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International Studies Program
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Urbanization and the Poverty Level

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Abstract

This paper analyzes the effect of urbanization on the poverty level. Our theoretical model suggests a U-shape relationship between the level of urbanization and poverty. Urbanization contributes to poverty reduction but at much higher levels, urbanization leads to increases in poverty. Empirically, we estimate the "optimal level" of urbanization by using: (i) an instrumental variable approach in the framework of the generalized method of moments and (ii) a dynamic panel analysis approach. We also investigate the robustness of the impact of urbanization on the poverty level by examining a variety of linkages. The empirical analysis covers different regions of the world to study whether the magnitude of the urbanization effects varies across regions. Our results support the hypothesis that there exists a U-shape relationship between the level of urbanization and the poverty level.

Keywords: urbanization, public infrastructure, poverty reduction, pro-poor growth

JEL Codes: H50, I30, R11

1. Introduction

For many decades now, countries in all corners of the world have experienced rapid migration from rural to urban areas. A primary engine of this migration process has been people's desire to escape poverty and improve their standard of living. In parallel, the process of urbanization has been enhanced by agglomeration effects in production and consumption. These agglomeration effects have been not only fundamental forces that have shaped the economic structure of many countries, but they have also allowed a more efficient delivery of basic public services which, in turn, make a significant importance in the standard of living. There is little dispute in academic and policy circles that agglomeration economies and urbanization have played a significant positive role on economic growth and GDP per capita across countries. But, even though poverty reduction may be generally considered a natural by-product of the urbanization process, there is still considerable disagreement in the academic and policy literatures regarding what the impact is (positive or negative) of the urbanization process on the poverty level of any particular country. The main goal of this paper is to contribute to this debate by taking a careful look from a theoretical and an empirical perspective at what the channels are through which the urbanization process may impact poverty levels and whether, from the perspective of poverty reduction, there is an "optimal" level of urbanization.

When studying the effects of the urbanization process, it is useful to make a distinction between urbanization itself and the associated process of urban concentration, which has been defined as bias in public resource allocation towards few urban areas. Although urbanization might be associated with urban concentration and vice versa, the academic literature has been more concerned about the effect of urban concentration on poverty, as opposed to the effects of urbanization itself. In this paper we focus on clarifying the relationship between urbanization and poverty. As Ravallion et al. (World Bank 2007) have pointed out, the processes of urbanization may simply shift poverty incidence from rural to urban areas. The question we are interested in is whether the urbanization process has the net effect of reducing overall poverty incidence in both urban and rural areas and whether we can expect this relationship to be monotonic, greater urbanization will always deliver poverty reduction; or whether we can expect to see limitations and even reversals to that process.

In this paper we analyze, both theoretically and empirically using a variety of estimation approaches, the impact of urbanization on poverty reduction outcomes, looking at a variety of ways of defining poverty. One of our goals is to identify the different channels through which urbanization may work towards poverty reduction. Our approach allows us to derive the "optimal level" of urbanization from the perspective of poverty reduction. Our findings have some policy implications. To the extent that a certain degree of urbanization can be effective as a tool for poverty reduction, policymakers concerned with the effective reduction of poverty levels should pay close attention to the planning and management of urbanization processes.

The rest of the paper is organized as follows. In Section 2 we review the definitions of poverty, pro-poor growth, and urbanization processes; in this section we also briefly review the previous literature on urbanization and poverty. In Section 3 we develop a theoretical model that links urbanization processes, infrastructure provision, and income outcomes for the poor. In Section 4 we discuss our empirical estimation strategy and the data sources. In Section 5 we present our empirical results. In Section 6 we conclude.

2. Working definitions and literature review

2.1 Conceptual perspectives on the measurement of poverty

Poverty is a multi-dimensional concept and therefore it can be defined and measured in many different ways. First, poverty can be viewed from an objective and a subjective perspective. The objective approach involves some quantitative measurements, while the subjective approach places a premium on people's preferences. Second, poverty measures can capture physiological deprivation, such as those involving food and clothing, and sociological deprivations such as risk exposure and vulnerability. Poverty can also be evaluated from an absolute level or a relative level. For instance, a person may be considered absolutely poor if her income is less than a defined income poverty line; a person may be considered relatively poor if she belongs to a lowest income strata, say, the poorest 10 percent of the population. Regarding absolute poverty, for example, the World Bank has constructed poverty lines by defining cut-off states of poverty and non-poverty based on consumption ability. This constructed poverty line varies across different regions of the world; for example, for Africa it is usually set at 1 U.S. $ a day per person (1993 PPP$) as opposed to 2 U.S. $ (1993 PPP$) a day per person for Latin America.

