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ACCELERATING URBANIZATION EXPLAINED: THE ROLE OF INFORMATION

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Abstract

In this paper, we argue that urbanization has accelerated in the last few decades, and that this largely overlooked phenomenon cannot be explained by existing empirical models of urbanization. Consequently, we explicitly bring forward the role of information in driving urbanization, focusing on information and communication technology (ICT), especially the Internet. For this purpose, we develop a simple two-sector general equilibrium model, demonstrating the potential effect of information on the urbanization rate. The prediction from the theoretical model is then verified by cross-country regressions based on 1960–2013 data from 109 non-OECD countries. Both fixed effects and IV-fixed effect results show that: (1) information is important in explaining the acceleration of urbanization; (2) the conventional push–pull factors become weak as the urbanization drivers; and (3) the results are robust to different regions, different information proxies, and urbanization quantiles.

JEL Classification: O18; D8; O15

Contents

1. INTRODUCTION

There is a clear trend that urbanization has accelerated over time. Figure 1 shows the number of years a country took from about 10% to about 50% urbanized. That number is more than 400 for the earliest starters, such as Portugal, Poland, Switzerland, Sweden, France, and Great Britain. It reduced to just over 100 when counting countries that began the urbanization process in the mid-19th century, e.g., Rumania, Norway, Greece, and Germany. For the late starters in Asia (e.g., the People's Republic of China [PRC], Indonesia, and Thailand) and Africa (e.g., Cameroon, Cote d'Ivoire, and Liberia), this number is only about 60. It is useful to point out that this phenomenon is not unique to fast growing economies like the PRC and Indonesia but also applicable to least developing countries such as Togo and Angola. The acceleration trend can also be sensed from how fast a major city grows. For example, it took London 130 years to grow from a population of one million to eight million, but only 45 years for Bangkok and 25 years for Seoul (WHO 2010).

Of course, Figure 1 can be misleading because urbanization depends on various drivers. In Table 1, we report preliminary regression results, showing that the coefficients for the decadal dummy variables are all positive, significant and increasing over time. These confirm that urbanization has indeed been accelerating, even after controlling for the conventional determinants.

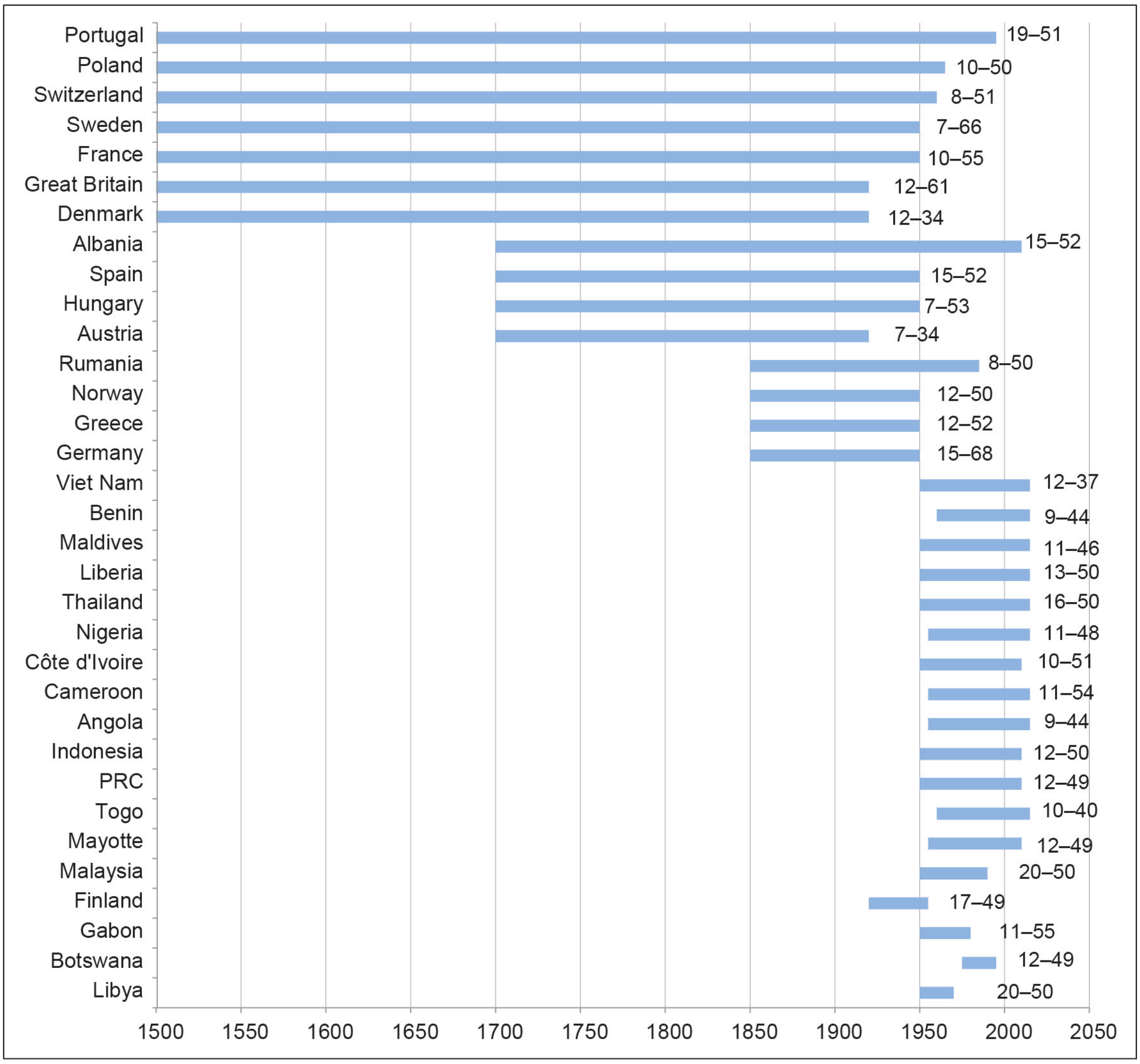
To our best knowledge, the accelerating trend just discussed has largely been overlooked by the research community. One related study is by Jedwab, Christiaensen, and Gindelsky (2015), who attribute fast urbanization to lower urban mortality rates in developing countries. We challenge this conclusion based on the stylized fact that, in the absence of internal migration, natural population growth is typically faster in rural areas than in urban areas. For example, according to Table 18 of the United Nations Demographic Yearbook 2013,[1] the urban population mortality rate is higher than the rural counterparts in many developing countries, such as Egypt, Mauritius, Cuba, Georgia, and Kyrgyzstan. It appears that faster urbanization cannot be explained by the difference in the urban–rural mortality rates in the absence of internal migration.

It is important to point out that our ignorance about the acceleration of urbanization may have resulted in unpreparedness by governments and other stakeholders in dealing with large-scale internal migration, contributing to urban diseases such as slums, crowding, congestion, and pollution. In other words, rapid and unplanned urban growth undermines sustainable development due to insufficient or lagging policies and public services. Thus, it is important and urgent to analyze urbanization acceleration and its drivers.

This paper represents the first attempt to expose and explain urbanization acceleration. We develop a simple two-sector general equilibrium model, demonstrating the potential effect of information on the urbanization rate. The prediction from the theoretical model is then verified by cross-country regressions based on 1960–2013 data from 109 non-Organisation for Economic Cooperation and Development (OECD) countries. Both fixed effects and IV-fixed effect results show that: (1) information is important in explaining the acceleration of urbanization; (2) the conventional push–pull factors become weak once the additional driver of information is incorporated; and (3) the results are robust to different regions, different information proxies, and urbanization quantiles.

1 http://unstats.un.org/unsd/demographic/products/dyb/dyb2013.htm (accessed 9 June 2016).

Figure 1: Years From About 10% to 50% Urbanization[2]
(%)



PRC = People' Republic of China.

Source: Authors' compilation based on two sources. Bairoch et al. (1988) reports the size of 2,191 European cities over the period 800–1850. Data are available at https://github.com/JakeRuss/bairoch-1988 (accessed 1 November 2015). Urban population are added up and then divided by the estimated total population for each country. Data on total population are available from Table B-10 of OECD (2001, p.241). Data on urbanization rate in and after 1950 are from WDI of the World Bank.

