates in parts 1 and 2 are similar, they are, however, more pronounced in the former. We use regressions to orthogonally decompose the effects of potential determinants on productivity because TFP as "a measure of our ignorance" to date has remained largely unexplained. Further, data limitation prevents us from directly revealing influences of these determinants. Human capital, however, can be more or less estimated, as we have done in earlier sections. We therefore adopt the tfp_{hc} approach to decompose the causes of the PRC's post-crisis slowdown of productivity growth in the next section.

7.4 Decomposing the Recent Decline in Productivity Growth

Next, we analyze the difference in TFP growth rate between 2001 to 2007 and 2008 to 2014, and then determine the extent to which the gap could be explained by the change in individual determinants before and after 2008 (see Table 7.3).

To be more specific, we first calculate the TFP growth rate (in the tfp_{hc} situation with human capital included) and the values for the four subsequent indicators–relative income level (*L*.ln *relativeGDP*),[26]

[26] That is, the natural logarithm of relative lagged real GDP per capita of the PRC to lagged real GDP per capita of the US. For estimation methods and data source, see previous discussion.

investment rate (*inv_rate*), and industrial structure (*prim* and *third*)—year by year from 2001 to 2014 at the national level.[27] Then we compare the mean values of these four indicators before and after 2008. Based on a given determinant's average effect on TFP growth (which is obtained applying the estimated coefficient from column 4 in Table 7.2), we next compute percentage of change in its rate after 2008 that can be explained by the change in a given determinant. As Table 7.3 clearly shows, the PRC suffered a drop (0.019) in TFP growth rate after 2008, about 95.08% of which could be attributed to the four growth determinants.

Table 7.3: Change in TFP Growth Rate Before and After 2008 and the Percentage Explainable by Growth Determinants

	Interval Mean		Change after 2008		
	2001–2007	2008–2014	Change	Marginal Effect of Change on TFP	Percentage Explained (%)
tfp_{hc}	0.0388	0.0197	−0.0191	–	–
L.lnrelativeGDP	−3.2787	−2.9693	0.3094	−0.0201	105.43
inv_rate	0.3986	0.4665	0.0678	−0.0046	24.14
prim	0.1224	0.0964	−0.0260	0.0102	−53.52
third	0.4188	0.4520	0.0332	−0.0036	19.03
Total	–	–	–	−0.0181	95.08

Notes: (i) All items presented in this table are authors' estimates (for methods of calculation, see previous discussion). (ii) Percentage explainable by a given determinant is given by the following equation: explainable percentage = change in determinant after 2008*estimated coefficient/change in total factor productivity (TFP) growth rate after 2008 (tfp_{hc}).

Sources: The China Compendium of Statistics; The Demographic Data Assembly of the People's Republic of China; Almanac of China's Population; County Level of Population Statistics in the People's Republic of China; National Bureau of Statistics of China (stats.gov.cn/English).

[27] We choose the 2001–2014 time horizon because it can be conveniently divided into two intervals of the same length: 2001–2007 (before 2008) and 2008–2014 (after 2008). The four indicators are chosen because their estimated coefficients are statistically significant. For estimation methods and data source, see previous discussion.

To further explore the PRC's post-crisis productivity variations, we conduct a counter-factual analysis (CFA) under a comparative static situation. In other words, to assess the growth effects attributable to a candidate determinant, we assume that only this particular determinant remains constant during the observing period and look at the "outcome" in the absence of its "intervention." The determinant's impact on TFP growth rate (i.e., its explainable percentage) is then estimated by comparing CFA predictions to actual observations. Let the candidate determinant be *x*, with the CFA predictions given by the equation $tfp_{\text{no x,t}}^{CFA} = tfp_t - \hat{\beta}_x \bullet (x_t - x_0)$ where tfp_t refers to the actual outcomes, β_x is the estimated marginal impact of *x* on productivity (which equals the estimated coefficient of *x* in column 4 of Table 7.2), and x_0 and x_t stand for the original value of *x* and the value of *x* in a given year during the observing period, respectively. The "comparative static" analysis is so called to distinguish it from the later dynamic analysis, as this approach neglects the interactive effects among these determinants over time.[28]

Before proceeding further, it is useful to look at the combined effect of the four indicators on the TFP growth rate during 2008–2014. Figure 7.2 demonstrates this effect (the "without time trend" curve), calculated based on estimated coefficients from column 4 in Table 7.2 and values for the four indicators from 2008–2014, and its prediction when cyclical effects, namely the estimated time dummies from column 4 in Table 7.2, are included (the "with time trend" curve).[29]

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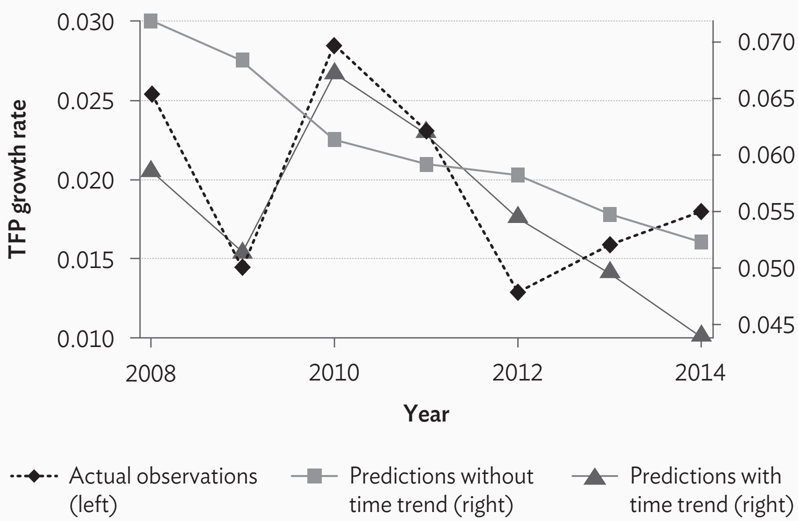
28 For example, a change in investment rate in 2008 would cause a change in TFP in 2008; therefore, the GDP in 2008 would change. The new GDP would further predict a new TFP in 2009 since its growth rate is related to GDP in 2008 as implied by convergence theory (the GDP in 2009 would also change).

29 We cannot get corresponding estimators for time dummies at the national level, but their cyclical pattern can be approximated from those at the provincial panel (though most of them are statistically insignificant in all columns of Table 7.2). It is worth noting that the means of the indicators in Table 7.2 for the national time series and the provincial panel are not exactly the same; therefore, we show the actual observations on the left axis and the "with-" and "without time trend" curves on the right vertical axis in Figure 7.2. This is to better show the trend of these curves without affecting the final conclusion.

Figure 7.2 shows that the "with time trend" curve moves closely with the data between 2008 and 2014, when both the long-run trend (as predicted by the four indicators) and short-run cyclical variations (as implied by estimated time dummies) are considered. This further supports the validity of orthogonally decomposing effects of potential determinants with panel data as we have done in previous sections. The "without time trend" curve indicates that it is the long-run structural factors that are mainly responsible for the decrease in TFP growth rate during this period, rather than short-run cyclical factors. The differences between the "with-" and "without time trend" curves result from influences of policies (excluding investment stimulus) and many other factors during this period.

Figure 7.2: Change in TFP Growth Rate and Its Source, 2008–2014



TFP = total factor productivity.

Sources: The China Compendium of Statistics; The Demographic Data Assembly of the People's Republic of China; Almanac of China's Population; County Level of Population Statistics in the People's Republic of China; National Bureau of Statistics of China (stats.gov.cn/English).

Table 7.4: CFA Predictions of TFP Determinants, 2008–2014

		2008	2009	2010	2011	2012	2013	2014
CFA predictions	L.lnrelativeGDP	0.030	0.021	0.042	0.039	0.029	0.034	0.039
	inv_rate	0.027	0.018	0.033	0.028	0.017	0.020	0.022
	prim	0.025	0.013	0.026	0.020	0.010	0.012	0.013
	third	0.025	0.016	0.030	0.025	0.016	0.020	0.024
Actual observations		0.025	0.014	0.028	0.023	0.013	0.016	0.018

Notes: (i) The actual observations in the above table are the national total factor productivity (TFP) growth rates (tfp_{hc}) for 2008–2014. (ii) Counter-factual analysis (CFA) predictions are estimates calculated holding a given determinant constant at 2007 level. The difference between CFA predictions and their corresponding actual observations reflects the marginal effect of this particular determinant on the growth rate of productivity.

Sources: The China Compendium of Statistics; The Demographic Data Assembly of the People's Republic of China; Almanac of China's Population; County Level of Population Statistics in the People's Republic of China; National Bureau of Statistics of China (stats.gov.cn/English).

Table 7.4 presents the CFA estimates of the growth effects of four indicators from 2008 to 2014. The figures in the first part show what the CFA productivity growth rate would be over the period 2008–2014 and how would it change if we fixed a certain candidate determinant from 2008 onward at the 2007 level while allowing all the others to take their actual values. The differences between the corresponding CFA estimates and the actual observations (as shown in the last row) can be treated as the marginal effects of the particular determinant on productivity growth.

In summary, the continued fast growth of the PRC economy relative to the US since the financial crisis has slowed down the convergence process. The changes in investment rate and the weight of the tertiary industry have combined to impede the continued improvement in TFP growth. Their negative influence has far outweighed the positive impact brought by the decrease in the weight of the primary industry. Had all four indicators remained constant at the 2007 level, the growth rate of the PRC's productivity would have risen by 0.006, 0.009, 0.016, 0.018, 0.020, 0.023, and 0.026 in 2008, 2009, 2010, 2011, 2012, 2013, and 2014, respectively. Of all the three factors acting against growth in productivity, diminishing late-mover advantage as implied by higher relative income level is the primary culprit, followed by investment rate and the weight of the tertiary industry.

Given that the PRC economy is set on an upward track, with relative higher growth rates than that of the US for years to come, the investment rate is likely to remain high and the tertiary industry will keep expanding in the short term. Consequently, the slowdown since 2008 will become an inevitable trend for the conceivable future. The need to find new ways to raise productivity is urgent and real. Policies to facilitate trade openness and the optimal allocation of resources, and support full employment are a good start to improve the PRC's productivity and long-term economic growth.

7.5 Roles of the Stimulus-Induced Investment Surge

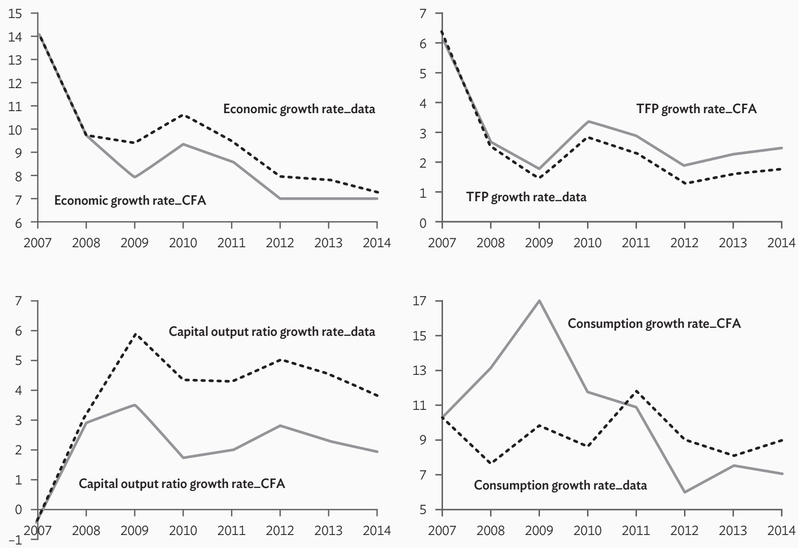
The massive stimulus package rolled out by the government in the wake of the 2008 financial crisis has had a discernable effect: the PRC economy has been able to continue to expand at a relatively fast pace in spite of the tumbling productivity growth. Our concern is with the role the package, and, in particular, the surge in investment induced by it, played in this process. In this section, we adopt a dynamic CFA to investigate how the interaction between investment rate (*inv_rate*) and other determinants affect TFP growth.

Again, we maintain the investment rate on construction and installation, as well as equipment, at the 2007 level while all other determinants take actual, observed values. We then calculate TFP growth rates and physical capital stock for 2008 based on the estimated coefficients in column 4 in Table 7.2. The GDP for 2008 is obtained next by substituting relevant estimates into the equation $\dot{Y} = \frac{1}{1-\alpha}\dot{A} + \frac{\alpha}{1-\alpha}\dot{\left(K/Y\right)} + \dot{H}$,[30] with which

[30] The GDP value obtained here could affect capital output ratio and, in turn, its growth rate. For this reason, instead of using the growth accounting equation, we adopt the goal-seeking method to find a GDP to solve the equation for each year.

we are able to assess the TFP growth rate for 2009 based on an assumed investment rate for the same year. The same procedures are then repeated to compute the physical capital stock and the GDP for 2009, etc. Combined with CFA predictions, we obtain the growth rates of the national economy, capital output ratio, as well as the TFP growth rates. Further, we hold the ratio of aggregate capital formation to GDP (i.e., investment rate) fixed at the 2007 level while allowing the share of government spending in GDP, and the share of net exports in GDP, to take observed values.[31] Based on the thusly estimated GDP data we compute consumption and, in turn, its growth rate for 2008–2014.

Figure 7.3: Investment Surge Impact over the Period 2008–2014



CFA = counter-factual analysis, TFP = total factor productivity.

Sources: The China Compendium of Statistics; The Demographic Data Assembly of the People's Republic of China; Almanac of China's Population; County Level of Population Statistics in the People's Republic of China; National Bureau of Statistics of China (stats.gov.cn/English).

31 Recall that GDP as measured by the expenditure approach equals the sum of consumption; investment, or capital formation; government spending; and net exports. These two assumptions are consistent with the CFA on investment rate where the government size and trade dependency ratio both take their actual values for all the years from 2008 to 2014.

Figure 7.3 consists of four charts comparing the growth rates of the economy, TFP, capital output ratio, and consumption from actual data with those predicted by CFA, respectively. Several observations from Figure 7.3 can be made. First, the rise in the investment rate has effectively mitigated the negative impact of the financial crisis on the growth of the PRC economy; its effect is most evident for 2009 and 2010. If the PRC had been able to maintain its investment rate at the 2007 level (41.24%) over the consecutive years, its annual economic growth rate would have dropped to 9.64%, 8.03%, 9.37%, 8.62%, 7.08%, 7.09%, and 7.01%, below the actual observations by 0.06, 1.37, 1.23, 0.88, 0.82, 0.71, and 0.29 percentages, respectively.

In addition, increasing the investment rate has a negative effect on the TFP growth rate in the same duration (cutting the TFP growth rates by 0.13, 0.33, 0.52, 0.61, 0.61, 0.66, and 0.67 percentages, respectively). Its effect on the capital input is the opposite (the capital output ratio rose by 0.31, 2.41, 2.56, 2.30, 2.23, 2.27, and 1.88 percentage points, respectively). The investment rate's impact on consumption, however, is less consistent. From 2008 to 2010, the increase in investment drove the growth rate of consumption down by 5.83, 7.48, and 3.12 percentage points, respectively, whereas the former's continued rise since 2011 was emulated by the latter (the consumption growth rate increased by 0.94, 3.05, 0.58, and 1.96 percentage points, respectively).

All in all, the investment rate experienced a sharp climb and remained at a high plateau between 2008 and 2014. Although it has alleviated the negative effects of the financial crisis, it does so by harming productivity improvement and impeding consumption growth. Moreover, it failed to retard the long-term slowdown of the PRC's economy.

7.6 Conclusion

The causes of the PRC's slowdown in the aftermath of the 2008 financial crisis and its economic outlook have been the subject of much contention. The answers have particularly important policy implications.

Some believe that this slowdown is merely a cyclical downturn that may be soon reversed. Others consider it the start of a long-term structural trend. We find that the economic slowdown since 2008 is a combined result of a decrease in both the labor growth rate and the productivity growth rate. The cause of the former is readily explained by an increasingly aging population and more than 2 decades of widening coverage of compulsory education. A better understanding of what has led to the latter, therefore, is central to understanding the PRC's current economic slowdown and forecasting its future performance.

Previous studies that employed a variety of methods to survey the PRC's TFP at sectoral, regional, and national levels based on available data sought to trace different sources of TFP movement, including those that link "reform dividends" to post-reform economic growth. However, model uncertainty and the challenges researchers face in selecting and handling data hamper TFP estimation consensus. Building on studies that investigate the source of potential TFP growth, we first select a series of robust indicators, construct comparable time series from historical records, and then estimate the provincial and national TFP. Next, we examine three aspects—the technical efficiency, utilization efficiency, and allocative efficiency—to explain the evolving pattern of the PRC's productivity growth based on the orthogonal decomposition method using panel data, which allows controlling for both regional and year fixed effects. Finally, we apply counter-factual analysis to decompose the national productivity movement from 2008 onward, and simulate the effectiveness of the stimulus-induced investment surge as a tool in mitigating the impact of the financial crisis.

The results suggest that, in terms of technical efficiency, both economic openness and relative income levels have an expected significant impact on productivity, although the former has a positive effect and the latter has a negative effect. In addition, a significantly negative correlation is observed between inventory stock and productivity through the former's influence on effective factor usage, while the opposite is observed between the labor force involvement rate and productivity. As for indicators acting on factor utilization, both government size and investment rate have significantly negative effects on productivity; weights of the primary and the tertiary industries tend to be negatively correlated with productivity growth. State ownership and population migration, however, show no statistically significant effects. Lastly, a decrease in late-mover advantage and growth in the investment rate are both major contributors to the recent decline in the PRC's productivity growth since the financial crisis. Moreover, although the stimulus-induced rise in investment has effectively mitigated the negative effects of the financial crisis on the PRC's growth, it is not conducive to the growth of productivity and consumption. Therefore, we believe that the PRC economy will continue to slow down in the conceivable future. Policies that facilitate trade openness and optimal resource allocation, and support full employment are a good start to improving the PRC's productivity and, thus, its long-term economic growth.

This chapter is certainly not devoid of flaws. For example, we still rely on historical data. We choose to ignore the nuanced effect of migration when we estimate human capital stock and working-age population. Moreover, we consider a sub-optimal method of econometric regression analysis to identify determinants of productivity; the regression results we obtained are better suited to describe the correlation (instead of causality) between TFP growth rate and the indicators we choose. In addition, our counter-factual analysis conveniently ignores the effect the interaction between determinants (except the investment rate) could have on TFP growth rate. The issues outlined above could all be interesting directions for future research.

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CHAPTER 8

Factors Affecting the Outlook for Medium- to Long-term Growth in the People's Republic of China

Justin Yifu Lin, Guanghua Wan, and Peter J. Morgan

8.1 Introduction

The People's Republic of China (PRC) achieved an outstanding economic growth record since major economic reforms were initiated in 1978, showing an average annual real gross domestic product (GDP) growth rate of 9.7% over the entire period through 2015.[1] Per capita GDP in 2005 purchasing power parity (PPP) terms reached approximately $11,300 in 2015. Even more remarkably, there was no significant slowdown trend in the decadal averages over the period, since the average growth rates in the 3 most recent decades stayed in the range of 9%–10% growth. However, such a long growth record inevitably raises the question of how long it can be sustained, especially when per capita GDP levels have reached middle-income status, and the normal tendency of economies is to slow down as they mature. The question is particularly important in view of the PRC now being the world's second-largest economy, and having increasingly deepened its trade ties with the rest of the world, especially Asia.

Other developments have also raised concerns about the outlook for growth. GDP growth in the past 4 years (2012–2015) averaged just 7.4%, lower than that during the global financial crisis (GFC) period

1 CEIC Database. https://www.ceicdata.com/ja (accessed 15 April 2016).

of 2007–2009, and the lowest since 1991, which occurred because of tight monetary policy, reduced foreign direct investment, and other shocks at the time. Given that the external environment, although weak, is still much more favorable than that experienced during the GFC period, this raises the question of whether cyclical factors alone can explain the recent slowdown. However, we present evidence in this chapter that the sources of the slowdown can mainly be explained by external factors.

This chapter aims to review the recent literature on the determinants of and outlook for real GDP growth in the PRC and address some of the key issues. Section 8.2 provides a review of the literature. Section 8.3 outlines the supply-side factors that can help sustain high growth in the PRC assuming rather favorable conditions. It also explores risk factors that might cause growth to fall short of these conditions. Section 8.4 reviews issues on supply-side determinants of growth in the PRC under the growth accounting framework, while Section 8.5 examines issues related to major demand factors potentially driving growth, including exports, capital formation and household consumption. Section 8.6 concludes.

8.2 Literature Review

8.2.1 Global Comparisons of Economic Growth

Ben-David and Papell (1998) examined 74 countries for significant structural breaks in their postwar growth rates during 1950–1990. For most industrialized countries, other than the US, Canada, and the United Kingdom, the growth slumps cluster in the early 1970s. Developing countries, especially those in Latin America, experienced much more severe slowdowns, from positive average growth rates prior to the breaks to negative average growth rates after the breaks, and these breaks mostly occurred in the 1980s. The triggers for the declines in growth rates of developed economies were the collapse of the Bretton Woods system, the first oil crisis of 1973 and the second oil shock of 1979, and the start of emerging market debt crises for developing countries in the 1980s and the 1990s.

Ferreira et al. (2010) estimated structural breaks in total factor productivity (TFP)[2] for a sample of 77 countries in the period between 1950 and 2000. They suggested that the slumps in growth of TFP in the developed countries are mainly associated with external factors, in particular oil shocks, whereas those of developing countries relate to country-specific forces.

Eichengreen, Park, and Shin (2012) analyzed the contributions of the components of the standard growth-accounting framework—capital input, labor input, human capital input, or TFP—to slowdowns in the growth trend. They find that declines in TFP contribute around 85% of the slowdowns of output growth.

According to Eichengreen, Park, and Shin (2012) and Kehoe and Ruhl (2010), there is no consistent relation between trade openness and growth. Trade openness is more important during the early stage of growth, but institutions become more important later on. In particular, Eichengreen, Park, and Shin (2012) concluded that small open economies such as Hong Kong, China; and Singapore experienced growth slowdowns at much higher income levels than the average level, and that it was their trade openness rather than their economic size that differentiated them from average.

Eichengreen, Park, and Shin (2012) examined the relation of high investment, high consumption, and high government spending with growth slowdowns. Only the consumption share is significant, in the sense that, as consumption rises from low levels, the probability of a slowdown falls. The probability of slowdown is minimized when consumption accounts for 62%–64% of GDP.

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[2] Total factor productivity growth is the difference between the growth rate of output and the weighted average growth rate of inputs, where the weights are income shares. See Section 8.4 for more discussion.

The investment ratio also matters, although not very significantly, implying that slowdowns are less likely in countries that maintain exceptionally high investment rates.

Eichengreen, Park, and Shin (2012) also examined the income levels at which slowdowns occur and their determinants using a probit model. The results show that a growth slowdown typically occurs when per capita income reaches $16,740 in 2005 PPP terms, or reaches 58% of that of the lead country, or when manufacturing employment accounts for at least 23% of the total employment.

Eichengreen, Park, and Shin (2015) analyzed determinants of TFP growth in low-, middle-, and high-income countries. They found the country-specific determinants of TFP slowdown are similar for countries at different income levels: lower levels of average years of schooling, excessive investment, higher manufacturing employment shares, higher manufacturing value-added, weak political systems, and lower energy prices. Global correlates of the TFP growth slowdown include oil shocks in the 1970s and financial crises, which adversely affected productivity of all countries. The information and communication technology revolution in the 1990s boosted productivity growth worldwide. For middle-income economies, the decline in TFP growth tends to be related to the process of reallocation of labor from low-productivity agriculture to manufacturing having largely run its course.

Barro (Chapter 2) estimated two models of long-term convergence of per capita real GDP. The first model uses data on 89 countries from 1960 to 2010. The results imply a conditional convergence rate of 1.7% per year. The second model uses a dataset that covers a much longer period, 1870–2010, but has a smaller sample of only 28 countries. The second model yields an estimated conditional convergence rate of 2.6% per year. Barro argued that the true coefficient of the lagged dependent variable probably lies between these two values. Lee (Chapter 5) estimated a cross-country panel regression for per capita GDP growth using a sample of 75 economies over the period 1960–2010. His estimates of the conditional convergence rate for per capita GDP growth range between 1.7% and 3.4% per year, depending on whether country-fixed effects are included, a somewhat wider range than Barro's estimate.

Thus, the literature points to two kinds of factors leading to a slowdown in trend growth rates of countries. The first is the general finding of so-called convergence theory, i.e., growth tends to slow as incomes rise either in absolute terms or relative to the levels of developed economies, as exemplified by the studies of Barro and Eichengreen et al. The second is the effects of specific shocks, such as oil price shocks or financial crises. The first factor is more pertinent to the case of the PRC, although the aftermath of the global financial crises of 1997–1998 could also have had some effect on the PRC. Our view, as described below, is that relative income levels matter more than absolute levels for growth convergence; by this criterion, the PRC still has plenty of room to maintain a high growth rate.

8.2.2 Literature on the People's Republic of China's Economic Growth

Bosworth and Collins (2008) compared sources of economic growth in the PRC and India using the growth accounting approach. They found that the industrial sector is the main source of growth in the PRC and the service sector is the main driver of growth in India. They also found that the PRC's increase in capital per worker and rate of TFP growth in agriculture were more than twice those of India. The PRC's TFP growth rate in the industrial sector was also much faster than India's, while only in services can India compete with the PRC. Unlike for the PRC, India's growth performance largely relies on TFP growth.

Lee and Hong (2010) found that the main sources of GDP growth in the PRC during 1981–2007 were capital in the first 2 decades and TFP in the third. The PRC is projected to experience a slowdown in the 2021–2030 decade to growth of 5%–6%. This slowdown will come mainly from a decline in TFP growth, smaller improvements in high school educational attainment rates, and aging of the population.

Brandt and Zhu (2010) argued that traditional simple decompositions of growth are not appropriate to gauge the contributions that sectors make to growth. They proposed a dynamic three-sector model, which can differentiate the contributions from state and non-state components within the non-agricultural sectors to TFP and labor productivity growth in the PRC.

Dekle and Vandenbroucke (2011) highlighted the key role of the reduction in the size of the government (measured by taxes) as a driving force of the PRC's structural transformation. Vandenberg and Zhuang (2011) and Zheng (2011) emphasized income inequality as the biggest risk for the PRC to fall into the middle-income trap. They all highlighted that the aging population is one of the major factors that can cause a middle-income trap in the PRC. Vandenberg and Zhuang (2011) and Cai (2012) suggested that rising labor costs are eroding the PRC's comparative advantage. Liu (2011) suggested that improvement from the current low level of urbanization could be a potential source of growth for the PRC to avoid the middle-income trap.

Zhu (2012) found that in the pre-reform period the main drivers for growth were the increase in government investment and a rise in education levels, whereas post-reform growth mainly came from productivity improvement arising from economic reforms rather than capital investment. He argued that there is still substantial scope for economic reforms to boost growth.

Wu (2014) constructed a new set of data for five major sectors of the PRC economy spanning 1949–2012. Under different scenarios, he found that both the PRC's GDP growth and TFP growth are overestimated using official data. He also found that the impacts of external shocks are more significant using this new set of data estimates of GDP than when using the official data.

Zhang, Xu, and Liu (2015) predicted that the potential growth rate of per capita GDP adjusted by PPP will average 6.02% from 2015 to 2035.

They argued that the growth of labor has been a minor contributor to GDP growth over the past 35 years, accounting for a share of slightly more than 10%, and that the negative impact of a flat or declining labor supply can be offset by a faster rise in the level of human capital. Lai (2015) found that the PRC's growth slowdown since 2008 mostly comes from a sharp slowdown in TFP, which offset strong growth of investment, and that a sharp slowdown in investment is likely.

Barro (Chapter 2) found that the PRC's recent growth rate is much higher than predicted by his first model described above, and the results imply that the PRC's per capita growth rate is likely to decrease from 8% to a range of 3%–4%. Pritchett and Summers (2014) hold a similar view, and projected the PRC's growth to fall to a range of 2.3%–5.5% over the next 20 years. Cai and Lu (2015) emphasized the detrimental effect of aging and predict that the PRC's potential growth rate will slow to 6.2% in the short term (2016–2020) and slow further to 3%–4% by 2050, depending on the extent to which structural reforms are successfully implemented.

Fukao and Yuan (Chapter 4) compared the experiences of the PRC's and Japan's high-speed growth periods and following periods. First, compared with Japan, the PRC's high growth rate was driven more by capital accumulation and less by TFP growth, which will tend to lower the rate of return on capital and might lead to an earlier end of the PRC's high-speed growth. Second, the fact that the labor-force-age population will decline at an earlier stage of development in the PRC than in Japan will also tend to reduce the rate of return on capital. Taking these factors into account, they concluded that the PRC's high rate of capital investment growth is unsustainable, and recommend that the PRC speed up economic reforms to promote higher growth of TFP. Based on the estimation of a growth equation using cross-country panel data, Yao (Chapter 3) forecast that, under reasonable assumptions about the growth rate of the world economy and the PRC's investment rate, the PRC could maintain reasonably high potential growth rates in the next 10 years in the range of 6%–7%.

Lee (Chapter 5) estimated the contribution of various growth factors to the growth rates of the PRC, Japan, and the Republic of Korea. He attributed the Republic of Korea's recent slowdown to its unbalanced economic structure and estimated that the PRC's potential GDP growth will decline to 5%–6% over the coming decades, unless it significantly improves institutions and policy factors. However, he noted that the Republic of Korea and the PRC share some favorable conditions for more rapid growth than in other developing countries, including strong investment, high trade openness, macroeconomic stability, and continuous improvement of the quality of human resources and institutions. He argued that future reforms and policies might partially offset the growth deceleration due to convergence in the coming decades.

Thus, the literature on the PRC's growth can largely be divided into pessimistic and optimistic camps. Pessimists tend to find that the PRC's growth rate is mostly explained by capital accumulation, which suggests that the rate of return on capital has declined substantially, while optimists tend to find that TFP growth has been the most important factor, which points to a greater sustainability of high growth rates. Pessimists also tend to emphasize structural factors limiting the PRC's growth potential such as declining labor force, end of surplus agricultural labor, and policy distortions, while optimists emphasize the scope for further reforms to boost growth, positive macroeconomic conditions, and continued investment opportunities. Our view is at the upper end of the optimistic camp.

8.3 Supply-Side Factors Supporting a Potential Growth Rate of Around 8%

The PRC still has many positive supply factors that, under the favorable circumstances, could support a potential growth rate of 8% through 2028.[3] Most importantly, developing countries, such as the PRC,

3 This section is based on Lin (2012).

possess a "latecomer advantage," because they can achieve technological progress through imitation, importing capital goods, integration, and licensing of technology. These factors will tend to reduce their costs and investment risks. Over the past 150 years, developed economies have grown at an average rate of 3% per year, whereas some developing countries achieved annual growth rates of 7% or higher for periods of 20 years or longer.[4]

To estimate the remaining potential of the PRC's latecomer advantage after 37 years (1978–2015) of unprecedented growth, one should compare the gaps between its levels of technological and industrial development and those of high-income countries. This can best be gauged by comparing its per capita income, adjusted for PPP, with those of developed countries. As noted in Section 8.2.1, the basic finding of convergence theory is that the greater the gap in per capita incomes, the larger the latecomer advantage and the higher the potential growth rate.

In 2008, the PRC's per capita income was just over one-fifth that of the US. This is approximately equal to the gap between the US and Japan in 1951, and Japan grew at an average annual rate of 9.2% over the following 20 years. Following a similar gap with the US in 1977, the Republic of Korea grew at 7.6% per year for 2 decades, while Singapore (1967); Taipei,China; and the PRC (1975) had similar gaps and growth experiences.[5] Following these examples, in the 20 years after 2008, the PRC should have a potential growth rate of roughly 8%.

From the perspective of a production function analysis of supply-side growth potential, the key determinants of economic growth include:

- *Factors of production.* Among the various factors of production (including labor, capital, natural resources, and land), labor and land are relatively stable, while capital is most critical for economic growth. The PRC's high savings rate has supported and can continue to support rapid growth of capital.

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4 Data comparisons taken from Maddison (2010).

5 Footnote 4.

- *Industrial structure.* Output can also increase if the factors of production are allocated to industries with higher value added. This implies that the economy can also grow even without increasing basic production factors.
- *Technology.* Technological progress means higher productivity. Thus, even when both industrial structure and factors of production remain unchanged, an economy's output and growth can grow as technology improves.
- *Institutions.* The level of productive inputs, industrial structure, and technology determine an economy's maximum obtainable output in an ideal state. However, institutions and regulations also affect how closely the economy can approach its productive potential.

The rate of technological progress is closely related to the potential growth rate of the capital stock. Since land and natural resources are basically fixed, and the growth of labor is rather limited, if capital accumulates at great speed without technological progress, the rate of return on capital will decline because of diminishing returns. This would tend to reduce the incentive for investing in new capital. Only if technology progresses at a certain rate can the effects of diminishing returns be avoided to maintain the incentive for high rates of capital accumulation.

Without technological innovation, there would be no new industries with higher value-added, and industrial upgrading would be out of the question. Developed economies must innovate to increase productivity, but developing countries can both innovate and import more advanced technologies from developed countries. By doing so, developing countries can innovate faster and at lower cost and maintain high growth rates. As mentioned above, developed economies grew at approximately 3% per year, while some successful developing economies grew at 8% a year in the second half of the 20th century, including Japan, the four Asian Tigers, and the post-reform PRC.

Potential for Upgrading Industrial Structure

Even though the PRC now has industrial overcapacity in sectors such as iron and steel, cement, plate glass, aluminum, and shipbuilding, overall it is still a moderately developed country. Although the traditional labor-intensive processing industries are losing competitiveness due to rising wages, the PRC can take advantage of high-end industrial upgrading. Such upgrading requires a high rate of investment, including in research and development, human capital, and the emerging information industry. Considering the advantages of the PRC's large domestic market, highly entrepreneurial culture, innovative public, and well-developed competition, these kinds of investments should offer a lot of opportunities with high rates of return.

Potential for Infrastructure Investment

High rates of investment in infrastructure have already been carried out in the past 2 or 3 decades, but these were mainly for connecting one city with another, including highways, railways, airports, and ports. However, there is still a serious shortage of infrastructure within cities, including subways and underground pipe networks. To overcome these shortcomings, investment in these areas can reduce transaction costs and improve economic efficiency. The social and economic returns to such investments should be high.

Potential for Environment-related Investment

The third major area to support investment growth is to improve the environment. It is clear that the process of rapid economic development in the PRC has led to serious environmental problems. There is a need to strengthen environmental law enforcement. Also, the introduction of new energy-saving and less-polluting production equipment is an area of investment with high social returns.

Potential for Urbanization-related Investment

There is still substantial potential for further urbanization in the PRC. The rate of urbanization in 2016 was only 57% (including migrants), compared with levels of 80%–85% in developed economies.[6]

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6 World Bank Database. Urban Population (%). http://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS (accessed 5 July 2017).

This process will require substantial investments to provide adequate housing, basic infrastructure, and public services.

The PRC has a number of other advantages that can support high rates of investment growth. First, the total debt of the central and local governments amounts to less than 50% of GDP.[7] This contrasts with many developing and developed countries where government debt levels exceed 100% of GDP. This means that the PRC has much more fiscal policy space than other countries. One major problem is that many local governments carry out long-term infrastructure investment with short-term funding by banks or shadow banking platforms. The Ministry of Finance of the PRC recently announced that it will allow local governments to issue bonds to replace its loans, which is a positive development. The savings rate in the PRC is as high as 50% of GDP, among the highest in the world. The government's active fiscal policy can also leverage private investment, including public–private partnerships to open up private investment in infrastructure. Finally, the PRC has more than $3 trillion in foreign exchange reserves, the highest in the world.

Nonetheless, potential growth is just part of the story. Whether it can be attained depends on domestic institutional conditions and the international environment. To exploit its latecomer advantage, the PRC must deepen its reforms and eliminate residual distortions in the economy. The government should take the lead in overcoming market failures, such as externalities and coordination problems that are likely to accompany the processes of intensive technological innovation and industrial upgrading. Moreover, there are many external factors that could limit growth in the PRC below its potential under the favorable conditions described above. These downside risks to growth will be described in the following sections.

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7 International Monetary Fund World Economic Outlook Database. General Government Debt as % of GDP. http://www.imf.org/external/pubs/ft/weo/2017/01/weodata/weorept.aspx?sy=2015&ey=2016&scsm=1&ssd=1&sort=country&ds=.&br=1&c=513%2C518%2C514%2C836%2C516%2C558%2C522%2C565%2C924%2C853%2C819%2C566%2C534%2C862%2C536%2C813%2C826%2C524%2C544%2C578%2C548%2C537%2C556%2C866%2C867%2C869%2C868%2C846%2C948%2C582&s=GGXWDG_NGDP&grp=0&a=&pr.x=56&pr.y=6 (accessed 5 July 2017).

