



How does urbanization affect the human development index? A cross-country analysis

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Abstract

Higher economic development without urbanization is almost impossible. However, the magnitude of development can vary with the accuracy of the management of an urban area. Though several studies have established a positive effect of urbanization on economic growth, its impacts on the human development index (HDI) are unknown. In this context, we assessed the impacts of urbanization on the value of country-level HDI with a random effect Tobit and dynamic panel data estimations for 187 countries from 1990 to 2017. We found that overall, total urban populations, percentage of the urban populations, urban population growth rates, and percentage of the population living in million-plus agglomerations have a positive effect on the HDI values. The percentage of the urban population residing in the largest city of a country negatively affects the value of HDI. The analysis was also done by dividing countries based on their level of income. The percentage of urbanization is the most important measurement of urbanization having a positive impact on the HDI across countries separated by different income groups. The total urban population also has a positive effect on HDI except for upper-middle-income countries. However, all other measurements of urbanization have an ambiguous effect on HDI, suggesting the impacts of urbanization on HDI depend on different stages of development in a country. Among the control variables, higher emissions of carbon dioxide, fertility rate, GDP growth rate, level of inequality, and inflation rate negatively affect HDI, whereas higher foreign direct investment has a positive effect. Finally, policy options are prescribed to make an urban area more productive in higher economic development.

Keywords Urbanization · Economic growth · Fertility rate · Human development index · Cross-country

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1 Introduction

No country has developed without sustainable urbanization. Urbanization is a typical characteristic of development and a process strongly associated with economic and social development. Hence, urbanization has a direct positive effect on the income of a country if it is managed properly. Urbanization has a potentially positive effect on economic activity, higher provision to employment opportunities, and enhances access to basic services. Cities switch low-productivity agriculture into high-productive industry and service sector-led economy. In developing countries, cities are the engine of economic growth. Cities account for about 70% of global gross domestic product (World Bank 2009). Several studies (Williamson 1965; Martin and Ottaviano 1999; Fujita and Thisse 2002; Baldwin and Martin 2004; Henderson 2003; Brühlhart and Sbergami 2009; Tripathi 2013) found that urbanization has a positive link with higher per capita gross domestic product (GDP). The basic idea is that urbanization pulls resources from the predominantly agricultural sector to more advanced industrial and service sectors and promotes economic development (Lewis 1954). Therefore, the process of economic development not only accompanies economic structural change, but also contributes to a higher urbanization rate. It works with two forces: push from the countryside and pull from the city (Lewis 1954; Fei and Ranis 1964). The city offers greater specialization of labor (Smith 1976), which leads to greater efficiency benefits (Marshall 1890; Duranton 2008). It is sourced from urban increasing returns (Krugman 1991), which include sharing (e.g., local infrastructure), matching (e.g., employers and employees), and learning (e.g., new technologies) (Duranton and Puga 2004). Therefore, a higher rate of urbanization is beneficial for improving GDP.

On the other hand, Kalediene and Petrauskiene (2000) found that the urban population has better access to medical care, better education opportunities, and improved socioeconomic infrastructure which have a positive impact on health and hence life expectancy. Therefore, urbanization is one of the most important indicators of life expectancy both for developed and developing nations' perspectives. Shahbaz et al. (2016) showed that urbanization, directly and indirectly, contributes to life expectancy via income-generating, education, and medical factors. Bergh and Nilsson (2010) scrutinized the association between life expectancy and globalization by considering 92 countries of the world. The study found that urbanization, globalization, education, public health measures, nutrition, and income were all positively related to life expectancy. The estimated results are highly significant except for the impact of urbanization on life expectancy in developing countries. Jayasuriya and Wodon (2003) suggested that urbanization and to some extent bureaucratic quality both have strong positive impacts on increasing efficiency in improving health and education indicators.

The discussion indicates that though several studies have attempted to assess the positive effect of urbanization on GDP per capita, life expectancy at birth, and to some extent on education, the quantification of the impact of urbanization

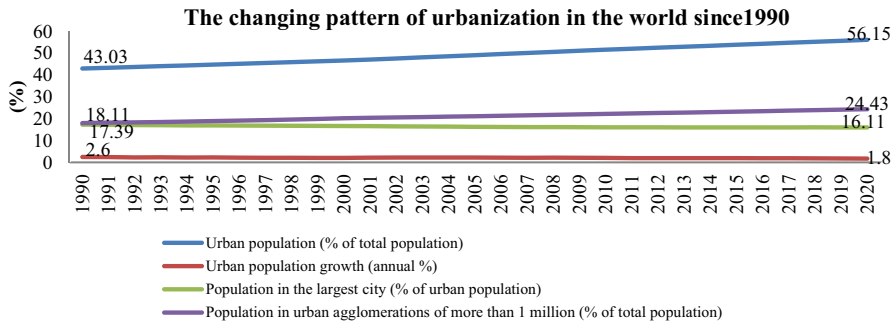


Fig. 1 The changing pattern of urbanization in the world since 1990. Source: the author's calculation based on data from the World Bank

on the human development index (HDI) is highly neglected. On the other hand, HDI considers a person's capabilities and wellbeing and it is far more crucial than GDP in capturing the progress that has been achieved. HDI captures not only GDP but also the other two important aspects such as life expectancy and education (mean years of schooling completed and expected years of schooling upon entering the education system). It is expected that a higher rate of urbanization increases income and with adequate provision of educational and health infrastructure improves the rank in HDI of a country. However, higher urbanization does not mean a higher rank in HDI. For instance, the Russian Federation has 74.6% urban population but it holds 49th rank in HDI ranking by all countries in the world. In contrast, Switzerland with a similar rate of urbanization ranked in the second position in HDI ranking in the world. Therefore, there is no guarantee that countries with a higher level of urbanization have a higher rank in the HDI. Figure 1 shows that the percentage of urbanization in the world has increased steadily from 43% in 1990 to 56% in 2020. The growth rate of urbanization has fallen from 2.6% to 1.8% during the same period. It also shows that the percentage of the urban population in the largest city of a country has declined and the percentage of the total population in million-plus cities has increased from 1990 to 2020. This compels us to assess the impact of different patterns of urbanization on the HDI.

In this context, the following questions are very important. How does urbanization affect the value of HDI? Does this impact changes with the consideration of different measurements of urbanization? Do results vary according to different income levels or stages of development of a country? In this study, we answer all these questions. We consider 187 countries for the analysis. We estimate the random effect of Tobit and dynamic panel data models by considering data from 1990 to 2017. We start with 1990 as this is the year when Pakistani economist Mahbub ul Haq created HDI. We find evidence that urbanization has a positive impact on HDI. We also analyze by considering high-, upper-middle-, lower-middle-, and low-income countries separately. The different measures of urbanization have a varying effect on HDI. The results are also different according to the level of income of a country.

