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DOES THE EXPOSURE TO ROUTINIZATION EXPLAIN THE EVOLUTION OF THE LABOR SHARE OF INCOME? EVIDENCE FROM ASIA

Mitali Das

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Mitali Das is deputy division chief at the International Monetary Fund.

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Please contact the authors for information about this paper.

Email: MDas@imf.org

Asian Development Bank Institute
Kasumigaseki Building, 8th Floor
3-2-5 Kasumigaseki, Chiyoda-ku
Tokyo 100-6008, Japan

Tel: +81-3-3593-5500
Fax: +81-3-3593-5571
URL: www.adbi.org
E-mail: info@adbi.org

Abstract

This paper analyzes the evolution of the labor share of income in Asia, a region where countries have experienced steep declines and increases as well as stable labor income shares in the quarter-century since 1990. An innovation of this study is to expand the standard drivers of labor shares—technological advance, trade, institutions, and policies—by considering whether the exposure to routine jobs has also played a role in the evolution of the labor share of income. The more exposed a country is to routinization, the greater is the probability that ICT capital substitutes mid-skilled jobs, lowering the overall wage share of workers. Using a new dataset on the exposure to routinization, the study finds that it is an important determinant of the evolution of labor shares in developed Asian economies where the initial exposure was high but not in developing Asian economies where the share of routine jobs was small.

JEL Classification: C23, E24, E25, O33

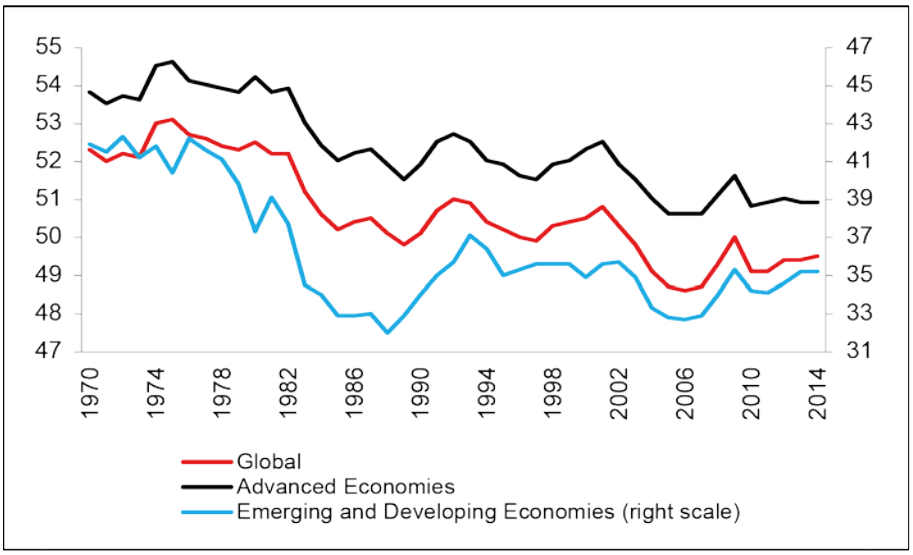
Contents

1. INTRODUCTION

After decades of relative stability, labor income shares began to decline globally in the 1980s (Figure 1). A deeper examination of the country evolutions behind the global decline, as Figure 1 shows, indicates, however, that this evolution was remarkably heterogeneous both across and within regions (Figure 2). North and South America, Europe, Asia, and Africa witnessed declining and rising as well as stable labor shares of income. For example, within Asia, the labor share of income fell in Japan and the People's Republic of China (PRC) but rose in Malaysia and Thailand and remained relatively stable in Singapore (Figure 3). However, on the global scale, the labor shares of income declined in the largest economies of the world, including four of the five largest economies and eight of the largest ten, resulting in the observed (GDP-weighted) decline in the global labor share of income.

This paper will discuss the evolution of the labor shares within Asia, a region that has not received much attention in the literature relative to the large body of work that has examined the decline in the labor share of income in the United States and in advanced economies more generally (see e.g., Blanchard 1997; IMF 2007; Karabarbounis and Neiman 2014). Asia is particularly interesting, because its constituent countries are highly diverse along many dimensions. For example, Asia includes a heterogeneous set of countries in terms of their economic development, consisting of developed economies such as Japan, large emerging economies such as the PRC, Malaysia, and Thailand, newly industrialized economies such as Singapore and Hong Kong, China, and lower-income countries such as the Philippines.[1] Countries within Asia also have remarkable diversity in demographics, technological advancement, and trade linkages with countries within and outside Asia, which may be relevant factors in analyzing the evolution of the labor share of income.

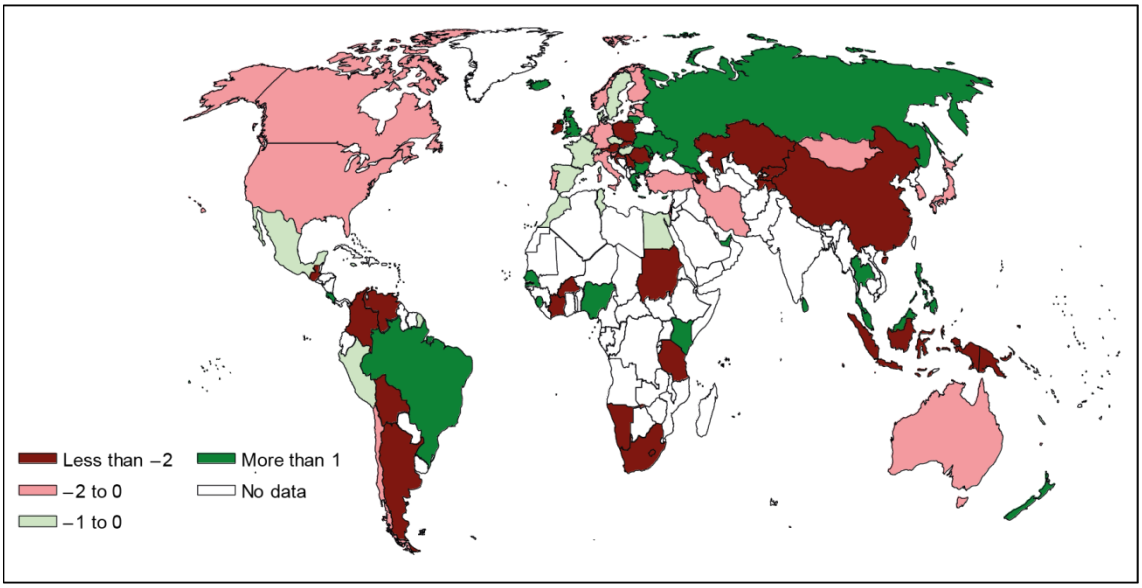
Figure 1: Evolution of the Labor Share of Income
(%)



Sources: National authorities and IMF staff calculations.