8.4 Supply-side Factors (Growth Accounting)

Supply-side estimates of the contribution of production factors to growth, including labor, capital, land, natural resources, intermediate inputs, and TFP typically rely on the growth accounting framework pioneered by Solow (1956, 1957). As described in Section 8.2, there is already a rich literature applying this framework to the PRC. To be sure, the Solow model may be less applicable for developing countries because it does not account for structural change in the model, especially with regard to capital deepening, a point discussed below. Also, as mentioned above, the underlying data have many problems, which raises a fair degree of uncertainty about the results of such analyses. In particular, the contribution to growth from technological change or TFP is very important, since it governs the speed at which returns to capital would fall as a result of high investment rates. As will be seen, there are significant disagreements about the size of this contribution.

A number of studies have attempted to estimate the contribution to the PRC GDP growth of various factors of production using the growth accounting approach, and they can largely be divided into "optimistic" and "pessimistic" camps. The optimists generally find that the contribution of TFP growth to overall GDP growth has been large. This is important, because it implies that the PRC's high growth rates are potentially sustainable, because they have not depended on a rapid rise in the capital–output ratio, which would imply a sharp decline in the rate of return to capital. On the other hand, the pessimists tend to find that most of the PRC's growth can be attributed to capital deepening, which implies a substantial reduction of the return to capital, and hence is likely to limit potential growth going forward.

Table 8.1 summarizes the results of a number of studies regarding the contribution of TFP and other factors to the PRC's real GDP growth since the start of the reform period in 1978. The figures are not strictly comparable, because some reported results for GDP, some for GDP per capita, and some for GDP per worker. However, the general picture is clear. All studies found that most of the PRC's growth can be explained by capital deepening and TFP, but there is wide disagreement about the relative contributions of these two factors.

Table 8.1: Estimates of Contribution to the People's Republic of China's Real GDP Growth by Factor

Study	Period	Output measure	Annual growth rate, %		Contribution to output growth, percentage points			
			Output	Output per worker	Physical capital	Labor	Education	TFP
Young (2003) – official data	1978–1998	GDP/ L (NA)	10.1	6.1	3.1	N/A	--	3.0
Young (2003) – alternate data	1978–1998	GDP/ L (NA)	8.6	3.6	2.2	N/A	--	1.4
Bosworth and Collins (2008)	1978–2004	GDP/L	9.3	7.3	3.2	N/A	0.3	3.6
Perkins and Rawski (2008)	1978–2005	GDP	9.5	7.6	4.2	1.0	0.6	3.8
Brandt and Zhu (2010)	1978–2007	GDP/L	--	7.6	3.7	N/A	--	3.9
Lee and Hong (2010)	1981–2007	GDP	9.4	7.7	3.8	1.0	0.5	4.1
Wu (2011) – official data	1978–2008	GDP	9.2	8.2	5.2	0.5	0.3	3.1
Wu (2011) – alternate data	1978–2008	GDP	7.2	5.2	6.1	0.4	0.3	0.3
Zhu (2012)	1978–2007	GDP/P	--	8.1	0.0	0.6	1.2	6.3

-- = not available, GDP = gross domestic product, L = employment, N/A = not applicable, NA = non-agricultural, P = population, TFP = total factor productivity.

Sources: Bosworth and Collins (2008), Lee and Hong (2010), Perkins and Rawski (2008), Wu (2011), Young (2003), Zhu (2012), authors' estimates.

Studies in the optimistic camp include Bosworth and Collins (2008), Perkins and Rawski (2008), Brandt and Zhu (2010), Lee and Hong (2010), and Zhu (2012), which found that TFP growth averaged 3.2%

to 4.1% and contributed approximately 40% to total GDP growth in the post-reform period from 1978.[8] The pessimistic camp, which tends to rely on substantial revisions to the official data, includes studies by Young (2003) and Wu (2011). Young (2003) found a TFP growth rate of only 1.4% and a small contribution to GDP of only about 15% during 1978–1998, while Wu (2011) found TFP growth rates in the range of 1.7% to –0.3% and GDP contributions in the range of 19% to –3% during 1978–2008, depending on the alternative assumptions used. Contrary to Wu (2011), the optimist camp including Zhu (2012) found only a small contribution from capital deepening to output per head.

One key question is the extent to which such high growth rates of TFP over a long period are credible and sustainable. As noted in this section, among high-income Asian economies, only Japan achieved TFP growth rates as high as the PRC did, and this may have been due to the special nature of its growth path, i.e., a postwar bounce-back to the earlier trend. Zhu (2012) argued that much of the PRC's unusually high TFP growth rate can be attributed to economic reforms that increased economic efficiency, which started at a very low level during the central-planning period before 1978. These started with market-oriented reforms in the agricultural sector in the early reform period, first with revised incentive schemes and then liberalization of prices of inputs and outputs, with the highest gains coming in the first decade of 1978–1988. Zhu (2012) estimated that agriculture contributed 2 percentage points to total TFP growth, approximately half the total. The second phase of liberalization occurred in the non-state non-agricultural sector, including collectives, which also benefited from price liberalization. The third phase was the reform of state-owned enterprises, which led to a substantial reduction of employment in those firms beginning in 1995 with a concomitant rise in TFP. The fourth stage was privatization and trade liberalization, including WTO accession in 2001, which boosted productivity growth in both the

[8] The figure for TFP contribution for Zhu (2012) is for per capita GDP, which is twice the growth rate of TFP (3.2%).

state and non-state sectors. According to Zhu (2012), between 1998 and 2007, average annual TFP growth rates of the state and non-state sectors were 5.5% and 3.7%, respectively.[9]

The following subsections focus on individual factors that could affect the outlook for growth of labor inputs and TFP.

8.4.1 Effect of Aging Population

The PRC's slowing population growth, a result of the one-child policy, meant that the labor force population (age 15–64) started to decline modestly in 2015. This would turn labor inputs into a slightly negative factor for growth going forward. However, this trend can be offset by a couple of positive factors. First is the potential to raise labor-force participation rates. The PRC has extremely early retirement ages: 50 for women and 55 for men in enterprises (55 for women and 60 for men in other administrative departments). Even though the number of the working population may be reduced due to aging, it is possible for the PRC to extend the retirement ages to offset the adverse effect of aging on the working population. Second, what counts for output is not the number of workers per se but the quality of workers. The total amount of workers in the PRC may not increase but the amount of human capital can increase substantially, especially with a large increase in education investment.

8.4.2 Role of Reform

What new sources of increased efficiency can drive above-average growth rates of TFP from now? One possible source is capital market reform. Hsieh and Klenow (2009) estimated the within-industry misallocation of capital and labor across existing firms in the PRC's

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9 Revealingly, the Conference Board Total Economy Database™ (https://www.conference-board.org/data/economydatabase/) shows that the economies that typically enjoyed very high growth rates of TFP growth in the past 20 years are mainly those in Eastern Europe and former republics of the Soviet Union, which highlights the role of economic reforms in increasing economic efficiency and raising productivity growth.

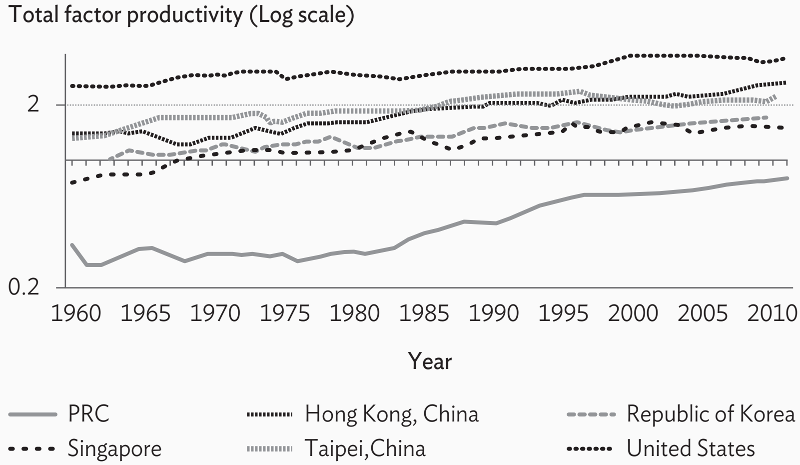
manufacturing industries. They estimated a potential TFP gain of 30% if the distortions are reduced to the US level. Brandt, Tombe, and Zhu (2012) estimated sector-level TFP in each province and measured the potential productivity gain from eliminating factor market distortions across provinces and between the state and the non-state sectors. They found that the potential TFP gain in the PRC's non-agricultural economy is at least 20%, approximately half from eliminating cross-provincial dispersion of returns to labor and half from eliminating within-province differences in returns to capital between the state and the non-state sectors. If this cumulative gain in TFP is spread evenly across 17 years, it would imply an average increment to annual increment to TFP growth of approximately 2 percentage points, quite enough to sustain continued high TFP growth. Of course, thorough reforms would be needed to achieve such goals.

Zhu (2012) also pointed out that the ratio of TFP in the PRC compared with that of the US is still quite low relative to those of other developed Asian economies during their high-growth phases, which also should give it plenty of room for above-average growth over the next 20 years. Figure 8.1 shows that, as of 2011, the PRC's TFP level had just reached that achieved by Singapore in 1960. However, Singapore's TFP growth rate in the 20 years since 1960 averaged 1.8%, while that of the Republic of Korea averaged 1.2%, so that does imply some greater limitation on TFP growth from here, unless, as discussed below, further efficiency gains can be achieved by additional reforms.

8.4.3 Role of Innovation

Lin (2012) argued strongly in favor of emerging economies importing more advanced technology. Technological innovation will lead to improved efficiency, higher returns to capital, faster capital accumulation, industrial upgrading, and economic growth. He also argued that for emerging economies borrowing technology is far cheaper than expenditures on research and development. However, another school of thought argues that innovation activity in emerging economies can contribute substantially to unlocking productivity gains

Figure 8.1: Total Factor Productivity Levels of the People's Republic of China and Reference Economies



PRC = People's Republic of China.

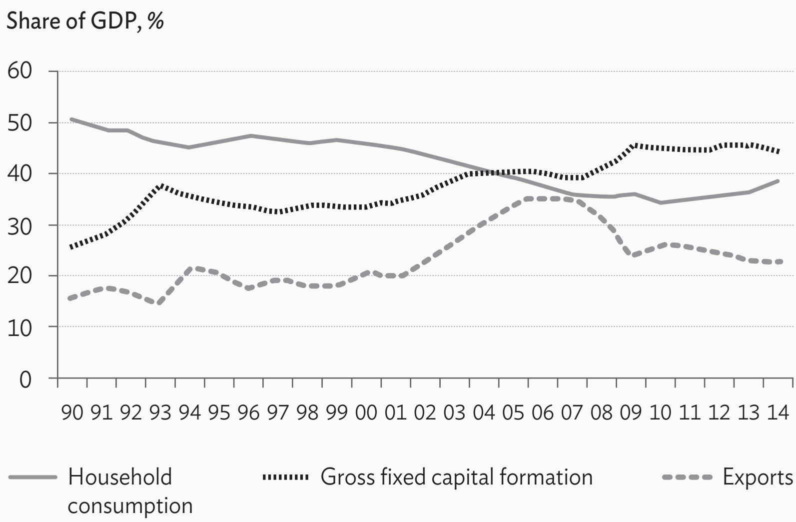
Sources: Feenstra, Inklaar, and Timmer (2013), authors' estimates.

from new technologies. On 8 November 2012, in a report delivered by President Hu Jintao at the 18th National Congress of the Communist Party, it was announced that the PRC would transit into an "innovation-driven economy." Fan (2014) described the rapid progress made by the PRC in innovation-related inputs and outputs such as research and development spending, number of researchers, and number of patents. Along with this, the PRC's national innovation system was reformed substantially to realize greater commercial value from innovation activity in the PRC. Fan (2014) also described the importance of innovation activity for the growth of a sample of biotechnology firms in the PRC. However, there are still relatively few studies of how research and development activity is related to improvements in TFP or output growth at the macro level in the PRC. Advocates of such innovation tend to focus on product innovation instead of process innovation. However, we would argue that unlocking the productivity gains from new technology depends mainly on process innovation rather than product innovation. Countries that rely on latecomer advantages need to emphasize process innovation.

8.5 Demand-side Factors

Demand-side factors could also potentially constrain growth in the PRC below its long-term potential based on supply-side factors. From the demand-side, the growth potential of the PRC economy is determined mainly by the outlook for the three main sectors: exports, fixed asset investment, and consumption. Growth in recent decades has been driven primarily by exports and investment. However, these growth drivers are showing signs of fatigue. The ratio of exports to GDP rose rapidly in the period of 1990–2010, but has declined significantly since 2006. The ratio of fixed asset investment to GDP also rose rapidly to around 45% of GDP, a level which many regard as unsustainable, and also appears to have stabilized. Conversely, the share of consumption in GDP fell dramatically from 50% to around 35% of GDP, an abnormally low level by international comparison, although it recently has begun to recovery moderately (Figure 8.2).

Figure 8.2: Share of GDP of Major Final-Demand Components (Nominal Basis), 1990–2014



GDP = gross domestic product.

Source: CEIC Data. https://www.ceicdata.com.

However, Lin (2016) argued that, although the PRC faces many structural problems, the deceleration of growth after 2010 is due mostly to external and cyclical factors. In 2010, the GDP growth rates of Brazil, India, and the Russian Federation (three of the BRIC countries) were 7.5%, 10.3%, and 4.5%, respectively, but their growth rates in 2014 dropped to 0.14%, 7.3%, and 0.6%, respectively. Their rate of slowdown was even greater than that of the PRC. We cannot attribute their slowdown to the PRC's structural problems. Moreover, the growth rates of the Republic of Korea and Singapore in 2010 were 6.1% and 15.2%, but in 2014 they slowed sharply to 3.3% and 2.9%, respectively.[10] Although they are high-income, high-performing economies that are supposed to have few structural problems, they encountered an even sharper growth deceleration in the same period than that of the PRC. Only common external and cyclical factors can explain why these economies had a similar pattern of growth deceleration in the same period of time.

The following subsections describe the main factors affecting the outlook for the three major demand-side sectors: exports, fixed asset investment, and consumption.

8.5.1 Role of Exports and Outlook

During the reform period, the PRC followed the developed Asian economies in pursuing export-led growth. The rapid expansion of production chain networks in Asia promoted this development, although in many cases the actual value percentage of value added to those exports made in the PRC was relatively small; for example, the case of the Apple iPhone (Xing 2012). The PRC's share of world trade also expanded rapidly, reaching 14% in 2014, and it now substantially exceeds the shares of other developed Asian economies in the relevant reference years (1958 for Japan, 1981 for the Republic of Korea, and 1967 for Singapore), which lie in the range of 0%–5% (Table 8.2).

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[10] Figures from World Bank Databank. http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG.

Table 8.2: Share of World Trade of the People's Republic of China and Reference Economies

Economy	World Trade Share (periods based on real GDP per capita, national prices)		
	Reference Year	After 10 Years	After 20 Years
Japan	1958	1968	1978
	NA	5.9%	5.8%
Republic of Korea	1981	1991	2001
	1.2%	2.2%	2.5%
Singapore	1967	1977	1987
	0.6%	0.8%	1.3%
Taipei,China	1972	1982	1992
	NA	NA	2.3%
People's Republic of China	1994	2004	2014
	3.0%	6.7%	14.1%

GDP = gross domestic product, NA = not available.

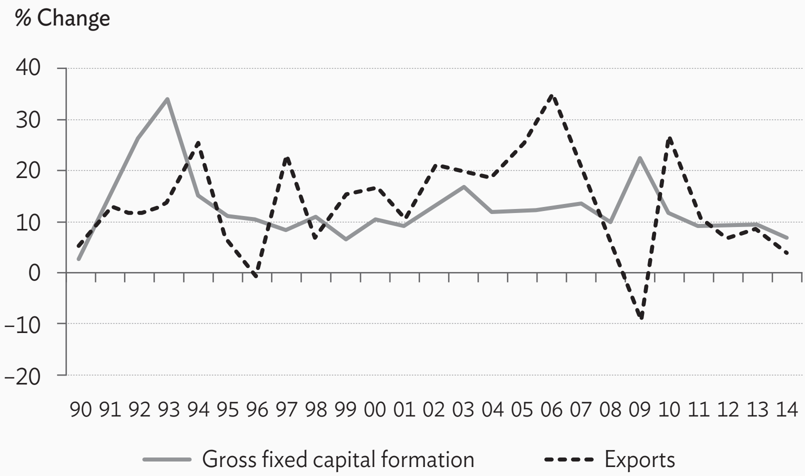
Source: UN Comtrade statistics. http://comtrade.un.org/db/.

The fact that this share of world trade is much larger than that of the comparator economies at a similar stage of development suggests that it will become increasingly difficult for the PRC's exports to grow substantially faster than overall world trade. This factor would tend to limit the export growth potential of the PRC relative to the comparator economies, and implies that increased reliance on domestic demand growth needs to be fostered through economic reforms and other means.

The mix of the PRC's exports has also steadily shifted toward higher-value-added products, although the trend toward greater reliance on production chain networks makes it more difficult to determine the degree of that value added which was actually added in the PRC.

Figure 8.3 shows that the trend of the growth rate of the PRC's real exports has slowed substantially since 2006. The average growth rate in 2012–2014 was only 6.6%, less than half of the 16% average rate seen in 1990–2006. Indeed, export growth slowed even further to −1.8% in 2015. The key question is whether this phenomenon is mainly cyclical, a reflection of relatively sluggish growth in the developed economies since the global financial crisis during 2007–2009, or whether it reflects more structural factors, including saturation of potential export markets and reduced competitiveness of the PRC's exports as a result of the strength of the yuan and the rising wages in the PRC.

Figure 8.3: Growth of the People's Republic of China's Real Exports and Gross Fixed Capital Formation, 1990–2014



Source: CEIC Data. https://www.ceicdata.com.

As noted previously in this chapter, we argue that the export slowdown mainly reflects external factors. From 1979 to 2013, the PRC's average annual export growth rate was 16.8%. However, due to the slow recovery from the 2008 global financial crisis and slow demand growth in the US, Europe, and other developed countries, the PRC's export growth rate dropped sharply to 6.1% in 2014 and further to −1.8%

in 2015. Other labor-intensive emerging market economies and the East Asian export-oriented high-income economies were similarly affected (Lin 2016). Nonetheless, in view of the large size of the PRC exports indicated in Table 8.2, structural factors may also be playing an important role, and the previous high growth rates of PRC exports may not return.

8.5.2 Role of Fixed Capital Investment and Outlook

Fixed capital investment has been the other key driver of the PRC's economic growth. Figure 8.2 shows that the rising share of gross fixed capital formation in GDP largely paralleled that of exports, and the shares of both stabilized after the global financial crisis of 2007–2009 although Figure 8.3 does not suggest any close correlation of annual growth rates. Nonetheless, it seems likely that a slower growth outlook for exports would, other things being equal, have a negative impact on fixed capital investment. Growth of real fixed asset investment averaged 13.4% in 1990–2006, and this fell to an average of 8.7% in 2011–2014, although this is a relatively short period and the growth rates may have been affected by high levels of fiscal stimulus spending in 2009–2010. Specifically, facing the 2008 global financial crisis, the PRC, like many other countries, adopted a large-scale fiscal stimulus program to support investment growth. Those investment projects have been completed, but in the meantime the global economy has not yet returned to normal and external demand remains weak. If there is no new stimulus, investment growth will inevitably experience a cyclical deceleration, and this is common to all countries (Lin 2016).

The question then arises as to what other drivers of fixed asset investment could replace exports. Potential drivers include urbanization, infrastructure investment, industrial upgrading, and environmental improvement, as discussed in Section 8.3.

8.5.3 Potential Drivers of Consumption Growth

As noted above, consumption has been a relative laggard in contributing to the PRC's economic growth. At the same time, the household savings rate has risen to very high levels. This, of course, has helped to support the high levels of fixed asset investment in the economy, but may reflect some hindrances to the growth of consumer spending. A number of potential hindrances to consumer spending have been identified in the literature, most notably limits on the provision of social welfare services, including pensions and health insurance, and limits on the provision of public education. These hindrances are partly related to the *hukou* (household registration system), which prevents migrants from being eligible to receive social services in the cities they have migrated to. Another major barrier to adequate provision of social services is lack of budgetary resources at local governments that are mandated to provide such services.

If the *hukou* system is reformed, and reforms are already underway, this could speed up the process of urban migration, which would support both higher levels of consumption, as migrants switch to higher-paying employment and enjoy greater access to social services, and support higher levels of urbanization-related infrastructure investment. If coverage of public pension plans can be extended to all households, this would reduce the incentive for savings somewhat, and therefore support consumer spending.[11] Similarly, more adequate provision of social services, such as health and education, would relieve some of the need for private savings for the expenditures in this area.

[11] With a better public pension plan, household savings may be reduced, but the public savings to support the pension will have to increase. As a result, the total savings in the PRC may not change much. Singapore is an example.

8.6 Conclusions

The PRC posted a remarkable growth performance in the past 37 years since the economic reform period began in 1978, averaging close to 10% annual real GDP growth from 1978 through 2015. Per capita GDP in 2005 PPP terms reached approximately $11,300 in 2015. However, as the economy has achieved middle-income status, there are increasing questions about how fast the economy can grow from here. As described in Section 2.2, optimists see scope for growth of 7%–8%, but pessimists forecast a slowdown to perhaps 5%–6% or even lower.

The PRC has many positive supply factors that, under favorable circumstances, could support a high potential growth rate. Most importantly, developing countries, such as the PRC, possess a "latecomer advantage," because they can achieve technological progress through imitation, importing capital goods, integration, and licensing of technology. This capacity can enable the PRC to substantially upgrade its industrial structure. The ability to upgrade technology is key to being able to maintain high growth of capital investment without a significant deterioration in the rate of return to capital. In 2008, the PRC's per capita income in 2005 PPP terms was just over one-fifth that of the US. Based on the growth experiences of Japan; the Republic of Korea; Singapore; and Taipei,China (the comparator economies) from the time when their ratios of per capita income to the US level were similar to that of the PRC currently, we estimate that the PRC has a potential growth rate of roughly 8% through 2028.

However, circumstances could be less than favorable, and there are factors, both domestic and external, that could pose downside risks for the PRC's growth prospects. First, from the supply-side perspective, the most remarkable aspect of the PRC's rapid growth has been the relatively high contribution of TFP, ranging from 3.1% to 4.1% per year according to optimistic estimates. This is significantly higher than in most other economies, aside from Japan. This unusually high rate of growth can plausibly be explained partly by various waves of reforms that increased economic efficiency from what was a very low base in the pre-reform period as well as steady industrial upgrading.

However, it may be more difficult to identify further candidates for reform that would have the same impact on efficiency going forward. Some estimates suggest that as much as 2 percentage points of additional TFP growth per year over the next 20 years could be realized by reforms of the capital market and reduction of inter-provincial and inter-sectoral differences in productivity. Policy reforms to support increased innovation could also have a positive impact on TFP growth. However, it would require a very thorough reform program to achieve this ambitious target. This suggests that there are some downside risks to the PRC's TFP growth performance compared with previous experience.

The other key issue on the supply side is the extent to which the capital–output ratio has risen, which would tend to reduce the rate of return to capital and the attractiveness of capital investment unless the accumulated capital is used for continuous industrial upgrading. As described previously in this chapter, estimates of the degree of capital deepening vary widely according to assumptions about the growth of the investment deflator and other factors.

From the demand-side perspective, the risk is high that the earlier high-growth performance of exports is not likely to be repeated, partly because of the slowdown in the developed countries and partly because of the sheer size of the PRC's share of world trade. Given the connection between export growth and fixed investment growth, this suggests that, other things being equal, the growth trend of investment would be likely to slow. The question is whether alternative sources of investment and consumption growth can be encouraged to fill in this gap. On the investment side, this could include investment related to urbanization, including infrastructure, industrial upgrading, and expenditures to improve the environment. For consumer spending, this could include reform of the *hukou* system to permit freer internal migration toward higher-paying jobs, plus strengthening of the social security system to reduce the need for precautionary savings by individuals.

On the whole, domestic and external risk factors suggest that it will be difficult to achieve the favorable circumstances that would support a potential growth rate of 8% through 2028. The risks lie in the slowdown of export growth and the increased difficulty of finding new sources of reform to sustain very high levels of TFP growth. However, the PRC's economy still has plenty of areas for industrial upgrading and to reform that could support growth, including reform of the capital market, strengthening of the social welfare system, and support for innovation. The key is to promote needed domestic economic and financial reforms to offset the negative drags on growth from overseas.

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CHAPTER 9

Impact of the People's Republic of China's Growth Slowdown on Emerging Asia: A General Equilibrium Analysis

Fan Zhai and Peter Morgan

9.1 Introduction

With its rapid economic growth and integration into the global economy over the last three decades, the People's Republic of China (PRC) has emerged as a major economic power and an important source of growth for the world economy. Now it is the second-largest economy at market exchange rates and the largest exporter in the world. The PRC accounted for about one-fourth of the world's growth using purchasing power parity-based gross domestic product (GDP) during 2001–2014, and, in the years ahead, the PRC is likely to account for between one-third and half of growth in global income, trade, and commodity demand (Summers 2015). In Asia, the PRC's role as a growth pole is even more prominent. Over the last 10 years, spurred by strong processing exports and domestic demand, the PRC's imports from Asia in United States (US) dollar terms have increased at an average annual rate of 9%. The PRC is currently the key driver of intra-regional trade and its rapidly rising imports have buoyed the strong growth performance of neighboring Asian economies.

The increasing importance of the PRC for other Asian economies represents not only opportunities for them, but also a potential source of macroeconomic risk. With increased integration in the regional economy, a downturn in the PRC's economy may spill over to elsewhere in Asia. After peaking at 10.6% in 2010, the PRC's GDP growth has decelerated sharply since then, dropping to below 7% in the first three quarters of 2015. With its traditional growth drivers—exports and investment—losing momentum, the PRC's current growth model may have reached its limits. In the face of growing excess industrial capacity, high financial leverage ratios in the corporate sector, and potential bubble risks in property and stock markets, the government is unwilling to introduce massive monetary and fiscal stimulus to boost growth as it did after the 2008–2009 global financial crisis. Rather, the government wishes to rely on supply-side measures, including accelerating structural reforms and promoting innovation, to sustain long-term economic growth and facilitate the transition of the growth model to one based more on consumer spending. The efforts toward structural reform, complemented with some mini-stimuli on the fiscal front, may support the economy to grow at a more balanced path of a 6%–7% annual rate. However, the risk of a hard landing also exists.

This chapter assesses the likely implications of a growth slowdown in the PRC for emerging Asian economies. Specially, we use a multi-sectoral computable general equilibrium (CGE) model of the global economy to investigate the macroeconomic and structural impacts of the PRC's slowdown through the trade channel. The CGE model is an economy-wide model that characterizes interactions among industries, consumers, and governments across the global economy. The detailed regional and sector disaggregation of the model makes it possible to capture the spillover effects of sector- or country-specific shocks.

Section 9.2 analyzes the economic linkages between the PRC and other Asian economies and examines the major channels through which the effects of the PRC's growth slowdown may be transmitted. Section 9.3 discusses the methodology and describes the specifications of the CGE model used in this study. Then in Section 9.4 we quantify the potential impacts on production, trade, and the macroeconomy using the CGE model simulations. Finally, Section 9.5 presents some conclusions and policy implications.

9.2 Transmission Channels

Trade linkages dominate the economic relationships between the PRC and its Asian neighbors. Through the trade channel, a slowdown of the PRC's economic growth could be transmitted to the rest of the Asian economies by affecting export demand and the terms of trade. As the PRC has become a major source of demand for final goods produced in Asian economies, a significant downturn in its economy would have a negative impact on their exports, which in turn would reduce the trade balance and national income through short-run trade multiplier effects. Furthermore, the absorption reduction in affected economies would spill over to their trade partners, resulting in second-round demand reduction effects. The PRC's imports have also contributed to the strength of the world commodity market in the past decade. Now it is the world's largest importer of copper and steel, and among the largest importers of other raw materials. A downturn of the PRC's economy may drive down the prices of commodities and thereby negatively impact those countries that rely on exports of commodities and other primary products for much of their export earnings.

The degree of these effects depends on the characteristics of individual economies and their trade relationships with the PRC. The remainder of this section briefly discusses the trade linkage between the PRC and its Asian neighbors, which will facilitate the understanding of the likely impacts of the PRC's downturn.

Based largely on trade relationships, Asian economies have been significantly intensifying their economic ties with the PRC in recent years. Table 9.1 shows the PRC's exports to a number of Asian economies, while Table 9.2 shows the PRC's imports. The PRC's exports to these countries grew at a compound rate of 13.6% from 2005–2014. The growth rates of exports to Brunei Darussalam, the Lao People's Democratic Republic (Lao PDR), Myanmar, and Viet Nam have been rising fastest, while those to Japan rose the slowest. The share of imports from the PRC in those economies' total imports increased substantially. The share of Japan's imports from the PRC was relatively stable at 18%–19% since 2010, and that for the Republic of Korea rose only modestly, but the PRC import shares in India, Indonesia, Malaysia, the Philippines, and Thailand rose substantially.

Table 9.1: PRC Exports to Asian Economies, 2005–2014

Destination Economy	Export Value ($ billion)			Compound Growth Rate 2005–2014 (%)	PRC Share of Total Imports (%)		
	2005	2010	2014		2005	2010	2014
Brunei Darussalam	0.1	0.4	1.7	47.4	N/A	N/A	0.9
Cambodia	0.5	1.3	3.3	22.3	0.5	1.2	N/A
India	8.9	40.9	54.2	22.2	7.2	7.9	4.2
Indonesia	8.4	22.0	39.1	18.7	7.8	9.9	10.0
Japan	84.0	121.0	149.4	6.6	13.5	19.4	18.3
Republic of Korea	35.1	68.8	100.3	12.4	21.8	25.1	25.4
Lao PDR	0.1	0.5	1.8	37.7	N/A	N/A	N/A
Malaysia	10.6	23.8	46.4	17.8	6.6	12.6	12.1
Myanmar	0.9	3.5	9.4	29.2	N/A	27.1	6.2
Philippines	4.7	11.5	23.5	19.6	9.9	11.1	13.0
Singapore	16.6	32.3	48.9	12.7	8.6	10.3	12.6
Thailand	7.8	19.7	34.3	17.9	8.3	11.0	11.0
Viet Nam	5.6	23.1	63.7	30.9	10.0	10.7	N/A
Total	**183.4**	**368.9**	**576.0**	**13.6**	**N/A**	**N/A**	**N/A**

PRC = People's Republic of China, Lao PDR = Lao People's Democratic Republic, N/A = not available.

Source: UN Comtrade database. http://comtrade.un.org (accessed 15 September 2015).

The PRC's imports from these countries grew at a compound rate of 9.2% over 2005–2014. The average growth rates of imports from Cambodia, Indonesia, the Republic of Korea, the Lao PDR, Malaysia, Myanmar, Thailand, and Viet Nam rose more than 10% per year. The PRC's share of total exports rose significantly for Indonesia, Japan, the Republic of Korea, Malaysia, the Philippines, Singapore, and Thailand, with Japan and the Republic of Korea having the largest shares.

Table 9.2: PRC Imports from Asian Economies, 2005–2014

Destination Economy	Export Value ($ billion)			Compound Growth Rate 2005–2014 (%)	PRC Share of Total Imports (%)		
	2005	2010	2014		2005	2010	2014
Brunei Darussalam	0.2	0.7	0.2	–1.0	N/A	N/A	9.9
Cambodia	0.0	0.1	0.5	37.6	16.6	24.2	N/A
India	9.8	20.8	16.4	5.9	7.2	11.8	12.7
Indonesia	8.4	20.8	24.5	12.6	10.1	15.1	17.2
Japan	100.4	176.7	162.8	5.5	21.0	22.1	22.3
Republic of Korea	76.8	138.3	190.1	10.6	14.8	16.8	17.1
Lao PDR	0.0	0.6	1.8	60.2	N/A	N/A	N/A
Malaysia	20.1	50.4	55.7	12.0	11.5	12.6	16.9
Myanmar	0.3	1.0	15.6	56.7	N/A	N/A	N/A
Philippines	12.9	16.2	21.0	5.6	6.3	8.5	15.2
Singapore	16.5	24.7	30.8	7.2	10.3	10.8	12.1
Thailand	14.0	33.2	38.3	11.8	9.4	13.3	16.9
Viet Nam	2.6	7.0	19.9	25.6	16.0	23.8	N/A
Total	**262.0**	**490.6**	**577.5**	**9.2**	**N/A**	**N/A**	**N/A**

PRC = People's Republic of China, Lao PDR = Lao People's Democratic Republic, N/A = not available.

Source: UN Comtrade database. http://comtrade.un.org (accessed 15 September 2015).

Table 9.3 further compares the trade dependence of emerging Asia on the PRC against those on the developed world. It shows a massive rise in the importance of the PRC in Asia over the past 10 years. For the Association of Southeast Asian Nations (ASEAN) and South Asia, the PRC's shares in their total trade have doubled from 2004 to 2014. The PRC has outpaced the US, the European Union, and Japan as the largest trade partner of most Asian developing economies.

Because a substantial part of Asia's exports to the PRC is composed of intermediate goods that will be processed and re-exported overseas, the PRC's import growth reflects the rise in both domestic demand and external demand from outside the region. As a result, the role of the PRC's demand in supporting regional growth may be exaggerated by the amount of total trade. However, there have been two important structural changes in the PRC's trade pattern in the years since the global financial crisis. First, the PRC has been moving rapidly up the value-added chains of global production, leading to higher domestic content and value-added in the PRC's exports. Second, the domestic demand of the PRC has been increasingly contributing to the value-added of its trading partners (IMF 2011). This suggests a larger impact of the PRC's demand shock on its trading partners.

Table 9.3: Regional Distribution of Merchandise Trade in Emerging Asia *(%)*

	PRC	US	EU	Japan
2004				
NIEs (excluding Hong Kong, China)	13.7	13.9	9.3	13.0
Hong Kong, China	43.7	11.0	11.0	8.8
ASEAN (excluding Singapore)	8.2	13.9	11.4	16.0
South Asia	5.9	11.6	20.3	3.1
2014				
NIEs (excluding Hong Kong, China)	18.7	9.8	9.8	7.5
Hong Kong, China	50.2	7.1	8.2	5.3
ASEAN (excluding Singapore)	16.2	8.6	9.4	10.6
South Asia	10.4	8.0	13.8	2.2

ASEAN = Association of Southeast Asian Nations, PRC = People's Republic of China, EU = European Union, NIEs = newly industrialized economies, US = United States.

Source: Haver Analytics database. http://www.haver.com/our_data.html (accessed 25 September 2015).

9.3 Methodology

Two types of economic models have been widely used to assess the impact of international transmission of shocks. The first is the multi-country, vector auto-regressions (VARs) model, which captures the linear interdependencies among multiple time series of macroeconomic variables, such as GDP, inflation, and exchange rate, among others.

In a VAR, each variable has an equation explaining its evolution based on its own lags and the lags of the other variables. However, such econometrically estimated reduced-form VARs fail to offer clear economic interpretations in examining the effects of structural shocks. The second type of model is the New Keynesian dynamic stochastic general equilibrium (DSGE) model. This model captures macroeconomic transmission mechanisms with rigorous microeconomic foundations, but often is highly aggregated by region and sector.[1]

We complement the model-based literature on international spillover of economic growth by using a global trade simulation model to evaluate the effect of the PRC's growth on its Asian neighbors. The model is a dynamic, multi-sectoral global CGE model built on the LINKAGE model developed at the World Bank (van der Mensbrugghe 2005). The CGE model has its intellectual roots in the group of multi-country applied general equilibrium models used over the past two decades to analyze trade and tax issues (Shoven and Whalley 1992, Hertel 1997). However, we utilize the demand-driven Keynesian closure rule in this model, as opposed to the supply-driven neoclassical assumptions employed in most CGE models for long-term analysis. This makes the model more appropriate for analyzing the short- to medium-term impacts of growth shocks.