The results are very important for the promotion of urbanization in the world mostly from developing countries' perspectives for achieving a higher HDI ranking.

The paper adopts the following structure. The next section highlights a brief review of the literature. Sections 3 and 4 present the conceptual and empirical frameworks, respectively. Regression results are given in Sect. 5. Discussions based on the estimated results are highlighted in Sect. 6. The major conclusions and policy implications are made in Sect. 7.

2 Review of literature

Very few studies have attempted to establish a link between urbanization and HDI. Anisujjaman's (2015) district-level analysis found that there is a positive relationship between the level of urbanization and the HDI in West Bengal, India. Huang and Jiang (2017) conducted a partial correlation analysis between the HDI and urbanization rate while controlling for the effects of the GDP for Mongolia. They found that urbanization rates are positively correlated with the HDI even when they controlled the effects of the GDP ($p < 0.001$). Maiti (2017) argued that China was able to create a greater intensity of sustainable development from urbanization than India. The author also found that HDI has a negative and statistically significant effect on the urban population growth rate for China and India. Malik (2014) argued that the relationship between urbanization HDI is not direct and is dependent on how urbanization is managed. Though urbanization offers many opportunities, it can also drive places of deprivation, inequality, and exclusion. For example, though Sub-Saharan Africa has a higher level of urbanization compared to South Asia, its human development performance is lower than that of South Asia. Overall, an increasing level of urbanizations is associated with a higher level of HDI.

The study by the United Nations Human Settlements Programme (UN-Habitat 2016) examined the relationship between the degree of urbanization and HDI by considering countries from Asia, Africa, and Latin America. The analysis suggested that there are huge variations among continents, although the association is positive for all countries except the Philippines and Sri Lanka. Among the African countries, Botswana and Ethiopia have reached a threshold level of the HDI where the index becomes inelastic to the urban population growth. Only in Thailand, among all other Asian countries, HDI reached a threshold level of 0.72 and became inelastic to the degree of urbanization at the level of 44.08% of the urban population. Except for Bolivia, all countries in Latin America, the HDI reached a threshold level at some point from 2005 to 2013. On the other hand, in the rest of the Latin American countries, the HDI became inelastic to the urban population as they have reached a saturation level in terms of the urban population.

However, the HDI not only depends on urbanization, but also many other factors. A cross-country study by Shah (2016) found that GDP, life expectancy rate, and literacy rate have a positive effect on the HDI, while the Gini index, fertility rate, and CO₂ emissions have a negative effect on it.

In the context of the effect of urbanization on environmental degradation, Wang et al. (2019) found a positive contribution of urbanization to road sector energy

consumption. This deteriorates environmental quality, through high-energy consumption that leads to CO₂ emissions. Ahmed et al. (2020a) argued that urbanization and economic growth contribute to environmental degradation. Ahmed and Le's (2021) study showed that information communication technology influences trade globalization and energy consumption. Ahmed et al. (2021a) found that energy consumption deteriorates the environment by increasing the ecological footprint. In the case of the USA, renewable energy technology budgets are not sufficient enough to reduce pollutant emissions (Ahmed et al. 2021b). There is also unidirectional causality from human capital and urbanization to the ecological footprint for G7 countries (Ahmed et al. 2020b).

In the perspective of other important variables, Arisman (2018) found that for the ASEAN countries, population and per capita income growth rate affect the HDI, while inflation rates and unemployment rate do not have an impact on it. Bhowmik (2019) argued that there were significant long-run causalities from education expenditure, health expenditure, and GDP per capita to the HDI of SAARC but they had no short-run causalities. Khan et al. (2019) found that in the case of Pakistan, information and communication technology and economic growth promote the HDI. On the other hand, urbanization, trade, and foreign direct investment (FDI) discourage it. Sangaji (2016) found that life expectancy at birth and gross domestic per capita had a positive effect, while the variables of inflation and the fertility rate had negative effects on the HDI in several Buddhist countries in the world. Binder and Georgiadis (2011) argued that macroeconomic policies affect development with less delay than suggested by conventional econometric frameworks, yet impact HDI with longer delay and overall less strongly than GDP.

Connoly et al. (2014) showed that the significant determinants that positively affect the probability of having a high human development index are: life expectancy, GDP per capita, and the number of years in education. Fossaceca (2019) stated that HDI in oil-dependent economies can be explained by the adolescent fertility rate, the value-added of different economic sectors, the effectiveness of governments in terms of policy formulation and implementation, and the levels of gender inequality. Crafts (1997) examined the interaction between the index of human development and growth of the gross domestic product per capita for 16 developed countries since 1870, concluding that the conventional measures which had supported economic growth have led to an improvement of life expectancy. Also, Khodabakshi (2011) examined life expectancy and education in India over the period 2005–2010, finding that low rates of life expectancy at birth led to a decline in the human development index. Arcelus et al. (2005) examined the effects of foreign direct investment on human development in the case of middle- and low-income countries, finding a positive impact for both country groups.

Asmita and Ruslan (2017) analyzed the influence of economic growth, percentage of poor population, government expenditure of education, health expenditure of government, and income distribution inequality on HDI in North Sumatera Province. Gökmenoğlu et al. (2018) state that foreign direct investments are very important for the host country, contributing to human development and the increase of the income of high-skilled graduates. This proves that attracting FDIs should be a priority in the policy-making process. Tudorache (2020) confirmed a direct relationship

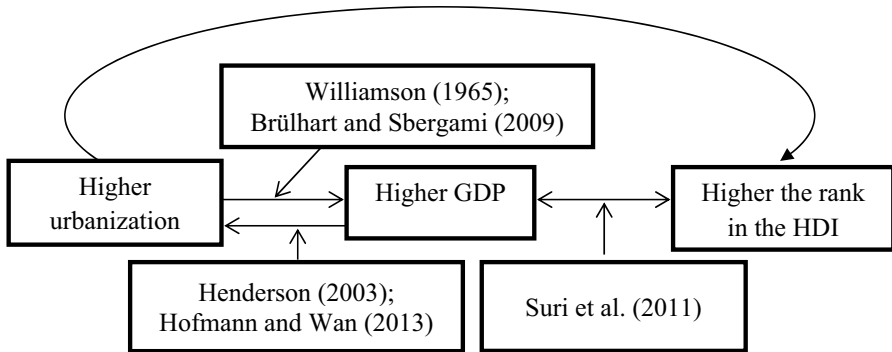


Fig. 2 Linking between urbanization and the HDI

between three independent variables (life expectancy, corruption perception index, and gross fixed capital formation) and the dependent variable—the human development index. Viddy et al. (2019) found that Indonesian foreign debt has a positive effect on the human development index. Fadillah and Setiartiti (2021) found that the gross regional domestic product (PDRB) and government spending in the health sector positively and significantly affect the human development index.