[1] The data for the labor share of income are from official sources and Dao et al. (2017). Official data are unavailable for certain Asian countries, including India, Bangladesh, and Cambodia.

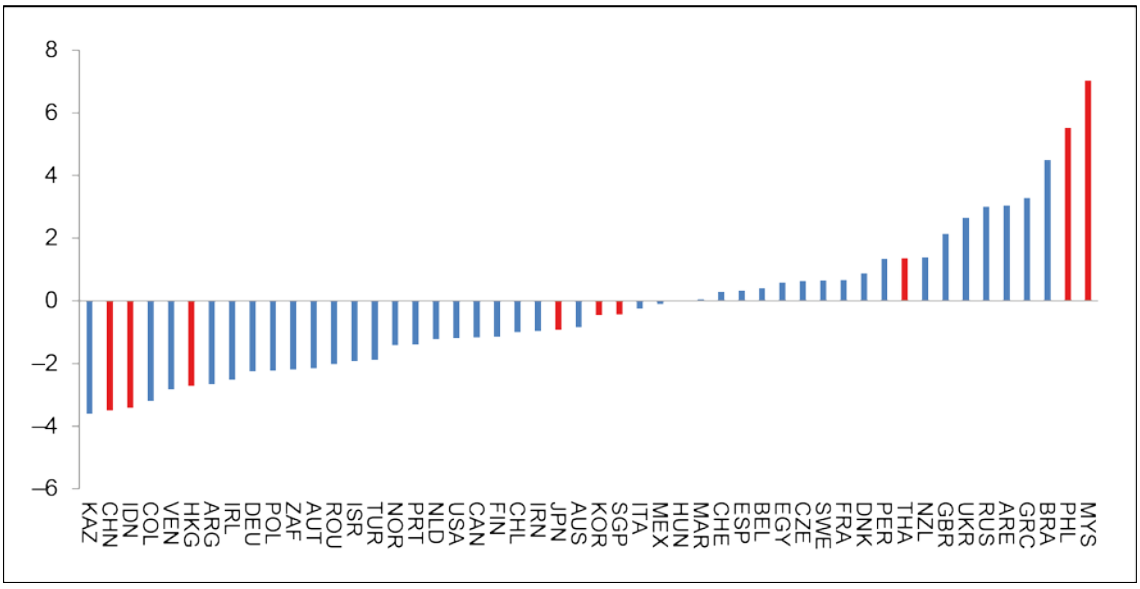
Figure 2: Trends in the Labor Share of Income
(percentage points per 10 years)



Sources: National authorities; and IMF staff calculation.

Note: This world map shows the labor share trend of countries with at least 10 years of data, starting from 1990.

Figure 3: Evolution of Asian Labor Shares, in Global Perspective
(percentage points per 10 years)



Notes and Sources: Data are from National Authorities. Figure shows the trend change in labor shares for countries with at least 10 years of data, starting in 1990.

To date, the understanding of the forces behind this striking—though heterogeneous—decline in the labor share is not complete. However, the recognition of the global nature of its evolution—through the peaks and troughs of domestic business cycles and over a period that has experienced profound structural transformation in advanced and emerging economies alike—has led to an emerging consensus that the primary forces behind this evolution are likely to be global as well, with varying impacts across

countries reflecting varying exposures to common global factors. In recent years, authors have advanced hypotheses that have narrowed these forces down to two key factors: the globalization of trade and capital (see e.g., Elsby, Hobijn, and Şahin 2013; Dao et al. 2017) and technological changes (e.g., Karabarbounis and Neiman 2014).

Concerning technological advancement, the hypothesis is that the rapid advance of technology has lowered the relative price of investment goods and thereby induced forms to replace labor with capital.[2] Karabarbounis and Neiman (2014) estimated that the associated capital deepening—in combination with an estimated elasticity of substitution between capital and labor that is larger than one—explains about half of the decline in labor shares globally. However, several authors have pointed to a predominant role of information and communication technology (ICT), in particular in the declining relative price of investment.[3] Following this, we present an exploratory analysis that differentiates the impact of technology on labor shares through two distinct but intertwined mechanisms: (a) the decline in the relative price of investment goods, reflecting technological progress broadly; and (b) the nature of technological progress, in particular the *routine bias* of technological change, that is, the development of technologies that induce firms to substitute capital for labor performing *routine* tasks.

As Autor, Levy, and Murnane (2003) define, routine tasks are those that ICT capital can easily substitute, as they require little abstract thinking, follow a natural sequence of operations, and are easily codifiable by programmers; thus, computerization can easily automate them. The two mechanisms are also likely to interact: a decline in the relative price of investment goods may trigger greater substitution away from labor that performs more routine tasks.[4]

It is well known that the steep decline in the price of automating technology in advanced economies over the last quarter-century has resulted in a large-scale "hollowing out" of the labor force—displacing middle-skilled labor into low-paying jobs (or unemployment) and raising the demand and wage premium for high-skilled workers (see e.g., Autor and Dorn 2013; Goos, Salomons, and Manning 2014; Ikenaga and Kamibayashi 2016). As Dao et al. (2017) discuss, the hollowing out is likely to have played a role in reducing the labor shares of income by lowering the incomes of low- and mid-skilled workers significantly more than it raised the incomes of high-skilled (capital-owning) workers. Very little knowledge, however, exists about the incidence of routine tasks in countries beyond the advanced economies that the existing literature has focused on, and whether the displacement of routine labor has similarly affected the labor shares in these countries.

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[2] Technological progress affects the labor share by lowering the user cost of capital and inducing firms to substitute capital for labor (with the impact on the labor share depending on the elasticity of substitution between labor and capital). The user cost of capital is the opportunity cost of using rather than selling the existing capital and is a positive function of the price of capital, the interest rate, the depreciation rate, and the expected decline in the price of capital. More efficient technology for producing investment goods lowers the price of capital and thus the user cost. A decline in interest rates or capital depreciation rates could play a similar role to technological progress in lowering the user cost of capital.

[3] For example, Krusell (1998) discussed the role of ICT in the relative price of investment; Katz and Krueger (1998) and Feenstra and Hanson (1999) that in skilled wage premia; and Autor, Levy, and Murnane (2003), Autor and Dorn (2013), and Goos, Manning, and Salomons (2014) that in the displacement of labor.

[4] We draw on a measure of routinization developed in Das and Hilgenstock (2018); see also Das (2018). This measure begins with a score for the routinizability of every occupation that Autor and Dorn (2013) created and then computes an occupation-weighted score for each sector in a country and an aggregate score for the country. The routinization scores vary over time as the occupation weights change.