The key features of the model are as follows. Production in each economic sector was modeled using nested constant elasticity of substitution (CES) functions and constant returns to scale was assumed. At the top level, output is produced as a combination of aggregate intermediate demand and value-added. At the second level, aggregate intermediate demand is split into each commodity according to Leontief technology specifications, that is, no substitutability between inputs. Value-added is produced by a capital-land bundle and aggregate labor. Finally, at the bottom level, aggregate labor is

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1 See Gauvin and Rebillard (2015) and Inoue, Kaya, and Ohshige (2015) for a global VAR analysis of the spillover effects of the PRC's growth slowdown, and Anderson et al. (2015) for a DSGE analysis of spillovers from the PRC on sub-Saharan Africa.

decomposed into unskilled and skilled labor, and the capital-land bundle is decomposed into capital and land (for the agriculture sector), or natural resources (for the mining sector). At each level of production, there is a unit cost function that is dual to the CES aggregator function and demand functions for corresponding inputs. The top-level unit cost function defines the marginal cost of sectoral output.

The model assumed differentiation of products by regions of origin, that is, the Armington assumption (Armington 1969). Top-level aggregate Armington demand was allocated between goods produced domestically and aggregate imports following a CES function. At the second level, aggregate imports were further disaggregated across the various trade partners using an additional CES nest. On the export side, it was assumed that firms treat domestic markets and foreign markets indifferently. Thus, the law of one price would hold, i.e., the export price was identical to that of domestic supply.

Incomes generated from production were assumed to accrue to a single representative household in each region. A household maximizes utility using the extended linear expenditure system, which is derived from maximizing the Stone-Geary utility function.[2] The consumption/savings decision is completely static. Savings enter the utility function as a "good" and its price is set as equal to the average price of consumer goods. Investment demand and government consumption are specified as a Leontief function.

All commodity and factor markets were assumed to clear through prices. There are five primary factors of production: agricultural land, skilled labor, unskilled labor, capital, and natural resources. Agricultural land and the two types of labor were assumed to be fully mobile across sectors within a region. Some adjustment rigidities in capital markets were introduced through the vintage structure of capital, under which

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2 The Stone-Geary utility function takes the form $U = \prod_i (q_i - \gamma_i)^{\beta_i}$, where U is utility, q_i is consumption of good i, γ_i is the subsistence level of consumption, and β_i is the marginal propensity to consume out of income.

the "new" capital was fully mobile across a sector, while "old" capital in a sector could be disinvested only when this sector was in decline. In the natural resource sectors of forestry, fishing, and mining, a sector-specific factor was introduced into the production function to reflect the resource constraints. These sector-specific factors were modeled using upward sloping supply curves. For other primary factors, stocks were fixed for any given year. The numéraire of the model was defined as the GDP deflator of the US, which was held fixed.

The model was recursive dynamic, beginning with the base year of 2011 and being solved annually through 2020. Dynamics of the model were driven by exogenous population and labor growth and technological progress, as well as capital accumulation, which was driven by investment. Population and labor force projections were based on the United Nations' medium variant forecast. Technological progress was assumed to be labor augmenting, so the model could reach a steady state in the long run.

There are three macro closures in the model: the net government balance, the trade balance, and the investment and savings balance. We assume that government consumption and saving are exogenous in real terms. Any changes in the government budget are automatically compensated by changes in income tax rates on households. For the current account balance, the foreign savings are endogenously in each region to achieve the equilibrium of foreign account, while the relative price across regions, that is, the real exchange rate (GDP deflator-based), are assumed constant.

Domestic investment is exogenously set to reflect the shock in investment demand. As government savings are exogenous and foreign savings are determined by the foreign account balance, the investment–savings account has to be balanced through the changes in the levels of household saving. The equilibrium is achieved through an endogenously adjusted economy-wide factor capacity utilization rate for both capital and labor, which in turn results in changes in household income and savings. This closure rule corresponds to the Keynesian macro closure in the CGE literature (Dewatripont and Michel 1987, Taylor 1990, Robinson 1991) and makes the model behave like a Keynesian trade-multiplier model.

The model was calibrated to the Global Trade Analysis Project (GTAP) version 9, using 20 economies/regions and 22 sectors. Eleven emerging Asian economies are explicitly modeled as individual regions in the model.

It should be noted that the model is only intended to capture the trade channels through which a slowdown of the PRC would exert short- to medium-term impact on the rest of the world. It is not aimed at modeling the impacts of a more severe crisis in the PRC, in which the financial channel and sentiments may play much larger roles in crisis contagion. Nor does it attempt to take account of countercyclical macroeconomic policies that countries might adopt. However, we believe this is an appropriate approach for addressing the question at hand: the effects of a trend slowdown in PRC growth.

9.4 Simulations and Results

We establish a baseline first, in which economic growth and other macroeconomic indicators are broadly assumed to be consistent with the projections of the International Monetary Fund's most recent World Economic Outlook (October 2015). In the baseline the PRC is set to achieve a soft landing and its GDP growth rate would slow to 6.2% in 2016–2020. Then we consider a set of counterfactual scenarios. In the counterfactual scenarios, growth shocks are imposed in each year of 2016–2020 only and all economic variables before 2016 are kept to be with the same baseline, assuming that the risk factors for a slowdown would not exert significant impact over the remainder of 2015.
We considered three counterfactual scenarios:

(i) The PRC's slowdown: a cut in the PRC's real investment growth by 3 percentage points during 2016–2020

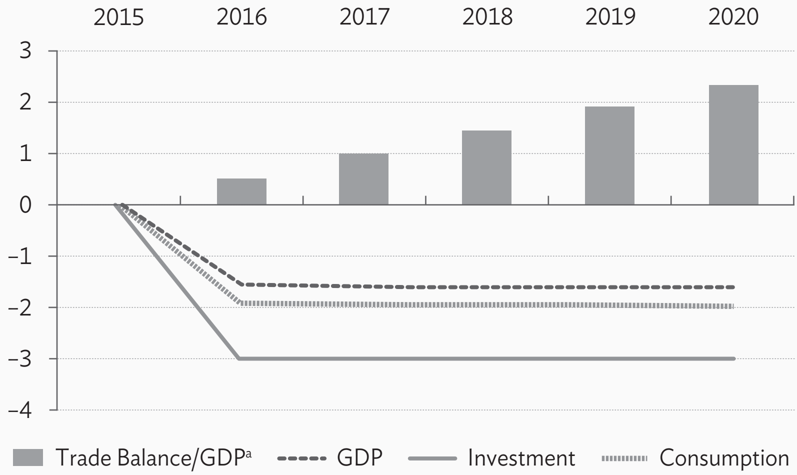
(ii) The PRC's slowdown plus growth acceleration in the US: an identical investment cut in the PRC and an acceleration of growth in the US by 1 percentage point from the baseline
(iii) The PRC's slowdown plus India's growth acceleration: an identical investment cut in the PRC and an acceleration of growth in India by 2 percentage points from the baseline

9.4.1 Impact on Output and Trade

The first counterfactual scenario looks at the potential results of a slowdown of the PRC economy. It assumed the real investment growth of the PRC would be lowered by 3 percentage points in each year of 2016–2020. Lower investment depresses income and employment through the multiplier effect. The annual average growth rate of the PRC's private consumption drops by 1.8 percentage points and its income growth falls from an annual average of 6.2% to 4.8% during the same period (Figure 9.1). Falling domestic demand drags down imports growth, leading to improvement in the trade balance, which rises by 0.5% of GDP in 2016 and 2.5% of GDP in 2020. As a result of the growth slowdown, the PRC's real GDP declines by 7.2% in 2020 relative to the baseline (Figure 9.2).

The simulation results suggest that such a slowdown would have a moderate regional impact. The average GDP growth rate of developing Asia as a whole (excluding the PRC) would decelerate by 0.26 percentage points in the coming 5 years because of the PRC's slowdown. Hong Kong, China and Taipei,China would be most affected, with losses of 0.54 percentage points and 0.51 percentage points in annual GDP growth respectively, reflecting their strong integration with the PRC. The other newly industrialized economies (the Republic of Korea and Singapore) would experience smaller output losses, owing to their relatively lower trade dependence on the PRC. In Southeast Asia, Malaysia and the Philippines would be hardest hit, with GDP growth slowing down by more than 0.40 percentage points, due to their strong trade linkages with the PRC. The adverse growth effects on other ASEAN countries (Indonesia, Thailand, Viet Nam, and

Figure 9.1: Macroeconomic Effects of Investment Slowdown of the PRC, 2015–2020 (changes relative to the baseline, percentage points of growth rate or ratio to GDP for trade balance)

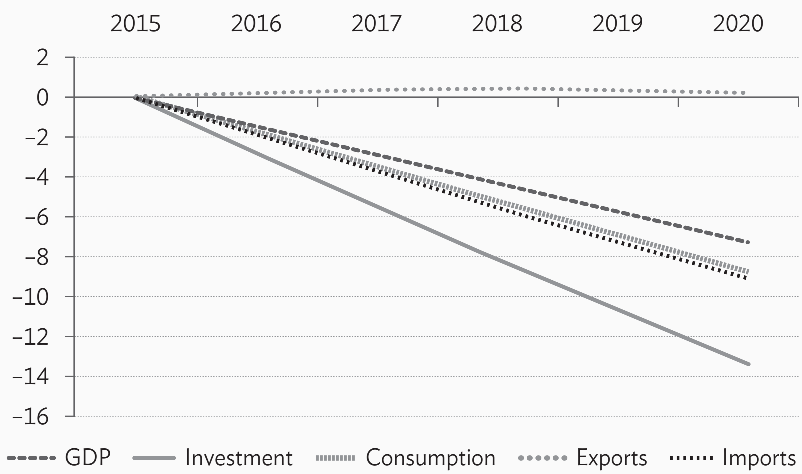


PRC = People's Republic of China, GDP = gross domestic product.

[a] Changes in percentage points.

Source: Prepared by authors.

Figure 9.2: Macroeconomic Effects of Investment Slowdown of the PRC, 2015–2020 (% changes relative to the baseline)



PRC = People's Republic of China, GDP = gross domestic product.

Source: Prepared by authors.

other Southeast Asia) are generally smaller, ranging from 0.27 to 0.35 percentage points. India is most insulated from the PRC's slowdown—its annual GDP growth would be lowered by a slight 0.14 percentage points in 2016–2020 (Table 9.4).

Table 9.4: Effects of the PRC's Slowdown on GDP and Trade, 2016–2020 (percentage point changes in annual growth rates relative to the baseline, except for trade balance)

	GDP	Exports	Imports	Trade balance as % of GDP
Australia and New Zealand	–0.37	–0.80	–0.31	–0.35
PRC	–1.59	0.05	–2.01	1.45
Japan	–0.24	–0.61	–0.30	–0.18
Developing Asia (excl. the PRC)	–0.26	–0.50	–0.35	–0.25
Hong Kong, China	–0.51	–0.66	–0.49	–0.38
Taipei,China	–0.54	–0.72	–0.64	–0.37
India	–0.14	–0.35	–0.19	–0.13
Indonesia	–0.29	–0.58	–0.20	–0.29
Republic of Korea	–0.26	–0.51	–0.42	–0.28
Malaysia	–0.42	–0.53	–0.41	–0.34
Philippines	–0.47	–0.75	–0.45	–0.29
Singapore	–0.34	–0.40	–0.37	–0.32
Thailand	–0.27	–0.39	–0.33	–0.24
Viet Nam	–0.35	–0.40	–0.30	–0.30
Other Southeast Asia	–0.31	–0.58	–0.29	–0.24
Other South Asia	–0.22	–0.34	–0.17	–0.12
Canada	–0.19	–0.32	–0.18	–0.16
United States	–0.17	–0.40	–0.16	–0.10
European Union	–0.19	–0.31	–0.23	–0.14
Latin America	–0.29	–0.51	–0.24	–0.19
Rest of the world	–0.36	–0.46	–0.27	–0.29
The World	**–0.42**	**–0.35**	**–0.42**	**0.00**

PRC = People's Republic of China, GDP = gross domestic product.

Source: Authors' model simulations.

The PRC's slowdown would also negatively impact developed economies, though the magnitudes would be smaller. Australia and New Zealand appear to be more exposed than other developed economies because of their stronger export dependence on the PRC, especially in view of their reliance on commodity exports. In other parts of the world, Latin America would experience a modest growth reduction of 0.29 percentage points annually, while the rest of the world would suffer a larger growth deceleration of 0.36 percentage points, mainly due to the latter's larger trade openness and higher exposure to the PRC's import demand. Through the trade linkage and multiplier effects, a slowdown in the PRC's economy is estimated to lower world GDP growth by 0.42 percentage points.

Changes in the trade balance driven by the PRC's slowdown are key factors to determine the above growth effects. The simulation results show that the investment cut and growth slowdown would reduce the PRC's import growth by 2.0 percentage points from the baseline, and increase its trade balance by 1.45% of GDP. This would be accompanied by a global trade adjustment. As shown in Table 9.4, world trade growth would fall by 0.42 percent points relative to the baseline due to PRC's slowdown.

The economies with closer trade linkages to the PRC would suffer more export deceleration. Australia and New Zealand would be worst hit in terms of exports, whose growth would fall by 0.80 percent points annually with respect to the baseline in 2016–2020, mainly due to the PRC's weakening demand for commodity imports. The PRC's slowdown would dampen the exports growth of Hong Kong, China; Taipei,China; and the Philippines by 0.66–0.75 percentage points, reflecting the central role the PRC plays in the regional production chains of textiles, apparel, and electronics. The exports slowdown for other Asian economies would be more modest, ranging from 0.35 percentage points for India to 0.61 percentage points for Japan.

Reflecting the increased trade surplus of the PRC would be a reduction of trade balances in other economies. The trade balances of Hong Kong, China; Taipei,China; and Australia and New Zealand would be reduced by 0.38%, 0.37%, and 0.35% of their GDP, respectively. The reduction of trade balances in other East and Southeast Asian economies would be generally in the range of 0.24%–0.34% of GDP. The South Asian economies would experience only small adjustments in their external accounts, with their trade balances declining by 0.12%–0.13% of GDP. The fall in external demand significantly contributes the output reductions in these economies.

The extent of the impact on economic growth also depends on the magnitude of the Keynesian demand multiplier in individual economies. The Keynesian multiplier is the rate at which changes in the exogenous demands are magnified into changes in the overall level of income. The economies with higher propensities to consume tend to have larger multipliers. This explains why the Philippines and other South Asia would suffer relatively large output adjustments although the reduction in their trade balances as ratios to GDP would be smaller. This factor also partially contributes to the relatively smaller growth impact on the Republic of Korea, as Korean households have a relatively low propensity to consume.

9.4.2 Sectoral Impacts

Table 9.5 presents the impact of the PRC's investment-induced growth slowdown on sectoral output of developing Asian economies, and shows percent changes with respect to the baseline in 2020. It shows that the output reduction would vary across sectors. In the PRC, the construction sector would be hard hit, with a loss of 13.1% of annual production in 2020 compared with the baseline. Other service sectors (including trade and transportation and private services) and capital goods sectors such as motor vehicles and metals would also be the major losers, with outputs shrinking by around 8.2%–9.5% relative to the baseline in 2020. Textiles, apparel, and other crops would be the least-hit sectors. But they would also suffer output contractions of around 2.5% because of the general economic downturn.

Table 9.5: Effects of the PRC's Slowdown on Sectoral Output, 2020
(% changes relative to the baseline level)

	PRC	HKG	KOR	TAP	INO	MAL	PHI
Grain	–5.1	–1.0	–0.9	–1.3	–1.3	–1.0	–1.7
Other crops	–2.7	–1.0	–0.7	–0.6	–1.1	–1.5	–1.7
Livestock	–6.1	–2.1	–1.0	–1.5	–1.1	–1.7	–1.5
Forestry and Fishing	–5.4	–1.6	–1.1	–1.3	–1.1	–2.0	–1.7
Coal	–5.8	–3.2	–3.1	–3.8	–3.2	–4.2	–5.3
Oil and Gas	–2.9	–2.3	–1.6	–2.1	–1.7	–2.7	–3.1
Other mining	–7.0	–1.8	–3.0	–3.3	–3.1	–4.9	–6.5
Food	–4.9	–2.3	–1.0	–1.2	–1.4	–1.8	–1.8
Textiles	–2.2	–3.5	–2.0	–2.5	–2.0	–2.3	–3.5
Apparel	–2.6	–3.6	–1.4	–2.3	–1.6	–1.9	–2.5
Wood	–5.6	–3.7	–1.4	–2.4	–1.5	–2.1	–2.4
Chemicals	–5.8	–5.7	–1.9	–3.0	–1.8	–2.7	–2.8
Metals	–8.5	–2.5	–1.5	–3.3	–0.7	–2.8	–2.9
Electronics	–3.7	–3.4	–1.9	–3.0	–1.5	–2.8	–4.7
Vehicles	–9.5	–2.3	–0.9	–1.2	–1.3	–1.6	–1.4
Machinery	–7.8	–5.0	–3.1	–4.4	–1.2	–1.9	–2.8
Other manufacturing	–6.0	–2.4	–1.5	–1.7	–1.0	–2.5	–2.6
Utilities	–7.2	–2.6	–1.4	–2.7	–1.3	–2.2	–2.3
Construction	–13.1	–0.1	–0.1	–0.5	–0.1	–1.3	–0.1
Trade and Transportation	–8.2	–2.8	–1.6	–2.7	–1.4	–2.0	–2.7
Private services	–8.5	–2.0	–1.3	–2.7	–1.7	–2.1	–2.9
Government	–3.0	0.0	–0.5	–1.4	–0.5	–0.4	–0.8

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Commodity sectors and investment goods sectors would be the major losers in other developing Asian economies, reflecting the investment-induced nature of the PRC's slowdown. The output reductions in agricultural sectors are generally small, ranging from 1% to 2%. However, commodities sectors such as coal, oil and gas, and other mining would experience large production losses, as their export dependence on the PRC is large in most developing Asian economies.

Table 9.5: *Continued*

	SIN	THA	VIE	Other SEA	IND	Other SA
Grain	–0.5	–0.5	–1.2	–0.9	–0.5	–0.9
Other crops	–0.9	–1.9	–1.6	–1.2	–0.6	–1.0
Livestock	–1.7	–0.7	–1.1	–1.1	–0.4	–1.0
Forestry and Fishing	–1.0	–1.0	–1.6	–1.4	–0.5	–0.8
Coal	–	–2.8	–3.9	–3.8	–1.6	–3.3
Oil and Gas	–1.9	–2.1	–2.6	–2.8	–1.4	–2.1
Other mining	–3.7	–2.1	–4.5	–6.1	–4.0	–1.8
Food	–1.8	–0.7	–1.3	–1.4	–0.5	–1.0
Textiles	–2.0	–1.9	–2.1	–1.8	–1.0	–1.8
Apparel	–1.7	–1.2	–1.0	–1.3	–1.1	–1.2
Wood	–1.6	–1.8	–2.0	–2.6	–0.6	–1.0
Chemicals	–1.6	–2.0	–2.5	–2.5	–0.5	–1.6
Metals	–2.0	–1.2	–1.8	–2.4	–0.4	–1.0
Electronics	–2.3	–2.5	–2.0	–1.7	–0.6	–1.0
Vehicles	–1.4	–0.7	–1.5	–1.4	–0.4	–0.9
Machinery	–1.8	–1.3	–2.2	–2.3	–0.3	–1.0
Other manufacturing	–1.3	–1.0	–1.6	–4.2	–0.8	–1.1
Utilities	–1.6	–1.4	–1.9	–1.8	–0.6	–1.1
Construction	–0.2	0.0	–0.1	–0.1	–0.1	–0.2
Trade and Transportation	–2.1	–1.5	–1.9	–1.9	–0.7	–1.2
Private services	–1.6	–1.7	–2.3	–1.7	–0.9	–1.2
Government	–0.7	–0.4	–0.8	–0.3	–0.4	–0.3

PRC = People's Republic of China; HKG = Hong Kong, China; IND = India; INO = Indonesia; KOR = Republic of Korea; MAL = Malaysia; PHI = Philippines; SA = South Asia; SEA = Southeast Asia; SIN = Singapore; TAP = Taipei,China; THA = Thailand; VIE = Viet Nam.

Source: Authors' model simulations.

Output declines would be relatively evenly distributed across manufacturing sectors. However, for economies that are more deeply integrated with the PRC through regional production chains, such as Hong Kong, China; Taipei,China; the Republic of Korea; and the Philippines, their machinery, electronics, and chemicals sectors would be more negatively impacted.

Tables 9.6 and 9.7 present the sectoral changes in real exports and imports. As a result of its growth slowdown, the PRC's imports of metals, vehicles, machinery, coal, other mining and some agricultural products would experience double-digit reductions in 2020 relative to baseline. This would directly affect the exports of the PRC's Asian neighbors. Given the geographical proximity and the high transportation costs incurred in commodity trade, the PRC is the dominant destination for commodity exports of most Asian emerging economies. The shrinking import demand for coal and other minerals from the PRC would hit developing Asia's exports in these sectors hard. Beside these commodity sectors, machinery exports of Hong Kong, China; Taipei,China; and the Republic of Korea and electronics exports of the Philippines would be significantly affected as well, largely due to the high participation of these sectors in PRC-centered Asian production chains.

Table 9.6: Effects of the PRC's Slowdown on Sectoral Exports, 2020
(% changes relative to the baseline level)

	PRC	HKG	KOR	TAP	INO	MAL	PHI
Grain	9.4	–4.8	–0.3	–1.4	–1.4	2.0	–1.0
Other crops	12.9	–3.5	–2.3	–1.6	–1.6	0.0	–2.9
Livestock	12.1	–4.8	–4.1	–4.0	–3.0	–1.2	–1.2
Forestry and Fishing	6.8	–1.8	–0.9	–0.9	–4.6	–3.6	–3.7
Coal	11.2	3.0	–7.5	–	–3.4	–13.5	–10.8
Oil and Gas	7.3	–	–1.6	0.2	–1.7	–2.5	–2.8
Other mining	5.8	–8.9	–8.4	–5.6	–8.4	–8.4	–9.7
Food	6.2	–3.4	–1.4	–0.9	–2.5	–2.1	–2.1
Textiles	0.9	–4.1	–2.0	–2.5	–2.4	–2.0	–3.1
Apparel	0.9	–4.3	–2.6	–2.6	–1.7	–1.4	–2.8
Wood	0.8	–6.2	–2.1	–2.0	–2.7	–1.8	–2.6
Chemicals	–0.4	–7.3	–2.9	–3.5	–2.8	–3.0	–3.1
Metals	0.9	–3.4	–2.0	–3.7	–2.2	–3.5	–4.0
Electronics	–0.4	–3.7	–2.4	–3.1	–2.3	–2.9	–4.7
Vehicles	–0.1	–3.0	–1.0	–0.8	–1.6	–1.6	–1.8
Machinery	0.4	–7.2	–4.5	–5.3	–1.7	–2.2	–3.3

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Table 9.6: *Continued*

	PRC	HKG	KOR	TAP	INO	MAL	PHI
Other manufacturing	−0.2	−2.2	−1.9	−1.3	−1.3	−2.2	−3.0
Utilities	0.3	−2.2	−1.0	0.0	−1.0	−1.6	−2.5
Construction	2.1	0.4	−0.7	−1.2	−1.0	−0.8	−1.2
Trade and Transportation	−1.2	−3.3	−1.6	−1.9	−2.1	−1.8	−2.3
Private services	−2.7	−1.4	−1.2	−1.3	−1.7	−1.8	−2.3
Government	−3.7	−0.6	−0.5	−1.8	−1.4	0.3	0.3
	SIN	**THA**	**VIE**	**Other SEA**	**IND**	**Other SA**	
Grain	−0.5	0.9	−0.8	−4.3	−2.1	0.3	
Other crops	−0.9	−5.5	−2.3	−2.2	−4.0	−0.8	
Livestock	−2.0	−1.3	−0.7	−4.8	−2.3	−0.6	
Forestry and Fishing	−1.2	−2.4	−5.8	−4.9	−2.8	−3.4	
Coal	–	−4.4	−9.3	−8.1	−3.7	−6.4	
Oil and Gas	−2.4	−2.9	−2.9	−2.9	−3.1	−4.0	
Other mining	−3.7	−6.1	−8.1	−8.0	−7.2	−8.0	
Food	−2.3	−0.6	−1.3	−2.1	−1.1	−1.7	
Textiles	−2.0	−2.1	−1.9	−1.3	−1.8	−1.9	
Apparel	−1.9	−1.7	−0.9	−1.2	−1.5	−1.6	
Wood	−1.7	−2.7	−2.1	−3.3	−1.1	−1.5	
Chemicals	−1.7	−2.6	−2.8	−3.2	−0.9	−2.3	
Metals	−2.4	−1.4	−1.8	−2.8	−2.1	−2.1	
Electronics	−2.4	−2.6	−2.0	−1.8	−1.3	−1.9	
Vehicles	−1.9	−0.9	−1.7	−1.1	−0.9	−1.3	
Machinery	−1.9	−1.6	−2.3	−3.0	−0.9	−1.4	
Other manufacturing	−1.5	−1.0	−1.3	−9.2	−1.3	−1.5	
Utilities	−2.8	−1.2	−2.7	−2.3	−2.2	−1.8	
Construction	−0.8	−0.4	−0.7	−0.9	−0.4	−0.9	
Trade and Transportation	−2.4	−1.6	−2.0	−2.4	−2.4	−1.9	
Private services	−1.6	−1.7	−2.5	−2.1	−1.9	−1.8	
Government	−0.3	−1.2	0.1	−1.1	−0.8	0.5	

PRC = People's Republic of China; HKG = Hong Kong, China; IND = India; INO = Indonesia; KOR = Republic of Korea; MAL = Malaysia; PHI = Philippines; SA = South Asia; SEA = Southeast Asia; SIN = Singapore; TAP = Taipei,China; THA = Thailand; VIE = Viet Nam.

Source: Authors' model simulations.

Table 9.7: Effects of the PRC's Slowdown on Sectoral Imports, 2020
(% changes relative to the baseline level)

	PRC	HKG	KOR	TAP	INO	MAL	PHI
Grain	–12.6	–1.5	–0.9	–1.1	–1.3	–2.1	–1.8
Other crops	–8.9	–1.2	–1.0	–0.7	–0.8	–2.2	–1.1
Livestock	–11.8	–2.5	–1.2	–1.4	–1.2	–2.4	–1.7
Forestry and Fishing	–9.3	–2.1	–1.3	–2.1	–0.7	–1.4	–1.2
Coal	–11.9	–2.7	–1.5	–2.9	–2.2	–2.1	–2.3
Oil and Gas	–6.9	–2.6	–1.8	–3.0	–1.9	–2.6	–2.8
Other mining	–10.0	–2.1	–1.4	–2.1	–0.4	–2.2	–2.3
Food	–8.7	–1.6	–1.0	–1.5	–0.5	–1.6	–1.0
Textiles	–5.5	–1.3	–1.4	–2.3	0.0	–1.4	–0.8
Apparel	–7.4	–0.8	–0.3	–1.4	0.3	–0.9	1.0
Wood	–8.5	–2.2	–1.2	–2.5	–0.5	–1.3	–1.0
Chemicals	–7.1	–2.7	–2.0	–3.1	–0.7	–1.9	–1.8
Metals	–11.0	–1.6	–1.6	–3.1	0.2	–1.7	–1.3
Electronics	–6.6	–2.2	–1.7	–2.9	–0.4	–2.0	–3.0
Vehicles	–11.4	–1.5	–1.1	–1.9	–0.6	–1.4	–0.5
Machinery	–10.7	–1.5	–1.4	–2.1	–0.3	–1.0	–1.0
Other manufacturing	–9.4	–2.6	–1.1	–2.4	–0.4	–1.6	–0.5
Utilities	–9.1	–2.4	–2.4	–4.5	–1.6	–2.0	–1.3
Construction	–14.9	–0.4	–0.2	–0.9	0.4	–1.1	0.5
Trade and Transportation	–8.8	–2.9	–1.9	–3.1	–1.0	–1.9	–2.1
Private services	–7.4	–2.6	–1.7	–3.6	–1.5	–1.8	–2.1
Government	–1.4	–0.3	–0.5	–0.8	0.0	–0.8	–1.2

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Accompanying the changes in output and exports, total employment also declines in the PRC and its Asian neighbors. As shown in Table 9.8, total employment in the PRC would drop by 6.1% in 2020 compared with the baseline. This is slight smaller than the real GDP loss of 7.2%, as some heavily impacted capital goods sectors are less labor-intensive. Losses in total employment in other emerging Asian economies range from 0.6% of the baseline level in India to 2.5% of the baseline level

Table 9.7: ***Continued***

	SIN	THA	VIE	Other SEA	IND	Other SA
Grain	−0.6	−1.5	−1.6	−0.5	−0.9	−1.3
Other crops	−0.7	−1.1	−1.4	−0.4	−0.6	−1.3
Livestock	−1.0	−1.1	−1.3	−0.2	−0.6	−1.4
Forestry and Fishing	−1.1	−1.2	−1.2	−0.7	−0.3	−0.5
Coal	−2.2	−0.7	−1.4	0.6	0.0	0.0
Oil and Gas	−1.6	−2.0	−2.7	−1.8	−0.4	−1.0
Other mining	−1.7	−0.2	−1.2	−2.6	−0.6	−0.3
Food	−0.9	−0.9	−1.0	−0.8	−0.6	−0.5
Textiles	−1.2	−0.5	−0.9	−1.0	1.1	−0.1
Apparel	−0.7	0.4	−0.5	−0.6	0.9	1.0
Wood	−1.3	−0.9	−1.1	−1.0	−0.3	−0.3
Chemicals	−1.8	−1.6	−1.3	−1.6	−0.7	−0.4
Metals	−1.1	−0.9	−0.9	−0.7	−0.3	−0.1
Electronics	−1.9	−1.8	−1.3	−1.1	−0.1	0.0
Vehicles	−0.7	−0.8	−0.9	−1.1	−0.1	−0.4
Machinery	−1.2	−0.7	−1.1	−1.3	−0.1	−0.2
Other manufacturing	−1.2	−1.2	−1.2	−0.4	−0.6	−0.4
Utilities	−1.7	−1.7	1.1	−0.9	−0.6	−0.7
Construction	0.2	−0.2	0.1	0.3	0.2	0.1
Trade and Transportation	−1.9	−1.5	−1.7	−1.1	−0.6	−0.9
Private services	−1.7	−1.5	−1.3	−1.1	−0.5	−1.0
Government	−1.0	0.1	−1.1	0.2	−0.2	−0.8

PRC = People's Republic of China; HKG = Hong Kong, China; IND = India; INO = Indonesia; KOR = Republic of Korea; MAL = Malaysia; PHI = Philippines; SA = South Asia; SEA = Southeast Asia; SIN = Singapore; TAP = Taipei,China; THA = Thailand; VIE = Viet Nam.

Source: Authors' model simulations.

in Taipei,China. The sectoral distribution of job losses relative to the baseline are largely in line with that of output and exports, with largest job losses (in relative terms) taking place in coal and other mining sectors in most emerging Asian economies. In Hong Kong, China; Taipei,China; and the Republic of Korea, the machinery sector would also suffer a large job cut relative to the baseline.

Table 9.8: Effects of the PRC's Slowdown on Sectoral Employment, 2020
(% changes relative to the baseline level)

	PRC	HKG	KOR	TAP	INO	MAL	PHI
Grain	–5.3	–1.4	–1.2	–1.5	–1.8	–1.5	–2.1
Other crops	–3.0	–1.5	–1.1	–0.8	–1.6	–2.0	–2.1
Livestock	–6.3	–2.5	–1.4	–1.7	–1.6	–2.2	–1.9
Forestry and Fishing	–5.3	–2.1	–1.4	–1.6	–1.5	–2.2	–2.0
Coal	–7.2	–5.0	–3.9	–4.6	–4.5	–4.5	–6.7
Oil and Gas	–3.5	–3.7	–2.7	–3.0	–2.8	–3.2	–4.8
Other mining	–8.3	–2.6	–3.8	–3.7	–3.8	–5.9	–7.6
Food	–3.9	–2.4	–1.1	–1.3	–1.6	–2.2	–2.5
Textiles	–1.4	–3.5	–2.1	–2.5	–2.3	–2.8	–4.5
Apparel	–2.0	–3.6	–1.5	–2.3	–1.8	–2.2	–3.3
Wood	–4.6	–3.8	–1.5	–2.4	–1.8	–2.3	–3.0
Chemicals	–4.7	–5.7	–2.2	–3.2	–2.0	–3.1	–3.6
Metals	–7.4	–2.6	–1.7	–3.4	–0.9	–3.1	–3.8
Electronics	–2.9	–3.5	–2.1	–3.2	–1.8	–3.2	–6.3
Vehicles	–8.5	–2.4	–1.1	–1.4	–1.6	–1.8	–1.8
Machinery	–6.9	–5.1	–3.2	–4.5	–1.5	–2.2	–3.6
Other manufacturing	–4.7	–2.5	–1.6	–1.8	–1.3	–2.8	–3.2
Utilities	–5.8	–2.8	–1.7	–3.0	–1.5	–2.4	–2.9
Construction	–12.2	–0.3	–0.2	–0.5	–0.2	–1.3	–0.2
Trade and Transportation	–7.0	–3.0	–1.7	–2.8	–1.5	–2.1	–3.4
Private services	–7.1	–2.1	–1.5	–2.9	–2.0	–2.3	–3.5
Government	–2.8	0.0	–0.6	–1.5	–0.6	–0.4	–0.8
Total	**–6.1**	**–2.4**	**–1.3**	**–2.5**	**–1.4**	**–2.0**	**–2.3**

continued on next page

9.4.3 Impacts on Commodity Markets

Given the enormous importance of the PRC in global commodity markets, it is worthwhile to look at the effects of the PRC's slowdown on commodity demand and prices. Table 9.9 indicates that the PRC's growth slowdown would lower global grain demand by a modest 1.6%

Table 9.8: ***Continued***

	SIN	THA	VIE	Other SEA	IND	Other SA
Grain	–0.9	–1.1	–1.7	–1.4	–0.7	–1.1
Other crops	–1.3	–2.4	–2.1	–1.7	–0.8	–1.2
Livestock	–2.1	–1.2	–1.6	–1.6	–0.7	–1.2
Forestry and Fishing	–1.5	–1.4	–1.8	–1.7	–0.7	–0.8
Coal	–	–3.5	–5.1	–7.2	–2.4	–5.0
Oil and Gas	–2.6	–3.0	–3.5	–3.8	–2.2	–2.9
Other mining	–3.7	–2.6	–5.5	–8.6	–5.2	–2.0
Food	–1.9	–0.9	–1.4	–1.9	–0.6	–1.0
Textiles	–2.2	–2.2	–2.2	–2.3	–1.1	–1.9
Apparel	–1.8	–1.5	–1.0	–1.7	–1.2	–1.3
Wood	–1.7	–2.0	–2.2	–3.4	–0.6	–1.0
Chemicals	–1.9	–2.3	–2.6	–3.2	–0.7	–1.7
Metals	–2.2	–1.4	–1.8	–2.9	–0.6	–0.9
Electronics	–2.6	–2.8	–2.1	–2.3	–0.8	–0.9
Vehicles	–1.6	–1.0	–1.5	–1.8	–0.4	–0.9
Machinery	–2.1	–1.5	–2.3	–2.7	–0.4	–1.0
Other manufacturing	–1.5	–1.2	–1.6	–5.1	–0.8	–1.1
Utilities	–1.8	–1.6	–2.0	–2.3	–0.7	–1.1
Construction	–0.2	–0.2	0.0	–0.3	–0.1	0.0
Trade and Transportation	–2.3	–1.7	–2.0	–2.2	–0.7	–1.2
Private services	–1.7	–1.9	–2.4	–2.3	–0.9	–1.3
Government	–0.8	–0.4	–0.8	–0.3	–0.5	–0.2
Total	**–1.6**	**–1.3**	**–1.8**	**–1.5**	**–0.6**	**–1.0**

PRC = People's Republic of China; HKG = Hong Kong, China; IND = India; INO = Indonesia; KOR = Republic of Korea; MAL = Malaysia; PHI = Philippines; SA = South Asia; SEA = Southeast Asia; SIN = Singapore; TAP = Taipei,China; THA = Thailand; VIE = Viet Nam.

Source: Authors' model simulations.

in 2020 relative to the baseline. The PRC's grain consumption would contract by 4.4%, contributing to around 60% of the global demand reduction. The world real price of grain, deflated by the numéraire of the model, would only be marginally affected, falling by 0.6% in 2020 relative to the baseline.