The rest of the paper is organized as follows. Section 2 briefly reviews the literature and discusses the development of ICT and Internet. Section 3 proposes a simple theoretical model, establishing the relationship between information and urbanization. Section 4 presents data and empirical modeling results. Section 5 conducts robustness checks. Section 6 provides policy implications and conclusions.

[2] Urbanization rate is defined as the ratio of urban population to total population.

Table 1: Coefficient Estimates of Decadal Dummy Variables

Decade Dummy	Coef.	*p*-value
1960s	–	–
1970s	3.48	0.000
1980s	7.40	0.000
1990s	11.15	0.000
2000s	14.26	0.000
2010s	15.77	0.000
R-squared	0.98	0.000

Note: Table 1 corresponds to column (2) in Table 3, which reports the baseline results. Note that the dummy variables in this table represent decades while those in Panel B of Table 3 represent years. Control variables including the push–pull and other factors, as discussed in more details in Session 4.

Source: Authors.

2. LITERATURE REVIEW AND THE DEVELOPMENT OF ICT

Conventional wisdom states that urbanization is largely driven by the rural "supply push" and urban "demand pull" factors[3] (Marshall 1890; Todaro 1969). As long as the urban–rural income differential is positive, rural migrants will be continuously attracted to cities. This underlies most theoretical and empirical research on migration or urbanization. Note, however, as demonstrated in this paper, these pull–push factors cannot explain observed acceleration in urbanization.

Another strand of research focuses on the effects of cost or distance of migration. Sjaastad (1962) considers different components of migration cost, such as monetary cost and psychological cost. Greenwood (1997) listed six reasons why distance deters migrations, namely: (i) high out-of-pocket moving expenses; (ii) more time involved; (iii) high opportunity cost; (iv) high information search cost; (v) high psychological cost of separation from home; and (vi) following prior migrations to move to nearby cities. These arguments are consistent with empirical evidences. For example, Sahota (1968) reports negative distance impacts in Brazil. Similar findings were obtained by, Vanderkamp (1971) for Canada, and Beals, Levy, and Moses (1967) for Ghana.

Finally, there are studies directly exploring the role of information, but not in the context of urbanization acceleration. Several studies examine migrant network as an information channel and found that it helps reduce migration costs by providing information on jobs and housing and assisting new migrants to settle down (Chau 1997; Massey et al. 1993; Mckenzie and Rapoport 2007). Others focus on the role of information in reducing uncertainty. Kau and Sirmians (1977) classified migrants into three groups: return migrants, new migrants and repeat migrants, who are supposed to possess different amounts of information on migration. They show that information played an important role in the migration decision process. Schwartz (1973) found that education mitigates the negative distance impact and, therefore, interpreted distance as a proxy of information rather than cost of transportation. Similarly, Zhao (1999) reported that young, single, and male migrants in the PRC were more likely to move due to lower psychological cost. However, these studies did not directly and explicitly model the impacts of information and didn't construct indicators or measures of

[3] "Push factors" usually refer to those forcing migrants out of rural areas and "pull factors" are those attracting migrants to urban areas.

information. More importantly, they failed to consider changes in information over time and, therefore, their studies cannot be used to explain urbanization acceleration.

"Information distance" could be shortened even when the spatial distance is unchanged. With the development of ICT sectors, it is much easier for a potential migrant to obtain all kinds of information with negligible costs. For example, information on job opportunities is crucial. Information on weather and the environment can help gauge physical living conditions. Information on rental properties, schools and healthcare services are important for the choice of residential location. In addition, communication tools such as social networking sites (SNS) help migrants maintain contact with family and friends, reducing the emotional burdens for new migrants. In short, development of ICT reduces information asymmetry between rural and urban areas, leading to decreases in psychological and other costs of migration (Sjaastad 1962).

As is known, the ICT sectors have seen unprecedented development in last decades. The inventions of telegraph, telephone, radio, and computer enable communication over great distances. More importantly, the advent of the Internet marked a new era. It serves as both an infrastructure and a means for information provision, and allows individuals to interact with each other regardless of their geographic locations. The marginal cost of information broadcasting has become quite low. The Internet also enables people to share multi-media messages such as pictures and videos, which are generally more straightforward to understand and more informative than texts.

In our empirical study, we choose the year 1990 as the beginning of the Internet era because the Advanced Research Projects Agency Network (ARPANET), the first network using the protocol suite TCP/IP, was decommissioned in 1990. In the same year, scientists began the actual incarnation of the World Wide Web. Furthermore, the shared format for hypertext documents, Hypertext Markup Language (HTML), and the Uniform Resource Locator (URL), were all developed in 1990. They significantly broadened the interaction between users and the Internet networks and have been continuously used since that time. According to the International Telecommunication Union (ITU), the year 1990 marks the beginning of the free World Wide Web (WWW).[4]

Given the importance of ICT sectors, and especially the Internet, many studies have explored their social impacts. Gaspar and Glaeser (1998) examined the effect of ICT on the communications among urban residents. Their results suggested that telecommunications complement, or at least support, face-to-face interactions. Bhuller et al. (2013) used unique Norwegian data on crime and Internet adoption to investigate the relationship between Internet use and sex crimes. They found that the Internet effect is non-negligible and positive, possibly as a result of increased consumption of pornography. Czernich et al. (2011) estimated the effect of high-speed Internet on economic growth using panel data of OECD countries over 1996–2007 and concluded that a 10% increase in broadband penetration raised annual per capita growth by 0.9%–1.5%. However, no attempts have been made to estimate the impacts of ICT development on migration or urbanization.

[4] http://www.itu.int/en/ictdiscovery/Pages/timeline.aspx (accessed 8 April 2016).

3. THEORETICAL MODEL

Our theoretical framework is derived from the standard two-sector model (Barrios, Bertinelli, and Strobl 2006; Harris and Todaro 1970; Lucas 2004). The modeled economy consists of a rural/agricultural sector and an urban/industrial sector. All agents are born in the rural area and only live for one period. We assume both sectors employ the standard Cobb–Douglas production technologies:

$$Y_r = L^{1-\gamma} N_r^{\gamma} \tag{3.1}$$

$$Y_u = K^{1-\alpha} N_u^{\alpha}. \tag{3.2}$$

where *r* and *u* indicate rural and urban sectors, respectively; L and K denote land and capital inputs; γ and α (0<γ<1 and 0<α<1) are the elasticities of the outputs, $Y_r \ and \ Y_u$, with respect to the labor inputs, $N_r \ and \ N_u$, respectively. Given that the total labor supply is $N = N_r + N_u$, which can be normalized to be 1, then, the urbanization rate is $U = \frac{N_u}{N} = N_u$.

Following Harris and Todaro (1970) and Black and Henderson (1999), the price of the agricultural product is normalized to 1 and the relative price of the industrial product is denoted by *P*. Agents are paid the marginal outputs:

$$W_r = \gamma L^{1-\gamma} N_r^{\gamma-1} \tag{3.3}$$

$$W_u = P\alpha K^{1-\alpha} N_u^{\alpha-1}. \tag{3.4}$$

Following Harris and Todaro (1970), migrants make decisions based on the wage differences. However, in this paper, we introduce a migration cost function $C(I_c, Z)$, where I_c represents information cost and Z represents other costs (Sjaastad 1962). The information cost function can be specified as (Amrhein 1985):

$$I_c = \begin{cases} 1 - \rho M & M < \delta \\ 0 & M \geq \delta \end{cases}, \rho > 0 \tag{3.5}$$

where M stands for the information set a potential migrant may have; I_c is a decreasing function of M with a minimum value of 0; δ denotes a threshold value for complete information, under which the agent faces no uncertainties, and ρ is a parameter. Clearly, $\frac{\partial I_c}{\partial \mathrm{M}} < 0$ and $\frac{\partial \mathrm{C}}{\partial \mathrm{M}} < 0$.