By “globalization,” the literature refers broadly to the surge in three inter-related cross border trades: trade in final goods and services; trade in intermediate goods exemplified by the rise of supply chains; and financial asset trade. Regarding trade in final goods and services, the classical Stolper–Samuelson trade theory predicts that globalization (reflected most significantly in the entry of the PRC, India, the countries of the former Soviet bloc, and other economies into the global trading system) will lead capital-abundant developed economies to specialize in the production of capital-intensive goods, triggering resource reallocation across sectors that reduces the aggregate labor share in their economies, while the opposite will occur in developing economies.

Trade in intermediate goods and services is a closely related, but distinct, aspect of globalization that can affect labor shares following the entry of low-cost suppliers of intermediate inputs into the global economy (Feenstra and Hanson 1996; Grossman and Rossi-Hansberg 2008). The hypothesis is that access to cheaper intermediate inputs spurs “offshoring” in developed economies, as a Heckscher–Ohlin model for vertical trade predicts. Such offshoring is likely to raise the capital intensity of the remaining production in developed economies and labor’s share of income where the capital–labor elasticity of substitution is lower than one. A separate channel through which the rise in intermediate trade may decrease labor’s share is the credible raising of firms’ threat to offshore jobs, lowering workers’ bargaining power.

Finally, financial globalization is another plausible explanation for the decline in the labor share of income, as it lowers the cost of capital for developing economies that have removed the barriers to capital mobility, spurring an increase in capital-intensive production and a decline in the labor share of income. We will discuss these factors in further detail in Section 3.

1.1 Motivations

The decline in the labor share of income has potentially large and complex macroeconomic and social implications. A decline in the labor income share, by definition, implies that the owners of capital have accrued a greater share of income. As capital holdings tend to concentrate in the upper tail of the income distribution (Wolff, 2010), an increase in the capital share raises income inequality, all else being equal. If the decline in labor shares is more pronounced among unskilled workers, this can further widen the income gap. Such trends may fuel populist perceptions that the gains from growth are not broadly shared, raising the risk of a backlash against globalization—a trend that people widely perceive to benefit capital over labor. These concerns are of increasing importance in Asia, where political commentators have noted that rising populism may be an even bigger threat than in the West given that strong domestic institutions and norms will not constrain such forces (Kurlantzick 2017).

Falling labor shares can also imply that wages have been growing at a slower pace than labor productivity (Dao et al. 2017). This phenomenon can have a range of macroeconomic implications, including on aggregate demand and wage inequality. As capital holdings tend to concentrate in the upper tail of the income distribution, an increase in the capital share at the expense of the labor share increases income inequality. Research has identified several countries in Asia, including Viet Nam and the PRC, as experiencing extreme inequality (Asian Development Bank 2014), and exacerbation of these trends risks a significant backlash. Furthermore, if the decline in the labor share is more pronounced in the unskilled sector, this would further widen the income gap. Changes in factor shares have implications not only for the distribution of

income but also for the design of the fiscal policy. For instance, since lower-income households have a higher marginal propensity to consume, a declining labor share can depress the growth in the aggregate demand. This may be especially relevant in the lower-income countries of Asia, where the share of households in poverty is large.

The link between labor shares and income inequality is not always straightforward, however. Income inequality could increase due to a change in the distribution of wages, without any accompanying change in the labor share of income. At the same time, gains in employment and wages that concentrate in the upper tail of the income distribution could raise both the labor share and the income inequality at the same time. Finally, a decline in the average remuneration of labor vis-à-vis capital could increase the labor share if firms respond by substituting labor for capital, that is, if the so-called elasticity of substitution between labor and capital is high (above one).

Changes in factor shares also have implications for the design of tax and benefit policies. For instance, to the extent that a decline in the labor share results from the displacement of labor due to globalization and technological change, policy responses to ease the reallocation of workers across sectors could include the widening of safety nets as well as the strengthening of education and job retraining. In addition, to the extent that the same factors that reduce the labor share also lie behind higher inequality, greater use of redistributive policies may be necessary. More generally, identifying the forces behind the decline in the labor share is important for our understanding of the macro economy, particularly in emerging markets and developing economies, where the drivers of the labor share of income are not well understood.

Against this backdrop, this study will examine the role of exposure to routinization in the evolution of the labor share of income in Asia. We will begin in Section 2 by describing a measure of the exposure to technologies that tend to displace labor in routine tasks and presenting stylized facts about the exposure to routinization across Asian economies. Section 3 will examine the mechanisms that link the exposure to routinization with the labor share of income and consider whether these mechanisms apply in both developed and developing economies. Section 4 presents an empirical study that decomposes the contributions to the change in the labor share, illustrating the role of exposure to routinization in developing versus developed economies. Section 5 concludes.

2. EXPOSURE TO ROUTINIZATION: STYLIZED EVIDENCE FOR ASIA

Estimations have indicated that the real cost of computing power fell at a staggering rate of more than 50% *annually* between 1969 and 2005 (Nordhaus 2007). A fundamental insight into the implications of this technological revolution—on the nature of tasks, patterns of international trade, and industrial structure—began with the characterization of those tasks that the surge in computer capital is most likely to affect as *routine* tasks (Autor, Levy, and Murnane 2003). This work defines routine tasks as those that "… require methodical repetition of an unwavering procedure … exhaustively specified with programmed instructions and performed by machines."

The steep decline in computing costs has presented firms with strong incentives to automate routine tasks. Such *routinization* (i.e. the automation of routine tasks) apparently lies behind the substantial displacement, stagnant wage growth, and declining labor share in many advanced economies (Autor and Dorn 2013; Goos,

Manning, and Salomons 2014; Dao et al. 2017).[5] The magnitude of these dislocations, however, varies across economies, suggesting that, if routinization does lie behind these trends, either the intensity of routine occupations varies across countries or countries with comparable routine intensities automate at different rates, reflecting idiosyncratic factors such as industrial composition, or both.

Assessing such considerations empirically requires a consistent and comparable measure of routinization across industries and countries. Recently, Das and Hilgenstock (2018) proposed such a metric. This measure begins with a set of ordinal scores (Autor and Dorn 2013) that gauge the intrinsic routinizability of an occupation (i.e. its likelihood of automation by information technology). The scores contain no information other than the ordinal position of occupations in increasing order of routinizability. On the left tail of this scale are the most non-routinizable occupations: farming, firefighting, and teaching; on the right tail are the most routinizable tasks: cashier work, proofreading, and machine operation.

Using consistently defined occupations across countries from national population censuses, labor force surveys, and other sources, Das and Hilgenstock constructed employment-weighted scores of occupations in industries and the economy to measure the *exposure to routinization*. Thus, for occupation category *l,* industry *j*, and country *i* at time *t*, the industry- and country-level routinization exposures are respectively:

$$RTI_{jit} = \sum_{l} \omega_{ljit} \times RTI_{l}, \qquad RTI_{it} = \sum_{l} \omega_{lit} \times RTI_{l}$$

where ω_{ljit} and ω_{lit} are respectively occupation *l*'s share of employment in industry *j*, in country *i*, at *t* and occupation *l*'s share of employment in country *i* at *t*, and the intrinsic routinizability of a task (i.e. the propensity of a routine task to be automated) is denoted *RTI*, following Autor and Dorn (2013).[6] We construct the exposure for 160 countries (116 developing economies and 38 developed economies) and 14 2-digit industries.