A brief review of the literature indicates that several studies have attempted to investigate the relevant determinants of HDI from different countries' perspectives. However, the impact of urbanization on HDI is very limited. Higher income that is generated by a higher level of urbanization does not guarantee that quality of life has improved. Therefore, it is pivotally important to assess the impact of urbanization on the HDI from a cross-country perspective.

3 Conceptual framework

Figure 2 presents the main conceptual framework for linking between urbanization and the HDI. Our conceptual framework for linking urbanization and the HDI is based on two famous and prominent hypotheses. First, Williamson (1965) suggested that agglomeration matters for an early stage of development. When transport and communication infrastructure is limited and the reach of the capital market is scared, efficiency can be significantly enhanced by concentrating production in space. However, as availability of infrastructure improves and the market expands, congestion externalities may favor a more dispersed economic geography. This structure is consistent with the model of urbanization and growth with the focus on human capital accumulation by Bertinelli and Black (2004).¹ Brülhart and Sbergami (2009) found evidence that supports the “Williamson hypothesis”: agglomeration boosts GDP growth only up to a certain level of economic development. Henderson (2003) found

¹ More details explanation can be seen from Brülhart and Sbergami (2009).

that urbanization does not seem to cause growth. Hofmann and Wan (2013) argued that the direction of causality runs from growth to urbanization.

Second, Suri et al. (2011) suggested that there is a two-way relationship between economic growth and human development, building on an earlier work by Ranis et al. (2000). They found that human development is not only a product of economic growth, but also important to it. They hypothesized that upgrading human development for higher subsequent economic growth, in turn, leads to improved human development.

Now the question arises if urbanization may affect HDI via GDP, can we measure the causal relationship between urbanization and HDI? The answer is yes, as higher urbanization does not mean higher GDP. For example, in terms of the percentage of the urban population, Jordan is ranked 13, whereas in terms of per capita GDP its rank is 116 out of 180 countries in the world in 2017. Similar stories can be repeated for Chile and Brazil too. Castells-Quintana and Wenban-Smith (2020) argued that urbanization in many developing countries, especially in sub-Saharan Africa, does not deliver the kind of benefits that might be expected in the light of experience elsewhere in the world. This phenomenon is called urbanization without growth.

On the other hand, a higher GDP does not guarantee a higher rank in the HDI. For example, as per the per capita GDP Luxembourg is ranked top, whereas it is ranked 22 in the HDI ranking out of 180 countries in the world in 2017. In contrast, Sri Lanka is ranked 110 in per capita GDP, whereas it stands 76 in the HDI rank with only 18% urbanization for a similar comparison. Therefore, it is not always true that urbanization impacts on the HDI via GDP. It is also to be remembered that HDI depends on life expectancy and education rather than the only GDP. So, higher development as per higher GDP per capita always does not guarantee that the country will rank high in the HDI and the results also differ for different income group countries (Deb 2015).

Alternatively, urbanization provides higher employment opportunities, higher productivity, wages, localized technology spillovers, greater efficiency benefits, and enhances access to basic services such as education and health. Therefore, urbanization may have a positive effect on HDI. In fact, Cutler et al. (2005) found that the reductions in mortality and improvements in life expectancy have been induced by technology improvements, which came from improved incomes, helped by improvements in education. Therefore, it is expected that higher urbanization not only improves income, but also the HDI. Based on these theoretical arguments, the present study quantifies the associations between urbanization and quality of life which is measured by the HDI.

4 Empirical framework

The Tobit model or censored regression model is used to estimate the linear relationship between the HDI and urbanization as we find the evidence of the right censoring in the dependent variable of HDI. Histogram in the Appendix of Fig. 3 confirms that HDI is right censoring. A Tobit model with random effects is used as it is capable of accounting both serial correlations and censoring effects. The random effect Tobit

model is efficient to account for correlations across observations in addition to unobserved heterogeneity.

The Tobit model for panel data is defined as follows:

$$y_{it}^* = x_{it}\beta + \epsilon_{it}, \quad (1)$$

$$y_{it} = \begin{cases} 0 & \text{if } y_{it}^* \leq 0 \\ 1 & \text{if } y_{it}^* \geq 1 \\ y_{it}^* & \text{if } 0 < y_{it}^* < 1 \end{cases}, \quad (2)$$

where y_{it}^* is an unobservable latent variable, and ϵ_{it} is normally, identically, and independently distributed with zero mean and variance σ_u^2 . x_{it} is a vector of explanatory variables and β a vector of unknown coefficients.

Following Sangaji (2016), who investigated relevant determinants of HDI in several counties, we also consider random effect model for the estimation. The rationale behind using random effect model is that the variation across countries is assumed to be random and uncorrelated with the independent variables included in the model.

The following equation is specified to assess the impact of urbanization on HDI.

$$\begin{aligned} \text{HDI} = & \nu_i + \beta_1 \text{urbanization}_{it} + \beta_2 \text{Co2}_{it} + \beta_3 \text{FDI}_{it} + \beta_4 \text{fertility rate}_{it} \\ & + \beta_5 \text{gdp growth rate}_{it} + \beta_6 \text{Gini}_{it} + \beta_7 \text{inflation rate}_{it} + \epsilon_{it}, \end{aligned} \quad (3)$$

where i and t represent country and time, respectively, while ν_i is the random effects term which follows normal distribution with mean 0 and variance σ_u^2 , and ϵ_{it} is the disturbance term which follows normal distribution with mean 0 and variance σ_u^2 . Our data set contains up to 187 countries, over the period 1990–2017. The HDI data is sourced from the United Nations Development Programme (UNDP) and other data are from World Development Indicators (WDI) provided by the World Bank. Appendix Table A1 provides the definitions of variables used for the regression analysis.

Based on Henderson (2003), Brühlhart and Sbergami (2009) and Tripathi (2013), we measure urbanization in five different ways: percentage of urban population, total urban population, annual urban population growth, population in urban agglomerations of more than 1 million to total population, and population in the largest city to urban population. Five different measures of urbanization have very important implications for capturing various patterns of urbanization in different countries. Some countries/cities are overurbanized and some of them are underurbanized. Some cities are overcrowded and some of them are less. Therefore, these five measurements of urbanization are very crucial to capture the urbanization dynamics. Overall, a positive effect of urbanization on the HDI is expected, as urbanization is associated with higher employment, GDP, availability of infrastructure, provision of basic services, and lower poverty (Li et al. 2012; Khan et al. 2018). Thus, urbanization contributes to socioeconomic development by promoting the state economy and increasing the value of the HDI (Khan et al. 2019).