The equilibrium condition is simply given by:

$$W_r = W_u - C(I_c, Z) \tag{3.6}$$

Substitute (3.3) and (3.4) into (3.6) yields:

$$\gamma L^{1-\gamma} N_r^{\gamma-1} = P\alpha K^{1-\alpha} N_u^{\alpha-1} - C(I_c, Z) \tag{3.7}$$

Differentiating both sides of (3.7) with respect to I_c and rearranging, we have:

$$\frac{\partial N_u}{\partial I_c} = \frac{C'(I_c, Z)}{\gamma(\gamma-1)L^{1-\gamma}(1-N_u)^{\gamma-1}N_u^{\gamma-2} + (\alpha-1)(P\alpha K^{1-\alpha}N_u^{\alpha-2})} \tag{3.8}$$

Given $0 < \gamma < 1$ and $0 < \alpha < 1$, we have $\frac{\partial N_u}{\partial I_c} < 0$, which implies that the urbanization rate decreases with rising information cost. Adding $\frac{\partial I_c}{\partial M} < 0$, we obtain $\frac{\partial N_u}{\partial \mathrm{M}} > 0$, implying a positive relationship between the urbanization rate and information.

4. EMPIRICAL MODEL SPECIFICATION

Our empirical model specification follows that of Davis and Henderson (2003). We start with a naïve OLS regression with time λ and country μ fixed effects:

$$urban_{it} = \beta Infor_{it} + \alpha' X_{it} + \theta' C_{it} + \mu_i + \lambda_t + \epsilon_{it} \qquad (4.1)$$

where ε is the idiosyncratic error, *Urban* is the urbanization rate. *Infor* is the information variable, to be proxied by the Internet penetration rate (*inter*). Recall that year 1990 is discussed as the invention year of contemporary Internet. This allows us to conduct a natural experiment that Internet data was set 0 before 1990 and after 1990 is reported data from database; in conducting the robustness check, the number of Short Message Sent (SMS) is used as an alternative indicator. The vector *X* contains the conventional push–pull factors which include: per capita gross domestic product (GDP) (*lngdppop*); growth of per capita GDP (*gdpgr*); industrialization (*nagr,* measured as non-agricultural share of GDP); education (*schyr,* measured by average years of schooling of the adult population); trade (*trade,* measured as exports plus imports as a percentage of GDP); and infrastructure density (*density,* as kilometers of roads per square kilometer of land area). The vector *C* indicates other control variables including demographic factors, including (1) urbanization convergence (*urban60*, which is the urbanization level in 1960); (2) urban concentration (*primacy*, population of the largest city as a percentage of total urban population). A higher concentration may be associated with a higher overall urbanization rate (Davis and Henderson 2003); (3) Population density (*popdensity,* as the population per square kilometer of land). It accounts for the relative size of country and population, which might lead to population agglomeration (Beals et al. 1967); (4) Population growth (*popgr*). It can affect urbanization either directly *via* differential growth in urban vs. rural areas, or through migration (Jedwab et al. 2015). We expect that β is positive which indicates a positive information impact on urbanization, as predicted by our theoretical model. These control variables are included according to the existing literature (Hofmann and Wan 2013), as discussed below.

Economic development. Moomaw and Shatter (1996) suggest that economic development promote urbanization from two main channels: (1) Economic growth leads to more detailed labor division and increases industrial linkages, which highlights the demand of reducing transaction costs. Locating in urban areas helps firms to economize communication and transportation costs. (2) Industrialization: With the economic structure shifting from agriculture towards industry and services, the labor force needs to be transformed. Therefore, rural people are encouraged to move to cities, where industry and services sectors are clustered. These two channels can work jointly or independently: Labor division may lead to higher urbanization even when industrial structure is unchanged. Likewise, industrialization may occur without firms expanding their markets. Therefore, we add variables for economic development (as measured by per capita GDP and GDP growth) and industrialization (as measured by non-agricultural share of GDP).

Education. The impact of education on urbanization relates to knowledge spillovers. Within-industry spillover is a major reason for industrial agglomeration. High-tech industries, in particular, need an educated workforce. As a result, education and technological sophistication may jointly promote the clustering of business activities. Moreover, knowledge spillovers increase the returns to human capital (Black and Henderson 1999; Lucas 1988). Rauch (1993) shows that after conditioning on the characteristics of individual workers, cities with a higher average education level offer higher wages, which could attract individuals with all education levels to migrate to cities. In addition, education could change individuals' preferences towards more uncertainty environments and more likely to migrate (Schwartz 1973).

Trade. Trade promotes urbanization through at least two channels: (1) Trade development is accompanied by growth in transportation hubs, which are usually located in cities; and (2) The setup and maintenance of international trade connections increase demand for marketing and financing services that also concentrate in cities (Hofmann and Wan 2013). Besides, Gollin, Jedwab, and Vollrath (2016) found natural resource exports drive urbanization in 116 developing countries. Large amounts of resources trade produce "consumption cities" in exports countries like Kuwait, Gabon, Saudi Arabia, which urbanize fast even without industrialization.

Infrastructure. Better infrastructure can be a reason for household and business to move to urban areas. On the other hand, denser infrastructure is usually associated with lower transport costs, which reduce incentives to locate economic activity in overcrowded cities. The role of infrastructure has been prominently featured in the core-periphery literature (Krugman 1991) that analyze urban concentration in core regions and periphery regions in the presence of technological progress, which is often indicated by lower transport costs.

5. DATA AND RESULTS

5.1 Data

Our dataset covers 106 non-OECD countries and regions over 54 years from 1960 to 2013. OECD countries are excluded because they more or less completed the urbanization process by 1960s with stable urbanization rate. Three city-states—Hong Kong, China; Macau, China; and Singapore, are also excluded due to long-time 100% urbanized. Data are obtained from several sources: country-level development data are from the World Development Indicators Database (WDI) of the World Bank; ICT data are from the World Telecommunication/ICT Indicators Database (ITU); education data are from the Barro–Lee Educational Attainment Database (BL)[5]; road density data are from World Road Statistics Database (WRS). Table 2 provides the definitions and sources of each variable.

5 http://www.barrolee.com/ (accessed 1 September 2015). Because this database only offers data in 5-year periods, we obtain annual data from the nearest available years.

Table 2: Definitions and Sources of Variables

Variable	Definition	Source
Dependent:		
Urban	Urban population (% of total)	WDI
Independent:		
lninter	Logarithm of Internet users per 100 people	ITU
lnsms	Logarithm of number of short messages	ITU
Control: Push–pull		
lngdppop	Logarithm of GDP per capita (US$)	WDI
gdpgr	GDP per capita growth (annual %)	WDI
schyr	Logarithm of Schooling, to the nearest data available	BL
nagr	Non-agriculture (% of GDP)	WDI
openness	International trade （% of GDP）	WDI
density	Road density (kms of road per km^2 of land area)	WRS
lndurbanpop	Logarithm of urban population increase	WDI
Control: Others:		
popdensity	Population density (people per sq. km of land area)	WDI
popgr	Population growth (annual %)	WDI
primacy	Population in the largest city (% of urban population)	WDI
urban60	Urbanization rate in 1960	WDI
IVs:		
phone89	Fixed telephone subscriptions (per 100 people) in 1989	ITU

Source: Authors.

5.2 Descriptive Statistics

Table 3 presents summary statistics for the variables in our regression. Several points are worth noting. First, the numbers of observations vary among variables. In particular, the observations on infrastructure density and SMS are much less than other development indicators. Second, urbanization rate highly varies over a wide range, with a minimum value 3.13%, maximum 99.06% and standard deviation 22.5%. Countries with high urbanization rates[6] are from Latin America and the Caribbean, Northern America (UN 2014) and resource export states (Gollin, Jedwab, and Vollrath 2016). Therefore, we employ quantile regressions to check the robustness of our baseline results. Third, our data include some extreme observations, e.g., GDP growth decreased by 65% and the population growth rate was negative during war.[7] We did not drop these observations because we believe these macro factors would not change the information effects. Our robustness check confirms this.

[6] Countries that have urbanized rates higher than 85% are Argentina, Bahrain, Brazil, Gabon, Kuwait, Malta, Qatar, Uruguay, and Venezuela, and higher than 90% are Argentina, Kuwait, Malta, Qatar, and Uruguay.