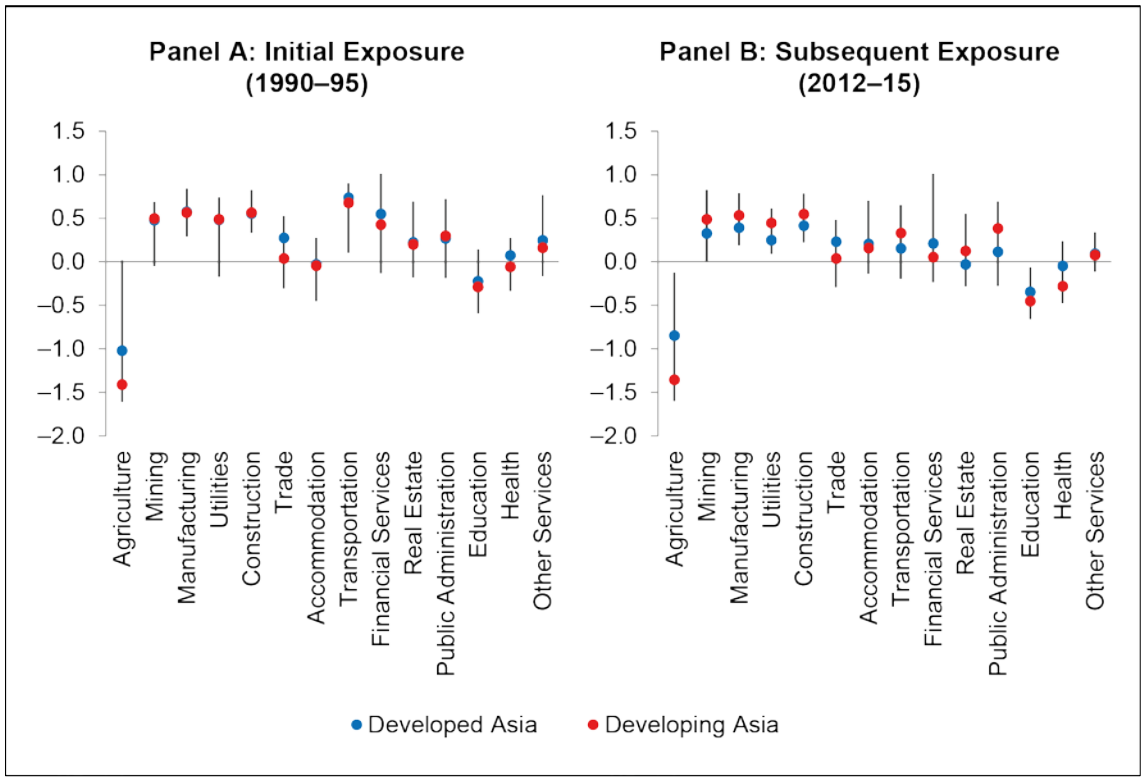
Using these data, this study analyzes the exposure to routinization across Asia and establishes several stylized facts. First, the labor markets in developing Asia are significantly less exposed to routinization than those in developed Asia and remain less exposed for the duration of the quarter-century between 1990 and 2015. This finding emerges from the industrial distribution of employment, as production concentrates in labor-intensive industries (agriculture, retail trade, and services) in developing Asia, particularly in manual tasks, which are naturally indisposed to automation, while it concentrates in routine-intensive industries (manufacturing, transportation, construction, and financial services) in developed Asia. This stylized finding suggests that, insofar as technological advancement (particularly in the adoption of ICT) lies behind the labor share, its role is likely to be consequential in developed Asia but inconsequential in developing Asia.

[5] Autor and Dorn (2013) and Goos, Manning, and Salomons (2014).

[6] This assumption implies that the tasks that, for example, a babysitter performs present inherent challenges to computerization, while those that an assembly plant worker performs are inherently automatable, regardless of the industry or the time when they are performed. Importantly, note that the assumed intrinsic quality of the task is *distinct* from whether the task is actually automated, which may indeed vary with time or across industries or countries.

Figure 4 illustrates this by presenting the distribution of exposures across industries. Panel A shows the "initial" exposure, measured as the earliest observation in 1990–95, while panel B shows the "subsequent" exposure, measured as the last available observation in 2010–15. Both panels also show the average routine exposure for each industry, separately for developed and developing economies.[7] The width of each box whisker line represents the range of routine exposures across economies.

Figure 4: Exposures to Routinization across Industries



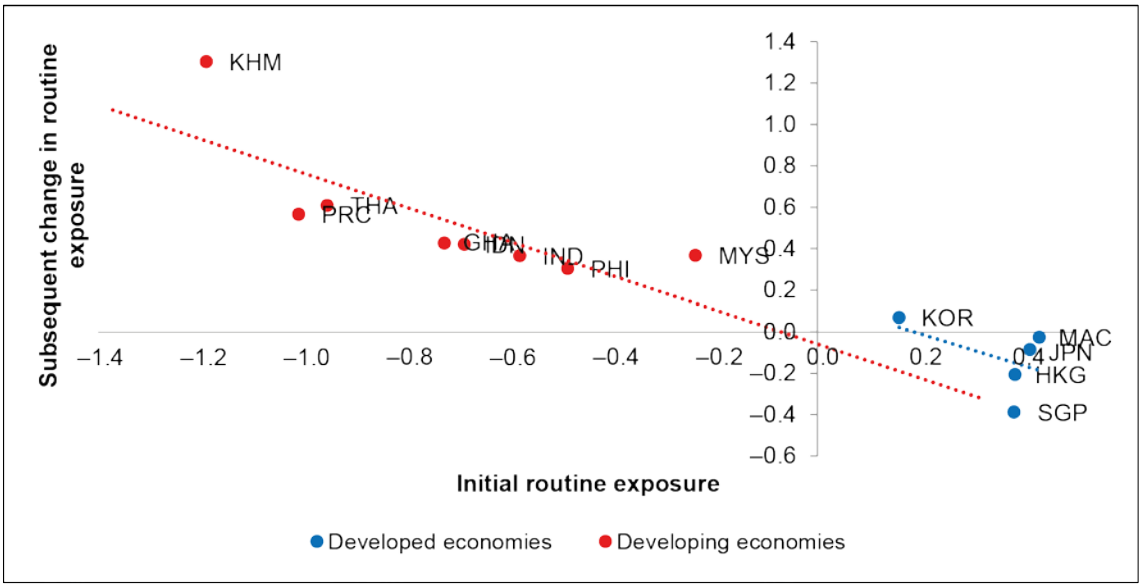
Note: The circles represent the average routine exposure for each industry in developed (blue) and developing (red) Asian economies. Source: Das and Hilgenstock (2018).