Table 9.9: Effects of the PRC's Slowdown on Commodity Demand and Prices, 2020 (% changes relative to the baseline level)

	Grain	Coal	Oil and Gas	Other mining
World Price Domestic Demand	–0.6	–1.4	–0.9	–1.0
Australia and New Zealand	–1.3	–1.9	–1.8	–2.6
Hong Kong, China	–1.1	–2.7	–2.6	–1.8
PRC	–4.4	–6.9	–5.8	–8.4
Taipei,China	–0.6	–2.8	–3.0	–2.6
India	–0.4	–0.6	–0.5	–0.3
Indonesia	–1.0	–1.2	–1.8	–0.9
Japan	–0.5	–1.6	–1.7	–1.6
Republic of Korea	–0.7	–1.5	–1.8	–1.5
Malaysia	–1.7	–2.3	–2.7	–2.3
Philippines	–1.4	–2.5	–2.8	–2.5
Singapore	–0.6	–1.9	–1.6	–1.6
Thailand	–0.8	–1.3	–2.0	–0.9
Viet Nam	–1.2	–1.8	–2.4	–1.7
Other Southeast Asia	–1.1	–2.2	–2.3	–1.7
Other South Asia	–1.0	–1.0	–1.5	–1.1
Canada	–0.5	–1.0	–1.1	–0.9
United States	–0.5	–0.9	–1.1	–1.0
European Union	–0.6	–1.2	–1.4	–1.0
Latin America	–0.9	–1.7	–1.7	–1.7
Rest of the world	–1.1	–1.6	–1.5	–1.4
The World	**–1.6**	**–3.8**	**–2.0**	**–4.9**

PRC = People's Republic of China.

Source: Authors' model simulations.

The impacts of the PRC's slowdown on energy and metal commodities are more profound. In the face of falling investment and slowing economic growth, the PRC's demand for coal, as well as oil and gas, would decline by 6.9% and 5.8% in 2020, respectively. Amplified by the spillover effects to other economies, global demand for these two energy goods would fall by 3.8% and 2.0%, respectively. They would experience price drops of 1.6% and 0.9%, respectively, reflecting a more elastic coal supply in the world. The other mining sector, which contains metal and non-metal minerals, would experience a sharp reduction of 8.4% in demand from the PRC. With the PRC accounting for roughly half of the global demand in this sector, this would cause a 4.9% drop in world demand and a 1.0% fall in its real price.

9.4.4 The Roles of the United States and India

As Asia's economies generally have large exposures to the US economy, it would be useful to examine the consequences of the interaction between the PRC's slowdown and the changes of growth conditions in the US. Moreover, with the Indian economy likely continuing its rapid growth spurred by economic reforms, a natural question is: will a growth pickup in India be able to offset a slowdown in the PRC? This subsection examines two alternative scenarios to investigate the spillover effects of the US and India for emerging Asia. In addition to a 3 percentage point investment deceleration in the PRC simulated in the first scenario, the two alternative scenarios further assume a GDP growth acceleration in the US by 1 percentage point, and a GDP growth acceleration in India by 2 percentage points, respectively. The major simulation results are reported in Table 9.10.

In the scenario of a stronger pickup in the US combined with the PRC's slowdown, the results for GDP indicate that the adverse effects of the PRC's slowdown would be partially offset by the stronger growth of the US. The impact on global growth would be negligible, and the growth of developing Asia as a whole (excluding the PRC) would be reduced by only 0.10 percentage points. In comparison with the first scenario, this suggests that around 60% of the adverse growth effect of the PRC's slowdown for developing Asia would be offset by a 1 percentage point growth acceleration in the US.

Looking at individual economies, only Hong Kong, China and Taipei,China would suffer negative growth shocks of above 0.20 percentage points annually under the combined effects of the PRC's slowdown and the pickup of the US economy. The growth

Table 9.10: Growth Effects of the PRC's Slowdown plus Changes in the United States and India, 2016–2020
(Percentage point changes in annual growth rates relative to the baseline)

	Scenario 2: The PRC slowdown plus faster US growth	Scenario 3: The PRC slowdown plus faster Indian growth
Australia and New Zealand	−0.27	−0.28
PRC	−1.46	−1.55
Japan	−0.09	−0.20
Developing Asia (excluding the PRC)	−0.10	0.54
Hong Kong, China	−0.22	−0.42
Taipei,China	−0.28	−0.49
India	−0.03	2.00
Indonesia	−0.16	−0.17
Republic of Korea	−0.12	−0.22
Malaysia	−0.14	−0.27
Philippines	−0.17	−0.40
Singapore	−0.10	−0.21
Thailand	−0.09	−0.20
Viet Nam	−0.09	−0.24
Other Southeast Asia	−0.12	−0.16
Other South Asia	−0.04	−0.11
Canada	0.12	−0.13
United States	1.00	−0.13
European Union	−0.04	−0.13
Latin America	−0.05	−0.21
Rest of the world	−0.12	−0.18
The World	−0.03	−0.27
Developing Asia excl. the PRC and India	−0.14	−0.25

PRC = People's Republic of China, US = United States.

Note: Scenario 2 assumes 1 percentage point faster growth in the US and Scenario 3 assumes 3 percentage points faster growth in India.

Source: Authors' model simulations.

deceleration of the Republic of Korea and Southeast Asian economies would range from 0.09 percentage points in Thailand and Viet Nam to 0.17 percentage points in the Philippines. The growth pickup in the US would almost fully offset the negative impact from the PRC for South Asia, whose growth would decelerate by a minimal 0.03 percentage points.

As shown by the differences between Table 9.4 and Table 9.10, most economies would enjoy 0.2–0.3 percentage point gains in GDP growth from the US growth pickup. Taipei,China; Malaysia; and the Philippines would benefit most as their GDP growth would increase by 0.26–0.29 percentage points compared with the scenario of the PRC's slowdown alone. On the contrary, the GDP gains of India from the US pickup are only 0.11 percentage points and those of the PRC are only 0.15 percentage points.

In the case where India's growth accelerates while the PRC's growth slows, global economic growth would fall by 0.27 percentage points on average during 2016–2020. The negative growth impact for developing Asian economies (excluding the PRC and India) would be reduced from 0.33 percentage points for the scenario of only the PRC's slowdown to 0.25 percentage points, suggesting India's growth pickup would provide an offset of one-fourth of the PRC's slowdown. This is largely in line with India's smaller economic size and its relatively weak trade linkages with other emerging Asian economies. For individual economies, the growth spillover from India's 2 percentage point growth acceleration would range from 0.04 percentage points in the PRC; Taipei,China; and the Republic of Korea, to 0.15 percentage points in Malaysia and other Southeast Asian economies.

9.5 Conclusions

The PRC's emergence as a major economic power brings to the regional economies both opportunities and challenges. An immediate risk faced by the PRC's Asian neighbors is the potential spillover effects of its economic slowdown. However, our model-based analysis suggests that its adverse impacts on regional economies would be relatively modest. Given the economic size of the PRC, the character of its slowdown and the nature of Asia's trade pattern, a growth slowdown of 1.6 percentage points in the PRC would bring about a growth deceleration of 0.26 percentage points in developing Asia as a whole (excluding the PRC). In most regional economies,the induced growth losses are less than 0.5 percentage points. Hong Kong, China and Taipei,China are the most vulnerable to the PRC's economic downturn, while South Asia is the most isolated from changes in the PRC.

Furthermore, two counterfactual scenarios, which take into account possible changes in growth conditions of the US and India, show that strengthened growth in the US and India would help dampen the negative shock from the PRC's slowdown, but not fully offset it. This suggests the important role of the PRC as the largest regional economy.

Although the simulation results lie in the range of other alternative estimations in literature,[3] several important limitations in this modeling exercise need to be mentioned. First, the modeling analysis captures the trade channel of international business cycle linkage only. It does not include some other transmission channels, such as private capital flows, contagion in regional financial markets, as well as services trade in tourism. Second, as a real CGE model focusing on global trade analysis, the model lacks financial variables and nominal prices changes.

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3 Duval et al. (2014) estimated a macro panel model and found that a 1 percentage point increase in the PRC's growth would raise GDP growth in the median Asian economy by over 0.3 percentage points after a year, and in the median non-Asian economy by about 0.15 percentage points at the same horizon. Using a global VAR model, Gauvin and Rebillard (2015) found large growth spillover effects of the PRC: the output multiplier of the PRC's growth is estimated to be 0.67 for Hong Kong, China; 0.66 for ASEAN; 0.42 for India; and 0.22 for the Republic of Korea. However, Inoue, Kaya, and Ohshige's (2015) VAR exercises showed very small spillover effects from the PRC's growth slowdown. The output multipliers they estimated are 0.12 for Indonesia, 0.095 for Thailand, 0.07 for the Republic of Korea, 0.05 for both Singapore and Malaysia, and 0.018 for India. Global DSGE model simulations often come out with small estimates of the spillovers effects; for example, the simulation by Anderson et al. (2015) using the flexible system of global models suggested that a 12% drop in the PRC's GDP would lower the GDP of developed economies by around 0.7%.

This absence limits its ability to incorporate macroeconomic adjustment behaviors and policies that are important to determine the transmission of macroeconomic fluctuations. For instance, the model assumes bilateral real exchange rates are constant throughout the simulations. This may lead to underestimation of the spillover effect of the PRC's slowdown as economies experiencing a negative demand shock often face pressure of real depreciation. Third, the multi-sector model is still highly aggregated, as it has only 20 sectors. It may underestimate the impact of a slowdown of the PRC's investment growth in some special commodity markets. Fourth, as vertical specialization and the fragmentation of productive processes are not explicitly modeled in the CGE framework, the simulation results may overestimate the effect of demand shock originating from the PRC. Therefore, the results reported in this chapter should be viewed as indicative rather than forecasts.

Two major policy implications emerge from the above analysis. First, most Asian economies have relied on exports as the major source of growth. This has rendered their economies vulnerable to the business cycles of either the developed markets or the PRC. To maintain a stable macroeconomic environment and enhance economic flexibility is important to mitigate the external shocks. However, a switch of development strategy from export-led growth to domestic demand-led growth would be more important for Asian economies to achieve sustainable growth. Over the past 7 years since the global financial crisis, there have been some favorable signs to show the strengthening of domestic consumption in regional economies. Further policy reforms to improve income distribution and domestic financial market would be necessary to implement the structural shift toward domestic demand.

Second, looking forward, the PRC will play an even larger role in the world economy and provide a strong support for the regional demand growth in the longer term. Stronger growth in the PRC's domestic economy, together with increasing links through regional production chains and outward direct investment, would make Asian developing economies more exposed to economic fluctuations in the PRC and lead to higher business cycle synchronization in regional economies.

This would call for Asian economies to strengthen coordination of macroeconomic policies.

As noted above, the model is only intended to capture the trade channels through which a slowdown of the PRC would exert short- to medium-term impact on the rest of the world. It is not aimed at modeling the impacts of a more severe crisis in the PRC in which the financial channel and sentiments may play much larger roles in crisis contagion. Nor does it attempt to take account of countercyclical macroeconomic policies that economies might adopt. However, we believe this is an appropriate approach for addressing the question at hand: the effects of a trend slowdown in PRC growth.

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CHAPTER 10

Spatial Estimation of the Nexus between the People's Republic of China's Foreign Direct Investment and ASEAN's Growth

Nathapornpan Piyaareekul Uttama

10.1 Introduction

From 2002 to 2015, Asia saw a series of regional integration initiatives and rapid dispersion of investment from the People's Republic of China (PRC) to Southeast Asian economies. Some key regional economic agreements between the Association of Southeast Asian Nations (ASEAN) and the PRC were concluded and implemented during this period, particularly the Framework Agreement on Comprehensive Economic Cooperation between ASEAN and the PRC in 2002, the ASEAN–PRC Investment Agreement in 2009, the ASEAN–PRC Free Trade Area in 2010, and the Regional Comprehensive Economic Partnership in 2015. In 2009, at the time of the global financial crisis, the PRC's foreign direct investment (FDI) also started to increase. ASEAN FDI inflows from the PRC increased from $1.965 billion in 2009 to $8.869 billion in 2014, a compound annual increase of 35.17% (ASEAN 2015). However, at the time of the 2012 eurozone crisis, there was a modest (but insignificant) decline in the PRC's direct investment in ASEAN.

Deepening regional economic integration, a transformation of external policy, and connectivity improvements contributed to a boom in the PRC's direct investment in ASEAN. In 2007, the declaration on the

ASEAN Economic Community (AEC) Blueprint was signed to establish ASEAN as a single market and production base, a highly competitive economic region, a region of equitable economic development, and a region fully integrated into the global economy (ASEAN 2008). In the implementation of AEC, foreign investment is crucial as a catalyst to enhance economic growth and foster equality in ASEAN countries. Moreover, the PRC government has utilized its external economic policy to shift development patterns. In 2000, the PRC transformed its economic development strategy from an export promotion and foreign capital utilization strategy to a "Go Global" strategy based on import promotion and outward investment (Ohashi 2015). In 2012, the PRC announced the "One Belt, One Road" strategy, which has two components: One Belt is a land route linking the PRC with Europe through Central and Western Asia; and One Road is a maritime Silk Road connecting the PRC with Southeast Asia, Africa, and Europe. The "One Belt, One Road" strategy results in more opportunities for PRC multinationals to expand or embark on operations abroad. Likewise, building and improving physical connectivity between the PRC and ASEAN is a critical element of an investment attraction strategy. Currently, the transnational economic corridors project under the Greater Mekong Subregion (GMS) Economic Cooperation Program helps to increase connectivity of economic activities among the GMS countries. These factors have contributed to the PRC becoming a major investor in ASEAN economies in recent years. In 2014, annual growth of the PRC's direct investment in ASEAN increased by 30.85% compared with that in 2013 (ASEAN 2015).

A number of studies investigated the relationship between FDI inflows and economic performance, e.g., economic growth, productivity, and employment. Some research confirmed the significant relationship between FDI and economic performance, e.g., economic growth and productivity (Pegkas 2015, Ahmed 2015, Iamsiraroja and Ulubaşoğlu 2015). Other studies found insignificant linkages between FDI, economic growth, and trade (Belloumia 2014, Temiz and Gökmen 2014). Opinions are strongly divided on this issue. In one camp are those who believe FDI is a major catalyst for increasing the capacity of horizontal and vertical linkages, which contributes to the development of the regional value chain. Therefore, the FDI attractiveness of ASEAN is commonly used as a strategy for improving the industrialization of the region and lifting the regional value chain in ASEAN. In the other camp are those who favor a slow development of FDI flows, as they believe a gradual increase in FDI may be helpful for effective and sustainable industrial development. That is because domestic firms can, in time, improve their capacity through horizontal and vertical spillovers. In other words, it is possible that the surge in the PRC's direct investment in ASEAN results in unbalanced economic gains for domestic firms in ASEAN. In short, the possible results of huge foreign investment flows are ambiguous, which means internal and external policies and synchronizing these policies are key to balancing foreign investment flows.

The first opinion implicitly assumes that domestic firms in a recipient country have high resilience in the face of foreign capital mobility. Consequently, an influx of FDI would boost economic growth and prosperity in the region. The second opinion implicitly assumes that recipient countries have little resilience to absorb huge FDI inflows, and that this obstructs economic growth. This leads us to wonder how ASEAN countries can adapt themselves to the PRC's trade and investment dynamics. It is always assumed that ASEAN's economic growth will improve according to the PRC's economic growth. And if this is true, it means that ASEAN's economic growth will undoubtedly be negatively affected when the PRC economy slows down.

Therefore, the question of how FDI affects the recipient country's economic growth and economic activities lies at the heart of the debate, and has important policy implications. This motivates us to study this issue in greater depth. In this chapter, we examine the impact of the PRC's FDI on ASEAN's gross domestic product (GDP) growth rate, international trade, domestic investment, employment, and economic geography. We look at these factors in the ASEAN member countries (Brunei Darussalam, Cambodia, Indonesia, the Lao People's Democratic Republic [Lao PDR], Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Viet Nam). The main question is whether ASEAN economies are elastic to the PRC's FDI. And if they are elastic, are ASEAN economies influenced to the same degree by the PRC's FDI? The empirical results reveal that the spatial Granger causality test is unable to capture a geographic scale of causality, and the causality between the PRC's FDI and ASEAN's economic growth is sensitive to the model specification. The PRC's direct investment in ASEAN causes economic growth in ASEAN as a whole, and in any ASEAN country, economic growth causes FDI from the PRC. These findings have interesting external economic policy implications.

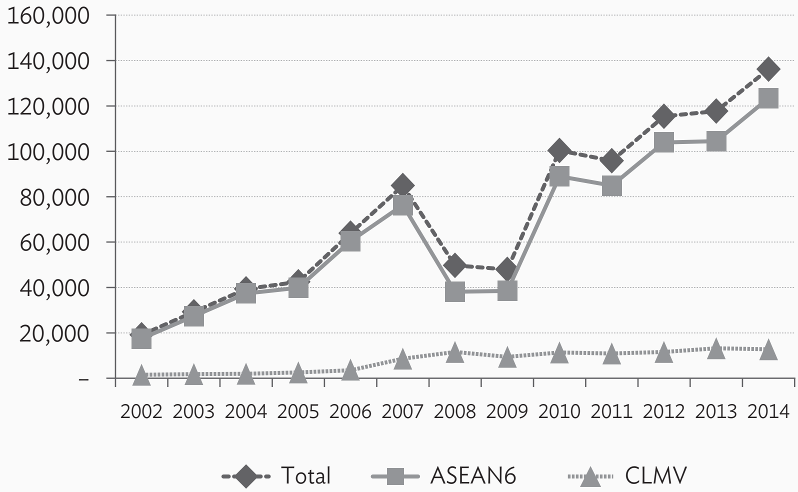
The remainder of the chapter is structured as follows. Section 10.2 presents stylized facts on the PRC's direct investment in ASEAN. Section 10.3 gives a brief overview of recent empirical contributions regarding the relationship between FDI and economic performance. Section 10.4 discusses data sources, methodology, and empirical results. Conclusions and policy implications are provided in Section 10.5.

10.2 The People's Republic of China's Direct Investment in the Association of Southeast Asian Nations: Stylized Facts

The closer economic relationship between the PRC and ASEAN began when the framework agreement on comprehensive economic cooperation between ASEAN and the PRC was signed in 2002. This agreement led to the creation of the ASEAN–PRC Investment Agreement in 2009, the ASEAN–PRC Free Trade Area in 2010, and the Regional Comprehensive Economic Partnership in 2015. As closer economic relations between the PRC and ASEAN have been forged over the last 2 decades, the PRC has become a major investor in ASEAN economies.

FDI inflows in ASEAN rose from $19,085 million in 2002 and peaked at $136,181 million in 2014, with the compound annual growth rate at 17.79% (Figure 10.1). FDI growth in Cambodia, the Lao PDR,

Figure 10.1: Foreign Direct Investment Inflows in the Association of Southeast Asian Nations, 2002–2014 ($ million)



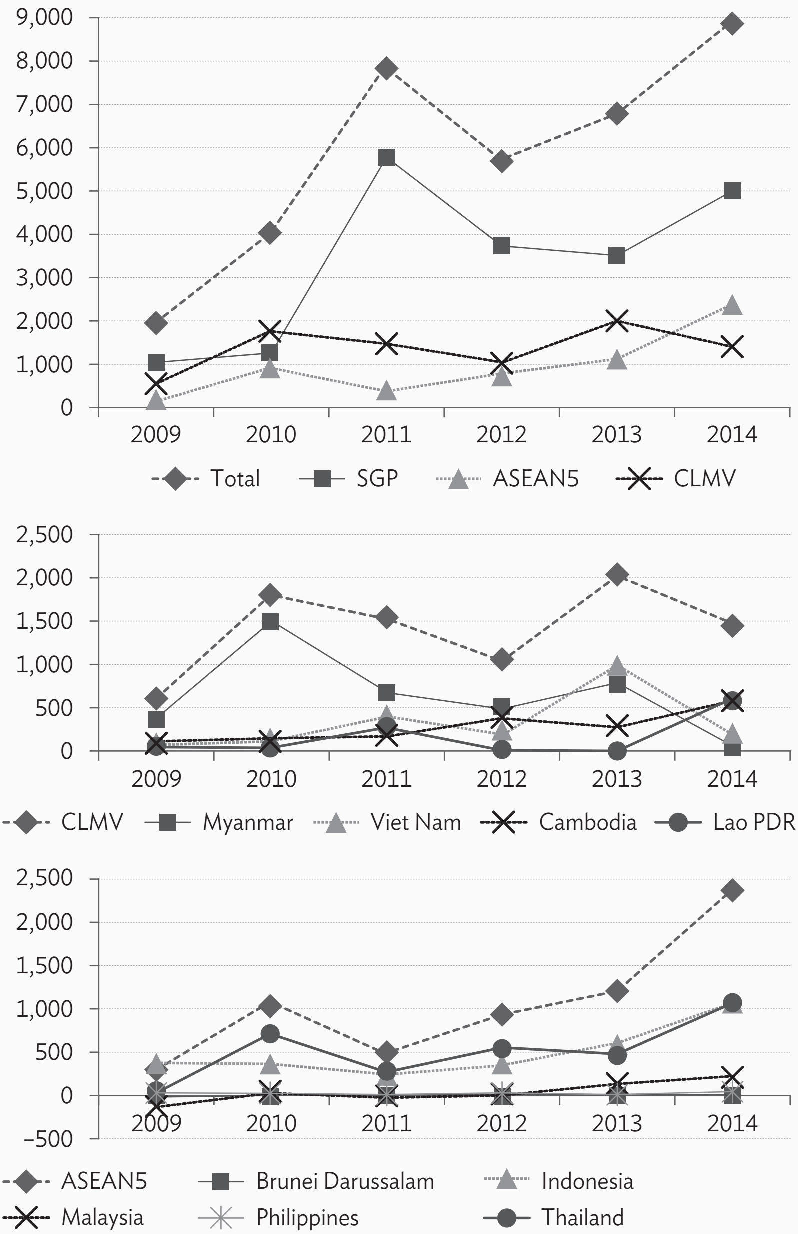
ASEAN = Association of Southeast Asian Nations; CLMV = Cambodia, Lao People's Democratic Republic, Myanmar, and Viet Nam.

Source: ASEAN (2015).

Myanmar, and Viet Nam (CLMV countries) was higher than in Brunei Darussalam, Indonesia, Malaysia, the Philippines, Singapore, and Thailand (ASEAN6). The reason may be that the CLMV countries have more abundant natural resources and they are emerging markets offering great opportunities for foreign investors and traders.

The PRC's FDI in ASEAN, which surged during the period of regional integration from 2002 to 2015, rose from $1.965 billion in 2009 to $8.869 billion in 2014 (ASEAN 2015). This amounted to an annual average growth rate of 35.17% from 2009 to 2014 (Figure 10.2) despite a modest decline in the PRC's FDI to ASEAN due to the 2012 eurozone crisis. Singapore was an outlier; it ranked first with $20.452 billion FDI from the PRC during 2009–2014, amounting to an annual average growth of 35.73%. Of the ASEAN5 countries (Brunei Darussalam, Indonesia, Malaysia, the Philippines, and Thailand), Thailand ranked first with $3.126 billion, or 111.72% average annual growth, followed

Figure 10.2: People's Republic of China's Direct Investment Flows to the Association of Southeast Asian Nations, 2009–2014 ($ million)



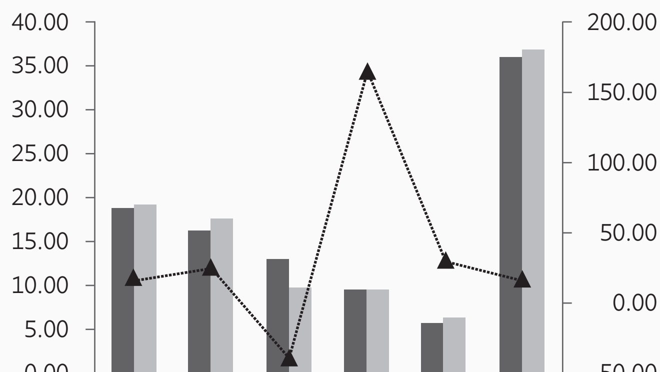
ASEAN = Association of Southeast Asian Nations; CLMV = Cambodia, Lao PDR, Myanmar, and Viet Nam; Lao PDR = Lao People's Democratic Republic; SGP = Singapore.

Source: ASEAN (2015).

by Indonesia. Of the CLMV countries, the Lao PDR ranked first with 76.23%, followed by Cambodia. However, a slowdown of the PRC economy in 2014 led to a rapid reduction in the PRC's FDI in CLMV countries, from $2.027 billion in 2013 to $1.448 billion in 2014. In sum, the PRC's FDI to ASEAN increased continuously, except to Brunei Darussalam, Myanmar, and Viet Nam.

The PRC has become a major investor in ASEAN economies. In 2014, the PRC accounted for 6.51% of all FDI inflows in ASEAN. This was a share smaller than that of the European Union (19.29%), intra-ASEAN (17.90%), Japan (9.83%), and the United States (9.58%) (Figure 10.3). But the PRC's direct investment in ASEAN rose by 30.85% in 2014 compared with that in 2013.

Figure 10.3: Share of Foreign Direct Investment Inflows in the Association of Southeast Asian Nations by Major Investors, 2009–2014



	EU28	Intra-ASEAN	Japan	US	PRC	Others
2009–2014	18.88	16.42	13.08	9.65	5.75	36.21
2014	19.29	17.90	9.83	9.58	6.51	36.89
Annual Growth	18.03	25.66	−38.52	165.45	30.85	18.01

ASEAN = Association of Southeast Asian Nations, PRC = People's Republic of China, EU = European Union, US = United States.

Source: ASEAN (2015).

10.3 Literature Review

There have been a number of recent studies on the impact of FDI on host countries. According to Navaretti and Venables (2004), host-country effects of FDI are transmitted through three main channels: product market effects, factor market effects, and spillover effects.

First, product market effects occur when the entry of multinational firms leads to product market competition and crowding out of domestic firms. For example, Pilbeam and Oboleviciute (2012) showed a significant crowding out effect of FDI on domestic investment. Salike (2010) found a high degree of crowding out of Japan's FDI from the PRC's direct investment in other Asian countries. But a study by You and Solomon (2015) demonstrated a significantly positive influence of the PRC's outward FDI on domestic investment in the PRC. Besides, government support had an important role in terms of the impact of the PRC's overseas FDI on domestic investment in the PRC. Resmini and Siedschlag (2013) also examined the effect of FDI in the PRC on the PRC's direct investment in other countries. They showed that the surge of FDI in the PRC during 1990–2004 encouraged both horizontal and vertical direct investment by the PRC in other countries. Thus, the complementarity of FDI played a crucial role in FDI decisions, which implies that FDI inflows directly affected domestic investment.

Second, factor market effects occur when the entry of multinational firms leads to employment creation. Liu, Tsai, and Tsay (2015) explored the impact of outward FDI from Taipei,China on domestic employment, production, investment, and income distribution. As is commonly known, outward FDI to high-wage countries is horizontal FDI, and outward FDI to low-wage economies is vertical FDI. Their findings revealed that horizontal FDI from Taipei,China did indeed have a strong impact on domestic employment, production, and investment; whereas vertical FDI from Taipei,China led to job losses and industrial hollowing out in Taipei,China. Likewise, Cozza, Rabellotti, and Sanfilippo (2015) studied the effects of PRC outward direct investment in advanced European countries. They found a strongly positive impact of the PRC's outward FDI on domestic productivity and scales of operation.

Third, spillover effects occur when the entry of multinational firms leads to horizontal and vertical spillovers. Horizontal spillovers are regarded as technological externalities associated with specific knowledge such as a superior production techniques, know-how, and management strategy. The entry of multinational firms leads to an increase in the productivity of domestic firms in the same industry. The horizontal spillover effect is referred to as intra-industry spillover. Vertical spillovers are recognized to be pecuniary externalities from FDI via backward and forward linkages to input market transactions. They take place when multinational firms enter into transactions between local suppliers and customers, and provide them with technology transfer and know-how to improve the quality of intermediate goods. The entry of multinationals can raise demand for local output as backward linkage to intermediate goods suppliers, and improve productivity levels of domestic firms. Also, domestic producers that purchase intermediate goods from multinational suppliers gain benefits from the supply of more sophisticated inputs as forward linkages. The findings of Newman et al. (2015) indicated that inward FDI in Viet Nam was more likely to generate vertical spillovers than horizontal spillovers. In particular, they found evidence of positive spillovers from downstream FDI firms, i.e., joint ventures between multinational companies and domestic input suppliers. They also found negative spillovers from upstream FDI firms to downstream domestic producers. Moreover, they suggested that policies aimed at attracting FDI should be continued, whereas policies and measures on the direct transfer of knowledge between firms should be focused. Seyoum, Wu, and Yang (2015) explored the presence of technology spillovers from the PRC's outward FDI in the Ethiopian manufacturing sector and found that the PRC's direct investment in Ethiopia was positively associated with increases in productivity. The ownership of superior productive assets such as technological know-how and management skills induced higher productivity in Ethiopia. In sum, product market effects and factor market effects are a direct impact of a surge of FDI in host economies, whereas spillover effects are an indirect effect of a surge in FDI.

The theory of the new economic geography has attempted to explain how firms behave in the context of economic agglomeration (or dispersion) in geographical space (Fujita and Krugman 2004). Theoretically, increasing returns to scale, monopolistic competition, transaction costs, and the occurrence of external economies underpin firms' and workers' location behavior (agglomeration or dispersion). Ascani, Crescenzi, and Iammarino (2012) reviewed the contributions to new economic geography focusing on the effects of economic integration on spatial development. In brief, firms' location behavior is driven by trade costs as a proxy for economic integration. That is, dispersion forces prevail over agglomeration forces when trade costs are high (a proxy for a low level of economic integration), whereas agglomeration forces prevail over dispersion forces when trade costs are lower (a proxy for a high level of economic integration). However, economic geography is commonly used as an important determinant of economic activities such as international trade and FDI. There was little evidence to support a spatial effect. Baltagi, Egger, and Pfaffermayr (2007) revealed that third-country effects were significant for FDI; in particular, they lent support to the existence of various modes of complex FDI. But Chou, Chen, and Mai (2011), examining the impact of third-country effects and economic integration on the PRC's outward FDI using a spatial econometric approach, found that the PRC's outward FDI was not due to third-country effects.

Based on theoretical and empirical benchmark specifications, this chapter aims to test the following hypotheses:

Hypothesis 1: FDI flows are directly related to economic performance, i.e., economic growth, international trade, domestic investment, and employment.

Hypothesis 2: Spatial interaction on FDI is indirectly related to economic performance, i.e., economic growth, international trade, domestic investment, and employment.

The study of the nexus between foreign investment and economic performance could help to shed light on the role of the PRC's foreign investment in ASEAN's economic performance.

10.3.1 Empirical Analysis

This chapter analyzes the long-run impacts of the PRC's foreign investment on ASEAN's economic performance with spatial interaction. This section starts with data collection, then tests for the causal relation between FDI, spatial interaction on FDI, and economic performance (economic growth, trade, investment, and employment), and finally empirical results are presented.

10.3.2 Data

In this study, panel data sets for 10 ASEAN member countries are collected for the period 1995–2013. The data comprise the PRC's direct investment to ASEAN, GDP, GDP per capita, export and import volumes, domestic investment, and employment. All data are used in real terms. For the analysis, all data are transformed into logarithm. The spatial interaction on FDI (WFDI) is built up through spatially weighted averages based on the distance between the capitals of the PRC (home country) and ASEAN (host country). The spatially weighting matrix is used in its row-normalized form. The sources and descriptive statistics of the variables are given in Table 10.1.

Table 10.1: Data Source and Descriptive Statistics of the Variables

Variable	Description	Source	Obs.	Mean	Std. Dev.	Min.	Max.
fdi	PRC's FDI to ASEAN (in $)	ASEAN Secretariat	190	2.344	2.631	–4.605	8.675
gdp	ASEAN's real GDP (in $)	UNCTAD	90	10.537	1.619	7.300	13.022
gdppc	ASEAN's real per capita (in $)	UNCTAD	190	7.507	1.640	4.560	10.492

continued on next page

Table 10.1: *Continued*

Variable	Description	Source	Obs.	Mean	Std. Dev.	Min.	Max.
trade	ASEAN's imports plus exports (in $)	UNCTAD	190	10.060	2.867	0.000	13.577
iit	Intra-industry trade between PRC and ASEAN (index)	UNCTAD	190	−0.624	1.091	−6.688	0.000
gcf	ASEAN's gross capital formation (in $)	UNCTAD	190	9.070	1.740	5.914	11.733
employ	Total employment to population in ASEAN (in %)	World Bank	190	4.224	0.110	4.044	4.411

ASEAN = Association of Southeast Asian Nations, PRC = People's Republic of China, FDI = foreign direct investment, GDP = gross domestic product, Max. = maximum, Min. = minimum, Obs. = observations, Std. Dev. = standard deviation, UNCTAD = United Nations Conference on Trade and Development.

Note: All variables are in natural log form.

Source: Author's estimates.

10.4 Testing

Testing for a causal relationship between the PRC's FDI and ASEAN's economic performance in a panel context is usually conducted in three steps. First, the order of integration in the time series variable is tested. Second, a spatial panel cointegration test is used to investigate the existence of a long-run relationship between sets of integrated variables. The last step is to evaluate the causal relation among the variables examined.

A. Panel Unit Root Test

A panel unit root test is used to check for the existence of panel stationarity. In this chapter, the panel unit root test by Levin, Lin, and Chu (LLC), the Im–Pesaran–Shin (IPS) W-test, and the augmented Dickey–Fuller (ADF)–Fisher (ADFF) Chi-square test (Levin, Lin, and Chu 2002; Maddala and Wu 1999; Im, Pesaran, and Shin 2003) are used to examine the degree of integration between Lfdi, Lgdp, Lgdppc, Ltrade, Liit, Lgcf, and Lemploy. The results for the panel unit roots are given in Table 10.2.

Table 10.2: Panel Unit Root Tests

	In Level			First Differentiation			Second Differentiation		
Variables	LLC	IPS	ADFF	LLC	IPS	ADFF	LLC	IPS	ADFF
fdi	−6.465* (0.000)	−6.900* (0.000)	84.573* (0.000)	−6.692* (0.000)	−9.812* (0.000)	117.80* (0.000)	–	–	–
gdp	3.371 (0.996)	−2.603* (0.004)	34.900** (0.020)	3.731 (0.999)	−7.860* (0.000)	94.430* (0.000)	−1.011 (0.155)	−14.69* (0.000)	170.65* (0.000)
gdppc	0.800 (0.788)	−6.300* (0.000)	76.202* (0.000)	2.648 (0.999)	−7.855* (0.000)	94.37* (0.000)	−1.623** (0.052)	−8.656* (0.000)	102.97* (0.000)
trade	−1.212 (0.112)	−2.559** (0.005)	34.933* (0.020)	−2.259* (0.011)	−5.892* (0.000)	71.444* (0.000)	–	–	–
iit	−2.402* (0.008)	−3.325* (0.000)	43.247* (0.001)	−7.469* (0.000)	−9.111* (0.000)	109.82* (0.000)	–	–	–
gcf	2.246 (0.987)	−2.184* (0.014)	31.248** (0.052)	3.762 (0.999)	−5.947* (0.000)	71.680* (0.000)	1.328 (0.907)	−11.53* (0.000)	135.46* (0.000)
employ	3.942 (1.000)	−2.588* (0.004)	34.837** (0.021)	3.029 (0.998)	−5.723* (0.000)	69.023* (0.000)	1.363 (0.913)	−10.05* (0.000)	119.14* (0.000)

– = not applicable; ADFF = augmented Dickey–Fuller–Fisher; IPS = Im–Pesaran–Shin; LLC = Levin, Lin, and Chu.

Notes: (a) The *p* values are in parentheses. (b) * and ** denote rejection of null hypothesis: The panel series has a unit root at the 1% and 5% level of significance, respectively.

Source: Author's estimates.

The IPS and ADF panel unit root tests for all variables reject the null hypothesis at the 1% and 5% significance level, respectively, in the level form. However, the LLC panel unit root test (except for Lgdp, Lgcf, and Lemploy) can reject the null hypothesis at the 1% and 5% significance level in the first difference and the second difference. Based on the LLC test, Lfdi and Liit are integrated of order zero or I(0) process; Ltrade is integrated of order one or I(1) process; and Lgdp, Lgdppc, Lgcf, and Lemploy are integrated of order two or I(2) process.