[7] For example, GDP growth rate is highly negative during two Liberian civil wars (–50% in 1990 and –34% in 2004), Iraq during Gulf war (–65% in 1991) and Tajikistan civil war (–30% in 1992); GDP growth is 102.8% in 2012 just after Libyan civil war. Also, the population growth rate is negative in Rwandan civil war (–7.6& in 1993) and in Armenia during Nagorno–Karabakh conflict (–2.4% in 1994).

Table 3: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
urban	3,865	45.4	22.5	3.1	99.1
gdppop	3,563	35,57.5	6,628.5	50.0	60,290.2
gdpgr	3,597	1.9	6.4	–65.0	102.8
nagr	3,229	78.9	14.8	25.7	99.7
schyr	3,865	4.8	2.8	0.0	11.7
trade	3,522	72.8	39.5	0.3	280.4
density	2,390	0.6	5.5	0.0	256.0
popdensity	3,862	105.3	191.3	1.1	1,752.9
primacy	3,384	33.2	14.6	2.6	100.0
popgr	3,855	2.1	1.6	–7.6	17.5
inter[8]	3,326	6.7	14.0	0	90
sms	524	2.55E+10	8.80E+10	3,000	7.73E+11

Source: Authors.

5.3 Baseline Results

Before estimating our models, panel unit-root tests are conducted for each variable and both the ADF and ADF–PP tests reject unit roots in our data. Besides, the residual of model (3) is found to be stationary (Inverse χ^2 =267), which confirms that time-series correlation is not likely to be a problem in our analysis.

Table 4 tabulates the baseline results. Panel A reports the coefficients for the main variables, and Panel B reports the coefficients for year dummies. To save space, we only present time coefficients from 1990 here but all time coefficients are in Appendix A.1. Columns (1) and (2) show the results for estimation by conventional push–pull factors with and without control variables. Column (3) also includes the information proxy.

Table 4: Baseline Model Results

	(1)	(2)	(3)
	Panel A		
lngdppop	3.289***	4.115***	2.706***
	(0.62)	(0.61)	(0.72)
gdpgr	–0.109***	–0.117***	–0.111***
	(0.02)	(0.02)	(0.02)
nagr	–0.019	–0.002	0.022
	(0.02)	(0.02)	(0.03)
schyr	3.909***	2.588***	2.674***
	(0.77)	(0.72)	(0.85)
openness	0.006	0.016**	0.024***
	(0.01)	(0.01)	(0.01)

continued on next page

8 Internet is highly positive skewed (skewness = 2.72). In regression analysis, we take logarithms to make them more symmetrical (skewness = –0.11) (Field 2009).

Table 4 *continued*

	(1)	(2)	(3)
popdensity	–0.008	0.003	0.016*
	(0.01)	(0.01)	(0.01)
urban60		0.440***	0.371***
		(0.04)	(0.06)
primacy		–0.02	–0.011
		(0.04)	(0.04)
popdensity		–0.071***	–0.072***
		(0.01)	(0.01)
popgr		–0.157	–0.740***
		(0.15)	(0.23)
lninter			0.527***
			(0.13)
constant	–1.615	41.301***	77.037***
	(5.28)	(5.76)	(7.15)
Country dummy	Yes	Yes	Yes
N	1,923	1,710	1,386
adj. R-sq	0.972	0.977	0.977
	Panel B		
1990	12.373***	15.824***	0
1991	12.816***	16.494***	0
1992	13.225***	16.888***	–0.274
1993	13.703***	17.468***	0.328
1994	14.133***	17.942***	0.593
1995	14.247***	18.390***	0.485
1996	14.590***	18.829***	0.564
1997	15.237***	19.527***	0.434
1998	15.556***	19.588***	0.251
1999	16.566***	20.466***	0.705
2000	15.266***	20.096***	0.093
2001	15.640***	20.664***	0.248
2002	15.963***	20.740***	0.095
2003	16.620***	21.666***	0.661
2004	17.735***	22.763***	2.053
2005	17.178***	22.005***	1.139
2006	17.106***	22.347***	1.352
2007	17.667***	23.062***	2.255
2008	17.864***	23.000***	1.807
2009	17.594***	22.775***	1.604
2010	17.683***	23.201***	1.803
2011	18.639***	24.004***	2.496
2012	18.934***	24.446***	2.926
2013	18.693***	24.415***	2.946

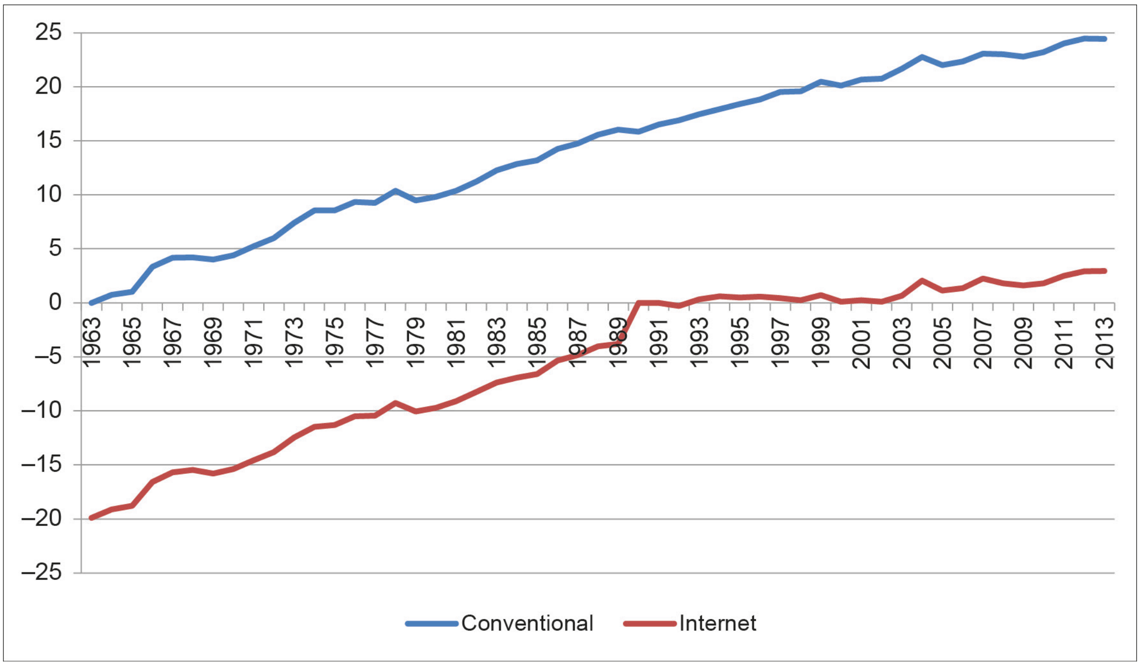
Note: Column (1), we only control push–pull factors; Column (2), all control variables; Column (3) natural experiment with information proxy. Panel A reports the coefficients for main variables; Panel B reports the coefficients for year dummies after 1990 to show the time trend; robust standard errors (SEs) are reported in parentheses in Panel A to two-significant digits, and the coefficients are reported to the same number of digits behind the decimal points as the corresponding SEs; the asterisks, *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Source: Authors.

Table 4 shows that: Frist, there is a clear accelerating trend in urbanization. In Columns (1) and (2) of Panel B, all the year dummies are significant with the magnitudes broadly increasing from 12.373 to 18.693 (also see Table A.1). This implies that, over time, the urbanization process has accelerated almost year by year. Second, the conventional "pull–push" factors can't explain the acceleration trend. Per capita GDP, economic growth and education have significant impacts on urbanization with expected signs, but industrialization, trade and infrastructure density are insignificant. However, with all these conventional determinations included, urbanization acceleration still remains unexplained as indicated by the significance of dummy variables in Columns (1) and (2) of Table 4. Third, the coefficient of the information proxy is strongly positive, showing a significant information effect on urbanization. Also, when the information proxy is added, the coefficients of year dummies become more stable and insignificant. Clearly, urbanization acceleration has been accounted for by the information variable. The unit root test for residuals in the baseline model (3) firms that the

These results can be seen clearly in Figure 2, which plots the coefficient estimates for the year dummies reported in Columns (2) and (3) of Panel B. The blue line, corresponding to the model which only incorporates conventional push–pull factors, shows a roughly monotonically increasing trend over the years. By contrast, the red line that corresponds to the model with information proxy as an additional variable parallels the blue line before year 1990, but becomes flat and close to zero when the Internet effect is included.