Second, the initial exposure to routinization (measured in the early 1990s) has a strong, negative correlation with subsequent exposure (measured in or around 2015), as Figure 5 shows. However, there is sharp asymmetry in the level of exposure. In developed Asia, where countries had already been heavily exposed to routinization by the early 1990s, the higher was the initial exposure, the lower was the subsequent exposure. Meanwhile, developing Asian economies largely fall into the second quadrant of Figure 5, indicating that the higher was the initial exposure, the lower was the subsequent *rise* in exposure.

For developed Asia, the interpretation is clear: the higher was the initial exposure to routinization, the greater was the displacement of middle-skilled labor as firms in advanced economies displaced them more intensely with capital, lowering the overall wage share of workers and resulting in *lower* subsequent exposure to routinization.

[7] These are weighted averages, with weights given by value added, and we calculate them separately for developed and developed economies. For example, for developed economies, the weights are the share of an industry's value added in the total value added of that industry across all developed economies. We use the same weighting scheme for developing economies.

Figure 5: Initial Routine Exposure and Subsequent Change in Routine Exposure



Source: Das and Hilgenstock (2018).

In developing Asia, where economies fall into the second quadrant of Figure 5, the interpretation is that the less initially exposed was an economy to routinization, the greater was its increase in exposure to routinization. A logical explanation for this phenomenon is that, in developing economies, the natural transition from agriculture to manufacturing and services—structural transformation—is consistent with the rise in routine-intensive jobs (which are high in manufacturing and certain service sector industries) and a decline in routine-weak jobs (which are predominantly in agriculture and low-skilled services). As the next section discusses, the globalization of trade may have also played a role as developed countries from Asia and other parts of the world offshored routine-intensive factory jobs to developing Asia (Blinder and Krueger 2013), raising the capital intensity of production and with it the capital share of income.

3. LINKING THE EXPOSURE TO ROUTINIZATION TO THE LABOR SHARE OF INCOME: MECHANISMS

Having described stylized facts about the exposure to routinization in Asia, we now propose several mechanisms by which routinization could affect the labor share of income, drawing from the literature on the risk of the skilled wage premium (see e.g., Feenstra and Hanson 2007), the globalization of trade (e.g., Blinder and Krueger 2013), and job polarization—the phenomenon of lowering employment and wages of mid-skilled labor relative to those of high- and low-skilled labor. The literature has emphasized these links in advanced economies, as this is where the preponderance of the evidence on skilled wage premia, offshoring, and polarization lies. Such drivers may operate differently in developing economies, reflecting differences in the factor shares of capital and labor, price distortions, informational asymmetries, and the low stage of development, or they may not even operate at all (Maloney and Molina 2016). We discuss four inter-related factors that are relevant.

The most significant factor is that the advancement of ICT—which the rapid improvement in its productivity as well as the steep decline in the cost of computerizing routine tasks reflect—has presented firms with incentives to displace routine labor for capital (see e.g., Levy and Murnane 1996; Card and DiNardo 2006; Autor and Dorn 2013; Beaudry, Green, and Sand 2016). The hypothesis is that, all else being equal, in countries where the relative price of investment goods has declined more, mid-skilled labor will have been displaced more to lower-paying jobs or unemployment and the labor share of income is likely to have declined more sharply.[8]

Second, for routinization to result in a decrease in the labor share of income, a significant share of the economy must be engaged in routine occupations. That is, the routine exposure must be large enough for a shock, such as a steep decline in automation costs, to trigger measurable dislocations of routine labor. The implication is that, for a given decline in the relative price of investment goods, the higher the exposure to routinization, the larger the adoption of labor-saving technologies and the more severe the decline in the labor share of income.

Another factor, which, for example, Feenstra and Hanson (1997) and Acemoglu and Autor (2011) emphasized, is the skill bias of ICT (i.e., its complementarity with skilled labor and its substitutability or neutrality for less-skilled labor).[9] The argument is that the adoption of ICT technologies has raised the demand for skilled labor, leading to a steady increase in their employment share; by simultaneously displacing middle-skilled labor performing routine tasks into lower-paying service sector jobs, it has also raised the employment share at the bottom of the wage distribution. Even if high-skilled wages rise measurably, if the majority of the labor force is engaged in low- and mid-skilled labor, the net impact of the skill bias of ICT will be to lower the labor share of income.[10]

The last possible mechanism lies at the intersection of trade and technology. Several authors have argued that technological advances have not just made the automation of routine tasks more feasible; by drastically lowering the costs of offshoring tasks to locations with lower factor costs, they have spurred vertically integrated production (Blinder and Krueger 2013). Blinder (2007), for example, noted that the tasks that companies are most likely to offshore are low-skilled clerical or factory jobs that require neither face-to-face interaction nor physical proximity to specific sites. Many of these characteristics, as Autor and Dorn (2013) noted, are also defining features of routine tasks.[11] This suggests that automation and offshoring may be mutually reinforcing, together lowering the relative demand for routine labor and contributing to a decline in the labor share of income.

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[8] Following a large literature, we measure the relative price of investment goods as the ratio of the investment deflator to the consumption deflator. In a two-sector economy, consisting of a capital goods sector and a consumption goods sector (e.g., Whelan 2000), a declining relative price of investment can result from either an increase in productivity in the investment goods sector or a decline in productivity in the consumption goods sector and leads to an increase in the employment of investment goods in production relative to factors used in consumption goods (which may include labor as well as other factors of production).

[9] Feenstra (2002) proposed the skill bias of ICT as the main explanation for the rising wage premium of skilled workers. Feenstra argued that, as routine tasks were automated and offshored, the composition of the remaining production in developed economies became more skill-intensive, raising the demand for high-skilled workers and generating a skilled wage premium. The growth of low-skilled labor and the "twisting" of the wage distribution has led to the additional observation that the skill bias of ICT lies behind labor market polarization.

[10] Among others, Katz and Murphy (1992); Autor, Dorn, and Hanson (2006); Firpo, Fortin, and Lemieux (2011); and Autor and Dorn (2013) presented empirical evidence.