B. Panel Cointegration Test

The second step is to estimate the long-run relationship between the PRC's FDI and ASEAN's economic performance with spatial interaction. The variables in the spatial panel are estimated using a spatial panel vector autoregressive (SpVAR) model. Theoretically, SpVAR is able to justify spatial cross-section dependence in the data (LeSage and Pan 1995, Beenstock and Felsenstein 2007). The SpVAR equations are as follows:

$$\Delta gdp_{i,t} = \alpha_0 + \sum_{k=1}^{p} \beta_k \Delta gdp_{i,t-k} + \sum_{k=1}^{p} \theta_k \Delta fdi_{i,t-k} + \sum_{k=1}^{p} \theta_k w \Delta fdi_{i,t-k} + u_{i,t} \quad (3\text{-}1)$$

$$\Delta trade_{i,t} = \alpha_0 + \sum_{k=1}^{p} \beta_k \Delta trade_{i,t-k} + \sum_{k=1}^{p} \theta_k \Delta fdi_{i,t-k} + \sum_{k=1}^{p} \theta_k w \Delta fdi_{i,t-k} + u_{i,t} \quad (3\text{-}2)$$

$$\Delta gcf_{i,t} = \alpha_0 + \sum_{k=1}^{p} \beta_k \Delta gcf_{i,t-k} + \sum_{k=1}^{p} \theta_k \Delta fdi_{i,t-k} + \sum_{k=1}^{p} \theta_k w \Delta fdi_{i,t-k} + u_{i,t} \quad (3\text{-}3)$$

$$\Delta employ_{i,t} = \alpha_0 + \sum_{k=1}^{p} \beta_k \Delta employ_{i,t-k} + \sum_{k=1}^{p} \theta_k \Delta fdi_{i,t-k} + \sum_{k=1}^{p} \theta_k w \Delta fdi_{i,t-k} + u_{i,t} \quad (3\text{-}4)$$

where i = 1, 2, ...; N is the country index; and i = 1, 2, ... K is the time index. All estimations are conducted with the panel fixed effect estimator. The results for the spatial panel vector autoregressive model are given in Table 10.3.

The estimated results confirm that the PRC's direct investment in ASEAN is a strongly positive significant autoregressive parameter. Higher FDI results in a strong increase in economic growth, trade, investment, and employment in ASEAN countries. Moreover, spatial interaction on FDI has a positive significant relationship with trade. To check the stability of the long-run relationship between FDI and economic growth and trade, we therefore use GDP per capita as a proxy for economic growth, and intra-industry trade between the PRC and ASEAN as a proxy for trade. Surprisingly, the alternative results reveal

Table 10.3: Spatial Vector Autoregressive Results

	Base Case				Alternative Case	
	gdp	trade	gcf	employ	gdppc	iit
fdi(t−1)	0.186** (2.903)	0.437* (4.710)	0.239* (3.615)	0.014* (3.178)	0.052 (0.809)	−0.091* (−2.557)
Spatial fdi(t−1)	0.175 (0.679)	0.642** (2.200)	0.310 (1.311)	0.031 (1.543)	0.404*** (1.671)	0.043 (0.701)
gdp(t−1)	0.012 (0.179)					
trade(t−1)		0.274* (4.513)				
gcf(t−1)			0.170* (2.612)			
gdppc(t−1)				−0.069 (−0.969)	−0.074 (−1.047)	
iit(t−1)				−0.069 (−0.969)		0.110 (1.500)
Rho	0.743* (17.808)	0.411* (4.504)	0.587* (8.926)	0.963* (160.005)	0.632* (10.719)	−0.518* (−2.864)
Observations	190	190	190	190	190	190
R-square	0.629	0.475	0.529	0.984	0.414	0.123
Log-likelihood	−385.956	−454.673	−388.991	89.258	−38.546	−275.864
Moran's I	1.105†	0.675†	1.212†	0.675†	1.033†	0.781†

Notes: (a) t-stats are in parentheses. (b) *, **, and *** are significant at 1%, 5%, and 10%, respectively. (c) † denotes rejection of null hypothesis: no spatial correlation at the 1% level of significance.

Source: Author's estimates.

that FDI has a negative significant relationship with intra-industry trade, whereas spatial interaction on FDI has a positive significant relationship with economic growth. However, these findings confirm the long-run relationship between the PRC's foreign investment and ASEAN's economic performance with spatial interaction.

C. Panel Causality Test

The final step is to estimate the causal relationship between the PRC's foreign investment and ASEAN's economic performance with spatial effect. Granger causality test technique is used to evaluate the nexus between FDI and GDP (Model 1), FDI and Trade (Model 2), FDI and investment (Model 3), and FDI and employment (Model 4) in ASEAN countries. According to the results of panel unit root tests and a panel cointegration test, the series employed in testing the causality is series I(1) and cointegrated. For causality analysis, the optimal lag lengths of the models are provided. Given the standard information criteria—Akaike Information Criterion, Schwarz Bayesian Information Criterion, and Hannan-Quinn Information Criterion—the numbers of optimal lag length of the model are shown in Table 10.4.

Table 10.4: Spatial Granger Causality Test Results

Null Hypothesis	VAR*	F-Stat.	p-value	Results
Model 1A:				
Δfdi no Granger cause Δgdp	8	9.459	0.000	Reject
Δgdp no Granger cause Δfdi	8	4.665	0.000	Reject
Spatial effect:				
Δwfdi no Granger cause Δgdp	8	1.505	0.140	Accept
Δgdp no Granger cause Δwfdi	8	0.794	0.609	Accept
Model 1B:				
Δfdi no Granger cause Δgdppc	8	14.027	0.000	Reject
Δgdppc no Granger cause Δfdi	8	2.725	0.011	Reject
Spatial effect:				
Δwfdi no Granger cause Δgdppc	8	1.385	0.217	Accept
Δgdppc no Granger cause Δwfdi	8	0.777	0.623	Accept
Model 2A:				
Δfdi no Granger cause Δtrade	7	8.610	0.000	Reject
Δtrade no Granger cause Δfdi	7	1.886	0.082	Accept
Spatial effect:				
Δwfdi no Granger cause Δtrade	2	0.182	0.833	Accept
Δtrade no Granger cause Δwfdi	2	1.458	0.235	Accept
Model 2B:				
Δfdi no Granger cause Δiit	5	4.323	0.001	Reject
Δiit no Granger cause Δfdi	5	4.658	0.000	Reject

continued on next page

Table 10.4: *Continued*

Null Hypothesis	VAR*	F-Stat.	p-value	Results
Spatial effect:				
Δwfdi no Granger cause Δiit	8	1.703	0.107	Accept
Δiit no Granger cause Δwfdi	8	0.810	0.595	Accept
Model 3:				
Δfdi no Granger cause Δgcf	8	12.761	0.000	Reject
Δgcf no Granger cause Δfdi	8	5.425	0.000	Reject
Spatial effect:				
Δwfdi no Granger cause Δgcf	8	0.810	0.595	Accept
Δgcf no Granger cause Δwfdi	8	1.606	0.137	Accept
Model 4:				
Δfdi no Granger cause Δemploy	7	1.900	0.079	Accept
Δemploy no Granger cause Δfdi	7	6.141	0.000	Reject
Spatial effect:				
Δwfdi no Granger cause Δemploy	8	0.645	0.736	Accept
Δemploy no Granger cause Δwfdi	8	1.304	0.255	Accept

Notes: The *p*-value statistics indicate a statistical significance at 1%. * represents the optimal lag order selection.

Source: Author's estimates.

The estimations of F-statistics for the common coefficient of the panel causality analysis (Table 10.4) indicate that all estimations *without* spatial effect are significant at the 1% significance level and reject the null hypothesis that there is no causality among the variables. There are unidirectional causalities from FDI to trade and from FDI to employment, and bidirectional causalities between FDI and GDP, FDI and GDP per capita, FDI and intra-industry trade, and FDI and domestic investment. Moreover, all estimations *with* spatial effect accept the null hypothesis: there is no causality among the variables. There is limited support for causality between spatial interaction on FDI and economic performance in ASEAN.

In sum, the spatial Granger causality test is unable to capture a geographic scale of causality, but it gives strong evidence that the

PRC's direct investment in ASEAN countries causes economic growth, international trade, investment, and employment in ASEAN. Hence, attractive foreign investment policies in ASEAN must be formulated and implemented.

10.5 Conclusion and Policy Implications

This chapter investigates the long-run relationship between the PRC's direct investment flows to ASEAN economies and ASEAN's economic performance (measured by economic growth, trade, domestic investment, employment) using the Granger causality test. The test for causal relationship in a panel context is conducted in three steps. First, the order of integration in the time series variable is tested. Second, a spatial panel cointegration test is used to investigate the existence of a long-run relationship between the sets of integrated variables. The last step is to evaluate the causal relation among the variables examined. Panel data sets of 10 ASEAN member countries over the period 1995–2013 are arranged. The panel unit root test results for all variables show the series in the panel are integrated of order one. The panel cointegration test results using a spatial vector autoregressive model show that there is a long-run positive relationship between the PRC's FDI and ASEAN's economic growth, trade, investment, and employment. But the results also show that there is no long-run relationship between spatial interaction on FDI and ASEAN's economic performance. The Granger causality test results reveal that the PRC's direct investment in ASEAN causes economic growth, international trade, and investment in ASEAN, whereas ASEAN's economic growth, investment, and employment cause growth in the PRC's FDI.

This evidence suggests that ASEAN's external investment policy should be continued, with improvement of strategic investment policies, in both an intra- and extra-ASEAN context. In this chapter, policy implications for ASEAN policy makers are shaped under the investment policy framework for a sustainable economy, the influence of the PRC's "One Belt, One Road" strategy, and the ultimate goal of the ASEAN Economic Community (AEC). First, the investment policy framework for a sustainable economy is constructed to facilitate the development of a new generation of investment policies (UNCTAD 2015). These new generation investment policies are meant to contribute to the achievement of the Sustainable Development Goals, e.g., relating to sustainable and inclusive growth, infrastructure, renewable energy, water and sanitation, food security, health, and education. To attract and maximize gains from investment, innovative investment promotion and facilitation mechanisms at the national and international levels should be incorporated. Second, the PRC's "One Belt, One Road" initiative is a strategic policy that aims to strengthen connectivity through interactions between regions. There are two aspects: One Belt is a land route linking the PRC with Europe through Central and Western Asia; and One Road is a maritime Silk Road connecting the PRC with Southeast Asia, Africa, and Europe. This policy focuses on building a new network of global partnerships and improving connectivity in five areas: policy consultation, infrastructure connectivity, free trade, free circulation of local currencies, and people-to-people connectivity. Moreover, it attempts to build a large and multilayered platform for all countries along "One Belt, One Road" to maximize mutual advantages and benefits. Third, the ultimate goals of the AEC are to establish ASEAN as a single market and production base, a highly competitive economic region, a region of equitable economic development, and a region fully integrated into the global economy (ASEAN 2008). The AEC is expected to be fully implemented by 2020.

Under all these aspects, ASEAN's strategic investment policies should be initiated based on the goal of the new normal of the PRC economy and ASEAN economy nexus. A push and pull investment strategy and an integrated investment strategy are appropriate for improving the strategic investment policies, in both intra- and extra-ASEAN contexts (Figure 10.4).

Figure 10.4: Association of Southeast Asian Nations' Strategic Investment Policy

GOAL	New normal of ASEAN–PRC nexus		
STRATEGIES	Push strategic policy	Pull strategic policy	Integrated strategic policy
PLAN	Public–Private	Investment climate	Common vertical linkage
	Connectivity	Investment facilitation	Individual vertical linkage

ASEAN = Association of Southeast Asian Nations, PRC = People's Republic of China.
Source: Author.

External investment policy should aim to create a better investment environment for foreign investors and to help domestic investors open up new markets abroad. It might be called push–pull strategic investment policy. Under the new normal of the PRC's economy, capacity building through investment innovation in ASEAN is a priority. Indeed, innovation paves the way for future change. The public–private partnership between the PRC and ASEAN and their connectivity are the key factors for successful strategic investment measures of the push type, whereas the investment climate and facilitation are still the main factors for successful strategic investment measures of the pull type. Moreover, external investment policies should be designed and implemented in conjunction with the PRC's external investment policy. It might be called common strategic investment policy.

The PRC's "One Belt, One Road" strategy aims to build connectivity and cooperation among countries along the Silk Road. And as part of the AEC road map, ASEAN has been attempting to develop the region into a well-developed and prosperous one. Hence, capacity building through improving vertical linkages between the PRC and ASEAN, and within ASEAN, is vital for sustainable investment development.

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CHAPTER 11

Investigating How a Slowdown in the People's Republic of China Affects Its Trading Partners and How Asia Can Mitigate the Impact

Willem Thorbecke

11.1 Introduction

Real GDP growth in the People's Republic of China (PRC) averaged 10% per year between 1978 and 2011. If growth in the Republic of Korea and Taipei,China from the 1960s to the 1990s is considered miraculous, the PRC's growth over this period could be dubbed the East Asian miracle on steroids. As occurred in the Republic of Korea; Taipei,China; and other Asian economies, growth in the PRC is decelerating. Between 2012 and 2016, growth averaged 7.3% per year. How is this slowdown affecting the PRC's trading partners?

Dizioli et al. (2016) investigated the effects of the PRC's slowdown and its rebalancing from investment to consumption on the Association of Southeast Asian Nations (ASEAN) economies. Looking at the direct effect on exports from the ASEAN-5 countries,[1] they found that it would take an enormous decrease in PRC demand to lower ASEAN gross domestic product (GDP) by 1%. Using structural vector autoregression models to account for indirect effects such as policy reactions and third-party trade, they reported that a 1 percentage point decline in the PRC's growth could reduce growth in ASEAN countries by between 0.2 and 0.5 percentage points.

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1 ASEAN-5 includes Indonesia, Malaysia, the Philippines, Singapore, and Thailand.

Duval et al. (2014) examined the effect of growth spillovers from the PRC on trading partners. They measured a PRC growth shock as the residual quarterly growth rate after removing the PRC's average growth rate. They found that countries that export more value added to the PRC experience larger negative growth responses following a negative PRC growth shock. They reported that a 1 percentage point decline in the PRC's growth would lower GDP growth in the median Asian country by over 0.3 percentage points after a year, and by over 0.15 percentage points in the median non-Asian country after a year.

Thorbecke (2017) estimated a gravity model to investigate how slower growth in the PRC can spill over to trading partners through the trade channel. The results indicated that Taipei,China and the ASEAN countries are exposed to the PRC because they produce goods for the PRC market and are exposed to developed economies because they ship parts and components to the PRC for processing and re-export to the West. On the other hand, the Republic of Korea is more exposed to a slowdown in advanced economies that purchase processed exports from the PRC than to a slowdown in the PRC. Major commodity exporters such as Australia and Brazil and exporters of sophisticated consumption and capital goods such as Germany are also exposed to a slowdown in the PRC domestic market. Thorbecke concluded by recommending that firms and countries diversify their export bases and their trading partners to reduce their exposures to the PRC and to advanced economies.

This chapter extends the gravity model by using data up to 2015. The results indicate that, in the last few years, there has been a decoupling in East Asia's exports to the PRC. The shortfall of actual exports from East Asia to the PRC relative to predicted exports reached $250 billion in 2015. This was almost one-third less than the predicted value. The shortfall of actual exports from the PRC to East Asia relative to predicted exports in 2015 equaled $442 billion. This was almost 50% less than the predicted value.

With exports to the West facing risks from protectionism and extremist policies, it would be desirable for East Asia to nurture intra-Asian trade in final goods. This could lead to a virtuous circle, where exports between East Asian nations could raise growth, and higher growth could raise imports from other Asian nations. Steps to promote greater intra-regional trade in consumption goods include promoting growth and development in the region, embracing an Asia-wide free trade agreement, and increasing the purchasing power of Asian consumers by allowing regional currencies to appreciate together.

Section 11.2 presents the gravity model and the results. Section 11.3 examines the PRC's imports from the world. Section 11.4 examines the PRC's exports to the world. Section 11.5 concludes.

11.2 Using a Gravity Model to Investigate Trade with the People's Republic of China

11.2.1 Data and Methodology

As developed by Tinbergen, gravity models traditionally posit that trade between two countries is directly proportional to GDP in the two countries and inversely proportional to the distance between them (Tinbergen 1962). Tinbergen justified this model by appealing to Newtonian physics, where the gravitational attraction between two objects varies directly with the masses of two objects and inversely with the distance between them. This model has proved extremely valuable at explaining trade flows (see the discussion by Leamer and Levinsohn 1995; and Baltagi, Egger, and Pfaffermayr 2014). The basic model is often augmented to include other variables that affect bilateral trade costs such as whether two countries share a common language or a free trade agreement (FTA).

Traditional gravity models take the form:

$$\ln Ex_{ijt} = \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln DIST_{ij} + \beta_4 LANG + \beta_5 FTA_{ij} + \partial_i + \Omega_j + \pi_t + \varepsilon_{ijt} \quad (1)$$

where Ex_{ijt} represents exports from country *i* to country *j*, *t* represents time, Y represents GDP, DIST represents the geodesic distance between two countries, LANG is a dummy variable equaling 1 if the countries share a common language and 0 otherwise, FTA is a dummy variable equaling 1 beginning in the year when an FTA enters in force between two countries and 0 before, and ∂_i, Ω_j, and π_t are country *i*, country *j*, and time-fixed effects.

Anderson and Van Wincoop (2003) and others have derived theoretical foundations for gravity models. They reported that exports depend on outward and inward multilateral resistance terms. These terms capture exports and imports between two countries depending not only on trade costs between the two countries, but also on trade costs between third countries. As an example, they noted that trade between two countries can be affected if one of the countries enters into an FTA with a third country.

Theoretically based gravity models can be estimated by the equation:

$$\ln Ex_{ijt} = \beta_0 + \beta_1 \ln DIST_{ij} + \beta_2 LANG + \beta_3 FTA + \partial_i + \Omega_j + \varepsilon_{ijt} \quad (2)$$

where the variables are as defined above. Here the distance and language variables capture trade costs for exports between countries *i* and *j* and the exporter and importer fixed effects variables capture the outward and inward multilateral resistance terms.

The log linear models in equations (1) and (2) have traditionally been estimated using panel ordinary least squares (OLS) techniques. However, Santos Silva and Tenreyro (2006) found that this method can lead to biased estimates when there is heteroskedasticity in the data-generating process. They presented simulation evidence indicating that Poisson pseudo-maximum-likelihood (PPML) estimators often perform better both in terms of bias and efficiency.

In preliminary work, the sum of squared residuals was approximately 10 times higher when equation (2) was estimated using time-varying exporter fixed effects and importer fixed effects than when equation (1) was estimated. Since the goal of the work in this chapter is to predict exports, the specification in equation (1) is used. Equation (1) is estimated using both panel OLS and PPML techniques, and the average of predicted exports according to these two techniques is employed. Results for the two approaches individually are similar, and are available on request.

The data are obtained from the Centre D'Études Prospectives et D'Information Internationales (CEPII) and the World Trade Organization (WTO). Data on distance and common language are obtained from www.cepii.fr. Distance represents the geodesic distance between economic centers. Data on exports and GDP are obtained from the CEPII–CHELEM database. Data on whether countries had an FTA in place are taken from the database entitled "Participation in Regional Trade Agreements" that is available from www.wto.org.

The gravity model is estimated using trade between 31 leading exporters and importers. These are: Australia; Austria; Brazil; Canada; the PRC; Denmark; Finland; France; Germany; India; Indonesia; Ireland; Italy; Japan; Malaysia; Mexico; the Netherlands; Norway; the Philippines; Poland; Saudi Arabia; Singapore; the Republic of Korea; Spain; Sweden; Switzerland; Taipei,China; Thailand; Turkey; the United Kingdom; and the United States (US). The model is estimated as a panel using annual data over the 1988 to 2015 period.

11.2.2 Gravity Model Estimates

Table 11.1 presents the results from estimating the gravity models. Column (1) presents the results from the PPML estimation and column (2) from the OLS estimation. The model performs well, with all the coefficients of the expected signs and significant at the 1% level.

Table 11.1: PPML and Panel OLS Gravity Estimates, 1988–2015

	(1)	(2)
Distance	−0.59*** (0.02)	−0.78*** (0.01)
Common Language	0.28*** (0.03)	0.40*** (0.01)
Free Trade Agreement	0.68*** (0.03)	0.71*** (0.02)
Exporter GDP	0.68*** (0.03)	0.79*** (0.05)
Importer GDP	0.66*** (0.02)	0.93*** (0.03)
Constant	−4.46*** (0.70)	8.87*** (1.14)
Estimation Technique	PPML	OLS
Fixed Effects Specification	Exporter, Importer, Time	Exporter, Importer, Time
Adjusted R-squared		0.845
Number of observations	26,040	25,990
Sample Period	1988–2015	1988–2015

GDP = gross domestic product, OLS = ordinary least squares, PPML = Poisson Pseudo Maximum Likelihood.

Notes: The table contains panel OLS and PPML estimates of gravity models. The model includes bilateral exports from 31 major exporters to each of the other 30 countries over the 1988–2015 period. For the panel OLS estimates, heteroskedasticity-consistent standard errors are in parentheses. For the PPML estimates, Huber–White standard errors are in parentheses.

*** denotes significance at the 1% level.

Sources: CEPII–CHELEM database, World Trade Organization, and calculations by the author.

Table 11.2 presents the difference between the PRC's actual and predicted imports from the 30 economies in 2015. Actual imports are markedly more than predicted for only three countries: Australia, Brazil, and Germany.

Table 11.3 presents the leading exports from these countries to the PRC.

For Australia, 54% of the value of exports was metal ores, 15% was metal products, 11% was agricultural and food products, and 8% was coal.

Table 11.2: Republic of China's Actual and Predicted Imports from 30 Economies in 2015 ($ billion)

(1) Economy	(2) Actual Imports	(3) Predicted Imports	(4) Actual–Predicted Imports
Australia	61.0	13.9	47.1
Brazil	39.5	11.3	28.2
Germany	79.4	58.5	20.9
Taipei,China	98.0	92.3	5.7
United Kingdom	27.6	22.0	5.7
Saudi Arabia	28.3	24.3	4.0
Canada	15.4	12.2	3.3
France	21.6	20.7	0.9
Denmark	3.2	3.8	–0.5
Mexico	9.6	10.2	–0.6
Finland	2.8	4.1	–1.3
Poland	2.6	4.3	–1.7
Austria	3.6	5.3	–1.7
Turkey	2.4	4.3	–1.9
Norway	3.0	5.2	–2.2
Spain	5.0	7.8	–2.8
Ireland	1.8	4.8	–2.9
Sweden	5.3	9.2	–3.9
Netherlands	9.5	13.7	–4.2
Philippines	19.2	23.8	–4.6
United States	11.5	12.3	–7.0
Italy	11.0	19.4	–8.4
Switzerland	20.3	31.6	–11.3
Thailand	36.5	55.0	–18.5
Indonesia	20.9	44.8	–23.8
Singapore	23.7	49.7	–26.0
Malaysia	54.6	83.1	–28.5
India	13.2	45.5	–32.3
Japan	124.7	159.2	–34.5
Republic of Korea	154.3	272.0	–117.6

Note: Predicted exports are calculated from a gravity model including exports between 31 economies over the 1988–2015 period.

Sources: CEPII–CHELEM database, World Trade Organization, and calculations by the author.

Table 11.3a: Australia's Exports to the PRC in 2015

Product Category	ISIC Classification Number	Exports ($ billion)	% of Total Exports to the PRC
Iron ore	1310	29.1	47.7
Manufacture of non-ferrous and precious metals	2720	9.1	15.0
Hard coal (1010)	1010	4.8	7.8
Non-ferrous metal ores	1320	3.6	5.9
Cereals and other crops	0111	2.2	3.6
Cattle; dairy farming	0120	1.7	2.8
Meat and meat products	1511	1.7	2.8
Other manufactured food products	1549	0.5	0.8
Sawmilled and planed woods	2010	0.4	0.7
Pharmaceuticals	2423	0.4	0.6
Wines	1552	0.3	0.5
Forestry and logging	0200	0.3	0.4
Manufactured dairy products	1520	0.2	0.4
Pulp, paper, and paperboard	2101	0.2	0.3
Medical and surgical equipment	3311	0.2	0.3
Office and computing machinery	3000	0.2	0.3
Chemical and fertilizer minerals	1421	0.1	0.2
Basic chemicals, excluding fertilizer	2411	0.1	0.2
Fruit, beverage, and spice crops	0113	0.1	0.2
Refined petroleum products	2320	0.1	0.2
Animal and animal products	0122	0.1	0.2
TV and radio transmitters	3220	0.1	0.1
Crude petroleum and natural gas	1110	0.1	0.1
Fish, products of fish hatcheries	0500	0.1	0.1

PRC = People's Republic of China, ISIC = International Standard Industrial Classification.

Source: CEPII–CHELEM database.

Table 11.3b: Brazil's Exports to the PRC in 2015

Product Category	ISIC Classification Number	Exports ($ billion)	% of Total Exports to the PRC
Cereals and other crops	0111	16.3	41.3
Iron ores (1310)	1310	8.9	22.5
Crude petroleum and natural gas	1110	5.1	12.8
Pulp, paper, and paperboard	2101	2.0	5.0
Meat and meat products	1511	1.1	2.8
Manufactured non-ferrous metals	1320	0.8	2.1
Manufactured sugar	1542	0.8	1.9
Tanned and dressed leather products	1911	0.8	1.9
Manufactured basic iron and steel	2710	0.6	1.5
Non-ferrous metal ores	1320	0.6	1.5
Building and repairing of ships	3511	0.4	1.0
Plastics and synthetic rubber	2413	0.2	0.6
Vegetable and animal oils	1514	0.2	0.5
Aircraft and spacecraft	3530	0.2	0.5
General purpose machinery	2919	0.2	0.5
Pumps, taps, and valves	2912	0.2	0.4
Stone, sand and clay	1410	0.1	0.3
Electric motors and generators	3110	0.1	0.3
Basic chemicals, excluding fertilizer	2411	0.1	0.2
Jewelry and related articles	3691	0.1	0.2
Spirits; ethyl alcohol	1511	0.1	0.2
Preserved fruit and vegetables	1513	0.1	0.2
Soap and detergents, perfumes	2424	0.1	0.2
Parts for motor vehicles	3430	0.1	0.1

PRC = People's Republic of China, ISIC = International Standard Industrial Classification.

Source: CEPII–CHELEM database.

For Brazil, 46% was agricultural and food products, 24% was metal ores, and 13% was crude petroleum. For Germany, 26% was related to motor vehicles, 22% was machinery and equipment, 10% was chemicals, and 8% was medical and precision instruments.

Table 11.3c: Germany's Exports to the PRC in 2015

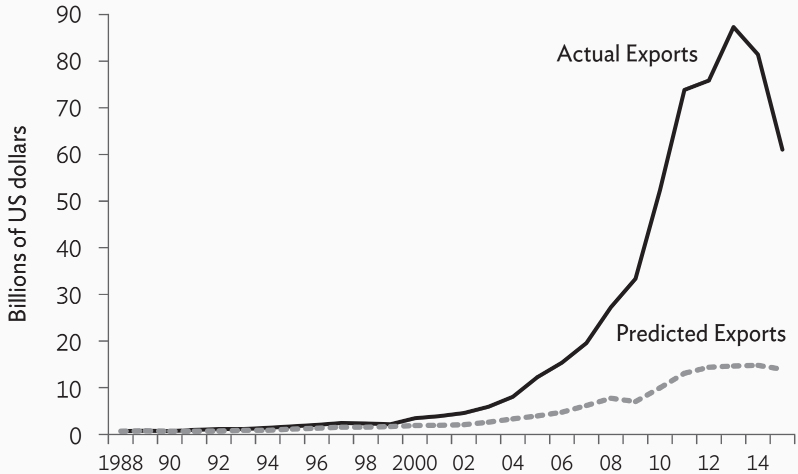
Product Category	ISIC Classification Number	Exports ($ billion)	% of Total Exports to the PRC
Motor vehicles	3410	11.5	14.6
Parts for motor vehicles	3430	9.0	11.3
Instruments for measuring	3312	3.9	4.9
Electricity distribution apparatuses	3120	3.8	4.7
Aircraft and spacecraft	3530	3.6	4.5
Special purpose machinery	2929	3.6	4.5
Machine-tools	2922	3.0	3.7
Pharmaceuticals	2423	2.8	3.5
Pumps, taps, and valves	2912	2.8	3.5
General purpose machinery	2919	2.6	3.2
Electric motors and generators	3110	1.8	2.3
Medical and surgical equipment	3311	1.8	2.3
Electronic valves and tubes	3210	1.8	2.2
Bearings, gears	2913	1.7	2.1
Other fabricated metal products	2899	1.5	1.9
Basic chemicals, excluding fertilizer	2411	1.5	1.9
Other electrical equipment	3190	1.5	1.8
Chemical products	2429	1.4	1.8
Plastic products	2520	1.3	1.6
Manufactured non-ferrous metals	1320	1.2	1.5
Plastics and synthetic rubber	2413	1.2	1.5
Manufactured iron and steel	2710	1.1	1.3
Machinery for textile production	2926	0.9	1.1
Lifting and handling equipment	2915	0.8	1.1

PRC = People's Republic of China, ISIC = International Standard Industrial Classification.

Source: CEPII–CHELEM database.

The lion's share of Australia's and Brazil's exports was thus primary products, and the lion's share of Germany's exports was sophisticated consumer and capital goods. Figure 11.1 shows that the value of Australia's, Brazil's, and Germany's exports to the PRC have been far more than predicted year after year. This remains true after the fall in the prices of primary products in the last 2 years of the sample period.

Figure 11.1a: Actual and Predicted Exports from Australia to the PRC

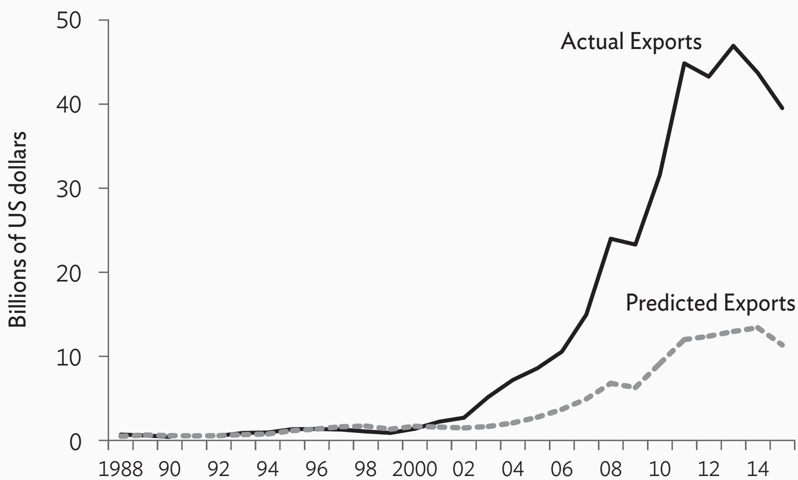


PRC = People's Republic of China, US = United States.

Note: Predicted exports are calculated from a gravity model, including exports between 31 economies over the 1988–2015 period.

Sources: CEPII–CHELEM database, World Trade Organization, and calculations by the author.

Figure 11.1b: Actual and Predicted Exports from Brazil to the PRC

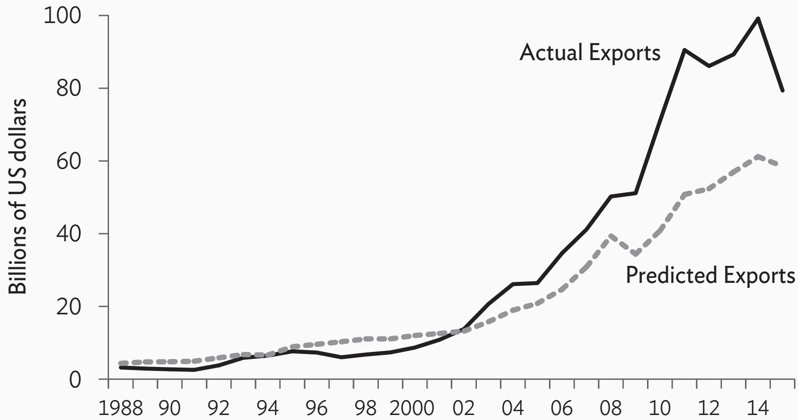


PRC = People's Republic of China, US = United States.

Note: Predicted exports are calculated from a gravity model including exports between 31 economies over the 1988–2015 period.

Sources: CEPII–CHELEM database, World Trade Organization, and calculations by the author.

Figure 11.1c: Actual and Predicted Exports from Germany to the PRC



PRC = People's Republic of China, US = United States.

Note: Predicted exports are calculated from a gravity model including exports between 31 economies over the 1988–2015 period.

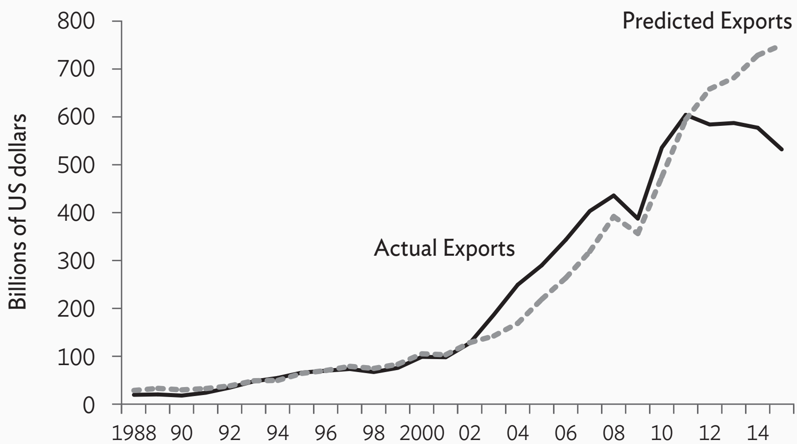
Sources: CEPII–CHELEM database, World Trade Organization, and calculations by the author.

Table 11.2 shows that one-half of the value of Australia's exports and one-quarter of the value of Brazil's exports came from iron ore. Much of this is used to produce steel that is used to build housing and infrastructure. If the PRC's building boom slows, Australia and Brazil may find that the PRC's demand for primary products will fall also. The table also shows that much of Germany's exports were high-end consumer goods. If President Xi's campaign against corruption continues to reduce luxury imports, it may significantly impact Germany's exports to the PRC.

11.3 The People's Republic of China's Imports from East Asia

Table 11.2 shows that, apart from Taipei,China, exports from East Asia to the PRC in 2015 were much less than predicted. Figures 112a–11.2e show actual and predicted exports from Japan; the Republic of Korea; Taipei,China; and the ASEAN-5 countries to the PRC over the 1988–2015 period. Figure 11.2a shows that actual exports were closely related to predicted exports until 2011, and that after that they became decoupled. Predicted exports increased by $156 billion between 2011 and 2015 while actual exports fell by $72 billion. Figures 11.2b–11.2e look at actual and predicted exports from ASEAN-5; Japan; the Republic of Korea; and Taipei,China. For ASEAN-5 in Figure 11.2b, the pattern mirrors the results for East Asia overall. Actual exports closely followed predicted exports up until 2011, and then actual exports fell and become decoupled from predicted exports. For Japan in Figure 11.2c, actual exports exceeded predicted exports from 2002 to 2011, and then actual exports plummeted.[2] For the Republic of Korea in Figure 11.2d, actual exports were close to predicted exports in 2009, and then they fell further and further away from predicted exports after this. Only for Taipei,China were actual exports consistently above predicted exports.

Figure 11.2a: Actual and Predicted Exports from East Asia to the PRC



PRC = People's Republic of China, US = United States.

Note: Predicted exports are calculated from a gravity model, including exports between 31 economies over the 1988–2015 period. East Asia includes Indonesia; Japan; the Republic of Korea; Malaysia; the Philippines; Singapore; Taipei,China; and Thailand.

Sources: CEPII–CHELEM database, World Trade Organization, and calculations by the author.

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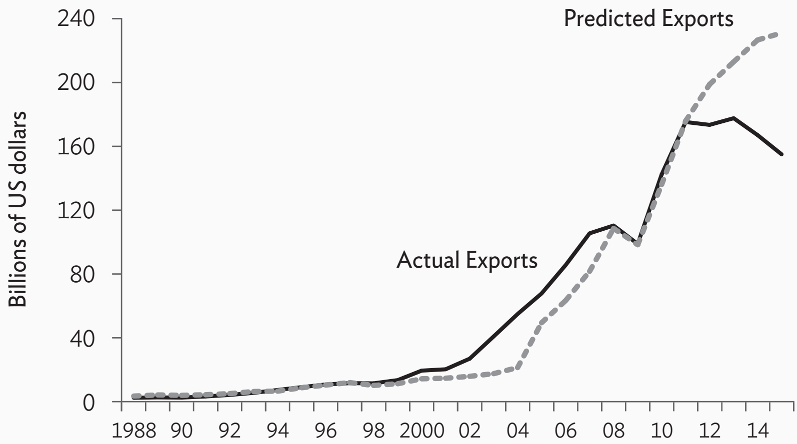
[2] One reason for this could be fallout from the Senkaku Island dispute between the PRC and Japan in 2012.