Figure 2: Coefficients of Year Dummies in Columns (2) and (3) of Table 2



Source: Authors.

5.4 IV-fixed Effects Results

Endogeneity might rise with our baseline models as reverse causality may run from urbanization to information. More urbanized countries are usually better off and can afford better facilities of Internet, meaning higher Internet penetration. In addition, it is possible for third factors to drive both urbanization and Internet, such as economic growth. As an economy develops, more people move to the cities (see the discussion in the previous section). At the same time, improvement in living standard leads to higher demand for Internet, which stimulates the development of the Internet (Czernich et al. 2011).

To address the endogeneity problem, we follow (Czernich et al. 2011) to use the predicted Internet penetration rate from the technology diffusion model as the instrumental variable (IV (users per 100 people). This rate is estimated by a logistic model of technology diffusion (Czernich et al. 2011).

When the Internet became commercialized in the 1990s, it relied on the cooper wire of the fixed telephone network and the main distribution frame is the so-called dial-up Internet Service Provider (ISP). In other words, access to the existing voice phone network, built for purposes other than the Internet, was necessary for fixed-line Internet connection. Following Czernich et al. (2011), we assume that the maximum of Internet ω_i is decided by the voice telephony spread that existed before the Internet.[9] use the number of subscriptions per 100 people in the year 1989 (tel_net_{i0}) as the indicator of existing telephone spread:

$$\omega_i = \omega_0 + \varphi_1 tel\_net_{i0} \tag{5.1}$$

After the pioneering work of Griliches (1957) on the technology innovation process, many studies found that the extensive margin of a technology can be best described by a logistic curve (Comin, Hobijn, and Rovito 2006; Geroski 2000):

$$inter_{it} = \frac{\omega_i}{1+\exp\left[-\rho(t-\tau)\right]} + \pi_{it} \tag{5.2}$$

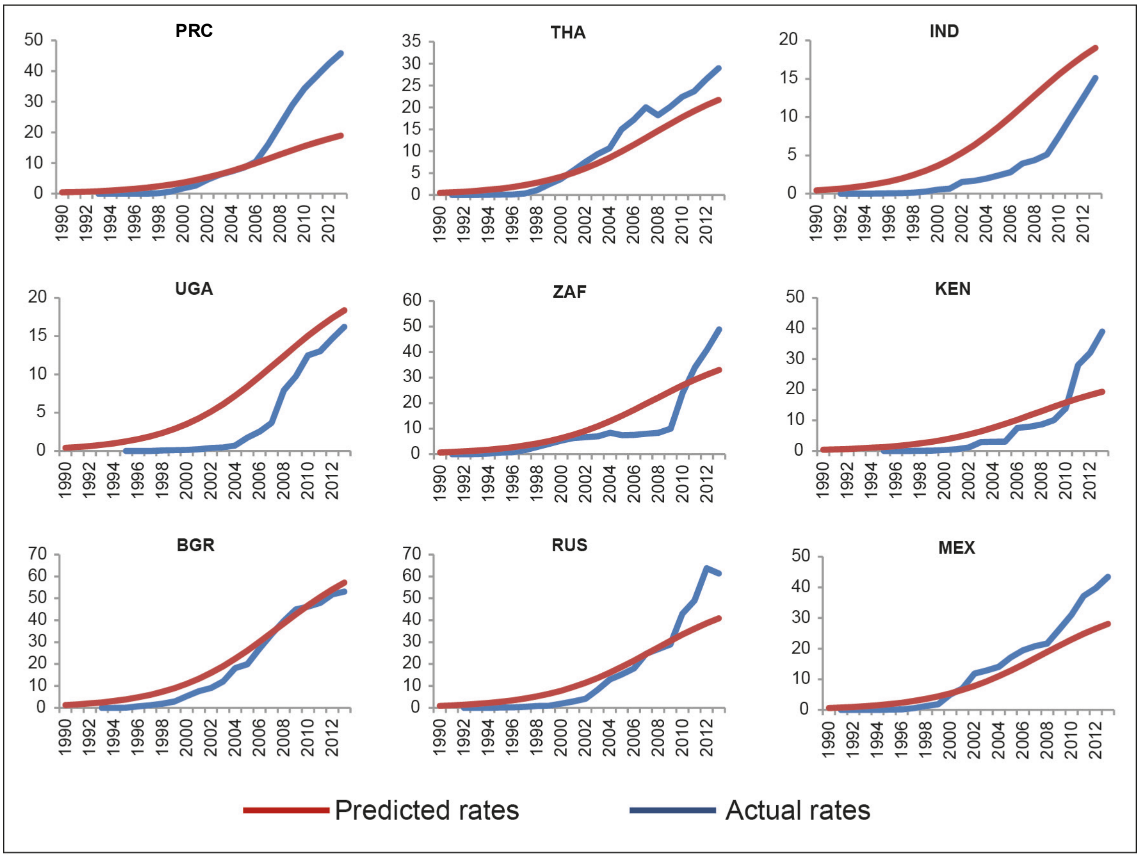
where *i* and *t* denote country and time; *inter* is the observed Internet penetration rate; the parameters ω, ρ and □ are the maxim
the speed and the inflection point of the diffusion curve, respectively;[10] and π_{it} is an error term.

We insert equation (5.2) into equation (5.1) and obtain a nonlinear first-stage equation, which can be estimated and used to predict the counterfactual Internet penetration rates, which are determined by purely exogenous factors. The first stage has a relatively good fitness with adjusted R2 as high as 0.875. Figure 3 plots the predicted and actual Internet penetration rates for several countries in different regions of the world. The top three charts are plots for three countries in Asia (the PRC, Thailand, and Indonesia); the middle ones are plots for three countries in Africa (Uganda, South Africa, and Kenya); and the bottom panel are plots for the three countries in Europe and America (Bulgaria, Russia, and Mexico). According to United Nations (2014), Asian and African countries have high urbanization growth rates, therefore, we separate these regions from others. The S-shape of the logistic Internet diffusion is visible in most countries and our predicted values show a close relationship with the actual ones.

[9] Czernich et al. (2011) predicted the penetration rates of broadband Internet, which could be provided by voice telephone network or cable TV network. Therefore, they use both as instruments. However, in our case, consumer use of the Internet began through dial-up Internet access

[10] At the inflection point τ, the diffusion curve reaches its maximum growth rate ρ/2.

Figure 3: Predicted and Actual Internet Penetration Rates



PRC = People's Republic of China; THA = Thailand; IND = Indonesia; UGA = Uganda; ZAF = South Africa; KEN = Kenya; BGR = Bulgaria; RUS = Russian Federation; MEX = Mexico.

Source: Authors.

Table 5 reports the results of the IV-fixed effect regressions. Columns (4) to (6) show results respectively using data of all countries, of Asian and African countries, and of developing countries in Europe and America. The results are quite consistent with baseline results in Table 4. The coefficients become less significant and more random in all the columns in Panel B. This implies that the time trend has been accounted for by the Internet penetration variable.

We conduct several tests to verify our IV analysis of model (4). The results are: (1) the endogenous test strongly reject that Internet is endogenous, where the p-value of Durbin–Wu–Hausman χ^2test is 0.00052. (2) The weak instrument test reports a large Cragg–Donald Wald F statistic (425.637), which strongly rejects the weak instrument hypothesis. (3) The underidentification test shows no underidentification with a large Anderson canon. corr. LM statistic (353.330). Finally, since the our equation is exactly identified with only one instrument variable and one instrumented variable, Sargan–Hansen Overidentificantion test is not applicable in our case[11]. Overall, the IV for Internet is valid.

[11] See help file of STATA command ivreg2.