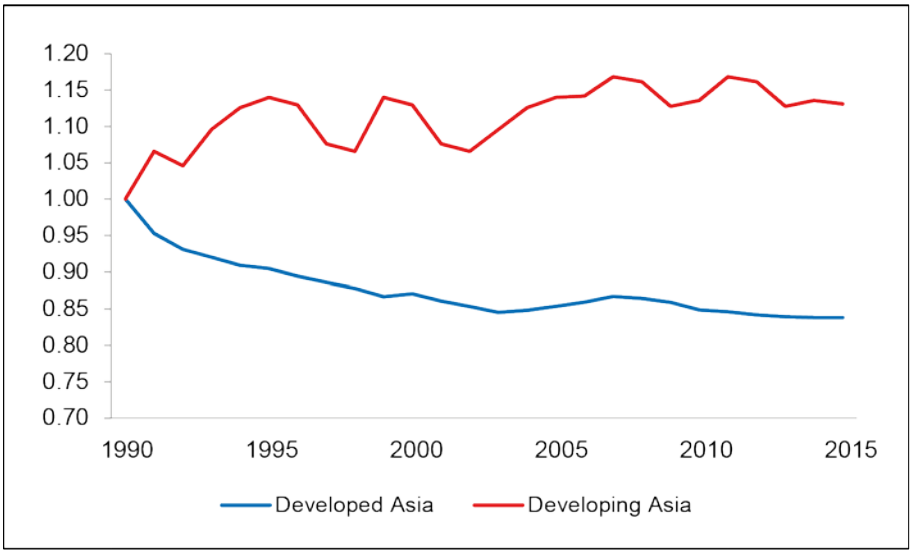
[11] In contrast, non-routine, low-skilled tasks, like construction and babysitting, require either physical proximity or face-to-face interaction, making them unsuitable for offshoring.

We consider how these arguments apply to the evolution of the labor shares in Asia, distinguishing their likely effects in developed versus developing countries.

3.1 Relative Price of Investment Goods

The steep decline in the relative price of investment goods is strongly evident in developed Asian countries, but in developing Asia it has experienced only very mild declines, has remained stable, or has even risen over the last quarter-century, mirroring the general pattern globally (see Dao et al. 2017). Figure 6 illustrates: whereas the relative price of investment has declined by 15% in the developed Asian countries since 1990, in the developing countries of Asia, it has risen by 13% in the same period.[12]

Figure 6: Relative Price of Investment Goods, 1990–2015. Index (1990=1)



Source: World Economic Outlook, National Authorities, and Author's Calculations.

This suggests that developing Asia has not faced the pecuniary incentives to automate jobs and thus the decline in the labor share in these countries is unlikely to be related to technological advancement, while it is likely to have played a role in the evolution of the labor share in developed Asia. Considering that the labor costs in developing economies are a fraction of those in developed economies, countries in developing Asia would have needed an even *stronger* decline in the price of investment goods than in their developed counterparts to adopt labor-saving technologies, all else being equal.

[12] This is distinct from the stylized finding that the price *level* of investment goods is higher in developing economies (Hsieh and Klenow 2003). The factors behind this differential evolution may be related to the high dependence on capital imports in developing countries, where local currency prices are subject to import tariffs; the commodity intensity of imports; non-trade barriers and transportation costs; and the volatility of exchange rates (Dao et al. 2017).

3.2 Occupational Distribution of Employment

Even if faced with rising capital goods prices, countries in developing Asia might have elected to adopt labor-saving technologies if the resulting efficiency gains had outweighed the higher factor costs. This could have resulted in dislocation from routine jobs, with downward pressure on wages. For this to have a measurable effect on the labor share of income, however, a nontrivial share of the existing tasks in developing Asian economies would need to be automatable by information technologies.

There is a widely held belief, however, that labor in developing economies concentrates in jobs with low susceptibility to routinization (ILO 2014; Maloney and Molina 2016). The ILO estimates that the primary sector employs about 40% of their workforce. Confirmation comes from the low exposure to routinization of developing Asia (shown in Figure 5), a result of the large share of the workforce in low routine-intensive agriculture and service occupations and the small share in high routine-intensive occupations. The disparity between the exposures to routinization reflects the differences in the occupational structure of employment between developed and developing Asia. The small share of routinizable jobs suggests that even a favorable shock to capital goods prices may not result in significant labor displacement in the short term (see also Das and Hilgenstock 2018).

4. GLOBALIZATION AND THE OFFSHORING OF ROUTINE TASKS

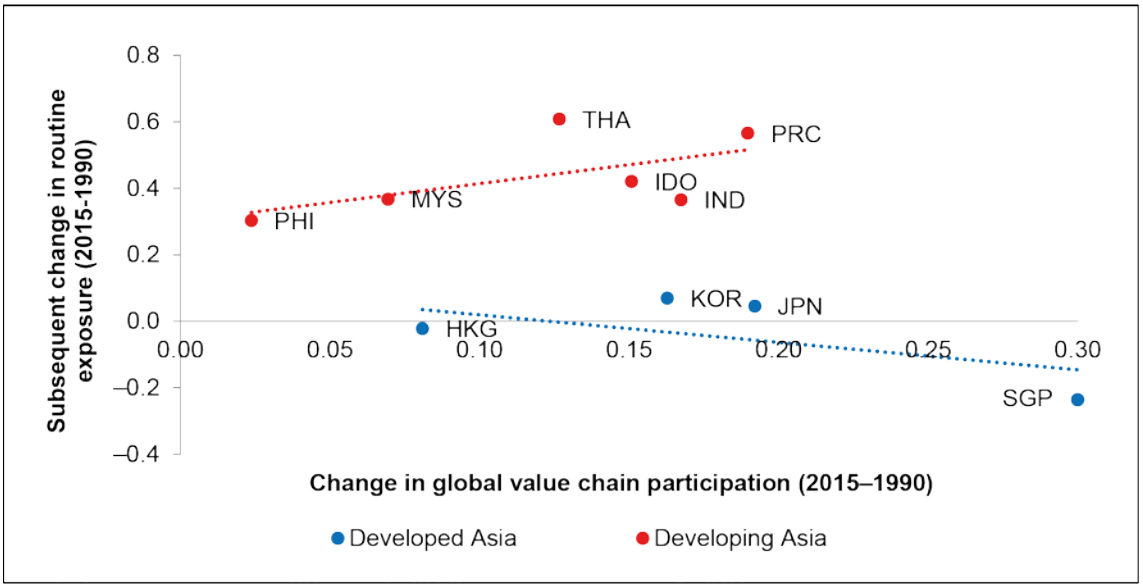
Research has established well that, starting in the 1990s, Asia was the predominant destination of jobs offshored from advanced nations. If developing Asia is a recipient of low-skilled jobs offshored from developed countries (including those in Asia) and such jobs have high routine intensity, as Blinder (2007) suggested, then offshoring should raise their employment of routine labor and with it the capital intensity of production.

By the same logic, the offshoring of routine-intensive jobs from advanced Asia would lower their demand for routine labor and thus reduce the capital intensity of production. This suggests that the globalization of trade—as the rising phenomenon of vertically integrated chains and offshoring reflects—is likely to have affected the labor share of income differently in developed versus developing economies: increasing the labor share of income in developed countries and decreasing it in developing ones. Autor and Dorn (2013) acknowledged that the polarization of the United States labor market could result from offshoring in addition to (or in place of) the automation of routine jobs; see also Elsby, Hobijn, and Şahin (2013).