Figure 11.2b: Actual and Predicted Exports from ASEAN-5 to the PRC

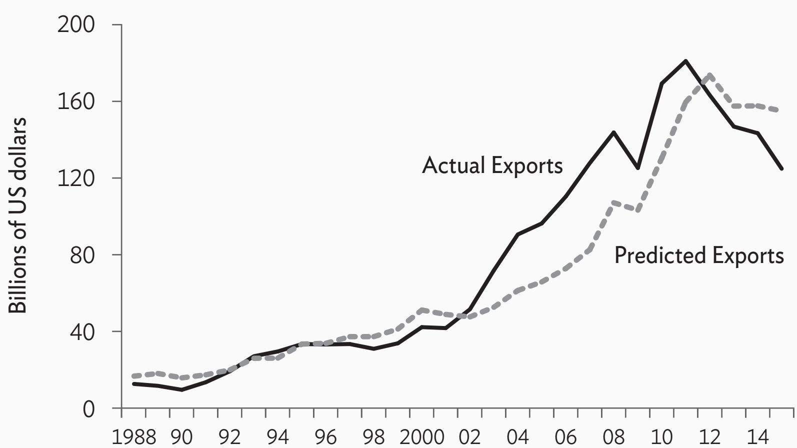


ASEAN = Association of Southeast Asian Nations, PRC = People's Republic of China, US = United States.

Note: Predicted exports are calculated from a gravity model, including exports between 31 economies over the 1988–2015 period. ASEAN-5 includes Indonesia, Malaysia, the Philippines, Singapore, and Thailand.

Sources: CEPII–CHELEM database, World Trade Organization, and calculations by the author.

Figure 11.2c: Actual and Predicted Exports from Japan to the PRC

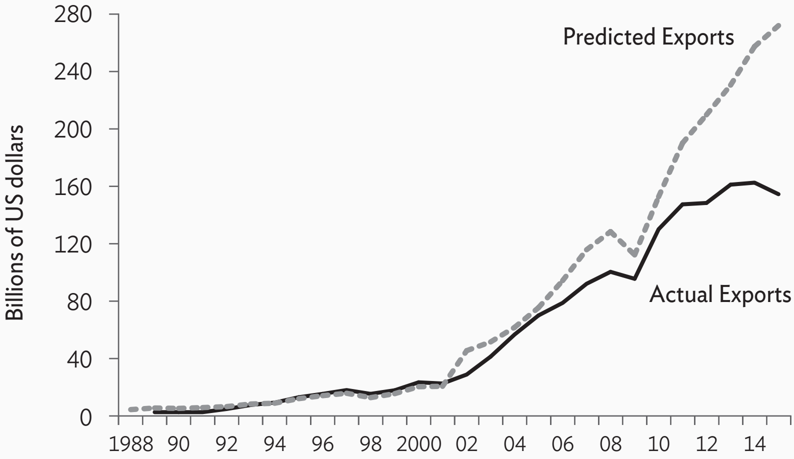


PRC = People's Republic of China, US = United States.

Note: Predicted exports are calculated from a gravity model, including exports between 31 countries over the 1988–2015 period.

Sources: CEPII–CHELEM database, World Trade Organization, and calculations by the author.

Figure 11.2d: Actual and Predicted Exports from the Republic of Korea to the PRC

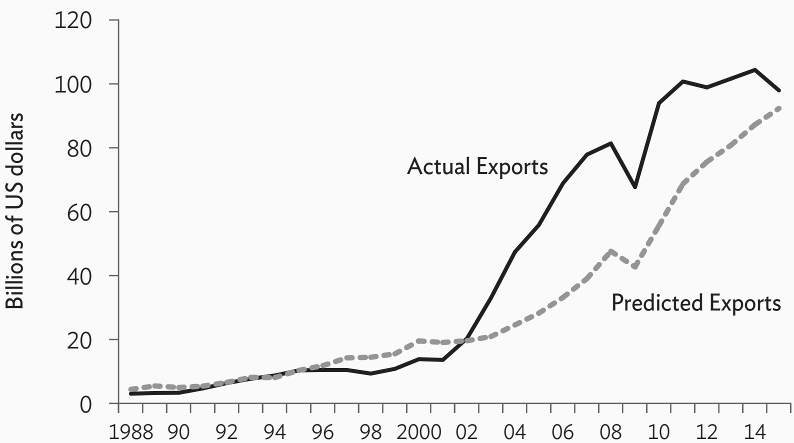


PRC = People's Republic of China, US = United States.

Note: Predicted exports are calculated from a gravity model, including exports between 31 economies over the 1988–2015 period.

Sources: CEPII–CHELEM database, World Trade Organization, and calculations by the author.

Figure 11.2e: Actual and Predicted Exports from Taipei,China to the PRC



PRC = People's Republic of China, US = United States.

Note: Predicted exports are calculated from a gravity model including exports between 31 economies over the 1988–2015 period.

Sources: CEPII–CHELEM database, World Trade Organization, and calculations by the author.

Tables 11.4a–11.4e present individual export categories from East Asia; ASEAN-5; Japan; the Republic of Korea; and Taipei,China to the PRC in 2015. Abstracting from the category optical instruments, which includes photolithography equipment and other inputs into the production process, less than 5% of East Asia's exports to the PRC in 2015 were consumption goods. For Japan, consumption goods were less than 8% of exports, and for ASEAN; the Republic of Korea; and Taipei,China consumption goods were only 4% of exports. For every economy in Table 11.4, far and away the largest export category to the PRC was electronic parts and components (ep&c) (ISIC category 3210).

How closely are ep&c imports in East Asian supply chain countries related to the subsequent re-export of electronics goods? To examine this, we can regress ep&c imports within supply chain countries on electronics exports, non-electronics exports, and factors reflecting domestic demand for imports such as gross domestic product and the exchange rate.

The key economies in the regional electronics value chain are Japan, the Republic of Korea; Malaysia; the Philippines; the PRC; Singapore; Taipei,China; Thailand; and Viet Nam. To investigate the relationship between imports and exports, Singapore is excluded because of distortions in the data caused by entrepôt trade. Viet Nam is excluded because it only joined the electronics value chain after 2008. Japan is also excluded because it is very much upstream in regional value chains and less dependent on imported inputs (see Riad et al. 2012). This leaves the following economies: the Republic of Korea; Malaysia; the Philippines; the PRC; Singapore; Taipei,China; and Thailand.

Data on electronic parts and components imports are available from the CEPII–CHELEM database. Since these data are measured in US dollars and since Asia's exports of ep&c represent imports from countries such as the US, they can be deflated using ep&c price deflators obtained from the US Bureau of Labor Statistics.

Table 11.4a: East Asia's Exports to the PRC in 2015

Product Category	ISIC Classification Number	Exports ($ billion)	% of Total Exports to the PRC
Electronic valves and tubes	3210	147.5	27.7
Optical instruments and photo equipment	3320	36.5	6.9
Basic chemicals, excluding fertilizer	2411	32.5	6.1
Plastics and synthetic rubber	2413	26.7	5.0
Office and computing machinery	3000	23.7	4.5
TV and radio transmitters	3220	17.8	3.3
Special purpose machinery	2929	15.0	2.8
Parts for motor vehicles	3430	13.2	2.5
Manufactured non-ferrous metals	2720	13.1	2.5
Electrical equipment	3190	12.1	2.3
Electricity distributing apparatus	3120	11.2	2.1
Manufactured iron and steel	2710	11.1	2.1
Chemical products	2429	10.0	1.9
Refined petroleum products	2320	9.4	1.8
Plastics products	2520	9.0	1.7
Instruments for measuring	3312	7.2	1.4
TV and radio receivers	3230	6.4	1.2
Motor vehicles	3410	6.1	1.2
Machinetools	2922	5.9	1.1
Rubber products	2519	5.8	1.1
Electric motors and generators	3110	5.0	0.9
Non-metallic minerals	2699	4.8	0.9
Vegetable and animal oils and fats	1514	4.8	0.9
Pumps, taps, and valves	2912	4.6	0.9
Non-ferrous metal ores	1320	3.8	0.7
Fabricated metal products	2899	3.8	0.7
Prepared textile fibers; fabrics	1711	3.6	0.7
General purpose machinery	2919	3.5	0.7
Crude petroleum and natural gas	1110	3.3	0.6

PRC = People's Republic of China, ISIC = International Standard Industrial Classification.

Source: CEPII–CHELEM database.

Table 11.4b: ASEAN-5's Exports to the PRC in 2015

Product Category	ISIC Classification Number	Exports ($ billion)	% of Total Exports to the PRC
Electronic valves and tubes	3210	50.9	32.8
Office and computing machinery	3000	13.4	8.6
Plastics and synthetic rubber	2413	8.1	5.2
Basic chemicals, excluding fertilizer	2411	7.6	4.9
Other rubber products	2519	4.9	3.2
Vegetable and animal oils and fats	1514	4.8	3.1
TV and radio transmitters	3220	4.0	2.6
Non-metallic minerals	2699	4.0	2.6
Refined petroleum products	2320	3.8	2.4
Non-ferrous metal ores	1320	3.7	2.4
Crude petroleum and natural gas	1110	3.3	2.2
Manufactured basic non-ferrous metals	2720	3.3	2.1
Hard coal	1010	2.4	1.6
Chemical products	2429	2.4	1.5
Cereals and other crops	111	2.0	1.3
Optical instruments and photo equipment	3320	2.0	1.3
Lignite	1020	1.9	1.2
Fruit, beverage, and spice crops	113	1.7	1.1
Instruments for measuring	3312	1.7	1.1
Sawmilled and planed woods	2010	1.5	1.0
Electricity distributing apparatus	3120	1.4	0.9
Pulp, paper, and paperboard	2101	1.4	0.9
Electric motors and generators	3110	1.4	0.9
Other electrical equipment	3190	1.3	0.8
Jewelry and related articles	3691	1.2	0.8
TV and radio receivers	3230	1.1	0.7
Medical and surgical equipment	3311	0.9	0.6

PRC = People's Republic of China, ISIC = International Standard Industrial Classification.

Source: CEPII–CHELEM database.

Table 11.4c: Japan's Exports to the PRC in 2015

Product Category	ISIC Classification Number	Exports ($ billion)	% of Total Exports to the PRC
Electronic valves and tubes	3210	15.0	12.0
Special purpose machinery	2929	7.1	5.7
Basic chemicals, excluding fertilizer	2411	6.9	5.5
Optical instruments and photo equipment	3320	6.7	5.4
Parts for motor vehicles	3430	6.1	4.9
Manufactured basic iron and steel	2710	6.0	4.8
Motor vehicles	3410	4.9	4.0
Plastics and synthetic rubber	2413	4.7	3.8
Manufactured basic non-ferrous metals	2720	4.7	3.8
Electricity distributing apparatus	3120	4.7	3.7
TV and radio transmitters	3220	3.9	3.1
Plastics products	2520	3.6	2.9
Other chemical products	2429	3.3	2.6
Office and computing machinery	3000	3.1	2.5
Machine-tools	2922	3.1	2.5
Instruments for measuring	3312	3.0	2.4
Pumps, taps, and valves	2912	2.5	2.0
Electric motors and generators	3110	2.1	1.7
Electrical equipment	3190	2.0	1.6
Bearings, gears	2913	1.8	1.4
TV and radio receivers	3230	1.5	1.2
Fabricated metal prod.	2899	1.4	1.1
General purpose machinery	2919	1.3	1.1
Articles of paper and paperboard	2109	1.2	1.0
Medical and surgical equipment	3311	1.1	0.9
Prepared textile fibers; fabrics	1711	1.0	0.8
Pulp, paper, and paperboard	2101	1.0	0.8
Accumulators and primary cells	3140	0.9	0.7

PRC = People's Republic of China, ISIC = International Standard Industrial Classification.

Source: CEPII–CHELEM database.

Table 11.4d: Republic of Korea's Exports to the PRC in 2015

Product Category	ISIC Classification Number	Exports ($ billion)	% of Total Exports to the PRC
Electronic valves and tubes	3210	40.4	26.2
Optical instruments and photo equipment	3320	17.6	11.4
Basic chemicals, excluding fertilizer	2411	12.0	7.8
Plastics and synthetic rubber	2413	7.7	5.0
TV and radio transmitters	3220	7.7	5.0
Electrical equipment	3190	6.9	4.5
Parts for motor vehicles	3430	6.2	4.0
Special purpose machinery	2929	5.5	3.6
Office and computing machinery	3000	5.0	3.2
Refined petroleum products	2320	4.5	2.9
Electricity distributing apparatus	3120	4.2	2.7
Manufactured iron and steel	2710	3.4	2.2
Plastics products	2520	3.0	2.0
Manufactured non-ferrous metals	2720	2.6	1.7
TV and radio receivers	3230	2.4	1.6
Instruments for measuring	3312	1.8	1.1
Accumulators and primary cells	3140	1.6	1.1
Chemical products	2429	1.6	1.0
Soap and detergents, perfumes	2424	1.4	0.9
Pumps, taps, and valves	2912	1.1	0.9
General purpose machinery	2919	1.0	0.7
Motor vehicles	3410	1.0	0.7
Fabricated metal prod.	2899	1.0	0.6
Machine-tools	2922	1.0	0.6
Electric motors and generators	3110	0.9	0.6
Prepared textiles fibers; fabrics	1711	0.9	0.6
Paints and printing ink	2422	0.7	0.5

PRC = People's Republic of China, ISIC = International Standard Industrial Classification.

Source: CEPII–CHELEM database.

Table 11.4e: Taipei,China's Exports to the PRC in 2015

Product Category	ISIC Classification Number	Exports ($ billion)	% of Total Exports to the PRC
Electronic valves and tubes	3210	41.3	42.2
Optical instruments and photo equipment	3320	10.2	10.4
Plastics and synthetic rubber	2413	6.1	6.3
Basic chemicals, excluding fertilizer	2411	6.0	6.2
Chemical products	2429	2.8	2.8
Manufactured non-ferrous metals	2720	2.6	2.6
Office and computing machinery	3000	2.2	2.3
TV and radio transmitters	3220	2.2	2.2
Electrical equipment	3190	1.9	2.0
Plastics products	2520	1.8	1.8
Special purpose machinery	2929	1.7	1.7
Machine-tools	2922	1.6	1.6
TV and radio receivers	3230	1.4	1.5
Manufactured iron and steel	2710	1.3	1.3
Glass and glass products	2610	1.0	1.0
Prepared textile fibers; fabrics	1711	1.0	1.0
Electricity distributing apparatus	3120	1.0	1.0
Instruments for measuring	3312	0.8	0.8
Fabricated metal prod.	2899	0.8	0.8
Electric motors and generators	3110	0.6	0.6
Textiles	1729	0.6	0.6
Bearings, gears	2913	0.6	0.6
Paints and printing ink	2422	0.5	0.5
General purpose machinery	2919	0.5	0.5
Knitted fabrics and articles	1730	0.5	0.5
Refined petroleum products	2320	0.5	0.5
Building and repairing of ships	3511	0.4	0.4
Man-made fibers	2430	0.4	0.4
Pumps, taps, and valves	2912	0.4	0.4

PRC = People's Republic of China, ISIC = International Standard Industrial Classification.

Source: CEPII–CHELEM database.

Data on total electronics exports from countries importing ep&c can also be obtained from the CEPII–CHELEM database. These can be deflated using the electronics goods deflator constructed by Thorbecke (2016) with data from the US Bureau of Labor Statistics. Data on real exchange rates and real GDP in the importing country are also available from the CEPII–CHELEM database. Finally, data on non-electronics exports from countries importing ep&c can be obtained from the CEPII–CHELEM database. These data are also measured in US dollars and can be deflated using the US consumer price index.

Results from panel unit root tests and Kao (1999) cointegration tests indicate that there is a cointegrating relation between the variables. The equation can thus be estimated using panel dynamic OLS, a technique for estimating cointegrating models.

Table 11.5 presents the results. The coefficient on electronics exports is statistically significant at the 1% level and equal to at least 0.6 in every case. This implies that a 10% increase in ep&c imports is associated with a 6% increase in electronics exports. By contrast, the GDP elasticity is small and only marginally significant and the coefficient on the exchange rate takes on the wrong sign in three of the four cases and the coefficient on non-electronics exports takes on the wrong sign in every case. There is thus a tight relationship between the import of ep&c and the subsequent re-export of electronics goods and a tenuous relationship between ep&c imports and variables such as GDP and the exchange rate that are related to domestic demand.

These findings indicate that ep&c exports within East Asian supply chains are largely used to produce electronics goods for re-export to the rest of the world. This implies that the high level of ep&c exports from East Asia to the PRC does not reflect exposure to PRC demand as much as it does exposure to demand for final electronics goods in the rest of the world.

Table 11.5: Dynamic OLS estimates for Electronic Parts and Components Imports into East Asian Supply Chain Economies, 2001–2014

	(1)	(2)	(3)	(4)
Electronics Exports	0.68*** (0.05)	0.64*** (0.07)	0.87*** (0.06)	0.60*** (0.09)
GDP	0.20* (0.12)	0.48 (0.38)	0.31** (0.12)	0.90* (0.46)
Real Exchange Rate	–0.02 (0.08)	–0.18 (0.12)	0.15 (0.09)	–0.14 (0.13)
Non-electronics Exports			–0.36*** (0.08)	–0.10 (0.13)
Fixed Effects Included	Yes	Yes	Yes	Yes
Time Trend Included	No	Yes	No	Yes
Number of Observations	78	78	78	78
Adjusted *R*-squared	0.995	0.997	0.996	0.997

GDP = gross domestic product, OLS = ordinary least squares.

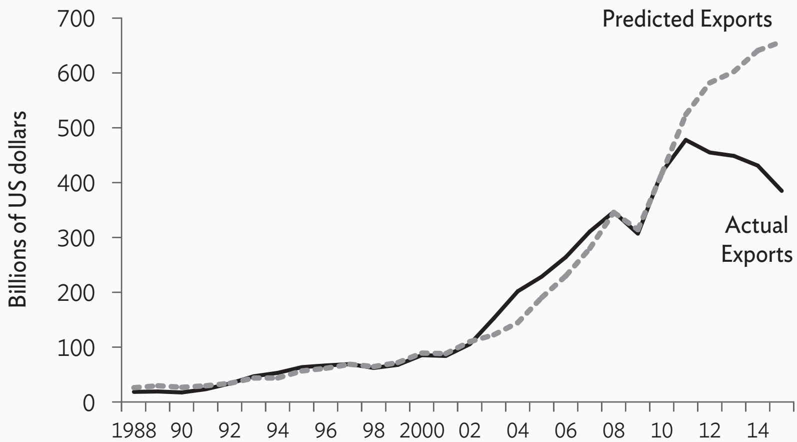
Notes: The importing economies are the PRC; Malaysia; the Philippines; the Republic of Korea; Taipei,China; and Thailand. The dependent variable is electronic parts and components into each economy from the world, deflated using a price deflator for electronic parts and components obtained from the Bureau of Labor Statistics. Electronics exports represent all electronics goods. They are deflated using a price deflator obtained from Thorbecke (2016b).The lag length for each cross-section is selected based on the Schwarz Criterion. Standard errors are calculated using the Bartlett Kernel and the Newey–West fixed bandwidth method.

(***) [*] denotes significance at the (1%) [10%] level.

Sources: CEPII–CHELEM database, Bureau of Labor Statistics, and calculations by the author.

To better gauge the exposure of East Asian economies to the PRC economy, we can estimate a gravity model excluding ep&c trade. The model again performs well, and detailed results are available on request. Figure 11.3 shows actual and predicted exports from East Asia to the PRC excluding ep&c exports. The decoupling after 2011 is even more extreme in this case.

Figure 11.3: Actual and Predicted Exports (excluding electronic parts and components) from East Asia to the PRC



PRC = People's Republic of China, US = United States.

Note: Predicted exports are calculated from a gravity model, including exports of all goods except electronic parts and components between 31 economies over the 1988–2015 period. East Asia includes Indonesia; Japan; the Republic of Korea; Malaysia; the Philippines; Singapore; Taipei,China; and Thailand.

Electronic parts and components come from the International Standard Industrial Classification category 3210.

Source: CEPII–CHELEM database, World Trade Organization, and calculations by the author.

11.4 The People's Republic of China's Exports to the World

If the PRC's growth slows, it may seek to increase its exports (see Pettis 2016). This could cause dislocation in areas that already import disproportionate amounts from the PRC.

The gravity model estimated in Section 11.2 can be used to measure the PRC's predicted exports. The results are presented in Table 11.6. The table indicates that the value of the PRC's exports to the North American Free Trade Agreement countries (Canada, Mexico, and the US) in 2015 was $249 billion or 79% more than the model predicts. Its exports to the European Union countries were $88 billion

Table 11.6: People's Republic of China's Actual and Predicted Exports to 30 Economies in 2015

(1) Economy	(2) Actual Exports ($ billion)	(3) Predicted Exports ($ billion)	(4) Actual–Predicted Exports ($ billion)
US	445.7	268.5	177.2
Mexico	64.9	18.3	46.5
Germany	90.3	61.2	29.1
Canada	51.4	26.5	24.9
Brazil	34.8	15.7	19.1
UK	54.0	39.4	14.6
France	46.2	32.5	13.6
Poland	21.6	9.6	12.0
Netherlands	33.7	21.7	12.0
Australia	42.0	31.5	10.5
Turkey	21.5	11.9	9.7
Spain	23.0	18.7	4.4
Saudi	27.5	23.3	4.1
Italy	26.7	24.1	2.6
Norway	7.1	5.2	1.8
Austria	7.5	5.8	1.7
Denmark	5.4	4.6	0.8
Ireland	4.2	4.9	–0.7
Finland	3.8	4.6	–0.8
Sweden	6.0	9.3	–3.3
Japan	153.8	157.5	–3.8
Indonesia	37.3	45.4	–8.1
India	69.3	80.2	–10.9
Philippines	29.4	41.9	–12.6
Thailand	46.8	67.0	–20.3
Switzerland	11.4	40.0	–28.7
Malaysia	49.9	81.6	–31.7
Taipei,China	42.4	102.0	–59.6
Singapore	23.1	101.9	–78.8
Republic of Korea	86.1	313.3	–227.2

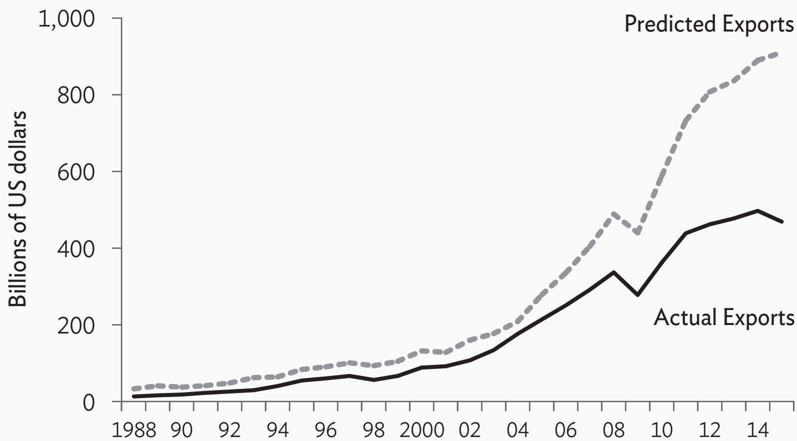
UK = United Kingdom, US = United States.

Note: Predicted exports are calculated from a gravity model including exports between 31 economies over the 1988–2015 period.

Sources: CEPII–CHELEM database, World Trade Organization, and calculations by the author.

or 36% more than the model predicts. By contrast, the PRC's exports to East Asia were $442 billion or 49% less than predicted. Figure 11.4 shows that the gap between the PRC's predicted and actual exports to East Asia has widened steadily between 2005 and 2015.

Figure 11.4: Actual and Predicted Exports from the PRC to East Asia



PRC = People's Republic of China, US = United States.

Notes: Predicted exports are calculated from a gravity model, including exports of all goods between 31 economies over the 1988–2015 period. East Asia includes Indonesia; Japan; the Republic of Korea; Malaysia; the Philippines; Singapore; Taipei,China; and Thailand.

Sources: CEPII–CHELEM database, World Trade Organization, and calculations by the author.

Since East Asia sends parts and components to the PRC and since the PRC disproportionately sends final goods to the West, both the PRC and its Asian neighbors are exposed to market disruptions in the US and Europe. Several researchers have reported that import penetration from the PRC has led to "stunning" job losses in the West and to pressures for protectionism and extremist policies (see, e.g., Acemoglu et al. 2014; Autor et al. 2016; and Colantone and Stanig 2017). Further import penetration in response to a slowdown in the PRC could lead to protectionism in the West. Exports from East Asia to the US and Europe are also exposed to recessions, exchange rate changes, taste changes, and other factors.

Figures 11.2 through 11.4 indicate that East Asia's exports to the PRC and the PRC's exports to East Asia are far less than expected. This is true *a fortiori* when considering final goods. Although not shown in the figures, trade between East Asian countries is also far less than predicted. To guard against restricted market access in the West and to nurture another engine of growth, policy makers should promote intra-Asian trade in consumption goods.

Table 11.3c shows that one-quarter of Germany's exports to the PRC are either automobiles or parts for automobiles to be assembled in the PRC. Many of Germany's automobile exports to the PRC are high-end goods consumed by wealthy consumers. As is well known, higher-income individuals have lower marginal propensities to consume. To increase consumption and consumption imports in East Asia, it would be helpful to increase the ranks of the middle class.

This is a long-run goal. It could be promoted by investing in the health and education of citizens beginning at a young age. Rozelle (2010) documented that most rural children in the PRC cannot afford preschool, and that health problems, bad sanitation, and inadequate nutrition restrict students' ability to learn. He documented that students suffered from anemia, vitamin deficiencies, and visual difficulties. He also documented that these problems could be fixed inexpensively. Rozelle also reported that rural high schools and colleges were prohibitively expensive for many families.

Investing in human capital in ASEAN would help workers in these countries to advance from labor-intensive operations to higher-value-added activities such as engineering and design. To achieve this, it is necessary for children to receive adequate nutrition, healthcare, and primary education. It is also desirable that high school students receive high-quality education in science and math, and that university students receive scientific and engineering training.

The educational system should focus on providing students with marketable skills that businesses need. As the World Bank (2013) discussed, this is not just the government's job. Employers, schools, universities, students, and parents need to work together to ensure that students acquire marketable skills. The government should not manage education using a central, top-down approach. Instead, it should help the key stakeholders to make good decisions by facilitating the flow of information, providing good incentives to schools, and investing in capacity building.

Structural factors such as tariffs on consumption imports can also restrict the flow of final good to Asian consumers. The Regional Comprehensive Economic Partnership (RCEP) among 16 East Asian economies, if ratified, could remove protectionist obstacles. The RCEP could also be designed to reduce the development gap among Asian economies.

Targeting consumers in Asia requires long-term investments by firms. To give them confidence to undertake these expenditures, it is important that governments in Asia refrain from arbitrary interferences with trade flows for political reasons.

Exchange rate appreciations would also increase the purchasing power of Asian consumers and allow them to buy more from abroad. However, because Asian countries compete fiercely in exporting final goods to North America, no country would want its currency to appreciate unilaterally against the US dollar. There may thus be room for coordination to allow Asian currencies to appreciate together against the dollar. Such a joint appreciation would help to redirect final goods away from North America and to East Asia.

11.5 Conclusion

This chapter has investigated how a slowdown in the PRC's growth would affect trading partners through the trade channel. To do this it uses a gravity model and data up to 2015 to investigate what countries export more or less than one would expect to the PRC. The results indicate that Australia exported five times more than predicted and Brazil four times more. Australia's exports to the PRC equaled 3.5% of Australia's GDP and Brazil's exports equaled 2% of Brazil's GDP. A large decrease in exports to the PRC could thus cause a noticeable decrease in growth. Since much of Australia and Brazil's exports to the PRC were iron ore, coal, and metals that are used to build housing and infrastructure, a slowdown in the PRC's investment in these areas could significantly affect growth in Australia and Brazil.

Germany's exports to the PRC in 2015 were $21 billion more than predicted. Germany's exports to the PRC were 2% of GDP. Many of Germany's exports were sophisticated consumer and capital goods. The PRC's crackdown on corruption has reduced imports of luxury consumption goods (see Qian and Wen 2015). This may be reducing Germany's consumption exports to the PRC. The PRC is also developing the ability to manufacture more sophisticated goods such as industrial robots domestically.[3] This may reduce the PRC's demand for capital goods from Germany. Thus, Germany should be ready for a reduction in demand from the PRC.

A notable finding in this chapter is that the PRC's exports to East Asia, East Asia's exports to the PRC, and intra-East Asian exports in general are much less than predicted. This is even more true when electronic parts and components, which are used largely to produce goods for re-exports, are removed from the model.

These findings imply that there is a lot of room to increase intra-Asian trade in consumption goods. Thorbecke (2011) found that consumption imports into Asian economies depend strongly on GDP in the importing countries and on real exchange rates. Promoting growth and development in the region would thus allow Asian consumers to purchase more imported goods. Also, as the PRC; the Republic of

3 The PRC's exports of ISIC category 2929 that includes industrial robots and semi-conductor manufacturing machines have increased by $5 billion between 2011 and 2015, while its imports of these goods have fallen by $10 billion over this period.

Korea; Japan; Singapore; Taipei,China; and other economies involved in the electronics supply chain run significant trade and current account surpluses year after year, it would be desirable for their currencies to appreciate against the US dollar. This would increase the purchasing power of Asia's consumers and help to correct the imbalances in the PRC's exports that are evident in Table 11.2.

World trade is at a crossroads. Disproportionate exports from the PRC to the US are fostering protectionist pressures. East Asian economies still generally favor freer trade. They should redouble efforts to implement a regional FTA that would reduce tariffs and other protectionist obstacles to consumption goods imports. They should also make their long-run goal not to maintain high or miraculous rates of GDP growth, but to improve living standards and consumption for the great mass of citizens in Asia.

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CHAPTER 12

Estimating the Impact of Slower People's Republic of China Growth on the Asia and the Pacific Region: A Global Vector Autoregression Model Approach

Tomoo Inoue, Demet Kaya, and Hitoshi Ohshige

12.1 Introduction

Led by the People's Republic of China (PRC), the Asia and the Pacific countries' trade volume rose 18 times over the period 1990–2014, more than that of any other regional country group.[1] The export-oriented development strategy brought the Asia and the Pacific region economic success through rapid growth, making it the fastest growing region and the world's growth engine. However, increased integration and dependence on exports have also made the region more vulnerable to external and internal shocks.

Since 2008, due to slower growth in the United States (US) and the eurozone sovereign debt crisis and its aftermath, the advanced economies' demand for Asia and the Pacific exports has showed slow growth. Nevertheless, thanks to continuing strong demand from the PRC, export growth of other Asia and the Pacific countries' (Asia henceforth) remained relatively robust. Asian exports to the PRC doubled between 2010 and 2015, and the PRC became the largest market for Asia after surpassing Japan in 2005 and the US in 2007.

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1 The Asia and the Pacific countries in this chapter are defined by the 10 largest countries in the Asia and the Pacific region in terms of GDP, i.e., ASEAN-4 (Indonesia, Malaysia, the Philippines, and Thailand), Australia, the PRC, India, Japan, the Republic of Korea, and New Zealand.

As the PRC became the focal point of Asian supply chains, its demand has been supporting the region's production of goods ranging from raw materials to electronic components.[2] Despite the recent recovery of US growth, the advanced economies' overall growth expectations remain subdued. Therefore, the PRC's continuing role of supporting other Asian economies remains critical. However, the PRC's economy has been slowing down since 2010 after the rapid growth rates exceeding 10% over the past several decades. Real gross domestic product (GDP) growth in 2016 was 6.7%, which was the weakest in 26 years. Further slowdown is possible, with some projections showing the PRC's growth rate dropping to about 6% by the end of the decade.

Reflecting these developments, the aim of this chapter is to examine and quantify the impact of a negative PRC GDP shock on Asian economies by employing the Global Vector Autoregression (GVAR) model developed by Pesaran, Schuermann, and Weiner (2004), and Dees, di Mauro, Pesaran, and Smith (2007). Using the GVAR model, we examine how and to what extent PRC economic growth affects other Asian countries. The transmission mechanisms of this slowdown are no doubt diverse, but in this chapter we focus on shocks to the real economy via trade linkages. For simplicity, the original GVAR model assumes fixed trade weights for the sample period. However, taking into account the recent rapid expansion of PRC trade volume, the fixed weight assumption is probably not appropriate. Therefore, following Cesa–Bianchi et al. (2011), we construct a model with time-varying trade weights. After estimating the GVAR model, we calculate a set of generalized impulse response functions (GIRFs) for four different timings[3] with different trade weights, and investigate the changes of the shock propagation mechanism from the PRC to other Asian countries.[4]

2 The PRC's "export powerhouse" role undeniably contributed to other regions' growth particularly those of the commodity exporters in Latin America and Africa; however, this chapter will only focus on the PRC's linkages to Asia.

3 As we discuss below, the PRC's membership of the World Trade Organization in 2001 dramatically altered the outlook of global trade. Thus, we have investigated the effect of the PRC at years 1985, 1995, 2005, and 2013. Two of them are before joining, and two others are after joining the World Trade Organization.

4 The focus of Cesa–Bianchi, Pesaran, Rebucci, and Xu (2011) was to investigate the effect of the PRC economy on the Latin American countries.

As far as we know, Han and Ng (2011) is the first study that analyzes Asian economies using the GVAR methodology; however, its focus was on evaluating macroeconomic forecasts for the original Association of Southeast Asian Nations (ASEAN) economies. Matsubayashi (2013) examined the impact of the financial crisis in the US and eurozone on the East Asian countries using GVAR with a time-varying weight matrix. In light of the structural changes in world trade from around 1995, Matsubayashi also estimated the GVAR model using a sample up to 1994Q4, and compared its impulse response functions (IRFs) with the ones obtained from the entire sample period. Matsubayashi found that the impact of the US and the eurozone on Asian countries, especially the PRC, became larger from the second half of the 1990s, reflecting the stronger trade linkages between the PRC, the US, and the eurozone.

Several recent studies examined the impact of a PRC slowdown employing various techniques. The International Monetary Fund's China Country Report (2011)[5] analyzed the spillover effects of domestic policies in the PRC. Based on Chen et al. (2010),[6] the report assessed how the worsening credit quality of PRC corporates and banks negatively affects the rest of the world by using the GVAR. Ahuja and Nabar (2012), and Ahuja and Myrvoda (2012) are other examples. They investigated the impact of two different sources of the PRC's slowdown: one emanating from the real estate investment slowdown, and the other from a slowdown in investment spending (as a component of GDP). Duval et al. (2014) examined the relationship between trade integration and business cycle synchronization, and reported how the PRC's growth shocks affected the real GDP growth of other countries.

These papers are different from ours in several respects. First, their sample period is shorter. Chen et al. (2010) used monthly data for the period January 1996 to December 2008, Duval et al. (2014) used 1995Q1–2012Q4, and Ahuja and Nabar (2012), and Ahuja and Myrvoda (2012) used January 2000 to September 2011. Our dataset

5 URL is http://www.imf.org/external/pubs/ft/scr/2011/cr11193.pdf.
6 URL is https://www.imf.org/external/pubs/ft/wp/2010/wp10124.pdf.

ranges from 1979Q1 to 2014Q3, thus covering more than 3 decades when the size of the PRC economy and its regional and global influence expanded greatly. The second difference concerns the measurement of country linkages. Duval et al. (2014), for instance, reported the importance of using value-added trade data for measuring trade integration. On the other hand, Chen et al. (2010) used financial weights and trade weights to construct foreign variables. However, due to limited data, they used fixed weights for both financial and trade linkages. Reflecting the lack of historical time series data, as reported by previous researchers, and following the tradition of GVAR literature by Pesaran and others, we decided to use gross trade flow data. Thirdly, except for Chen et al. (2010), the models are different: Ahuja and Nabar (2012), and Ahuja and Myrvoda (2012) used the factor-augmented vector autoregressive (FAVAR) model, and Duval et al. (2014) used a reduced-form panel regression model. We used the GVAR specification because it imposes an intuitive structure on cross-country linkages (Chudik and Pesaran 2014), and also allows us to measure the responses of major macroeconomic variables.