On the other hand, based on review of literature on the determinant of the HDI (Arisman 2018; Khan et al. 2019; Sangaji 2016; Bhowmik 2019), we expect that GDP growth rate has a positive effect on the HDI.² On the other hand, higher CO₂ emissions, fertility rates, and the Gini index have a negative effect on the HDI. The higher rate of inflation reduces the purchasing power of money and makes investment less desirable, so it may reduce GDP and the HDI. However, the Phillips curve shows that high inflation is consistent with low rates of unemployment. This implies that inflations have a positive effect on economic growth. Therefore, inflations may have a positive or negative effect on the HDI. The FDI stimulates the labor market and economic growth, a high tax incentive environment. Therefore, a positive impact of FDI on the HDI is expected (Khan et al. 2019).

5 Regression results

Before we go to regression results, first we present the descriptive statistics of the variables. Table 1 presents the summary statistics of each variable used in the regression models. The coefficient of variation (CV) measures the dispersions of data points in a data series. HDI, Gini coefficients, fertility rate, percentage of the urban population, and population in the largest city have lower values of a CV, which indicates that little differences in their means, implying a more symmetrical distribution. However, it is not the case for inflation rates, total urban population, foreign direct investment, and GDP growth rate. Table 1 also presents the variance inflation factor (VIF) for the explanatory variables based on a simple OLS model.

Table 2 presents the raw correlation coefficients. The estimated values of correlation coefficients quantify the direction and strength of the linear association between the variables. The results show that the HDI has a positive association with the percentage of the urban population, the population in million-plus urban agglomerations, CO₂, and foreign direct investment. In contrast, the values of the HDI are negatively correlated with urban population growth rate, fertility rate, populations in the largest city, Gini coefficients, and GDP growth rate.

Except for fertility rates, there is no strong correlation between HDI and other explanatory variables. This lessens the probability that regression results are inconsistent and biased. Correlation coefficients together with variance inflation factors (VIF) (Table 1, the last column) recommend that multicollinearity is not present in regression analysis.

Table 3 presents the estimated random effect Tobit regression models of Eq. 3. The sigmas signify the variances of the two error terms μ_i and ε_{it} . Their relationship is explained by the variable ρ , which informs us about the relevance of the panel data nature. When ρ is zero, the panel-level variance component is unimportant, and the panel estimator is not different from the pooled estimator. As can be seen

² As per-capita GDP, life expectancy at birth, and adult literacy rate are considered to construct HDI, we did not consider these variables in the regression analysis.

Table 1 Descriptive statistics of panel data variables

Variable	No. of observation	Mean	Standard deviation	Minimum	Maximum	CV	VIF
Human development index (HDI)	4725	0.655	0.166	0.2	0.95	25.4	–
Percentage of urbanization (PU)	5230	53.86	23.39	5.42	100	43.43	2.96
Total urban population (TUP)	5227	1.66e+07	5.31e+07	4873	8.00e+08	319.88	1.52
Urban population growth (UPG)	5226	2.24	2.06	– 7.18	17.76	92.31	2.57
Population in urban agglomerations of more than 1 million (% of total population) (PUAM)	3301	23.831	16.833	2.105	100	70.63	2.83
Population in the largest city (% of urban population) (PLC)	4107	33.059	17.342	2.867	100	52.46	2.40
CO ₂ emissions (CO ₂)	4347	0.281	0.243	0.005	2.12	86.54	1.35
Foreign direct investment (FDI)	4848	6.50	39.81	– 58.32	1282.63	612.05	1.10
Fertility rate (FR)	5096	3.24	1.68	0.901	8.606	51.83	2.60
GDP growth rate (GDPG)	5004	2.11	6.33	– 64.99	140.37	300.46	1.14
GINI index (GINI)	1359	39.22	9.40	23.7	65.8	23.97	1.55
Inflation rate (IR)	5004	38.41	496.61	– 36.56	26765.9	1293.01	1.10

Source: author

Table 2 Correlation coefficient of the variables used in regression model

	HDI	PU	TUP	UPG	PUAM	PLC	CO ₂	FDI	FR	GDPG	GINI	IR
HDI	1.00											
PU	0.73	1.00										
TUP	0.03	-0.01	1.00									
UPG	-0.64	-0.57	0.04	1.00								
PUAM	0.29	0.52	0.05	-0.14	1.00							
PLC	-0.24	-0.14	-0.41	0.15	0.41	1.00						
CO ₂	0.10	0.06	0.23	-0.28	-0.08	-0.33	1.00					
FDI	0.11	0.07	-0.10	-0.07	-0.02	0.09	0.04	1.00				
FR	-0.84	-0.58	-0.15	0.71	-0.21	0.27	-0.32	-0.07	1.00			
GDPG	-0.10	-0.12	0.10	0.02	0.02	0.11	0.06	0.17	-0.01	1.00		
GINI	-0.41	-0.11	0.03	0.41	0.33	0.27	-0.22	-0.15	0.35	0.01	1.00	
IR	-0.05	0.02	0.04	-0.02	-0.01	-0.09	0.20	-0.05	-0.01	-0.19	0.04	1.00

See Table 1 for variable definitions. The correlation coefficients are based on 945 observations

Source: author

from Table 3, the panel data structure of the model has to be taken into account. The significant values of Wald χ^2 specify that for regression models 1–6 fit well; all coefficients in the model are different from zero. The higher values of log-likelihood for regression models 1–6 show that our regression estimations are good. The statistically significant values of likelihood-ratio tests for all the regression models reject the null hypothesis that there are no panel-level effects.

The size of our country sample for estimations varies between 105 and 153, depending on the explanatory variables that are included in the regressions. Regression model 1 presents the full model, which includes all variables identified by the literature review. Regression models 2–6 report results for a parsimonious model, excluding controls that are not found to be statistically significant in our data and to estimate the impact of particular independent variables on the dependent variable. In other words, regression models 2–6 are designed to capture the effect of each urbanization variable on the HDI separately.