Using the measure of participation in global value chains (GVCs) of Koopman Wang, and Wei (2014),[13] Figure 7 suggests that the globalization of trade could have played a role in both raising routine exposure in developing economies and lowering it in developed economies. We test this hypothesis further in the empirical analysis.

[13] This is a widely used metric of value-added trade, which includes measures of both backward linkages (defined as the share of foreign value added in gross exports, which captures the extent of offshoring of intermediate inputs used in exports) and forward linkages (defined as the share of exports consisting of intermediate inputs that trading partners use for the production of their exports to third countries, which is a measure of the extent of vertical specialization). See for example Koopman, Wang, and Wei (2014) and Dao et al. (2017).

Figure 7: Global Value Chain Participation and Subsequent Change in Routine Exposure



Notes and Sources: Change in GVC participation and routine exposures are measured as the difference of the measures in 2010–15 and in 1990–95. Data sources: Dao et. al. (2017), Autor and Dorn (2013), Das and Hilgenstock (2018), and authors' calculations.

Finally, one must acknowledge that idiosyncratic factors may constrain the adoption of technologies in developing Asian economies. Comin and Mestieri (2013) found that the adoption lags have recently begun to converge with those in developed countries but that the penetration rates have simultaneously diverged. Insufficient information about new technologies, a key determinant of adoption, is one factor that research has cited as a cause of lower penetration (Foster and Rosenzweig 1995). Institutional barriers related to ineffective property rights enforcement, misappropriation of funds, and a lack of enforcement are structural impediments that hinder large-scale technological adoption. The lack of information, coupled with a limited number of suppliers of new technology, can lead to significant price dispersion à la Stigler, whereby the end-users face significantly higher prices than those at the port, making the adoption of technologies less likely on the margin.

5. EXPLORING THE IMPACT OF THE EXPOSURE TO ROUTINIZATION ON THE LABOR SHARE OF INCOME

We now examine the empirical relation between labor shares and their key determinants, including technology, globalization, and other factors, introducing the exposure to routinization as an additional determinant. Following influential work on the analysis of labor shares, the approach focuses on long-run trends in labor shares and relates them to long-run trends in potential drivers.[14] Important considerations motivate this strategy, including the fact that adjustments to the structural changes that technological advances and globalization trigger occur over long horizons and that,

[14] See, for example, Harrison (2005); Elsby, Hobijn, and Şahin (2013); Karabarbounis and Neiman (2014); and Acemoglu and Restrepo (2017).

even at the business cycle frequency, changes in labor shares can exhibit little to no change even when the underlying trend is declining.

Limiting the analysis to countries that have at least 10 years of data over the period 1990–2015, the empirical analysis focuses on a sample of 49 countries (33 advanced economies and 16 emerging markets). We then apply the estimated results to Asia.

To estimate the effect of technology, the analysis follows Karabarbounis and Neiman (2014) by using the trend change in the relative price of investment goods as a proxy for firms' incentives for capital–labor substitution and adding to that the change in exposure to routinization. By measuring the exposure to routinization for each country at the start of the time period, this approach circumvents the concern that high initial exposure to routinizable jobs will itself lead to greater adoption of routine technology and thereby lower the subsequent exposure to routinizability.

To examine the impact of globalization, we use several measures, including the long-run trends in overall trade (measured as the sum of value-added exports and imports relative to the GDP); participation in global value chains (GVCs, measured as the sum of forward and backward linkages);[15] and, as an approximate measure of financial globalization, the sum of external assets and liabilities (excluding international reserves) as a percentage of the GDP. For the labor and product market structure, we use the trend changes in union density and corporate taxation rates and an indicator for those countries that enacted significant reforms in deregulating employment protection and in product markets.

The estimated model is:

$$\widehat{LS_c} = \alpha + \beta_2 \widehat{PI_c} + [\beta_3 IER_{0,c} + \beta_4 IER_{0,c} \widehat{PI_c}] + \beta_1{}' \widehat{G_c} + \beta_5{}' \widehat{Pol_c} + \varepsilon_c \quad (1)$$

where (hat) variables are long-run annualized changes during the period 1990–2015, the subscript *c* denotes countries, *PI* denotes the relative price of investment, ER_0 indicates the initial exposure to routinization, and *G* subsumes the variables measuring the evolution of globalization: the trend in total goods trade, trade in intermediate inputs, and trends in financial globalization (inward plus outward FDI as a percentage of the GDP). *Pol* summarizes the policy/institutional factors, including trends in union density, corporate taxation, and the incidence of a given country to implement major employment protection legislation (EPL) or carry out product market reforms (PMR). Table 1 provides the results.

While overall trade intensity does not appear to matter much for labor shares, participation in GVCs does. The research estimates that participation in GVCs exerted a strong negative effect in both advanced economies and emerging markets, supporting the notion that offshored tasks are labor intensive for the former group of countries but raise the capital intensity in the latter.[16]

[15] Backward linkages capture the extent of offshoring of intermediate inputs used in exports, and we define them as the share of foreign value added in gross exports. Forward linkages measure the extent of vertical specialization, and we define them as the share of exports consisting of intermediate inputs that trading partners use for the production of their exports to third countries (see Koopman, Wang, and Wei 2014).

[16] The larger impact of offshoring in receiving developing economies could reflect the fact that the reallocation of displaced workers in advanced economies from manufacturing to low-skill (but labor-intensive) service industries (as Autor and Dorn [2013] showed) may itself raise the labor share and work against the negative effect of offshoring, while, in developing economies, the reallocation effect (from labor to more capital-intensive jobs) is more unambiguous. Another reason is that imported

Table 1: Drivers of the Change in Labor Shares of Income

	(1) Technology	(2) Globalization	(3) Institutions, Policies		(4) All
Initial Exposure to Routinization	–0.0001 (0.001)				–.0003 (.001)
Rel. Price of Investment x Initial Exposure to Routinization	0.27** (0.09)				.53*** (.099)
Relative Price of Investment	0.09** (0.04)				.17*** (.05)
GVC Participation (Intermediate Trade)		–0.53*** (0.15)			–1.27*** (.25)
Financial Globalization		–0.003** (0.001)			.045*** (.013)
Final Goods and Services Trade		.017** (0.007)			
Product and Labor Market Reform			–0.0002 (0.0002)	0.0001 (0.0002)	
Unionization				0.05 (0.05)	.02 (.03)
Corporate Taxation				0.18*** (0.06)	.03 (.04)
N	47	48	48	26	47
R-squared	.21	.25	.02	.36	.62

Notes: Results are for equation (1), estimated using generalized least squares with robust standard errors shown in parenthesis.