Table 5: Results Using IV

	(4) All Samples	(5) Asia and Africa	(6) America and Europe
		Panel A	
lninter	1.227***	2.391***	3.145
	(0.24)	(0.33)	(2.42)
lngdppop	1.913***	2.367***	1.611
	(0.55)	(0.72)	(1.11)
gdpgr	–0.102***	–0.107***	–0.025
	(0.02)	(0.03)	(0.03)
nagr	0.028	0.003	0.219***
	(0.02)	(0.03)	(0.07)
schyr	3.278***	1.919***	4.616***
	(0.57)	(0.72)	(1.52)
openness	0.019***	–0.007	–0.018*
	(0.01)	(0.01)	(0.01)
density	0.017	–0.107	0.008
	(0.01)	(0.08)	(0.01)
primacy	–0.013	0.014	–0.415***
	(0.03)	(0.03)	(0.13)
popdensity	–0.068***	–0.082***	0.124***
	(0.01)	(0.01)	(0.02)
popgr	–0.554***	0.409*	–2.508***
	(0.18)	(0.24)	(0.72)
urban60	1.996***	2.168***	0.565***
	(0.30)	(0.34)	(0.16)
_cons	–23.306***	–39.497***	–25.84
	(6.27)	(7.97)	(41.59)
Country dummy	Yes	Yes	Yes
N	1,386	879	507
adj. R-sq	0.976	0.96	0.951
		Panel B	
1990	0	0	0
1991	4.585	18.270***	28.656
1992	3.754	15.217***	27.677
1993	3.427	11.894***	24.49
1994	3.263	10.534***	22.451
1995	2.529	9.849***	18.991
1996	2.115	9.182***	15.473
1997	1.1	5.838**	13.648
1998	0.236	2.75	11.475
1999	0.131	3.46	9.382
2000	–0.832	1.495	6.472
2001	–1.077	–0.009	6.399
2002	–1.437	–0.262	5.019
2003	–1.067	0.029	4.655
2004	0.236	1.766	4.372
2005	–0.958	0.091	2.826
2006	–0.827	–0.268	2.431
2007	–0.023	1.676	1.824

continued on next page

Table 5 *continued*

	(4) All Samples	(5) Asia and Africa	(6) America and Europe
2008	–0.621	–0.121	1.511
2009	–0.963	–0.753	0.802
2010	–0.958	–1.228	0.258
2011	–0.318	0.148	0.223
2012	0.028	0.29	0.319
2013	0	0	0

Note: Column (4) contains the Internet IV results using full sample data; Column (5) are results using subsample data of Asia and Africa; Column (6) contain the results for the subsample of Europe and America; Panel A reports the coefficients for the main variables; Panel B reports the coefficients for year dummies after 1990; robust standard errors (SEs) are reported in parentheses in Panel A to two-significant digits, and the coefficients are reported to the same number of digits behind the decimal points as the corresponding SEs; the asterisks, *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Source: Authors.

6. ROBUSTNESS CHECKS

6.1 Quantile Regressions

We conduct quantile regressions with 0.2, 0.4, 0.6, and 0.8 quantiles. Results are summarized in Table 6. Again, these results are quite consistent with those of previous tables. The proxies for information have a positive effect on urbanization among quantiles. The time trend becomes less significant and more stable when the proxy is added.

Table 6: Results of Quantile Regressions

	(7) 0.2Q	(8) 0.4Q	(9) 0.6Q	(10) 0.8Q
		Panel A		
lninter	0.320***	0.457***	0.532***	0.341***
	(0.08)	(0.17)	(0.16)	(0.13)
lngdppop	3.889***	3.282***	1.946***	1.642***
	(0.31)	(0.71)	(0.66)	(0.55)
gdpgr	–0.042***	–0.066**	–0.047*	–0.040*
	(0.01)	(0.03)	(0.03)	(0.02)
nagr	0.011	0.016	0.016	0.033
	(0.01)	(0.03)	(0.03)	(0.02)
schyr	1.075***	1.464*	2.993***	3.536***
	(0.34)	(0.76)	(0.71)	(0.60)
openness	0.016***	0.038***	0.026***	–0.003
	(0.00)	(0.01)	(0.01)	(0.01)
density	0.019**	0.024	0.019	0.012
	(0.01)	(0.02)	(0.02)	(0.01)
primacy	–0.089***	–0.090**	–0.110***	–0.090***
	(0.02)	(0.04)	(0.03)	(0.03)
popdensity	–0.063***	–0.062***	–0.061***	–0.059***
	(0.00)	(0.01)	(0.01)	(0.01)

continued on next page

Table 6 *continued*

	(7) 0.2Q	(8) 0.4Q	(9) 0.6Q	(10) 0.8Q
popgr	–0.564***	–0.826***	–0.613***	–0.571***
	(0.11)	(0.24)	(0.22)	(0.19)
urban60	1.426***	1.719***	1.922***	2.144***
	(0.19)	(0.42)	(0.39)	(0.33)
constant	–10.267***	–13.862	–8.995	–5.625
	(3.74)	(8.44)	(7.84)	(6.60)
Country dummy	Yes	Yes	Yes	Yes
N	1,386	1,386	1,386	1,386
		Panel B		
1990	0	0	0	0
1991	–2.19	–0.189	–2.069	–5.841**
1992	–2.989***	–2.137	–2.274	–5.401***
1993	–3.134***	–0.428	–1.551	–4.991***
1994	–2.169***	–0.646	–1.582	–4.102***
1995	–2.428***	–0.918	–1.561	–4.761***
1996	–2.210***	–1.14	–2.053	–4.781***
1997	–2.115***	–1.287	–2.215	–4.945***
1998	–2.018***	–1.36	–1.744	–5.093***
1999	–1.773**	–1.05	–1.691	–5.297***
2000	–1.936***	–1.641	–3.077***	–5.205***
2001	–1.093*	–1.06	–2.544**	–5.059***
2002	–1.278**	–1.281	–2.458**	–4.732***
2003	–1.313**	–0.884	–2.375**	–4.302***
2004	–0.641	–0.517	–1.913*	–3.916***
2005	–0.59	–0.877	–2.459**	–4.114***
2006	–0.549	–0.721	–2.344**	–3.801***
2007	–0.445	–0.562	–1.914*	–3.619***
2008	–0.506	–0.618	–1.854*	–2.837***
2009	–0.48	–0.46	–1.438	–2.358***
2010	–0.399	–0.428	–1.373	–2.122**
2011	–0.306	–0.218	–0.997	–1.375
2012	–0.198	–0.195	–0.611	–0.722
2013	0	0	0	0

Note: Columns (7) to (10) report results from the 0.2 to 0.8 quantiles, respectively; Panel A reports the coefficients for main variables; Panel B reports the coefficients for year dummies after 1990; robust standard errors (SEs) are reported in parentheses in Panel A to two-significant digits, and the coefficients are reported to the same number of digits behind the decimal points as the corresponding SEs; the asterisks, *, **, and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Source: Authors.

6.2 SMS as Information Proxy

Here, we use the number of short text messages sent (SMS) as an alternative proxy of information. Unfortunately, the cross-country data from the IUT database only start from the year 2000.

Like the potential endogeneity of Internet discussed before, more messages sent might be due to higher urbanization as urban areas usually have better telecommunication facilities. An IV for SMS is the lagged 1-year SMS. Previous year's SMS is exogenous to current urbanization process. The weak identification test and under-indentification test verify the validity of this IV.

Table 7 reports the results using SMS as the information proxy. Columns (11) to (14) display the results from our baseline model, IV results for total sample and different regions. Again, the time dummies become less significant, which implies that urbanization acceleration can be accounted for by the ICT.