The regression model 6 shows that FDI has a positive and statistically significant effect (at 1% level) on the HDI. The coefficient 0.001 indicates that for a unit increase in FDI, there is a 0.001-point increase in the predicted value of HDI. On the other hand, CO₂ emissions, fertility rate, GDP growth rate, Gini index, and inflation rate have a negative and statistically significant effect on the HDI. The sign of the estimated coefficients is matched with the expected sign. The impact of the Gini index, fertility rate, and CO₂ emissions on the HDI support the findings of Shah (2016) and Arisman (2018). In the line of Khan et al. (2019), we also get a positive impact of FDI on the HDI. However, the negative impact of economic growth on the HDI does not support the findings of Khan et al. (2019) and Asmita et al. (2017). The negative effect of the fertility rate on HDI supports the findings of Fossaceca (2019).

Most of the developing countries in the world have a higher growth rate, but the rank in the HDI is very low, so only economic growth cannot increase the HDI value. For example, India has experienced a 7.08% GDP growth rate between 2000 and 2016, but India's rank in the HDI is 130. So if growth does not guarantee education and health, it cannot increase the HDI rank alone. Inflation rates have a negative and statistically significant effect on the HDI. This shows that higher inflation is bad for economic growth and reduces the HDI values.

Turning now to our main focus of interest, we observe that the percentage of urbanization and urban population have a positive and statistically significant effect on the HDI, while higher urban population growth rate has a mixed effect on it. Populations in million-plus agglomerations have a positive effect on HDI, whereas the population in the largest city has a negative effect on the value of HDI.

Regression model 1 shows that a 1-unit increase in the percentage of urban population leads to a 0.004 point increase in the predicted values of HDI. Moreover, a 1-unit increase in total urban population is associated with a 0.0001-point increase in the predicted value of HDI. To avoid collinearity of the urbanization variables, we obtain separate regression results for five independent variables used for measuring urbanization regression models 2–6. Regression models 2, 3, and 5 are consistent with the results obtained in the regression model 1. Regression model 4 shows that

Table 3 Random effect Tobit estimation results for all countries (dependent variable: HDI)

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Percentage of urbanization	0.00397*** (0.000395)	0.00492*** (0.000251)				
Urban population	0.00009** (4.25e-05)		0.0004*** (4.74e-05)			
Urban population growth	0.00272** (0.00120)			- 0.0126*** (0.00154)		
Population in urban agglomerations of more than 1 million (% of total population) agglomerations	0.00374*** (0.000759)				0.00882*** (0.000513)	
Population in the largest city (% of urban population)	- 0.000724 (0.000553)					- 0.0008*** (0.00021)
CO ₂ emissions	- 0.116*** (0.00938)	- 0.142*** (0.00887)	- 0.155*** (0.0104)	- 0.148*** (0.0136)		- 0.157*** (0.0062)
Foreign direct investment	0.000327** (0.000129)			0.000063 (5.87e-05)	0.000366** (0.000143)	0.000732*** (0.000104)
Fertility rate	- 0.0375*** (0.00270)	- 0.0401*** (0.00247)	- 0.0671*** (0.00225)		- 0.0486*** (0.00245)	- 0.0662*** (0.00127)
GDP growth rate	- 0.000622*** (0.000186)	- 0.000497*** (0.000166)	- 0.0007*** (0.00019)	- 0.000421* (0.000256)	- 0.000753*** (0.000220)	- 0.00035*** (0.000103)
GINI index	- 0.00115*** (0.000235)	- 0.00112*** (0.000218)	- 0.0013*** (0.000255)	- 0.00254*** (0.000334)	- 0.00146*** (0.000271)	
Inflation rate	- 7.52e-07 (4.16e-06)	9.04e-07 (4.40e-06)	1.48e-08 (5.16e-06)	- 1.10e-05 (6.80e-06)	- 1.64e-05*** (5.07e-06)	
Constant	0.554*** (0.0317)	0.599*** (0.0227)	0.951*** (0.0138)	0.817*** (0.0188)	0.671*** (0.0227)	0.923*** (0.0111)
/sigma_u	0.0882***	0.0944***	0.0916***	0.1574***	0.11601***	0.0975***
/sigma_e	0.0194***	0.0207***	0.0243***	0.0321***	0.0245***	0.0295***
rho	0.9538	0.9539	0.9339	0.9601	0.9572	0.9162

Table 3 (continued)

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Wald chi ²	2563.8***	2427.6***	1528.4***	284.6***	1621.3***	3896.3***
Log likelihood	2124.7	2570.9	2408.24	2031.4	2140.7	6339.9
Likelihood-ratio test	195.9***	1978.03***	1978.1***	2291.7***	1679.3***	5997.9***
Observations	945	1,195	1,195	1,190	1,054	3,199
Number of country	105	153	153	152	107	144

Standard errors in parentheses

* $p < 0.1$

** $p < 0.05$

*** $p < 0.01$

Source: estimated using Eq. 3

the urban population growth rate has a negative effect on the HDI, whereas regression model 1 shows that the urban population growth rate has a positive effect on the HDI. Therefore, the urban population growth rate has a mixed effect on the HDI. Regression model 5 indicates that the percentage of urban population living in million-plus agglomerations has a positive effect on the HDI. The coefficient 0.009 specifies that for a unit increase in the percentage of urban population living in million-plus agglomerations, there is a 0.009 point increase in the predicted value of the HDI. In contrast, regression model 6 shows that the percentage of urban population living in the largest city has a negative and statistically significant effect on the HDI. It implies that though bigger city sizes have a positive impact on the HDI, there is a limit.

Table 4 presents the marginal effects of the overall expected values of the estimated random effect Tobit coefficients. Regression model 1 shows that a 1-unit increase in the percentage of urbanization (or total urban population) is associated with an increase of 0.348 (0.004) units on the HDI. Most importantly, regression model 5 shows that a 1-unit escalation of the percentage of urban population living in million-plus agglomerations contributes to a 0.290% higher probability of an increase of the HDI. Among the other important independent variables (except urbanization variables), we find that FDI has a positive effect on the HDI. On the other hand, a higher value of the Gini index, CO₂ emissions, fertility rate, and GDP growth rate reduce the values of HDI. Regression model 1 shows that a 1-unit increase of CO₂ emissions (or fertility rate) is associated with a decrease of 0.049 (or 0.164) units on the HDI.

However, regression models 1–6 consider all countries together. As different countries are in a different phase of urbanization, we run the regression models separately for high-, upper-middle-, lower-middle-, and low-income countries as well. We only consider urbanization variables, as lower data size of the other explanatory variables do not show robust results.