Financial globalization, which the trend change in external assets and liabilities approximates, has contrasting effects on the two country income groups, depressing the labor shares in advanced economies while raising them in emerging economies. Research has long argued that rising capital mobility strengthens capital owners' bargaining power relative to that of labor by facilitating the relocation of production.[17] The empirical estimates are consistent with this notion for advanced economies, which are in general the source countries of FDI flows. The finding for emerging markets is consistent with the notion that capital inflows lower the cost of capital and, if production has limited substitutability of capital for labor, raise the labor share of income, an outcome that is most likely a result of the high-skilled labor share.[18] The measures of trend changes in labor and product market regulation, as well as changes in corporate taxation, do not appear to have robust effects on the labor share trends over the sample period, having accounted for the trends in technology and globalization.

Figure 8 presents a decomposition to gauge the relative contributions to the labor share trends in advanced versus developing Asian economies. In advanced Asia, technological advancement, as the declining relative price of investment goods and the initial exposure to routinization reflect, has been the largest contributor to the downward trend in labor shares, accounting for half or more of the overall decline. This is particularly the case in Japan and the Republic of Korea, countries that experienced heavy exposure to routinization in the early 1990s and subsequently automated a significant number of manufacturing jobs (see Ikenaga and Kamibayashi 2016). Globalization—using participation in GVCs and financial globalization as

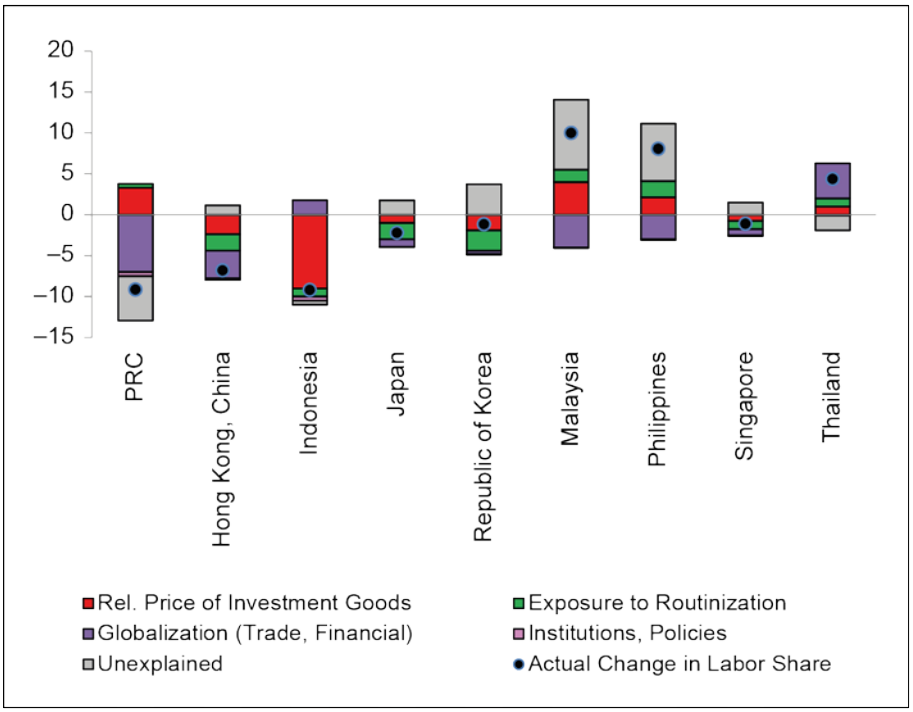
intermediate inputs may increase the labor share in some tasks/sectors in developed countries through their positive effect on productivity if such tasks have a relatively low elasticity of substitution.

[17] Feenstra and Hanson (1997); Harrison (2005); IMF (2007).

[18] See Jaumotte, Lall, and Papageorgiou (2013).

proxies—together contribute less than half as much as technology to the estimated decline in labor shares for Japan and the Republic of Korea but are significant in explaining the estimated decline in Hong Kong, China, an economy with stronger exposure to trade in global value chains. Overall, institutions and policies contribute a negligible amount to the estimated change in the labor share in developed Asian economies.

Figure 8: Estimated Decomposition of the Change in Labor Shares
(percentage points)



PRC = People's Republic of China.

Notes: The decomposition is based on the estimated coefficients in Table 1, applied to the economies shown. A decomposition could not be calculated for those countries for which there are no data for some covariates.

For developing Asian economies, the forces of globalization have generally been the predominant driver of the evolution of the labor share. As Figure 8 shows, in the PRC, Indonesia, Malaysia, Thailand, and the Philippines (which are the developing Asian economies for which there are adequate data on the covariates), the contribution of globalization has generally lowered labor's share of income. The surge in global value chains, in particular, has raised the capital intensity of production and thus raised the capital shares, although in many cases financial globalization has partially offset this, lowering the cost of capital and directing a smaller share of income toward capital owners.

Technology has generally played a small role in the evolution of developing Asia's labor shares, although its impact is fairly heterogeneous across individual countries. In certain cases (e.g., Malaysia, the Philippines, and the PRC), in which the relative price of investment goods has risen since 1990, it has spurred a greater allocation of production *away* from capital and toward labor, increasing the labor share of income. With low initial exposure to routinization in these economies, there has been little contribution of the routinization of labor to the trend changes in the labor share.

Indonesia is one exception to the general findings, as its relative price of capital has declined, which, unlike in most other developing economies, is the predominant contributor to the change in the labor share in this country. Even in Indonesia, however, the exposure to routinization has played an insignificant role in the trend decline in the labor share.

6. CONCLUSIONS

This study begins with the observation that the downward trend in the global labor share of income since the early 1990s has been broad based, though heterogeneous, across regions but also within regions. It focuses on the evolution of the labor shares in Asia, a region that is highly diverse in its demographics, technological advancement, and trade linkages, all of which may be relevant to an analysis of the labor share of income.

To expand on the growing literature on labor shares, this paper considers whether the exposure to routinization plays a role in driving the labor share of income and why its impact may differ across countries. The key hypothesis is that, where the initial exposure to routinization was high, firms more intensely displaced routine labor with capital as the price of automation declined. This led routine (mid-skilled) labor into lower-paying jobs or unemployment, pushing down the overall labor share of income.

The empirical analysis points to a dominant role of both technology and globalization, although to very different degrees in developed versus developing Asian economies. Technological progress, as the steep decline in the relative price of investment goods as well as the high exposure to routine occupations that can be automated reflect, has been the key driver in advanced Asia, with globalization playing a smaller contributing role. In developing Asia, the evolution of labor shares is driven predominantly by the forces of globalization, with a very limited role for technology. This reflects in part a much less pronounced decline in the relative price of investment goods as well as lower exposure to routinization, which has bounded the impact of technology on displacing labor.

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