In addition, the measurement of poverty can be done in monetary terms, as is the case with the World Bank poverty lines, but also in several non-monetary dimensions (based on qualitative information).

(1) Monetary Dimension

This approach to the measurement of poverty considers circumstances in which individuals and households are impoverished; that is, when their income or consumption ability falls below a certain threshold level, which is usually defined as a minimum, socially acceptable level of well-being by a group of population (Kakwani, Khandker and Son 2004; Kraay 2006). The most common measures for this dimension are:

- The Headcount Index (HI): This is simply the proportion of population that is poor, measured as the percentage of the population living below a certain threshold, i.e., people with their income or consumption below the poverty line or, in short, the incidence of poverty.

- The Poverty Gap (PG) index: It measures the degree or by how much the mean aggregate income or consumption of the poor differs from the established poverty line; in short, the depth of poverty.

- The FGT index: This stands for Foster, Greer and Thorbecke (1984) who proposed an alternative index combining the properties of the HI and PG indices and also adding the additional dimension of the severity of poverty. The formula for the FGT index is:

$$P_\alpha = \frac{1}{n}\sum_{i=1}^{q}\left[\frac{z - y_i}{z}\right]^\alpha \quad ,$$

where y_i is the income of the i individual ranked in increasing value of income; q is the number of individuals living below the poverty line z; n is the total population; and α is the aversion coefficient for poverty. An increase of α means that more weight is given to the poorest or those further away from the poverty line. Note that when $\alpha = 0$, P_α is the

HI; when $\alpha = 1$, P_α is the PG; and when $\alpha = 2$, P_α is the Square Poverty Gap (SPG). The SPG captures differences in income levels among the poor, reflecting the severity of poverty.

(2) Non-monetary Dimensions

Non-monetary indicators are used to assess poverty in terms of the level of human well-being. This approach to measuring poverty is based on the observation of human achievement outcomes. In this category of non-monetary indicators of poverty, one can broadly identify three main aspects: (i) health and nutrition poverty; (ii) education poverty; and (iii) composite indices of wealth, such as civil rights or vulnerability. Commonly used measures of non-monetary indicators of poverty include, the Human Development Index (HDI), the Human Poverty Index (HPI), the Gender-related Development Index (GDI), and the Gender Empowerment Measure (GEM). Behind each of those indices there is an explicit rationale. For example, the Human Development Index (HDI), developed in 1990 by the United Nations Development Programme (UNDP), is a comparative measure of average achievements of human development for a country. The index provides relative ratings from zero to one based on equal weighting (with one-third weights) of the three basic components: (i) basic health (ii) basic education (iii) a "decent standard of living" assessed with the Gross Domestic Product (GDP) per capita at Purchasing Power Parity (PPP) in US Dollars.

In this paper, as explained below, we will approach the measurement of poverty from a variety of perspectives. Since there is no absolute best way to measure poverty, it is important that, whatever results we obtain regarding the impact of urbanization processes on poverty, these results be robust regarding different ways to look at poverty.

2.2 Pro-poor growth

Relevant to our perspective on urbanization and poverty is the concept of pro-poor growth, which has been brought into the discussion of economic development policies in recent times. Under pro-poor growth policies, the poor are paid special attention in the programs seeking to facilitate income and employment generation and to alleviate inequalities in the distribution of income (Kakwani and Pernia, 2000; Ravallion and Chen, 2003; and Ravallion, 2004). In this literature, essentially, economic growth is pro-poor if and only if it is associated with higher growth rates in the income of the poor vis-à-vis the income of the non-poor.[1]

In our analysis we are interested in identifying the link between the process of urbanization and pro-poor economic growth.

2.3 The Process of Urbanization

Rural-urban migration movements have been the main cause behind the urbanization process all over the world. Rural-urban migration brings about both costs and benefits from economic and financial perspectives. From an economic perspective, urbanization processes represent a general thrust towards increased productivity and greater efficiency in the allocation of national resources. However, the other side of the coin is that rural-urban migration also imposes costs arising from undesirable socioeconomic developments associated with urban growth and imposes additional fiscal burdens because of the needed investment in infrastructure to meet the rapidly increasing demands for basic services (Linn 1982; Richardson 1987).