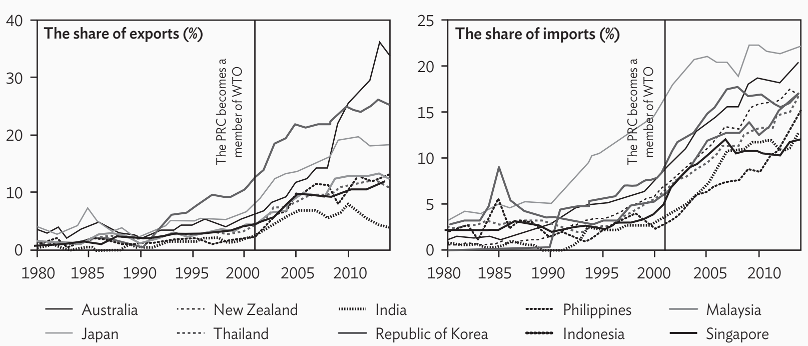
Our results confirm that the impact of a negative shock to PRC real GDP on the Asian countries has significantly increased under the recent trade structures of 2005 and 2013 compared to the earlier trade structures of 1985 and 1995. This confirms the common perception of Asia's increased dependency on the PRC. The GIRFs are significantly negative with the exception of the Philippines and New Zealand. All remaining Asian countries are negatively impacted by a real GDP shock to the PRC economy at the 68% confidence interval. A PRC slowdown also curbs its demand for commodities, and we investigated whether this translates into commodity price drops. Our GIRFs show that a negative shock to PRC real GDP not only reduces crude oil prices, as some previous studies have shown, but also metals' and agricultural prices.

The rest of the chapter is organized as follows. In Section 12.2 we analyze the historical transition of the PRC trade volume using trade data. In Section 12.3 we explain the standard GVAR model following past studies, and introduce several modifications, such as time-varying trade weights, an increased number of commodities, and inclusion of the “shift intercept” dummy variables to control for outliers. In Section 12.4 we estimate the model. In Section 12.5 we calculate the GIRFs, and investigate the effect of a PRC economic shock on other Asian countries by comparing the shapes of the GIRFs with various settings. Section 12.6 summarizes our conclusions.

12.2 The Transition of the People’s Republic of China’s Trade Shares

The PRC’s accession to the World Trade Organization in 2001 dramatically altered the outlook for global trade and became a turning point for the country’s economic development. The left panel of Figure 12.1 shows how the share of exports of Asian countries to the PRC evolved over the past several decades. We observe a significant jump from 2001: particularly, exports of Australia, Japan, and the Republic of Korea to the PRC have expanded more than three-fold. Likewise, the Asian countries’ imports from the PRC have been rising considerably in recent years (see the right panel of Figure 12.1). In particular, Australia, Japan, the Republic of Korea, Malaysia, and the Philippines saw the largest rises in their imports from the PRC.

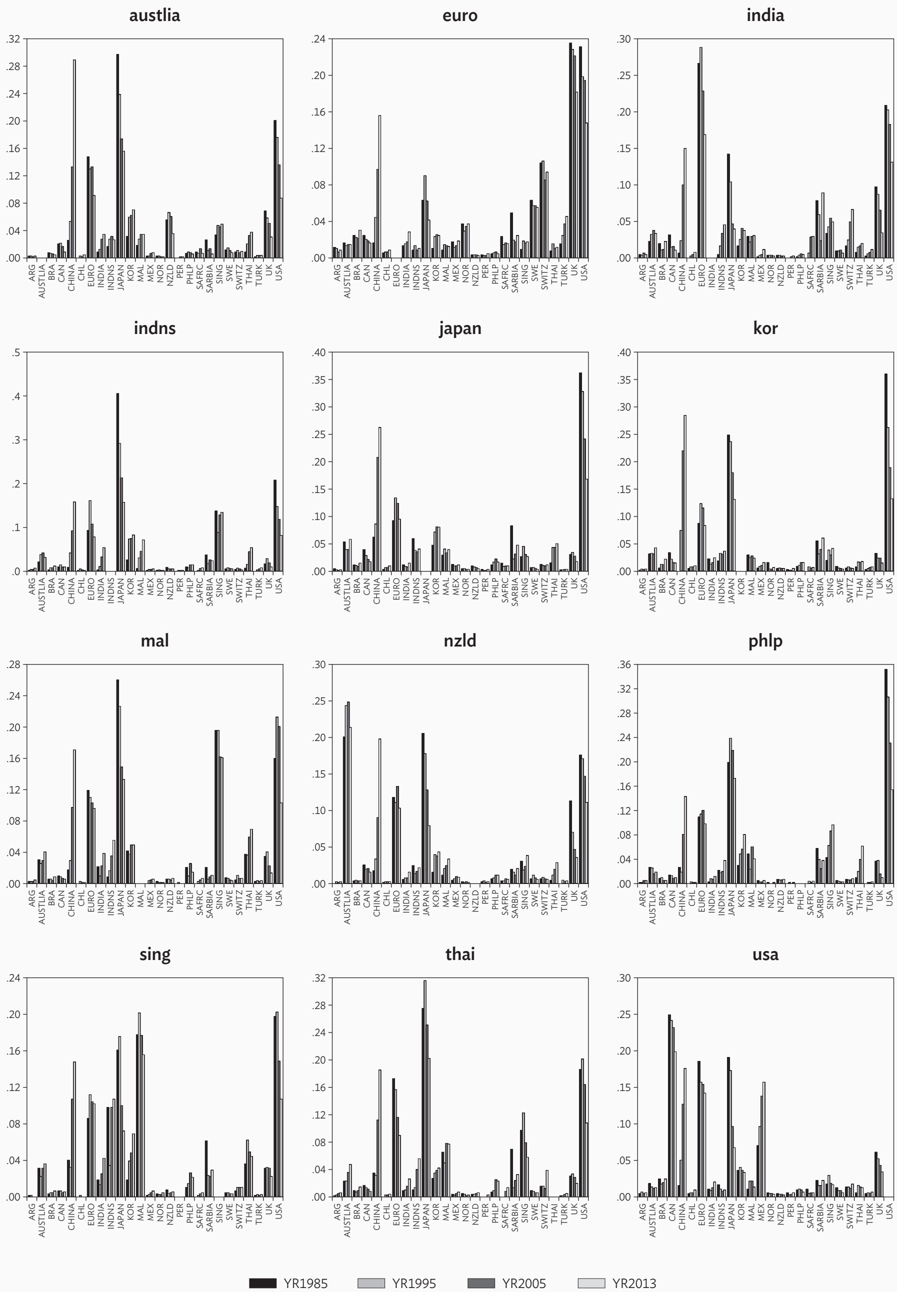
Figure 12.1: Trade Links between the PRC, Asia, and the World



PRC = People’s Republic of China, WTO = World Trade Organization.

Sources: IMF Direction of Trade Statistics; authors’ calculation.

Figure 12.2: Trade Weights of 1985, 1995, 2005, and 2013 for 12 Sample Countries



Note: Please refer to Table 12A in the Appendix for a glossary of acronyms.

Sources: IMF Direction of Trade Statistics; authors' calculation.

The PRC's share of world trade rose from about 4% in 2000 to around 11% in 2013. Figure 12.2 shows the evolution of trade shares of each country in 1985, 1995, 2005, and 2013. While the US, Japan, and eurozone countries have seen a decline in their share of trade in the global economy, the PRC's trade share has risen in recent years. The PRC is now the largest trading nation in the world after surpassing the US, and is the largest trading partner for 35 countries across the globe. In our sample of nine Asian countries, the PRC is the largest trading partner of seven countries (Australia, India, Japan, the Republic of Korea, Malaysia, New Zealand, and Thailand), the second largest trading partner of Indonesia, and the third largest of the Philippines.

In the next section, we explain the GVAR methodology. As we just reviewed above, the PRC's trade linkages drastically changed shortly after the PRC joined the World Trade Organization in December 2001. Thus, we expect that the magnitudes of shock propagations from the PRC to the global economy before and after the year 2001 to be quite different. Given these changes, we introduce several modifications to analyze the PRC's economic impact on Asian countries.

12.3 The GVAR Model

Our main goal is to measure the impact of the PRC's economic slowdown and, to do so, we assume a scenario where the PRC's real economic growth slows by one percentage point.

To quantify this change we use a novel time-series technique: the GVAR model, which was developed by Pesaran, Schuermann, and Weiner (2004), Dees, di Mauro, Pesaran, and Smith (2007), and Dees, Holly, Pesaran, and Smith (2007). Due to its flexibility, the GVAR model has been applied to various fields such as macroeconomics (Dees, di Mauro, Pesaran, and Smith 2007), industrial sectors (Hiebert and Vansteenkiste 2010), bond markets (Favero 2013), real estate markets (Vansteenkiste 2007), fiscal imbalance on borrowing costs (Caporale and Girardi 2013), and US credit supply shocks (Eickmeier and Ng 2015). It has also been applied to examine the financial crisis (Chudik and Fratzscher 2011), and the interactions between banking sector risk, sovereign risk, corporate sector risk, and real economic activity (Gray et al. 2013).

In the following section, we first review the structure of the standard GVAR model. Next, we explain several modifications, which are necessary to achieve our objectives.

12.3.1 Structure of the Standard GVAR Model

The standard vector autoregression (VAR) of country *i* is a stand-alone model in the sense that it specifies the inter-temporal as well as inter-variable relation among a set of country *i*'s macroeconomic variables, $\mathbf{x}_{it}$. The VAR(*p*) of country *i*, which includes *p*-th order lag of $\mathbf{x}_{it}$, is represented as follows:

$$\mathbf{x}_{it} = \mathbf{a}_{i0} + \mathbf{a}_{i1}t + \sum_{k=1}^{p} \Phi_{ik}\mathbf{x}_{i,t-k} + \mathbf{u}_{it}$$

where **a** and Φ are the coefficient vectors. A vector of country-specific shocks, $\mathbf{u}_{it}$, is assumed to be distributed serially uncorrelated with zero mean and a nonsingular covariance matrix, i.e., $\mathbf{u}_{it} \sim$ i.i.d.$(0, \Sigma_{ii})$. With this specification, all variables of $\mathbf{x}_{it}$ are assumed to be endogenous in general, thus interactively determined within its economy.

There are variables that are determined outside the country of interest. The price of crude oil, which largely reflects the demand and supply conditions in the world market, is one such example. For a small open economy, it is more likely that the oil price is exogenously determined. Thus we expand the VAR model and add such global variables, $\mathbf{d}_{it}$, as follows:

$$\mathbf{x}_{it} = \mathbf{a}_{i0} + \mathbf{a}_{i1}t + \sum_{k=1}^{p} \Phi_{ik}\mathbf{x}_{i,t-k} + \sum_{\ell=0}^{r} \gamma_{i\ell}\mathbf{d}_{i,t-\ell} + \mathbf{u}_{it}$$

A VAR model with exogenous variables is called "VARX".[7]

[7] The treatment of the oil price may vary across countries. For a large open economy, such as the US, it is plausible to assume that the oil price is determined domestically. Therefore it should be included in x_{it}.

The GVAR model consists of a set of county-by-country VAR models that includes a set of "country-specific foreign variables", which is constructed by taking the weighted average across all the countries j of the corresponding variable as follows:

$$\mathbf{x}_{it}^{*} = \sum_{j=1}^{N} \omega_{ij} \cdot \mathbf{x}_{jt} \quad (1)$$

where the weights satisfy $\omega_{ii} = 0$ and $\sum_{j=1}^{N} \omega_{ij} = 1$ for $i = 1, \ldots, N$. Since this weight represents the closeness of the economic activities between the countries, the trade share, which is constructed by using the bi-directional trade flow data, is often used.[8]

The VARX*(p,q,r) of country i, which includes p-th order lag of $\mathbf{x}_{it}$, q-th order lag of $\mathbf{x}_{it}^{*}$ and r-th order lag of $\mathbf{d}_{it}$, is represented as follows:

$$\mathbf{x}_{it} = \mathbf{a}_{i0} + \mathbf{a}_{i1} t + \sum_{k=1}^{p} \Phi_{ik} \mathbf{x}_{i,t-k} + \sum_{\ell=0}^{q} \Lambda_{i\ell} \mathbf{x}_{i,t-\ell}^{*} + \sum_{\iota=0}^{r} \Upsilon_{i\ell} \mathbf{d}_{i,t-\ell} + \mathbf{u}_{it} \quad (2)$$

where $\mathbf{a}$, Φ, Λ, and Υ are the coefficient vectors. Since this specification includes the foreign variables ("star" variables) and the global variables, both of which are assumed to be weakly exogenous, the model is called VARX*.

When we estimate the country-specific VARX*, $\mathbf{x}_{it}^{*}$ are constructed directly from the data. However, for dynamic analysis such as calculating the impulse response functions, the value of $\mathbf{x}_{it}^{*}$ is calculated internally from the forecasted values of $\{\mathbf{x}_{jt}^{*}\}$ for $i \neq j$, which are obtained by solving the system of Equations (1) and (2). This is why the GVAR model can describe the interactions of variables not only within a country but also between countries.

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8 In a strand of International Economies, the gravity equation of the international trade model suggests the cultural similarity, such as the language, the religion, and the historical background, and the physical distance are the important factors of trade flows between a pair of countries. Thus these factors can be a candidate for constructing the weight matrix. However, most of them are time-invariant. Since we are interested in the time-variation of the proximities, these cannot be used.

12.3.2 Data and a Related Specification Issue

In this chapter, following Cesa–Bianchi, Pesaran, Rebucci, and Xu (2011), we have estimated 26 country-specific VARX* models.[9] Based on the dataset obtained from Centre for Financial Analysis & Policy, Judge Business School, University of Cambridge,[10] which covers the periods from 1979Q1 to 2011Q2, we have extended the dataset up to 2014Q3 to investigate the up-to-date impact of the PRC economy on the world. The GDP of these 26 countries adds up to approximately 90% of world GDP; therefore we claim that the model covers the world economy.

The standard elements of three variables in Equation (2) in the related literature are as follows. The domestic variables, $\mathbf{x}_{it}$, include real GDP y_{it}, the inflation rate π_{it}, the real exchange rate $e_{it} - p_{it}$, the real equity prices q_{it}, the short-term interest rate ρ^S_{it}, and the long-term interest rate ρ^L_{it}. Since q_{it}, ρ^S_{it}, and ρ^L_{it}, are missing for some countries, they are included when available.[11] The foreign variables $\mathbf{x}^*_{it}$, are constructed as defined by Equation (1). As for the global variables, $\mathbf{d}_{it}$, the log of oil price index p^0_t is included in order to capture the influences from the international commodity market.[12]

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9 Since one of the economies is the eurozone, which consists of eight countries, i.e., Germany, France, Italy, Spain, the Netherlands, Belgium, Austria, and Finland, the total number of countries in our data is 33.

10 We have downloaded GVAR Data 1979Q1–2011Q2 (2011 Vintage) from "The GVAR Toolbox" website at Centre for Financial Analysis & Policy, Judge Business School, University of Cambridge. URL is http://www.cfap.jbs.cam.ac.uk/research/gvartoolbox/download.html. The most updated dataset currently available is 2013 Vintage at "Global VAR Modelling" website created by Dr. L. Vanessa Smith. URL is https://sites.google.com/site/gvarmodelling/.

11 Specifically, the definitions of the variables are as follows: $p_{it} = \ln(\mathrm{CPI}_{it})$, $q_{it} = \ln(\mathrm{EQ}_{it}/\mathrm{CPI}_{it})$, $e_{it} = \ln(\mathrm{E}_{it})$, $\rho^S_{it} = 0.25 \times \ln(1 + \mathrm{R}^S_{it})$, and $\rho^L_{it} = 0.25 \times \ln(1 + \mathrm{R}^L_{it})$, where
GDP_{it} = nominal GDP, in local currency
CPI_{it} = consumer price index; base year is 2000
EQ_{it} = nominal equity price index
E_{it} = exchange rate of country \$i\$ in terms of US dollars
R^S_{it} = short-term interest rate per year
R^L_{it} = long-term interest rate per year
y_{it} is constructed as follows: (i) calculate the real GDP by $GDP_{it}/\mathrm{CPI}_{it}$; (ii) from the 2006–2008 average of PPP-GDP, calculate the relative size of real GDPs for 2006–2008; (iii) rescale the real GDP of each country, with US GDP as a baseline; (iv) take the logarithm.

12 It is possible to include the global variables for some countries, but exclude them for the other countries. Thus we added country index "*i*" to its subscript.

The dataset contains various types of countries. Twenty-six economies are divided into two types: large open economies and small open economies.[13] The US is classified as the only large open economy. For this type, it is assumed that the foreign financial markets do not affect its economy. Also, the international commodity prices are included in the model representing its economy. See Dees, di Mauro, Pesaran, and Smith (2007) and Cesa–Bianchi et al. (2011) for similar treatment. Although the instantaneous commodity prices are only included in the US model, other countries, such as the PRC, can influence it through trade linkages but with a time lag. Thus in the US model, three commodity prices, i.e., p_t^0, p_t^M, and p_t^A are included in $\mathbf{x}_{US,t}$, and foreign financial variables, i.e., $q^*_{US,t}$, $\rho^{S*}_{US,t}$, and $\rho^{L*}_{US,t}$ are excluded from $\mathbf{x}^*_{US,t}$. This means that, for the US, the global variable $\mathbf{d}_{US,t}$ is empty.

For the rest of the sample economies, it is assumed that both the international commodity markets and the foreign financial markets influence their economies. Thus for economy *i*, three commodity prices are included in $\mathbf{d}_{it}$, and three foreign financial variables are included in $\mathbf{x}^*_{it}$.

Lastly, regarding the real exchange rate, we include $e_{it} - p_{it}$ in $\mathbf{x}_{it}$ for the remaining economies. However, conversely, it implies that the value of the US currency is determined outside the US economy, and thus $e^*_{US,t} - p^*_{US,t}$ is treated as a part of a “US-specific foreign” variable.

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[13] Treating the PRC either as small or large economy will be crucial depending on the sample period. Although the size of the PRC has rapidly grown, the US is still the biggest economy throughout our sample period. Thus, in this chapter, the US is treated as a large open economy. We appreciate Dr. Peter Morgan’s comment on this matter.

12.3.3 Several Modifications

To appropriately measure the effect of the PRC's emergence in the global economy, we introduce several modifications to the standard GVAR model. They are:

1. making the weight matrix ω_{ij} time-varying
2. adding the metal price index p_t^M and the agricultural price index p_t^A to $\mathbf{d}_{it}$
3. detecting structural breaks

Making the weight matrix time-varying

Previously, a set of "country-specific foreign variables" $\mathbf{x}_{it}^*$ was defined as Equation (1), which is constructed by using a constant weight matrix ω_{ij}. Now, it is modified as:

$$\mathbf{x}_{it}^* = \sum_{j=1}^{N} \omega_{ij}(t) * \mathbf{x}_{jt} \tag{3}$$

so that the evolving between-countries closeness is measured by a sequence of time-varying weights, which satisfies $\omega_{ij}(t) = 0$ and $\sum_{j=1}^{N} \omega_{ij}(t) = 1$ for $i = 1, \ldots, N$.

To our best knowledge, the first published application of a time-varying weight matrix was used by Cesa–Bianchi et al. (2011), who investigated the impact of the PRC's economic growth on the Latin American countries.

Since this weight represents the closeness of the economic activities between the countries, the ideal weights should properly reflect this magnitude. In the literature of GVAR, either one of two candidates is often used. One is the trade weight, which is constructed by using the bi-directional trade flow data. The other is the financial weight, which represents the flow of funds between the countries.

Table 12.1: Set of Variables Used for Country-specific VARX* Models

	non-US model ($i \neq$ US)			US model ($i =$ US)		
	Domestic x_{it}	Foreign x^*_{it}	Global d_{it}	Domestic x_{it}	Foreign x^*_{it}	Global d_{it}
real GDP	y_{it}	y^*_{it}		y_{it}	y^*_{it}	
inflation rate	π_{it}	π^*_{it}		π_{it}	π^*_{it}	
real equity price	q_{it}	q^*_{it}		q_{it}		
short-term interest rate	ρ^S_{it}	ρ^{S*}_{it}		ρ^S_{it}		
long-term interest rate	ρ^L_{it}	ρ^{L*}_{it}		ρ^L_{it}		
real exchange rate	$e_{it} - p_{it}$				$e^*_{it} - p^*_{it}$	
oil price			p^O_t	p^O_t		
metal price			p^M_t	p^M_t		
agricultural price			p^A_t	p^A_t		

GDP = gross domestic product, US = United States, VARX* model = a Vector Autoregression model with exogenous variables, including the foreign (star) variables.

Source: Authors.

As we have examined in Section 12.2, the PRC's trade linkages with the rest of the world drastically increased after it joined the World Trade Organization in 2001. Although its financial linkages are deepening, trade linkages continue to define the PRC's economic impact. Besides, the quality of data used for constructing trade weights is more reliable than that of financial weights, and these data are available from the 1980s.[14] Thus we construct $\omega_{ij}(t)$ by using the 3-year averages of bi-directional trade flow data, obtained from the International Monetary Fund's Direction of Trade Statistics.[15]

14 For more discussion, see Cesa–Bianchi et al. (2011).

15 In the GVAR literature, it is common to use moving averages to calculate the time-varying weight matrix. However, since this matrix is the key components of constructing the foreign variables, it is worth examining the more sophisticated estimation approach, such as the functional-coefficient regression model by Fan, Yao, and Cai (2003), and Cai, Chen, and Fang (2012). We thank Prof. Ying Fang for drawing our attention to this literature.

Adding two commodity price indices

In the literature, standard GVAR models are estimated with only one global variable, i.e., the crude oil price, which is the representative of commodity "energy." According to Table 12.2, which reports the shares used for calculating the World Bank's Commodity Price Index, the share of crude oil in the energy index is 84.6%. The importance and the influence of crude oil price fluctuations on the macroeconomic variables of countries, such as the US, are reported by numerous researchers. Just to name a few, Hamilton (1983, 1996, 2003), Hooker (1996), and Cunado and de Gracia (2005).

Table 12.2: Shares Used in the World Bank's Commodity Price Index, in %

Commodity	Share	Commodity	Share
Energy		**Non-energy Commodities**	
Coal	4.7	Agriculture	64.9
Crude Oil	84.6	Food	40.0
Natural Gas	10.8	Others	24.8
		Metals and Minerals	31.6
		Aluminum	8.4
Precious Metals		Copper	12.1
Gold	77.8	Iron Ore	6.0
Silver	18.9	Others	5.1
Platinum	3.3	Fertilizers	3.6

Source: World Bank, Development Prospects Group. Based on 2002–2004 developing countries' export values (24 November 2008).

Besides "energy," the World Bank publishes two more commodity price indices, i.e., "non-energy commodities" and "precious metals" (see Table 12.2); and the "non-energy commodities" group is further divided into "agriculture," "metals and minerals," and "fertilizers." The sum of "agriculture" and "metals and minerals" adds up to 96.5%. Since the PRC is a major importer of metals and agricultural products, it is worth investigating the importance of including these indices in $\mathbf{d}_{it}$, which allows us to model the multiple channels of impact propagation through the international commodity markets.

Table 12.3 summarizes the covariance analysis of three commodity prices (in log-differences). The price of oil is the most volatile and the price of agricultural products is the least volatile. In terms of the instantaneous correlation coefficients, Corr(Δp_t^M, Δp_t^A) = 0.5506 is the highest, Corr(Δp_t^M, Δp_t^O) = 0.4506 is the second highest, and Corr(Δp_t^A, Δp_t^O) = 0.3171 is the lowest. It is often reported that both metals and agricultural products require a fair amount of energy as an intermediate input. There is higher correlation between metals and oil, but this is not supported by the correlation between agriculture and oil.

Table 12.3: Covariance Analysis of Three Commodity Price Indices

Covariance/Correlation	Oil Δp_t^O	Agri Δp_t^A	Metal Δp_t^M
Oil	0.0199 *1.0000*		
Agri	0.0022 *0.3171*	0.0025 *1.0000*	
Metal	0.0061 *0.4506*	0.0026 *0.5506*	0.0091 *1.0000*

Note: p_t^k = ln(price index of commodity *k*) for *k* = *O*, *A*, *M*.

Source: Authors.

To further investigate the inter-variable relationship, a plain three-variate VAR model is estimated for Δp_t^O, Δp_t^A, Δp_t^M, and the causal relation is examined by the Granger causality test. The optimal lag length of VAR, three, is selected by AIC. Table 12.4 reports the results. The second column is the equation for "oil," where the exclusion hypothesis of "metal" is rejected at a 10% significance level. For the "agri" equation, neither "oil" nor "metal" is a significant causal variable. Lastly, for the "metal" price, there is strong Granger causality from the "agri" price. These results again contradict the view that "oil" is the foremost intermediate input, so that a hike of the oil price increases both agricultural and metal prices.

Table 12.4: VAR Granger Causality/Block Exogeneity Wald Tests

	Dependent Variable		
	Oil Δp_t^O	Agri Δp_t^A	Metal Δp_t^M
Oil		1.755	3.015
Agri	4.881		20.808***
Metal	7.479*	4.122	
All	15.155**	5.148	23.228***

VAR = Vector Autoregression.

Note: Three commodity prices are log-differenced. VAR(3) is used. ***, **, and *, represent 1%, 5%, and 10% significance levels, respectively.

Source: Authors.

Given this preliminary analysis, we are now confident that the inclusion of agricultural and metal prices provides additional information, which is not revealed by inclusion of only oil prices.

Detecting structural breaks with a difference-stationary VAR

As we formally report below, all the variables in our VARX* are the I(1) processes. Thus if they are co-integrated, the VARX* model can be transformed into a vector error correction model with exogenous variables. The previous papers in this field have mostly adopted this specification, which makes us impose any long-run relations that might exist in the economy, and which increases the efficiency of parameter estimation.

However, as our sample covers the period between 1979Q1 and 2014Q3, it includes influential events such as the Asian financial crisis in 1997, the global financial crisis in 2008, etc., which are likely to generate the structural breaks. The difficulty of detecting the structural break with the co-integrating VAR is reported by Hendry (2000). We treat the issue of structural breaks in the following manner. First, the following "difference-stationary" VAR specification is used from now on:

$$\Delta \mathbf{x}_{it} = \mathbf{a}_{i1} + \sum_{k=1}^{p-1} \tilde{\Phi}_{ik} \Delta \mathbf{x}_{i,t-k} + \sum_{\ell=0}^{q-1} \tilde{\Lambda}_{i\ell} \Delta \mathbf{x}^{*}_{i,t-\ell} + \sum_{\ell=0}^{r-1} \tilde{\Upsilon}_{i\ell} \Delta \mathbf{d}_{i,t-\ell} + \mathbf{u}_{it} \qquad (4)$$

If it is correctly specified, the vector error correction model (VECM) is preferred to the difference-stationary VAR since the former generates more efficient estimates. However, the presence of unpredictable structural breaks hinders this task. Thus, we decided not to pursue the VECM specification.

Second, we sequentially searched for one and only one significant "shift in intercept" event for each equation, which is one form of a structural break, by *t*-test. For this purpose, first, we search for the most significant intercept-shifts for each equation, by trimming the both 20% edges of the sample period. After detecting the most significant intercept-shifts, we add the intercept-shift dummy variables if and only if the intercept dummy is statistically significant at a 5% level, to the model to control the effect of possible structural breaks.

12.4 Estimation and Testing

We proceed with following analyses:
1. Testing for unit roots
2. Detecting structural breaks
3. Selecting the final specification of the model
4. Diagnostic tests

12.4.1 Testing for Unit Roots

We begin by investigating the order of integration of each variable by using the Augmented Dickey–Fuller Tests. The Akaike information criterion is used for selecting the optimal lag length. The results indicate that most of the variables in levels contain a unit root, but are stationary after a first differencing.

12.4.2 Detecting Structural Breaks

The presence of structural breaks sometimes raises questions about the validity of the estimated results. In the present case, any improper treatment of outliers might seriously bias the shape of the impulse response functions. A fully flexible treatment of structural breaks should consider such aspects as: (i) the timing of the occurrence, (ii) the number of occurrences in the sample period, and (iii) the types of changes, such as the intercept changes and/or the slope changes in the regression context. For our current application, a full-fledged treatment of structural breaks is very difficult due to the number of equations and the number of variables in each equation. Thus our proposed treatment is quite conservative. More specifically, we have adopted the following steps to detect and remove the intercept shifts.

(i) Create a set of step-indicator dummy variables for the 20% to the 80% of the sample period. Since our estimation period is 1980Q2 to 2014Q3, and the number of sample period is $T = 138$, we have created approximately 80 step-indicator dummy variables.
(ii) Estimate the parameters of the GVAR model along with a step-indicator dummy one at a time, and save the *t*-value of the step-indicator coefficient. Repeat this for all the step-indicator dummy variables.
(iii) Choose the most significant step-indicator coefficient for each equation. If the *t*-value is significant at a 5% level, then add the step-indicator dummy to the GVAR model. Otherwise, discard.

This algorithm was run equation-by-equation with all the lag combinations of p, q, and r, and seven combinations of three commodity prices. To reduce the total number of parameters, we restrict the maximum lag length of foreign variables, q, to two, and that of global variables, r, to one. Further, we restrict the maximum lag lengths of domestic variables, p, to three. The list of the detected outliers is stored, and used for selecting the final specification for each country in the next step.

12.4.3 Selecting the Final Specification of the Models

As the final step, adding the detected intercept dummy variable for each equation, we re-estimate the country-specific VARX*(p,q,r) models. Given these estimates, we search for the optimal lag lengths as well as the optimal combination of commodity prices for each country by using the Akaike Information Criterion (AIC). The results are shown in the left half of Table 12.5.

Table 12.5: Final Specification of Country-specific VARX*(*p*,*q*,*r*) Models

	Three Commodity Model					Single Commodity Model			
	Oil, Agri, and Metal					Oil only			
	p	*q*	*r*	AIC	selected	*p*	*q*	*r*	AIC
arg	3	1	1	707.4	O-M	3	1	1	706.4
austlia	3	1	1	2,887.9	O-A-M	3	1	1	2,878.3
bra	3	2	1	903.5	M	3	2	1	902.5
can	3	2	1	3,209.2	O-M	3	2	1	3,204.9
china	3	1	1	1,850.3	A	3	1	1	1,839.7
chl	3	2	1	1,577.8	O-A	3	1	1	1,564.6
euro	2	1	1	3,344.0	O-M	2	1	1	3,335.2
india	3	1	1	1,905.4	M	3	1	1	1,894.4
indns	3	1	1	1,295.4	A	3	1	1	1,285.3
japan	3	1	1	2,945.9	A-M	3	1	1	2,938.4
kor	3	2	1	2,558.9	A	3	2	1	2,553.1
mal	3	1	1	2,043.7	O-A-M	3	1	1	2,037.3
mex	3	2	1	1,366.2	O-A	3	2	1	1,364.1
nor	2	2	1	2,743.8	O-A-M	2	1	1	2,726.9
nzld	3	2	1	2,662.9	M	3	1	1	2,657.5
per	3	2	1	859.9	O-M	3	2	1	858.8
phlp	3	1	1	1,659.9	O-A	3	1	1	1,659.4
safrc	2	1	1	2,650.3	O-A	2	1	1	2,639.9
sarbia	2	1	1	1,443.1	O-A-M	2	1	1	1,441.8
sing	2	1	1	2,100.5	O-A	2	1	1	2,089.9
swe	3	1	1	2,826.8	O-A-M	3	1	1	2,810.3
switz	3	2	1	3,120.8	O-A	3	2	1	3,112.2
thai	2	1	1	1,735.0	O-A	2	1	1	1,729.3
turk	3	2	1	1,216.8	A	3	2	1	1,214.6
uk	2	1	1	3,128.2	O-M	2	2	1	3,120.7
usa	3	1	na	3,230.6	O-A-M	3	1	na	2,817.1

AIC = Akaike Information Criterion, VARX model = a Vector Autoregression model with exogenous variables.

Note: Please refer to Table 12A in the Appendix for a glossary of acronyms. The specification used is Equation (4), where *p* = lag length of domestic variables (maximum lag is three), *q* = lag length of foreign variables (maximum lag is two), and *r* = lag length of global variables (maximum lag is one). AIC = log *L* – (number of parameters). Each model includes at most one automatically detected intercept-shift dummy, at the significance level of 5%. A column labelled "selected" reports the set of commodity prices included in the final version of VARX* models, where O, A, and M means the oil, agriculture, and metal prices, respectively. For the US, the commodity prices are treated as its endogenous variables, thus the value of r is not available (na).

Source: Authors.

12.4.4 Diagnostic Tests

The country-specific VARX*, Equation (4), includes the contemporaneous values of $\mathbf{x}^*_{it}$ and $\mathbf{d}_{it}$, on its right-hand side. We investigate two issues relating to them in this subsection. One is about the weak dependence of the idiosyncratic shocks, which is a key assumption for the estimation of Equation (4). The second issue concerns the contemporaneous impact of foreign variables on the domestic counterparts.

In the GVAR literature, it is a common practice that in the country-specific VARX* models, i.e., Equation (4), the equations of $\mathbf{x}_{it}$ are estimated on a country-by-country basis. As listed in Table 12.1, the commodity prices $\mathbf{d}_{it}$ are part of $\mathbf{x}^*_{US,t}$, even though they are treated as exogenous in the small open economies. Thus, Equation (4) specifies dynamics of the domestic variables $\mathbf{x}_{it}$ as well as the commodity prices $\mathbf{d}_{it}$. On the other hand, the dynamics of $\mathbf{x}^*_{it}$ are not estimated, but defined by Equation (3). Practically, this enables us to reduce the number of parameters significantly, and allows us to construct the world model.

Three justifications for this estimation procedure are given by Pesaran, Schuermann, and Weiner (2004). They are: (i) stability of the system; (ii) smallness of weights ω_{ij}; and (iii) the weak dependence of the idiosyncratic shocks.[16] Here, we examine the weak dependence of the idiosyncratic shocks. Table 12.6 reports the average pair-wise cross-section correlations for the levels and first differences of $\mathbf{x}_{it}$, as well as the associated VARX* residuals.

Generally speaking, the average pair-wise cross-section correlations are high for the "levels", but they drop drastically as differenced. The correlations further decline as their dynamics are modeled by VARX*. A closer look reveals that the VARX* model with the

16 The stability of the system is numerically confirmed when the impulse response analysis is examined in the latter section. The smallness of weights calculated from the trade flow data is reported elsewhere, thus we do not repeat it. Concerning the weak dependence, see Appendix for additional discussion.