Table 5 presents the estimated random effect Tobit estimation results where we consider only all the variables of urbanization together. The results are almost similar to the results presented in regression results 1–6 with little variations. The percentage of urban population has a positive and statistically significant effect on HDI for all countries irrespective of income differences. The total urban population has a positive effect on HDI for the regression results obtained for all countries, high-income countries, lower-middle-income countries, and low-income countries. The effect in upper-middle-income countries is not statistically significant. The urban population growth rate does not have any effect on the HDI for all country-level, high-income countries, and lower-middle-income country's estimation. In contrast, it has a positive (or negative) effect on HDI for upper-middle-income countries (or low-income countries). The percentage of the population living in urban agglomerations of more than 1 million people has a positive effect on HDI except for high- and lower-middle-income countries. The percentage of the urban population living in the largest city has a positive effect on HDI in lower-middle-income countries, while it has a negative effect on the results obtained for all countries level and low-income countries. However, it does not have any impact on HDI for high- and upper-middle-income countries.

Table 4 Marginal effects of the overall expected value of estimated random effects Tobit coefficients

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Percentage of urbanization	0.348	0.408				
Urban population	0.004		0.0134			
Urban population growth	0.009			- 0.036		
Population in urban agglomerations of more than 1 million (% of total population) agglomerations	0.123				0.290	
Population in the largest city (% of urban population)	- 0.031					- 0.045
CO ₂ emissions	- 0.049	- 0.059	- 0.065	- 0.067		- 0.068
Foreign direct investment	0.002			0.0006	0.002	0.004
Fertility rate	- 0.164	- 0.168	- 0.279		- 0.208	- 0.381
GDP growth rate	- 0.002	- 0.002	- 0.003	- 0.002	- 0.003	- 0.001
GINI index	- 0.070	- 0.066	- 0.079	- 0.155	- 0.088	
Inflation rate	0.000	0.000	0.000	- 0.0004	- 0.0005	

Source: author

5.1 Robustness check

As per theoretical explanations, the relationship between urbanization and the HDI (as GDP is already part of HDI) is the question of reverse causality. Other macroeconomic variables such as CO₂ emissions are assumed to be endogenous, because causality may run in both directions—from CO₂ emissions to HDI and vice versa (Bedir and Yilmaz, 2016). Therefore, regressors may be correlated with the error term. The country-specific effect representing time-invariant determinants of HDI may be correlated with the explanatory variables. To solve this problem we estimate the “system GMM” approach initially proposed by Arellano and Bover (1995) for dynamic panel estimation. The “system GMM” model also takes care of the autocorrelation problem which arises from the use of lagged dependent variables. In summary, the system GMM model better controls for the three sources of endogeneity, namely unobserved heterogeneity, simultaneity, and dynamic endogeneity.

Table 6 presents the estimated results. The panel sample comprises between 105 and 157 countries, depending on which regressors are included. We limit the number of instruments by including a maximum of two lags, to avoid rejection of the null for the validity of overidentifying restrictions. Regression model 12 presents results for the full model, including all regressors we consider. Other regression models report comparable estimates with a parsimonious set of controls. We use parsimonious models, as they are simple models with great explanatory predictive power with the consideration of just the right amount of predictors needed to explain the best regression models. Regression models 12–15 consider the number of instruments less than the number of groups/countries. This avoids the problem of ‘too many instruments’ associated with the estimation. All tests for second-order autocorrelation and Hansen J-test are satisfactory. The null hypothesis of AR2 diagnostic

Table 5 Random effect Tobit estimation results (dependent variable: HDI)

Variables	All countries		High-income countries		Upper-middle-income countries		Lower-middle-income countries		Low-income countries	
	Model 7	Model 8	Model 9	Model 10	Model 11	Model 10	Model 11	Model 10	Model 11	
Percentage of urbanization	0.00779*** (0.000303)	0.00791*** (0.000547)	0.00628*** (0.000588)	0.00978*** (0.000701)	0.00202*** (0.000872)					
Urban population	0.000937** (0.000386)	0.00683*** (0.00230)	7.72e-06 (0.000460)	0.00619*** (0.000781)	0.130*** (0.0113)					
Urban population growth (annual %)	-0.000644 (0.000574)	-0.000166 (0.00115)	0.00468*** (0.00113)	-0.00105 (0.00162)	-0.00478*** (0.000871)					
Population in urban agglomerations of more than 1 million (% of total population)	0.00426*** (0.000578)	0.000915 (0.000979)	0.00564*** (0.00130)	0.00211 (0.00139)	0.00877*** (0.00133)					
Population in the largest city (% of urban population)	-0.00181*** (0.000424)	-0.000795 (0.000923)	-0.00148 (0.00102)	0.00275*** (0.000939)	-0.00580*** (0.000716)					
Constant	0.158*** (0.0224)	0.200*** (0.0514)	0.195*** (0.0427)	-0.0267 (0.0436)	0.410*** (0.0438)					
Observations	3159	966	860	808	525					
Number of country	118	35	32	30	21					

Standard errors in parentheses

* $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$

tests for all regression models cannot be rejected at a 5% or less statistically significant level. Therefore, our results have no caution of potential overfitting bias.

Regression results in Table 6 show that the percentage of urbanization, total urban population, urban population growth rate, the population in million-plus urban agglomerations, and FDI all have a positive statistically significant effect on the HDI. On the other hand, the population in the largest city of a country, CO₂ emission, fertility rate, GDP growth rates, and Gini index have a statistically significant negative effect on the HDI. The results are consistent with the previous results which are obtained by using the Tobit model in Table 3. However, inflation rates do not have any statistically significant effect on the HDI in Table 6. The estimated results support previous studies such as Shah (2016), Arisman (2018), Khan et al. (2019), and Asmita et al. (2017). The insignificant effect of inflation HDI supports Connolly et al. 2014.

6 Interpretation of the results

The estimated results show that, overall, the percentage of the urban population, total urban population, urban population growth rate, and percentage of the population living in million-plus urban agglomerations have a positive effect on HDI. This indicates that urbanization is beneficial for improving the social and economic development of a country. Now, the question arises on how urbanization improves HDI. Urban centers are much more productive than rural areas. It uses resources more efficiently. It provides more opportunities in terms of improving wages and subsequently living standards. Greater efficiency and rising prosperity are the outcomes of what is, on the whole, a virtuous circle (Turok 2014). Higher provisions of educational and health infrastructure are also expected in the cities through the higher investment. Therefore, urbanization not only improves the income of a country, but also the quality of life of its residents.

The results also show that a higher percentage of the urban population residing in the largest city of a country has a negative effect on HDI. This indicates that when a city becomes very large, it suffers from overconcentration of population and increases congestion cost in terms of insufficient provision of many types of infrastructure such as road, water, electricity, telecommunications, ports, railways, and air transportation. It also increases CO₂ emissions, if green technologies are not used adequately. Rumney and Binnie (2021) show that just 25 big cities from around the world produce more than half of the climate-warming gases. Therefore, the cost of congestion increases and diseconomies limit the efficiency of service providers and hinder economic growth (Nguyen and Nguyen 2018). Linn (1982) and Richardson (1987) argued that the effects of the diseconomies factor can be seen clearly in the large urban areas in the country. This specifies that overconcentration or urbanization in the largest city harms the quality of life and reduces the value of HDI.