Table 7: SMS as the Information Proxy

	(11)	(12)	(13)	(14)
	FE	SMS IV	Asia and Africa	America and Europe
		Panel A		
lnsms	0.112	0.535*	0.495*	–0.164
	(0.16)	(0.31)	(0.29)	(0.39)
lngdppop	4.273	3.831**	9.763***	–4.792**
	(2.93)	(1.69)	(2.24)	(1.94)
gdpgr	0.039	0.018	–0.053	0.039
	(0.04)	(0.03)	(0.06)	(0.03)
nagr	0.202*	0.272***	0.043	0.425***
	(0.10)	(0.09)	(0.11)	(0.13)
schyr	3.120**	3.998**	–0.885	3.522
	(1.49)	(1.80)	(2.10)	(2.59)
openness	–0.004	–0.02	–0.016	0.015
	(0.01)	(0.01)	(0.01)	(0.01)
density	7.202**	8.483***	2.515	0.962
	(3.29)	(2.52)	(3.42)	(3.25)
primacy	–0.395**	–0.366**	–0.157	–0.434***
	(0.16)	(0.15)	(0.36)	(0.13)
popdensity	0.051	0.042	–0.072	0.296***
	(0.04)	(0.05)	(0.06)	(0.07)
popgr	–1.151**	–2.355***	–1.907	–0.419
	(0.51)	(0.65)	(1.27)	(0.53)
urban60	0.378	–0.249	0.337	–10.306***
	(0.23)	(0.30)	(0.33)	(2.13)
constant	7.826	–13.846	–30.057*	380.291***
	(14.63)	(12.83)	(17.03)	(67.53)
Country dummy	Yes	Yes	Yes	Yes
N	219	173	85	88
adj. R–sq	0.996	0.997	0.998	0.995

continued on next page

Table 7 *continued*

	(11)	(12)	(13)	(14)
	FE	SMS IV	Asia and Africa	America and Europe
		Panel B		
2001	0.261	0.057	–0.794	0
2002	0.451	0	0	0
2003	–0.37	0.71	–1.781	–3.295**
2004	0.128	1.44	–0.653	–2.482**
2005	–0.177	–0.194	–0.52	–2.797***
2006	–0.431	0.167	–0.065	–2.343***
2007	–0.243	–0.02	–0.599	–1.471***
2008	0.034	0.179	–0.755	–1.019***
2009	0.592	0.354	–0.797	–0.52
2010	0.058	–0.212	–0.385	–0.893***
2011	0.452	–0.03	0.194	–0.485*
2012	0.771	0.411	0.491	–0.119
2013	0.484	0	0	0

SMS = Short Message Service.

Note: Column (11) fixed-effect model for all samples using SMS as the information proxy; column (12), IV results for all samples; column (13), IV results for subsample of Asia and Africa; column (14), IV results for subsample of America and Europe. Panel A reports the coefficients for main variables, and panel B reports the coefficients for year dummies after 2000 to show the time trend. Robust standard errors (SEs) are reported in parentheses in panel A to two-significant digits, and the coefficients are reported to the same number of digits behind the decimal points as the corresponding SEs; the asterisks, *,**, and *** indicate significant at the 10%, 5%, and 1% levels, respectively.

Source: Authors.

6.3 Other Robustness Check

A migration snowball effect might exist that the larger the current migrant community is in a given country, the more rural residents who tend to migrate (Sahota 1968; Kantorowicz 2010). This might be because migration costs decrease with the number of migrants already settled in the destination (Carrington, Detragiache, and Vishwanath 1996). Therefore, we account for the annual change of urban population. Besides, we drop the extreme observations with GDP growth (gdpgr>50) and population growth (popgr>100) to reduce the outlier impacts. The results are reported in Table 8.

The change of urban population has a positive coefficient estimate in all columns in Table 8, implying a positive snowball impact on urbanization. However, as shown in column 15 of panel B, the coefficient estimates for year dummies are still significantly positive after adding this variable. By contrast, these coefficients become less significant in column 16 and 17, where Internet is considered in both. These results suggest that, the trend is more likely due to the information effect than the growth of urban population.

Table 8: Other Robustness Results

	(15)	(16)	(17)
	Panel A		
urbanpopchange	1.724***	2.734***	3.874***
	(0.39)	(0.58)	(0.55)
lngdppop	5.773***	4.620***	5.327***
	(0.66)	(0.77)	(0.86)
gdpgr	–0.130***	–0.151***	–0.169***
	(0.03)	(0.03)	(0.04)
nagr	–0.013	–0.005	0.018
	(0.02)	(0.03)	(0.03)
schyr	1.843**	1.684*	1.287
	(0.75)	(0.90)	(1.00)
openness	0.002	0.012	0.001
	(0.01)	(0.01)	(0.01)
density	–0.01	–0.013	–0.023**
	(0.01)	(0.01)	(0.01)
urban60	0.473***	0.442***	1.518***
	(0.05)	(0.07)	(0.07)
primacy	–0.029	–0.021	–0.005
	(0.05)	(0.04)	(0.05)
popdensity	–0.080***	–0.083***	–0.087***
	(0.01)	(0.01)	(0.01)
popgr	–0.174	–1.069***	–1.595***
	(0.20)	(0.32)	(0.41)
lninter		0.537***	0.452***
		(0.13)	(0.14)
cons	23.842***	39.713***	–62.615***
	(7.47)	(9.73)	(6.69)
Country dummy	Yes	Yes	Yes
N	1,503	1,198	920
adj. R–sq	0.979	0.979	0.98
	Panel B		
1990	10.628***	0	0
1991	11.344***	–2.635	–1.033
1992	11.841***	–2.427	–1.422
1993	12.212***	–2.926*	–0.952
1994	12.743***	–2.785*	–0.79
1995	13.273***	–2.497*	–0.371
1996	13.798***	–2.049	–0.064
1997	14.069***	–2.772**	–0.447
1998	13.847***	–3.237**	–0.708
1999	14.846***	–2.878**	0
2000	15.085***	–2.747**	–0.432

continued on next page

Table 8 *continued*

	(15)	(16)	(17)
	Panel A		
2001	15.474***	–2.919***	–0.572
2002	15.698***	–2.812***	–0.312
2003	16.849***	–2.081**	0.283
2004	18.075***	–0.68	1.276
2005	17.558***	–1.401	0.871
2006	17.719***	–1.414	0.885
2007	18.634***	–0.284	2.192*
2008	18.492***	–0.881	1.372
2009	18.110***	–1.247	0.524
2010	18.487***	–1.016	1.325
2011	19.430***	–0.292	2.465**
2012	19.682***	0.01	2.481*
2013	19.697***	0	2.708**

Note: Column (15) contains results including urban population growth as the explanatory variable; column (16), results including Internet, column (17) results without outliers in samples. Panel A reports the coefficients for main variables, and panel B reports the coefficients for year dummies after 1990 to show the time trend. Robust standard errors (SEs) are reported in parentheses in panel A to two-significant digits, and the coefficients are reported to the same number of digits behind the decimal points as the corresponding SEs; the asterisks, *,**, and *** indicate significant at the 10%, 5%, and 1% levels, respectively.

Source: Authors.

7. CONCLUDING COMMENTS

There is a clear trend that the urbanization rate has accelerated for the last few decades. We explain this phenomenon from the perspective of migration information enrichment, which is associated with the worldwide development of ICT sectors. This effect has previously been largely neglected in the migration and urbanization literature. We build a two-sector general equilibrium model incorporating information cost and investigate its relationship with urbanization. Then a cross-country analysis is conducted using data from 109 countries over 1960 to 2013. Both the fixed effects and the IV-fixed effects results show that 1) information enrichment is important to explain this worldwide acceleration; 2) conventional factors in a “push–pull” analysis become weak as urbanization drivers; and 3) the results are robust to different developing levels, and to different urbanization quantiles and different proxies.

Our paper has significant policy implications. First, urbanization acceleration is inevitable with the development of the ICT sector. Governments should be alert to this fast trend and prepare for the migration surges by providing public services and implementing necessary policies, such as, providing housing and education facilities to accommodate the migrants and building roads and appropriate transportation infrastructures to solve the problems of congestion. Unplanned urbanization could threaten sustainable growth, similar to what happened in Africa since the 1970s (Fay and Opal 2000). Second, this trend is not likely to be temporary. During the period of our analysis from 1963 to 2013, urbanization has been continuingly increasing. The ICT sector development will always reduce the information cost and simulate migration. Third, this acceleration will be seen not only in developing countries but also in developed countries, because technology innovation occurs all over the world.

REFERENCES

Amrhein, C. G. 1985. Interregional Labor Migration and Information Flows. *Environment and Planning A* 17(8): 1111–1126.

Bairoch, P. 1988. Cities and Economic Development: from the Dawn of History to the Present. Chicago, IL: University of Chicago Press.

Barrios, S., L. Bertinelli, and E. Strobl. 2006. Climatic Change and Rural–urban Migration: The Case of Sub-Saharan Africa. *Journal of Urban Economics* 60(3): 357–371.