Table 12.6: Average Pair-wise Cross-section Correlations of Variables Used in GVAR Model and Associated Model's Residuals

	real GDP				inflation				real equity prices			
			VARX* Res				VARX* Res				VARX* Res	
	Levels	1st Diff	Type-1	Type-2	Levels	1st Diff	Type-1	Type-2	Levels	1st Diff	Type-1	Type-2
arg	0.91	0.08	−0.03	−0.02	0.29	0.05	0.06	0.03	0.46	0.23	0.15	−0.01
austlia	0.97	0.14	0.10	0.06	0.33	0.09	0.08	0.03	0.79	0.54	0.45	0.06
bra	0.96	0.15	0.06	0.04	0.25	0.02	0.00	−0.05				
can	0.97	0.20	0.04	0.00	0.41	0.14	0.07	0.01	0.73	0.55	0.45	0.04
china	0.97	0.09	0.03	0.04	0.13	0.06	0.03	−0.01				
chl	0.97	0.14	0.05	0.05	0.39	0.05	0.04	0.03	0.77	0.34	0.33	0.08
euro	0.96	0.25	0.13	0.10	0.44	0.16	0.10	0.02	0.75	0.56	0.49	−0.09
india	0.97	−0.02	−0.01	−0.01	0.16	0.04	0.05	0.04	0.76	0.32	0.25	0.02
indns	0.97	0.10	0.01	0.01	0.03	0.05	0.04	0.03				
japan	0.89	0.15	0.05	0.05	0.35	0.09	0.05	0.05	0.29	0.44	0.28	−0.08
kor	0.96	0.15	0.09	0.07	0.35	0.06	0.04	0.04	0.71	0.38	0.28	−0.03
mal	0.97	0.20	0.06	0.05	0.26	0.11	0.08	0.04	0.62	0.40	0.37	0.04
mex	0.97	0.16	0.06	0.04	0.23	0.00	0.03	0.02				
nor	0.96	0.09	0.06	0.05	0.37	0.08	0.06	0.02	0.08	0.50	0.39	0.08
nzld	0.96	0.14	0.08	0.08	0.32	0.07	0.08	0.04	0.40	0.41	0.32	0.03
per	0.88	0.06	0.02	0.02	0.26	−0.04	−0.02	−0.03				
phlp	0.95	0.06	0.02	0.00	0.21	0.02	0.01	0.02	0.72	0.36	0.30	0.03
safrc	0.95	0.19	0.07	0.07	0.33	0.04	0.02	0.01	0.77	0.47	0.38	0.10
sarbia	0.91	0.03	0.04	0.03	−0.01	0.01	0.05	0.05				
sing	0.97	0.20	0.11	0.09	0.20	0.05	0.07	0.03	0.74	0.54	0.48	0.03
swe	0.97	0.20	0.12	0.08	0.45	0.10	0.09	0.03	0.77	0.51	0.44	−0.01
switz	0.97	0.20	0.09	0.07	0.41	0.10	0.09	0.04	0.78	0.54	0.45	0.02
thai	0.95	0.14	0.05	0.03	0.28	0.06	0.02	0.00	0.65	0.40	0.34	0.06
turk	0.97	0.14	0.03	0.03	0.16	−0.01	0.00	−0.02				
uk	0.96	0.19	0.08	0.04	0.44	0.10	0.08	0.04	0.77	0.56	0.49	−0.01
usa	0.97	0.21	0.09	0.04	0.40	0.18	0.08	0.01	0.77	0.54	0.43	−0.01

	real exchange rate				short-term interest rate				long-term interest rate			
			VARX* Res				VARX* Res				VARX* Res	
	Levels	1st Diff	Type-1	Type-2	Levels	1st Diff	Type-1	Type-2	Levels	1st Diff	Type-1	Type-2
arg	0.37	0.09	0.05	0.04	0.45	0.03	0.05	0.01				
austlia	0.83	0.37	0.23	0.22	0.62	0.13	0.12	0.05	0.89	0.38	0.30	0.04
bra	0.79	0.21	0.11	0.10	0.43	0.01	0.04	−0.03				
can	0.81	0.32	0.15	0.13	0.67	0.18	0.14	0.11	0.91	0.36	0.31	−0.03
china	0.53	0.09	−0.01	−0.03	0.56	0.07	0.04	0.03				
chl	0.76	0.29	0.14	0.15	0.63	0.02	0.00	0.00				
euro	0.80	0.35	0.24	0.25	0.68	0.17	0.10	0.06	0.89	0.44	0.34	−0.08
india	0.61	0.26	0.12	0.10	0.30	0.10	0.07	0.06				
indns	0.35	0.22	0.12	0.12	0.26	0.07	0.06	0.05				
japan	0.72	0.16	0.11	0.11	0.62	0.03	0.02	0.02	0.86	0.26	0.21	−0.06
kor	0.80	0.30	0.15	0.12	0.63	0.05	0.02	0.04	0.83	0.04	0.00	−0.05
mal	0.76	0.30	0.17	0.15	0.50	0.06	0.02	0.05				
mex	0.73	0.10	0.01	0.00	0.52	0.02	0.03	0.03				
nor	0.82	0.39	0.24	0.24	0.63	0.05	0.00	−0.01	0.88	0.31	0.23	0.01
nzld	0.83	0.37	0.23	0.21	0.59	0.06	0.08	0.02	0.81	0.19	0.11	0.03
per	0.76	0.06	0.04	0.06	0.44	0.04	0.07	0.05				
phlp	0.82	0.18	0.13	0.14	0.64	0.09	0.09	0.06				
safrc	0.71	0.32	0.18	0.17	0.54	0.11	0.06	0.04	0.68	0.21	0.14	0.01
sarbia	0.67	0.08	0.04	0.04								
sing	0.83	0.38	0.24	0.24	0.60	0.08	0.07	0.04				
swe	0.78	0.35	0.21	0.20	0.70	0.09	0.04	0.01	0.91	0.40	0.31	0.04
switz	0.82	0.31	0.22	0.25	0.54	0.09	0.06	0.02	0.81	0.36	0.27	0.03
thai	0.82	0.30	0.20	0.19	0.62	0.11	0.09	0.06				
turk	0.81	0.22	0.14	0.10	0.34	0.05	0.04	0.00				
uk	0.78	0.33	0.19	0.18	0.69	0.15	0.09	0.05	0.90	0.40	0.30	−0.02
usa					0.62	0.10	0.06	0.04	0.88	0.40	0.33	−0.01

GVAR = Global Vector Autoregression.

Note: Please refer to Table 12A in the Appendix for a glossary of acronyms. VARX* Res (Type-2) refers to residuals from country-specific VARX* models. The specification is given as Equation (4). VARX* Res (Type-1) are obtained after re-estimating the model without the contemporaneous "star" variables.

Source: Authors.

contemporaneous "star" variables (Type-2) generally yields much weaker dependence of idiosyncratic shocks than that without the contemporaneous "star" variables (Type-1). This is consistent with the idea that the contemporaneous "star" variables function as proxies for the common global factors. Thus, once country-specific models are formulated as being conditional on foreign variables, the remaining shocks across countries becomes weak, as expected.

Next we examine the contemporaneous effects of foreign variables on their domestic counterparts. Because the data are either log-differenced (for real GDP, inflation, real equity prices, and the exchange rate) or differenced (for two kinds of interest rates), one can interpret the estimate as impact elasticity. Table 12.7 reports these estimates. The number of asterisks indicates the level of statistical significance.

Table 12.7: Contemporaneous Effects of Foreign Variables on Domestic Counterparts by Countries

	real GDP	inflation	real equity prices	short-term rate	long-term rate		real GDP	inflation	real equity prices	short-term rate	long-term rate
arg	0.106	−1.701	1.095†	2.195		nor	0.099	0.642	1.071†	0.232	0.733†
austlia	−0.007	0.625‡	0.854†	0.468†	1.039†	nzld	0.037	0.617†	0.729†	0.811‡	0.439‡
bra	0.037	6.563‡		−5.525*		per	−0.079	−1.065		0.483	
can	0.164†	0.677†	0.950†	0.524†	1.012†	phlp	−0.044	−0.323	0.905†	0.395	
china	0.096	0.403*		0.015		safrc	0.012	−0.074	0.813†	0.017	0.542‡
chl	0.071	0.091	0.762†	0.160*		sarbia	0.332‡	−0.033			
euro	0.090*	0.203‡	0.998†	0.065†	0.694†	sing	0.087	0.419‡	1.317†	0.293*	
india	0.030	0.335	0.609†	−0.045		swe	0.399†	0.896†	1.117†	0.481†	0.907†
indns	0.114	−0.334		0.649		switz	0.114	0.581†	0.899†	0.245†	0.510†
japan	−0.006	−0.202	0.638†	−0.040	0.504†	thai	0.059	0.294	0.870†	0.449	
kor	0.026	0.359	0.988†	−0.338	−0.069	turk	−0.032	1.823		1.014*	
mal	−0.012	0.447*	1.350†	−0.042		uk	0.077‡	0.396‡	0.813†	0.242‡	0.777†
mex	0.090	−0.770		0.764‡		usa	0.143†	0.357†			

GDP = gross domestic product.

Note: Please refer to Table 12A in the Appendix for a glossary of acronyms. White's heteroskedasticity robust standard error is used. †, ‡, and *, represent 1%, 5%, and 10% significance levels, respectively.

Source: Authors.

As for the statistically significant coefficients, all coefficients for short-term interest rates are positive, as expected. For real output, the Asian countries are relatively less sensitive to foreign demand since none of the coefficients is statistically significant even at a 10% level. Concerning inflation, significant foreign effects on Australia, the PRC, Malaysia, New Zealand, and Singapore are observed. This might reflect the degree of openness of these economies; however further investigation is needed. Notably, all the coefficients of equity prices are positive and significant at the 1% level. For the two interest rates, similar phenomena are observed. The fact that the impact elasticities of equity prices and long-term interest rates are highly significant might reflect the degree of financial integration. On the other hand, the insensitivity of short-term interest rates for several countries is due to their monetary policies. Except for Australia, New Zealand, and Singapore, the elasticities of short-term interest rates are insignificant for all Asian countries.

12.5 Impulse Response Analysis

12.5.1 The People's Republic of China Impact

In this section, we estimate the generalized impulse response functions (GIRFs) using the estimated GVAR model. The concept of GIRFs was proposed by Koop, Pesaran, and Potter (1996) and has been applied to VAR analysis by Pesaran and Shin (1998).

Mathematically, it is defined as

$$GIRF\left(\mathbf{x}_t : u_{i\ell t}, n\right) = \mathrm{E}\left[\mathbf{x}_{t+n} \middle| u_{i\ell t} = \sqrt{\sigma_{ii,\ell\ell}}, \Omega_{t-1}\right] - \mathrm{E}\left[\mathbf{x}_{t+n} \middle| \Omega_{t-1}\right] \qquad (5)$$

where $\sigma_{ii,\ell\ell}$ is the corresponding diagonal element of the residuals' variance–covariance matrix $\Sigma_{\mathbf{u}}$; Ω_{t-1} is the information set at time t–1.[17]

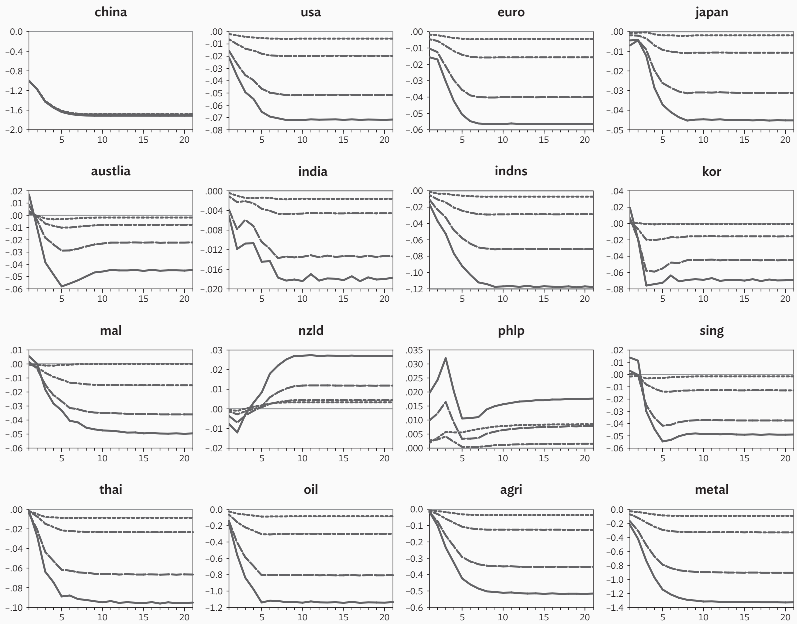
[17] Since our research interest was the historical transition of the PRC's impact on the global economy, rather than the economic forecast, we have used the GIRF analysis. However, as the PRC's growth rate is actually dropping, one might be interested in this effect. For this purpose, the conditional expectation can be used. See Gauvin and Rebillard (2015).

GIRFs are different from the standard impulse response functions (IRFs) proposed by Sims (1980), which assumes orthogonal shocks. The standard IRFs are calculated using the Cholesky decomposition of the covariance matrix of reduced-form errors. Thus, if we calculate the IRFs using different orders of variables, the shape of the IRFs will be different. If a VAR contains two or three variables, we might be able to use the standard IRFs by assuming a relation between the variables inferred from economic theory. However, the same approach is not useful for the GVAR model since it contains a large number of variables. This means that we cannot list a set of variables with a reasonable order that reflects economic theory. Therefore, instead of using the standard IRFs proposed by Sims (1980), we use the GIRFs, which produce shock response profiles that do not vary for different orders of variables.

We will investigate how a negative real GDP shock in the PRC transmits to other Asian countries as well as major developed economies based on the trade weights of 1985, 1995, 2005, and 2013. As explained in Section 12.2, as the trade linkages strengthen, we see a significant shift in the trade weight matrices of 2005 and 2013 from those of 1985 and 1995. Our focus is on seeing how the change of trade relations affects the propagation of shock.

First, we examine the impact of a one percentage point drop in the PRC's real GDP growth rate on the developed nations of the US, the eurozone, and Japan (first row of Figure 12.3). The first panel shows the evolution of the PRC GDP growth rate after a one percentage point decline. Possibly due to feedback effects, a one percentage point decline in the GDP growth rate results in 1.6% reduction of PRC real GDP in levels after 20 quarters. For the US, the eurozone, and Japan, the impact of a negative shock on PRC GDP is increasingly negative as we use more recent trade weights. However, the GIRFs have a negative shape when using the trade weight matrices of 1985 and 1995, and these lines are near zero. Therefore, it may imply that a negative PRC shock would have had minimal or nonexistent effect on these economies in 1985 and 1995.

Figure 12.3: GIRFs for a One Percentage Point Decline in the People's Republic of China's GDP Growth Rate



PRC = People's Republic of China, GDP = gross domestic product, GIRFs = generalized impulse response functions.

Note: Please refer to Table 12A in the Appendix for a glossary of acronyms. The lines correspond to the responses of 1985 (*short dash*), 1995 (*medium dash*), 2005 (*long dash*), and 2013 (*line*).

Source: Authors.

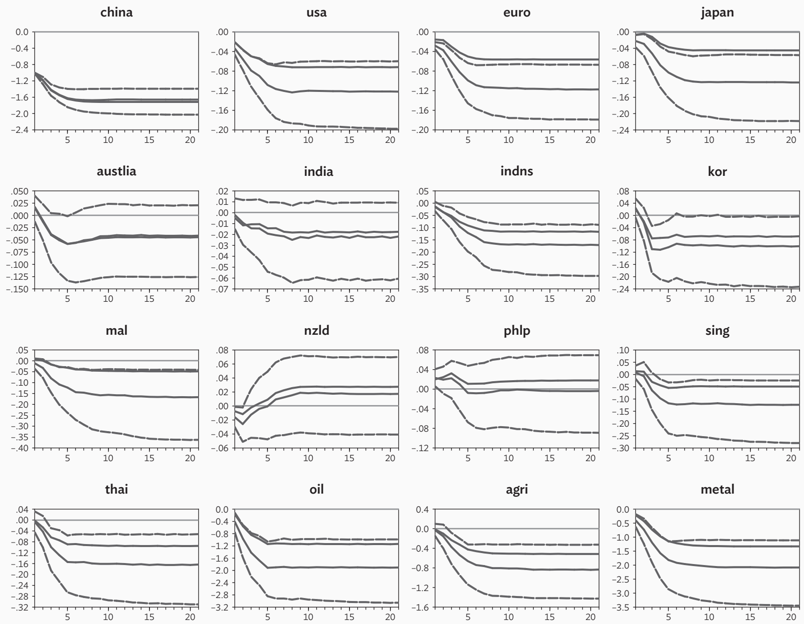
In terms of magnitude, the US experiences the most pronounced impact compared to the eurozone and Japan both in the short term as well as the long term. In the long-term, US GDP drops by 0.07%. For both the eurozone and Japan, GDP drops by approximately 0.05%. In terms of scale, the recent impact is approximately 12 times bigger than that of 1985 for the US and the eurozone. For Japan, it is about 20 times bigger. Thus, we conclude that, over 3 decades, the US and eurozone exhibit similar responses both qualitatively and quantitatively. We test the significance of the negative impact in the next section.

The second to fourth rows of Figure 12.3 show the GIRFs for a one percentage point decline in the PRC's growth on our set of Asian countries. As in the developed countries' case, the impact of a negative shock has become progressively greater on the Asian economies using more recent trade weight structures. The Republic of Korea, Malaysia, and Singapore had a nearly non-existent impact with 1985 trade weights. Similar phenomena results are observed for other countries.

Under more recent trade structures, every country except the Philippines experiences a negative shock either in the short term or in the long term; however, the level and extent of the shocks differ greatly. Indonesia is by far the most negatively impacted country both in the short term as well as the long term. It is followed by Thailand (−0.095% in the long term), the Republic of Korea (−0.070%), Singapore (−0.050%), Malaysia (−0.050%), and Australia (−0.045%). The impact of a negative PRC real GDP shock is less marked for India (−0.018%). Interestingly, for the Philippines, the impact of a negative PRC shock is positive.

In the last three panels of Figure 12.3, we display the GIRFs for a one percentage point decline in PRC GDP on the three commodity price indices. The PRC's increasingly commodity-intensive growth path manifests itself in the increasingly negative impact of a negative PRC growth shock on commodity prices. Similar to the GIRFs observed above, the impact of a negative PRC GDP shock is considerably more visible with the 2013 trade matrix structure. The PRC is the world's largest consumer of industrial metals (−1.33% drop in the long term) and the second-largest consumer of oil (−1.14%). The PRC's impact on agricultural prices rose significantly after year 2000, although the impact on prices in both the short term and the long term is much more muted compared to the impacts on oil and metal prices.

Figure 12.4: Bootstrapped GIRFs for a One Percentage Point Decline in the PRC's Growth using the Trade Weights of 2013



PRC = People's Republic of China, GIRFs = generalized impulse response functions.

Note: Please refer to Table 12A in the Appendix for a glossary of acronyms. The lines correspond to the paths of standard GIRF (*thick line*), median (*solid line*), and 16th and 84th percentiles (*dashed line*) of the distribution.

Source: Authors.

Figure 12.4 shows the GIRFs for a one percentage point decline in the PRC's real GDP growth using the trade weights of 2013 at a 68% confidence interval using a bootstrapping method. The figures show that the GIRFs of the US, the eurozone, Japan, Indonesia, the Republic of Korea, Malaysia, Singapore, and Thailand are significant at the 68% confidence level.[18]

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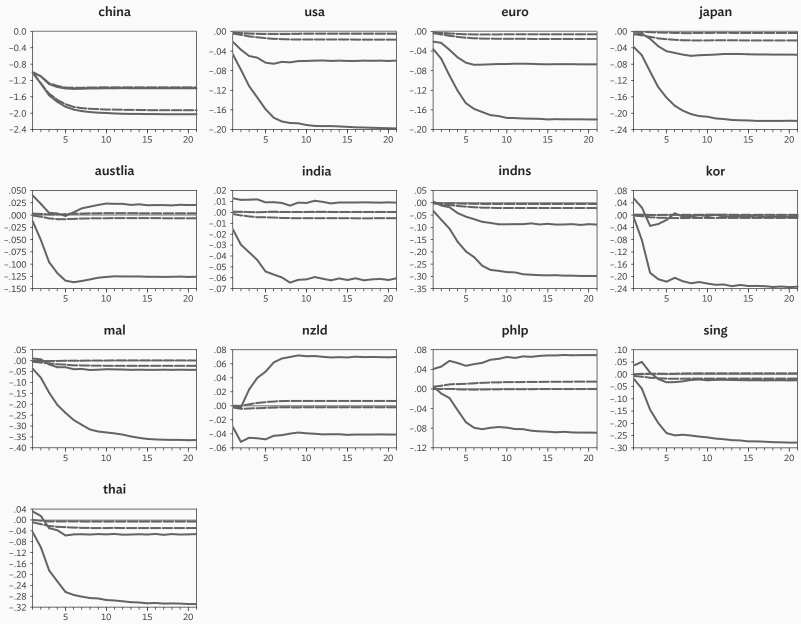
18 Unlike the other five Asian countries, we observe a significantly negative but short-lived response for the Republic of Korea. This dissimilarity might reflect the difference in the trade structure. By separating the processing and ordinary trade, Thorbecke (2016) pointed out that the Republic of Korea, compared to other Asian countries, is more exposed to a slowdown in the advanced economies purchasing processed exports from the PRC than to a slowdown in the PRC. For details, see Thorbecke (2016).

Figure 12.5: 68% Bands of the GIRF Distributions for Different Trade Weights



GIRFs = generalized impulse response functions.

Note: Please refer to Table 12A in the Appendix for a glossary of acronyms. The lines correspond to 16th and 84th percentiles of the distribution, calculated by the trade weights of 1985 (*dashed line*), and that of 2013 (*solid line*).

Source: Authors.

Figure 12.5 compares the distribution of GIRFs with different trade weights. When we use the trade weight matrix of 1985, the distribution of GIRFs stays close to the zero line for all of the sample countries. However, with 2013 trade weights, we observe significant downward shifts for the US, the eurozone, Japan, Indonesia, Malaysia, Singapore and Thailand. For Australia, India, and the Republic of Korea, the dominant portion of the distribution has also shifted downward. However, for the Philippines and New Zealand, the effect of a PRC shock is not very clear. The results are summarized in Table 12.8.

Lastly, oil, metal, and agricultural price indices are consistently all negatively significant.

Table 12.8: Classification of Response Patterns for the Asian Countries with a 1% Decline in the People's Republic of China's GDP Growth Rate

Response Patterns	Countries
Significantly lower	Japan, Indonesia, Malaysia, Singapore, Thailand
Mostly lower	Australia, India, Republic of Korea
Indeterminate	New Zealand, Philippines

GDP = gross domestic product.

Note: Please refer to Table 12A in the Appendix for a glossary of acronyms.

Source: Authors.

Figures 12.6 and 12.7 report the GIRFs of three other variables, *Dp* (rate of inflation), *eq* (real equity price), and *reer* (real effective exchange rate). To make the figures concise and easier to understand, we have shortened the horizontal axis from 21 quarters (5 years) to 13 quarters (3 years), and added two vertical lines, corresponding to 4 quarters and 8 quarters after the shock.

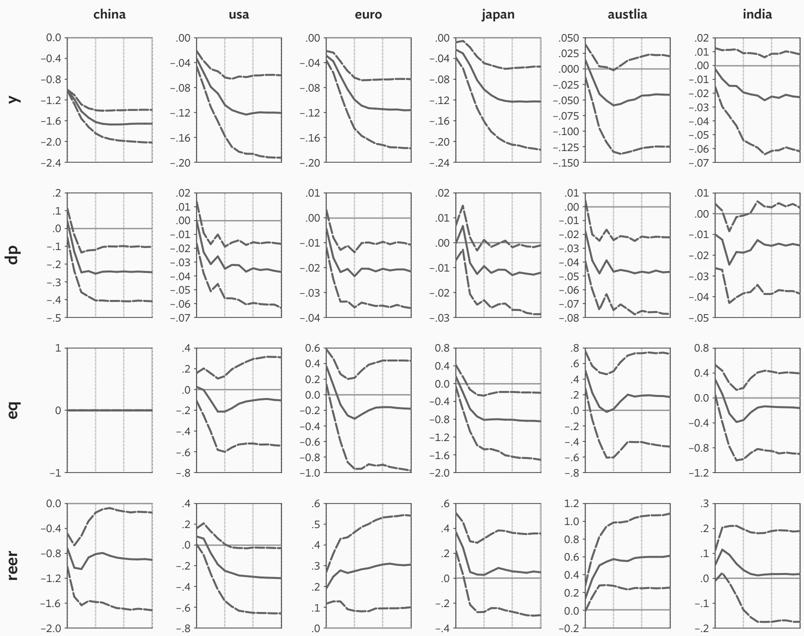
For the rate of inflation, it drops after a negative PRC shock for all countries except Indonesia. For the equity price, the markets of most countries are negatively impacted, although there are notable differences. New Zealand is the only exception, its equity market positively responding to a negative PRC shock. As we have obtained a positive response path for its real GDP, this might be the reason. Lastly, for the real effective exchange rate, all countries experience depreciation.

12.5.2 Shock Propagations through Metals and Agricultural Prices

Lastly, we re-examine the implication of adding two commodities to the standard GVAR model. As we briefly discussed, in terms of AIC, we found the benefit of selecting the best combinations out of three commodities over the oil-only model for all 26 economies.[19]

[19] We thank Joseph Zveglich and Renee Fry-McKibbin for their comments on the treatment of this issue.

Figure 12.6: Bootstrapped GIRFs for a One Percentage Point Decline in the People's Republic of China's Growth using the Trade Weights of 2013



GIRFs = generalized impulse response functions.

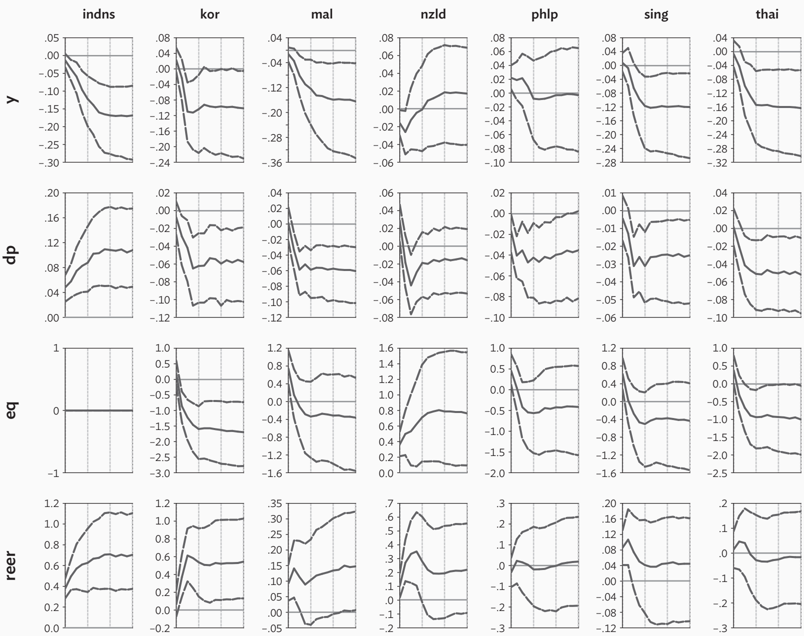
Note: Please refer to Table 12A in the Appendix for a glossary of acronyms. The lines correspond to the path of median (*solid line*), 16th and 84th percentiles (*dashed line*) of the distribution. The horizontal axis is now shortened to three years, and two vertical lines correspond to four quarters and eight quarters after the shock, respectively. For the PRC's equations, the real equity price is not included due to data unavailability. Thus the corresponding GIRFs are not calculated.

Source: Authors.

Here, instead, we compare the shapes of the GIRFs using the year 2013 trade weights (Figure 12.8).[20]

[20] For Argentina and Chile, the VARX* lags selected by the AIC were $p = 3$, $q = 2$, and $r = 1$, or (3, 2, 1). However, when the GIRFs are calculated, we could not obtain the stable solutions with them. After examining the AICs for different combinations of lags for all the countries, we noticed that the increments of AIC for Argentina and Chile from (3, 1, 1) to (3, 2, 1) were almost negligible. Thus we impose (3, 1, 1) for these two countries. Figure 12.10 is calculated under these restrictions.

Figure 12.7: Bootstrapped GIRFs for a One Percentage Point Decline in the People's Republic of China's Growth using the Trade Weights of 2013



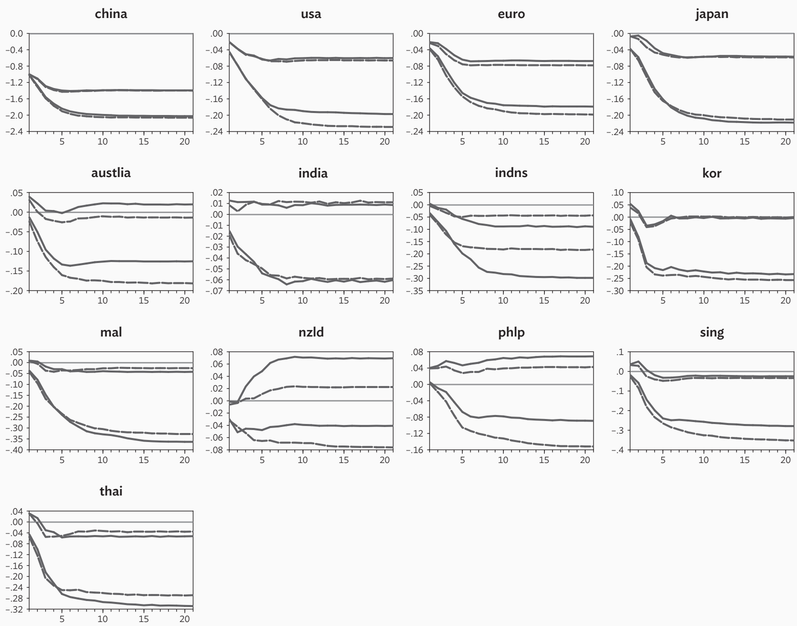
GIRFs = generalized impulse response functions.

Note: Please refer to Table 12A in the Appendix for a glossary of acronyms. The lines correspond to the path of median (*solid line*), 16th and 84th percentiles (*dashed line*) of the distribution. The horizontal axis is now shortened to three years, and two vertical lines correspond to four quarters and eight quarters after the shock, respectively. For Indonesia's equations, the real equity price is not included due to data unavailability. Thus the corresponding GIRFs are not calculated.

Source: Authors.

The responses of the "oil-only" model appear to overestimate the impact of the PRC's slowdown on the US, Australia, New Zealand, the Philippines, and Singapore. For example, the response of Australia was significant with the "oil-only" model, which now becomes marginally insignificant with the three-commodity model. According to Table 12.5, the VARX* model of Australia includes all three commodity prices. This suggests the usefulness of adding two commodity prices to the GVAR model. On the other hand, for Indonesia, the three commodities model suggests a larger negative impact in the long-term. Although the magnitude is much smaller than that of Indonesia, the negative impacts

Figure 12.8: GIRFs for a One Percentage Point Decline in the People's Republic of China's GDP Growth Rate With and Without Full Set of Commodities



GDP = gross domestic product, GIRFs = generalized impulse response functions.

Note: Please refer to Table 12A in the Appendix for a glossary of acronyms. The lines correspond to the 16th and 84th percentiles of the "oil-only" case (*dashed line*) and the "optimal combination of multiple commodities" case (*solid line*).

Source: Authors.

of a PRC shock on Malaysia and Thailand are also larger with three commodity models. These results indicate the usefulness of including the multiple commodity prices to capture the different channels of shock transmission.

12.6 Conclusions and Remarks

In this chapter, following Cesa–Bianch et al. (2011), we estimated a GVAR model using a time-varying trade weight matrix. The PRC's economy has been growing fast and its presence in the global economy is expanding through trade relations. We analyzed how and to what extent the PRC economic fluctuations affect the global economy—the Asia and the Pacific region in particular. After estimating the GVAR model, we calculated the GIRFs with different trade weight matrices of 1985, 1995, 2005, and 2013 to compare the size and timing of the shock propagations. We also calculated the 68% and 90% confidence intervals using the bootstrapping method and tested whether the estimated impacts are statistically significant.

Unlike under the earlier trade structures of 1985 or 1995, a negative shock to PRC real GDP has a significant impact on the surrounding countries under the more recent trade structures of 2005 and 2013. When we evaluated the impact using the trade weights of 2013, we found that a negative PRC GDP shock impacts commodity exporters, such as Indonesia, the most, reflecting both demand and terms of trade shocks. Export-dependent countries on the East Asian production cycle, such as Japan, Singapore, Malaysia, and Thailand, are also severely affected.

A shock to PRC real GDP has an impact on the international prices of not only crude oil but also metals and agricultural products, showing the degree of influence of the PRC on the global terms of trade.

With regard to future research, we consider improvement of the trade weight matrix to be the key. In this chapter, following Cesa–Bianchi et al. (2011), we used the trade weight matrix representing the linkages to different countries. However, capital inflows and outflows significantly affect economies. Since the measurement of closeness of countries is key for the GVAR model, we should also consider using foreign direct investment data. If we can capture the financial linkages between countries, we can, for example, analyze the impact of monetary policy changes in advanced economies on developing countries.

APPENDIX

Data

We obtained the data files that cover the period between 1979Q1 and 2011Q2 from the “The GVAR toolbox” website at Centre for Financial Analysis & Policy, Judge Business School, University of Cambridge.[1] We have added the recent data for the period from 2011Q3 to 2014Q3 mainly based on Appendix B in Smith and Gales (2011). We used the World Bank’s commodity price data downloaded from the following website.[2] We have replaced Smith’s oil price data with the World Bank’s index, and added the metal index and agriculture index.

Table 12A: Country Abbreviations

Name	Short name	Name	Short name
Argentina	arg	Norway	nor
Australia	austlia	New Zealand	nzld
Brazil	bra	Peru	per
Canada	can	Philippines	phlp
PRC	china	South Africa	safrc
Chile	chl	Saudi Arabia	sarbia
Eurozone	euro	Singapore	sing
India	india	Sweden	swe
Indonesia	indns	Switzerland	switz
Japan	japan	Thailand	thai
Republic of Korea	kor	Turkey	turk
Malaysia	mal	United Kingdom	uk
Mexico	mex	United States	usa

PRC = People’s Republic of China.

Note: The eurozone includes Austria, Belgium, Finland, France, Germany, Italy, the Netherlands, and Spain.

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1 Available at: http://www.cfap.jbs.cam.ac.uk/research/gvartoolbox/download.html.

2 Available at: http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTDECPROSPECTS/0,,contentMDK:21574907~menuPK:7859231~pagePK:64165401~piPK:64165026~theSitePK:476883,00.html.

On weak exogeneity

This subsection follows the example by Fisher (1993) with a slight modification. For simplicity, let both $\mathbf{x}_t$ and $\mathbf{x}_t^*$ be scalars, and consider the VAR* model for a country (without country index *i*)

$$\begin{bmatrix} \Delta \mathbf{x}_t \\ \Delta \mathbf{x}_t^* \end{bmatrix} = \begin{bmatrix} \mathbf{a}_1 \\ \mathbf{a}_2 \end{bmatrix} + \begin{bmatrix} \Gamma_{11} & \Gamma_{12} \\ \Gamma_{21} & \Gamma_{22} \end{bmatrix} \begin{bmatrix} \Delta \mathbf{x}_{t-1} \\ \Delta \mathbf{x}_{t-1}^* \end{bmatrix} + \begin{bmatrix} \mathbf{u}_{1t} \\ \mathbf{u}_{2t} \end{bmatrix} \tag{6}$$

One can reparameterize Equation (6) in terms of conditional and marginal models as:

$$\Delta \mathbf{x}_t = \theta_0 + \theta_1 \Delta \mathbf{x}_t^* + \theta_2 \Delta \mathbf{x}_{t-1} + \theta_3 \Delta \mathbf{x}_{t-1}^* + \zeta_t \tag{7}$$

$$\Delta \mathbf{x}_t^* = \mathbf{a}_2 + \Gamma_{21} \Delta \mathbf{x}_{t-1} + \Gamma_{22} \Delta \mathbf{x}_{t-1}^* + \mathbf{u}_{2t} \tag{8}$$

The error term of the conditional model becomes:

$$\zeta_t \equiv \mathbf{u}_{1t} - \theta_1 \mathbf{u}_{2t} \sim N(0, \Omega)$$

where $\Omega = \Sigma_{11} - \Sigma_{12}\Sigma_{22}^{-1}\Sigma_{21}$ with Σs being the corresponding covariance elements of $(\mathbf{u}_{1t}', \mathbf{u}_{2t}')'$. Then, the parameters in Equations (6), (7), and (8) are related as:

$$\theta_1 = \Sigma_{12}\Sigma_{22}^{-1}, \quad \theta_0 = \mathbf{a}_1 - \theta_1 \mathbf{a}_2, \quad \theta_2 = \Gamma_{11} - \theta_1 \Gamma_{21}, \quad \theta_3 = \Gamma_{21} - \theta_1 \Gamma_{22}.$$

The short-run dynamic stability of the conditional model requires θ_2 in Equation (7) to be $|\theta_2| < 1$. If this restriction is not imposed, the parameters of the conditional distribution $\lambda_1 = (\theta_0, \theta_1, \theta_2, \theta_3, \Omega)$ and marginal distributions $\lambda_2 = (\mathbf{a}_2, \Gamma_{21}, \Gamma_{22}, \Sigma_{22})$ define a sequential cut between the conditional and the marginal models. Hence, weak exogeneity holds.

If the short-run dynamic stability is imposed, on the other hand, it implies $|\Gamma_{11} - \theta_1\Gamma_{21}| < 1$ due to cross-equation restrictions. Under this circumstance, λ_1 and λ_2 are no longer variation free. However, if Γ_{21} is zero, weak exogeneity still holds.

Following this insight, we have investigated the weak dependence of idiosyncratic shocks, and confirmed that pair-wise cross-section correlations of shocks are actually very weak.

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Slowdown in the People's Republic of China

Structural Factors and the Implications for Asia

The People's Republic of China (PRC) has been growing at an unprecedented rate since economic reforms were initiated in 1978, achieving an average annual real GDP growth rate of 9.7% over the entire period through 2015. As a consequence, the PRC has achieved a remarkably successful transition from one of the poorest countries to upper middle-income status in just over one generation. However, there are concerns that the PRC's strong growth streak recently has run out of steam, showing a marked deceleration since 2010. The key question is whether the PRC's economy will continue to slow and be trapped in slow growth, or whether its growth can re-accelerate. The chapters in this volume focus on the root causes of the current slowdown and, in light of these, assess the growth potential of the PRC's economy, the conditions under which that potential growth could be realized, and the implications for other Asian economies.

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