The estimated results show that the impact of urbanization on HDI may vary with the differences in the income level of a country. For high-income countries urban population growth rates, the percentage of the total population living in million-plus cities, and the percentage of urban population living in the largest cities have no

Table 6 System GMM estimation results for all countries (dependent variable: HDI)

Variables	Model 12	Model13	Model 14	Model 15
Percentage of urbanization	0.001 (0.005)	0.015*** (0.002)		
Urban population	- 0.0004 (0.0003)		0.007*** (0.003)	
Urban population growth	0.009 (0.008)	0.030*** (0.010)		
Population in urban agglomerations of more than 1 million (% of total population) agglomerations	0.027** (0.012)			
Population in the largest city (% of urban population)	- 0.007 (0.011)		- 0.007* (0.004)	
CO2 emissions	- 0.185*** (0.070)		- 0.238*** (0.060)	
Foreign direct investment	0.0001 (0.0002)	0.00005* (0.00003)		
Fertility rate	0.007 (0.027)	0.001 (0.022)	- 0.005 (0.012)	- 0.060*** (0.016)
GDP growth rate	0.00003 (0.00002)			- 0.0004*** (0.00002)
GINI index	0.001 (0.001)	- 0.002 (0.001)		- 0.008*** (0.001)
Inflation rate	- 4.55e-06 (3.74e-06)			
Constant	0.211 (0.335)	- 0.193 (0.185)	0.771*** (0.138)	1.184*** (0.077)
Observations	945	1328	3276	1331
Number of country	105	156	145	157
Number of instruments	91	79	48	126
ARI	0.21	2.47	1.86	- 2.45
AR2	0.837	0.014	0.063	0.014
	1.02	1.55	1.90	0.52
	0.310	0.122	0.058	0.601
Hansen statistic	47.13	64.40	53.67	70.35
	0.998	0.754	0.128	1.000

Estimation by System GMM (robust standard errors in parentheses). *p* values for the null hypotheses of the usual diagnostic tests are reported in parentheses at the end of the table

**p* < 0.1

****p* < 0.05

*****p* < 0.01

impact on HDI. This implies that large cities in high-income countries have reached their saturation point. For upper-middle-income countries, the total urban population and percentage of the urban population living in the largest cities do not have any impact on HDI. This indicates that urbanization in these countries is reaching toward saturation point. The percentage of the urban population living in the largest city is beneficial for HDI for lower-middle-income countries, whereas the percentage of the population living in million-plus cities has no impact on it. This indicates that though the speed of urbanization for these countries is important, different large cities have different impacts on HDI. For low-income countries, it seems that the largest city of the country has reached its saturation point and has a negative effect on HDI. This indicates that the impact of urbanization on HDI can vary based on the different stages of development a country is undergoing.

It is evidenced that higher CO₂ emission, higher fertility rate, and higher GDP growth rate which are all linked to mainly urbanization of a developing country have a negative effect on HDI. In contrast, FDI has a positive effect on it. Dunning (1977, 1993) argued that FDI not only contributes to the economic growth and development of developing countries through capital formation, job creation, technology transfer, and knowledge spillovers, but also affects the process of urbanization development of developing countries. The level of inequality has a negative effect on HDI. Ha et al. (2019) stated that, in the short term, urbanization can increase income inequality because wages are higher for urban jobs than rural work. However, in the long term, when urbanization is highly developed, the difference in income distribution in the two regions may decrease, and income inequality will decrease. Kanbur and Zhuang (2013) found that the effect of urbanization and the economic structure change on income inequality varies from country to country.

7 Conclusions and policy implications

The present study assesses the impact of urbanization on HDI. We consider 187 countries from the period of 1990–2017. The random effect Tobit and dynamic panel data models are estimated for the analysis. Urbanization is measured by the total urban population, percentage of the urban population, urban population growth rate, percentage of the total population living in million-plus urban agglomerations, and percentage of the total urban population living in the largest city. In addition to urbanization, we also add other important variables such as CO₂ emissions, FDI, fertility rate, GDP growth rate, level of inequality (Gini index), and inflation rate to investigate the determinants of the HDI. As different countries are experiencing different stages of urbanization, we also separate our analysis into high-income countries, upper-middle-income countries, lower-middle-income countries, and low-income countries. Data were collected from the UNDP and the World Development Indicators provided by the World Bank.

All country-level analysis suggests that the percentage of urbanization, total urban population, growth rate of urban population, and percentage of the population living in million-plus agglomerations have a positive and statistically significant effect on HDI when we run the regression along with controlling all other

important variables. On the other hand, the percentage of urban population living in the largest city in a country has a negative effect on HDI. In addition to that FDI has a positive effect on HDI, higher CO₂ emissions, fertility rate, GDP growth rate, inequality, and inflation rate have a negative effect on it.

The results also are spread by country-level income differences. The percentage of urbanization has a positive effect on the HDI across all countries. The impact of the total urban population on the HDI is also positive except for upper-middle-income countries. The urban population growth rate does not have any effect on all-country level, high-income countries, and lower-middle-income countries estimations. The percentage of total population living in million-plus agglomerations does not have any impact on the HDI for high-income and lower-middle-income countries. The population living in the largest city of a country does not have any impact on the HDI for high-income countries and upper-middle-income countries. This indicates that the impact of urbanization on HDI depends on different stages of development a country is undergoing.

Based on the results, we suggest that overall urbanization has a strong positive effect on HDI. The increase in the percentage of the urban population is the most important indicator of urbanization to increase the HDI of a country. Therefore, the level of development in terms of per capita income a country is undergoing does not matter, but it must increase the percentage of the urban population to realize the benefit of urbanization for improving higher HDI. On the other hand, the promotion of urbanization through the development of the largest city of a country is not required. The largest city of any country is driven by higher diseconomies of scale. They have reached their saturation point. Therefore, the scope for expansion has been exhausted within the city proper. Though lower-middle-income countries managed their largest city, by and large million-plus cities are not well managed. In contrast, lower-income countries do not manage their million-plus cities including the largest city properly. Therefore, developing countries need a better plan for large cities, whereas developed countries need to promote middle-tiered cities or small towns.