Beals, R. E., M. B. Levy, and L. N. Moses. 1967. Rationality and Migration in Ghana. *Review of Economics and Statistics* 49(4): 480–486.

Bhuller, M., T. Havnes, E. Leuven, and M. Mogstad. 2013. Broadband Internet: An Information Superhighway to Sex Crime? *Review of Economic Studies* 80(4): 1237–1266.

Black, D., and V. Henderson. 1999. A Theory of Urban Growth Urban Growth. *Journal of Political Economy* 107(2): 252–284.

Carrington, W. J., E. Detragiache, and T. Vishwanath. 1996. Migration with Endogenous Moving Costs. *American Economic Review* 86(4): 909–930.

Chau, N. H. 1997. The Pattern of Migration with Variable Migration Cost. *Journal of Regional Science* 37(1): 35–54.

Comin, D., B. Hobijn, and E. Rovito. 2006. Five Facts You Need to Know about the Techology Diffusion. *NBER Working Paper.* URL: http://www.nber.org/papers/w11928 (accessed 15 February 2017).

Czernich, N., O. Falck, T. Kretschmer, and L. Woessmann. 2011. Broadband Infrastructure and Economic Growth Broadband Infrastructure and Economic Growth. *The Economic Journal* 121: 505–532.

Davis, J. C., and V. Henderson. 2003. Evidence on the Political Economy of the Urbanization Process. *Journal of Urban Economics* 53(1): 98–125.

Fay, M., and C. Opal. 2000. Urbanization without Growth: A Not-So-Uncommon Phenomenon. *The World Bank Policy Research Working Paper Series* 2412. Washington, DC: The World Bank.

Field, A. (2009). Discovering Statistics using SPSS. London: SAGE.

Gaspar, J, and E. Glaeser. 1998. Information Technology and the Future of Cities. *Journal of Urban Economics* 43(1): 136–156.

Geroski, P. 2000. Models of Technology Diffusion. *Research Policy* 29(4–5): 603–625.

Gollin, D., R. Jedwab, and D. Vollrath. 2016. Urbanization with and without Industrialization. *Journal of Economic Growth* 21(1): 35–70.

Greenwood, M. J. 1997. Internal Migration in Developed Countries. In *Handbook of Population and Family Economics, Vol. 1B*, edited by M. R. Rosenzweig and O. Stark. , Amsterdam: North-Holland.

Griliches, Z. 1957. Hybrid Corn: An Exploration in the Economics of Technological Change. *Econometrica* 25(4): 501–522.

Harris, J. R., and M. P. Todaro. 1970. Migration, Unemployment and Development: A Two-Sector Analysis. *The American Economic Review* 60(1): 126–142.

Hofmann, A., and G. Wan. 2013. Determinants of Urbanization. ADB Economics Working Paper 355. Manila: Asian Development Bank.

Jedwab, R., L. Christiaensen, and M. Gindelsky. 2015. Demography, Urbanization and Development: Rural Push, Urban Pull And...urban Push? *Journal of Urban Economics,* forthcoming.

Kantorowicz, E. H. 2010. Selected Studies in International Migration and Immigigrant Incorporation. *IMISCOE reports* 41(3).

Kau, J. B., and C. F. Sirmians. 1977. The Influence of Information Cost and Uncertainty on Migration: A Comparison of Migrant Types. *Journal of Regional Science* 17(1): 89–96.

Krugman, P. 1991. *Geography and Trade*. Cambridge, MA: MIT Press.

Krugman, P., and R. L. Elizondo. 1996. Trade Policy and the Third World Metropolis. *Journal of Development Economics* 49(1): 137–150.

Lucas, R. E. 1988. On the Mechanics of Economic Development. *Journal of Monetary Economics* 22(February): 3–42.

———. 2004. Life Earnings and Rural–Urban Migration. *Journal of Political Economy* 112(1): 29–59.

Marshall, A. 1890. *Principles of Economics*. London: Macmillan.

Massey, D. S., J. Arango, G. Hugo , A. Kouaouci, A. Pellegrino, and J. E. Taylor, 1993. Theories of International Migration: A Review and Appraisal. *Population and Development Review* 19(3): 431–466.

Mckenzie, D., and H. Rapoport. 2007. Network Effects and the Dynamics of Migration and Inequality: Theory and Evidence from Mexico. *Journal of Development Economics* 84(1): 1–24.

Moomaw, R. L., and A. M. Shatter. 1996. Urbanization and Economic Development: A Bias toward Large Cities? *Journal of Urban Economics* 40(1): 13–37.

Rauch, J. E. 1993. Productivity Gains from Geographic Concentration of Human Capital: Evidence from the Cities. *Journal of Urban Economics* 34(3): 380–400.

Sahota, G. S. 1968. An Economic Analysis of Internal Migration in Brazil. *Journal of Political Economy* 76(2): 218–45.

Schwartz, A. 1973. Interpreting the Effect of Distance on Migration. *Journal of Political Economy* 81(5): 1153–1169.

Sjaastad, L. A. 1962. The Costs and Returns of Human Migration. *Journal of Political Economy* 70(5): 80–93.

Todaro, M. P. 1969. A Model of Labor Migration and Urban Unemployment in Less Developed Countries. *The American Economic Review* 59(1): 138–148.

United Nations. 2014. *World Urbanization Prospects: The 2014 Revision, Highlights*. New York, NY: UN.

Vanderkamp, J. 1971. Migration Flows, Their Determinants and the Effects of Return Migration. *Journal of Political Economy* 79(5): 1012–1031.

WHO. 2010. Unmasking and Overcoming Health Inequities in Urban Settings. *Evolutionary Ecology* 10: 1–145.

Zhao, Y. 1999. Labor Migration and Earnings Differences: The Case of Rural China. *Economic Development and Cultural Change* 47(4): 767–782.

APPENDIX

Table A.1: Coefficients for Year Dummies of Baseline Results in Table 4

Year	(1)	(2)	(3)
1963	0	0	–19.904***
1964	0.673	0.748	–19.106***
1965	0.499	1.013	–18.786***
1966	2.085	3.327**	–16.580***
1967	3.562	4.174**	–15.675***
1968	3.316	4.206**	–15.466***
1969	2.923	4.001**	–15.789***
1970	3.13	4.404***	–15.372***
1971	3.84	5.243***	–14.569***
1972	4.589*	5.978***	–13.811***
1973	6.400***	7.419***	–12.455***
1974	7.471***	8.549***	–11.469***
1975	6.739***	8.553***	–11.312***
1976	7.391***	9.350***	–10.483***
1977	8.013***	9.254***	–10.450***
1978	8.596***	10.356***	–9.265***
1979	7.841***	9.483***	–10.038***
1980	7.688***	9.819***	–9.714***
1981	8.379***	10.380***	–9.114***
1982	9.154***	11.247***	–8.229***
1983	9.873***	12.279***	–7.371***
1984	10.419***	12.853***	–6.921***
1985	10.405***	13.175***	–6.595***
1986	11.317***	14.252***	–5.349***
1987	12.147***	14.749***	–4.829***
1988	12.936***	15.563***	–4.025***
1989	12.983***	16.025***	–3.804***
1990	12.373***	15.824***	0
1991	12.816***	16.494***	0
1992	13.225***	16.888***	–0.274
1993	13.703***	17.468***	0.328
1994	14.133***	17.942***	0.593
1995	14.247***	18.390***	0.485
1996	14.590***	18.829***	0.564
1997	15.237***	19.527***	0.434
1998	15.556***	19.588***	0.251
1999	16.566***	20.466***	0.705
2000	15.266***	20.096***	0.093
2001	15.640***	20.664***	0.248
2002	15.963***	20.740***	0.095
2003	16.620***	21.666***	0.661
2004	17.735***	22.763***	2.053
2005	17.178***	22.005***	1.139
2006	17.106***	22.347***	1.352
2007	17.667***	23.062***	2.255
2008	17.864***	23.000***	1.807
2009	17.594***	22.775***	1.604
2010	17.683***	23.201***	1.803
2011	18.639***	24.004***	2.496
2012	18.934***	24.446***	2.926
2013	18.693***	24.415***	2.946