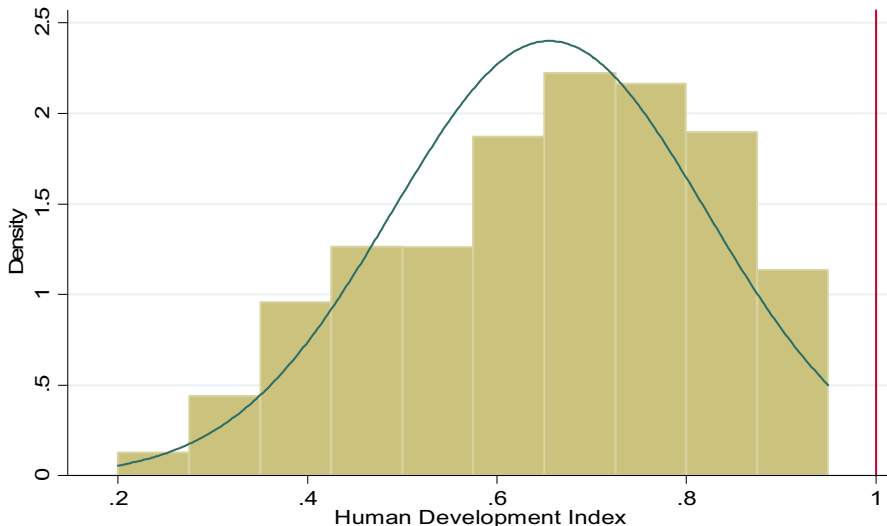
The percentage of urbanization is very low (i.e., about 30.98%) in low-income countries compared to high-income countries (i.e., about 71.25%) during study periods. These countries still depend on a rural-based agriculture economy. Therefore, to use resources such as land and labor more productively, they should promote urbanization. The percentages of the population living in million-plus cities are higher in lower-middle-income countries (i.e., 18.86%) than in high-income countries (i.e., 15.33%). This indicates that urbanization in the developing world is mainly driven by the concentration of population in large cities. This has led to an unsustainable urban system. Therefore, these countries should focus on middle-tiered cities for sustainable urbanization. Along with that, million-plus cities have to provide adequate basic services and need to manage properly so that they become the engine of economic growth.

Finally, it is suggested that along with the promotion of a higher urbanization rate, developing countries such as lower-middle-income and low-income countries should use green technologies to mitigate greenhouse gas emissions. It is also required to control the extent of inequality by distributing the benefits of urbanization among different regions and different groups of people, so that urbanization becomes an important factor behind an equal and prosperous society. To promote sustainable urbanization, higher investment is required. The investment should be driven by a higher level of FDI. Therefore, urban management should promote a supportive business environment too. It is also important to control inflation so that urbanization becomes instrumental to increasing HDI.

However, linking urbanization with poverty reduction, higher employment opportunities, higher provision of basic urban infrastructure, and higher government spending on education and health sectors for improving higher HDI values are left for future research.

Appendix

Figure 3, Table 7.



Source: Author

Fig. 3 Histogram of the dependent variable Source: author

Table 7 Variable definitions are given by the World Development Indicators

Variable	Definition	Source
CO ₂ emissions (kg per 2011 PPP \$ of GDP)	Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring	Carbon Dioxide Information Analysis Center, Environmental Sciences Division, Oak Ridge National Laboratory, Tennessee, USA
Foreign direct investment, net inflows (% of GDP)	Foreign direct investment are the net inflows of investment to acquire a lasting management interest (10% or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments. This series shows net inflows (new investment inflows less disinvestment) in the reporting of economy from foreign investors and is divided by GDP	International Monetary Fund, International Financial Statistics and Balance of Payments databases, World Bank, International Debt Statistics, and World Bank and OECD GDP estimates
Fertility rate, total (births per woman)	Total fertility rate represents the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with age-specific fertility rates of the specified year	(1) United Nations Population Division. World Population Prospects: 2019 Revision. (2) Census reports and other statistical publications from national statistical offices, (3) Eurostat: Demographic Statistics, (4) United Nations Statistical Division. Population and Vital Statistics Reprot (various years), (5) U.S. Census Bureau: International Database, and (6) Secretariat of the Pacific Community: Statistics and Demography Programme

Table 7 (continued)

Variable	Definition	Source
GDP per capita growth (annual %)	Annual percentage growth rate of GDP per capita based on constant local currency. Aggregates are based on constant 2010 US dollars. GDP per capita is gross domestic product divided by midyear population. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources	World Bank national accounts data, and OECD National Accounts data files
GINI index (World Bank estimate)	GINI index measures the extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution. A Lorenz curve plots the cumulative percentages of total income received against the cumulative number of recipients, starting with the poorest individual or household. The Gini index measures the area between the Lorenz curve and a hypothetical line of absolute equality, expressed as a percentage of the maximum area under the line. Thus, a Gini index of 0 represents perfect equality, while an index of 100 implies perfect inequality	World Bank, Development Research Group. Data are based on primary household survey data obtained from government statistical agencies and World Bank country departments. For more information and methodology, please see PovcalNet (http://firesearch.worldbank.org/PovcalNet/index.htm)
Inflation, GDP deflator (annual %)	Inflation as measured by the annual growth rate of the GDP implicit deflator shows the rate of price change in the economy as a whole. The GDP implicit deflator is the ratio of GDP in current local currency to GDP in constant local currency	World Bank national accounts data, and OECD National Accounts data files

Table 7 (continued)

Variable	Definition	Source
Urban population (% of total population)	Urban population refers to people living in urban areas as defined by national statistical offices. The data are collected and smoothed by United Nations Population Division	United Nations Population Division, World Urbanization Prospects: 2018 Revision
Urban population	Urban population refers to people living in urban areas as defined by national statistical offices. It is calculated using World Bank population estimates and urban ratios from the United Nations World Urbanization Prospects. Aggregation of urban and rural population may not add up to total population because of different country coverages	World Bank staff estimates based on the United Nations Population Division's World Urbanization Prospects: 2018 Revision
Urban population growth (annual %)	Urban population refers to people living in urban areas as defined by national statistical offices. It is calculated using World Bank population estimates and urban ratios from the United Nations World Urbanization Prospects	World Bank staff estimates based on the United Nations Population Division's World Urbanization Prospects: 2018 Revision
Population in urban agglomerations of more than 1 million (% of total population)	Population in urban agglomerations of more than one million is the percentage of a country's population living in metropolitan areas that in 2018 had a population of more than one million people	United Nations, World Urbanization Prospects
Population in the largest city (% of urban population)	Population in largest city is the percentage of a country's urban population living in that country's largest metropolitan area	United Nations, World Urbanization Prospects

Source: author's compilation

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