The economic benefits of urbanization stem from the "localized" and "urbanized" external economies of scale generally associated with that process. In the short run, efficiency is enhanced through the shifting of unproductive rural labor to urban areas where scale economies are realized. Location advantages generate demand for consumer goods and production inputs leading to higher productivity and allowing higher wages to be paid to the new urban labor force. Thus, in the migration process there is a substitution toward more productive urban economic activities and a shrinking rural employment. At the same time, urbanization enhances productivity of the rural sector through two kinds of complementarities. First, the rural sector benefits from a higher demand for rural goods from urban residents. Second, the productivity of the rural sector is also enhanced due to availability of new technologies. The latter effect results from the agglomeration

[1] For example, Kakwani et al. (2004) conceptualize pro-poor growth by introducing the concept of the Poverty Equivalent Growth Rate (PEGR). The PEGR yields the same level of economic growth, without any change in inequality. Similarly Kraay (2006) discusses two sources of pro-poor growth: 1) direct economic growth that increases incomes of the poorest group in the income distribution, and 2) poverty sensitivity to growth; for example, if the income of the poorest grows faster (i.e., more sensitive) than average income, then poverty falls faster.

of clusters in urbanized areas, which is likely to yield different specializations and increased productivities in each cluster as the labor pooling and availability of intermediate goods and services feed to technological progress. Due to the enhancement of rural productivity as urbanization progresses, the productivity differential between rural and urban sectors and therefore the gains from urbanization gradually diminish over time. Therefore, the relationship between urbanization and economic development appears to be a non-linear one as it is a product of the interplay of offsetting economic forces, similar to the interplay of centripetal and centrifugal forces hypothesized to shape the economic geography (Krugman 1999).

Overall, the migration and urbanization processes have enormous potential to increase per capita income and the standard of living and on the way to reduce the poverty level in a country. However, it is far from clear that this relationship will be a monotonic one. At some higher levels, the urbanization process may not indeed contribute to further reductions in poverty but it may actually become a contributor to poverty. How that can happen is the central question examined in this paper.

2.4 The previous literature on urbanization and poverty

A voluminous literature in economic development has identified the positive "direct effect" of urbanization on poverty through rising incomes. A variety of channels have been identified, including migration processes that arbitrage wage differentials between rural and urban areas (Tadaro 1969; Harris and Tadaro 1970), and enhancements in technology and labor skills that raise productivity (Tolley and Thomas 1987; Faria and Mollick 1996; Bertinelli and Black 2004; Polèse 2005). However, some more recent studies have pointed out that while urbanization can help reduce the overall incidence of poverty, it can also possibly lead to higher poverty in urban areas (Ravallion 2001; Ravallion et al. 2007).

The empirical studies of the relationship between urbanization and economic growth have produced mixed results (Jones and Kone 1996; Easterly 1999; Fay and Opal

2000; Davis and Henderson 2003). Nevertheless, most of these papers find some positive effects of urbanization on economic growth.[2]

Concerning some of the non-monetary dimensions of poverty, some theoretical studies have attempted to explain how differences in the availability of infrastructure for basic services between rural and urban areas relate to the urbanization process (Pham 2001; Issah et al. 2005). Some other empirical papers have found a positive and significant effect of urbanization on improved basic services (Dreze and Murthi 2001; Ramadas et al. 2002; Wodon and Ryan 2002 Liu et al. 2003; Issah et al. 2005) and increased efficiency in the provision of public infrastructure (Jayasuriya and Wodon 2002).

3. Theoretical Framework

In this section we build a theoretical framework to explore more in depth the relationship between urbanization and poverty outcomes. In this framework, poverty will be examined in the context of overall social welfare measured in turn by the growth in per capita consumption.

First, we model the growth of consumption building on the Devaranjan et al. (1996) framework. In order to analyze the effect of urbanization on growth, we modify their framework in three specific ways. First, whereas Devaranjan et al. (1996) model government spending in productive and unproductive sectors, we use rural and urban infrastructure as the two inputs into the production function. We also assume that the government is the sole provider of rural and urban infrastructure (see in Issah, et al. 2005).[3] Second, by using the CES production function instead of the Cobb-Douglas specification, we allow for varying degrees of complementarity between the rural and urban sectors; this allows us to accommodate completely urban economies like that of Singapore. Thus, in the generation of national income, urban infrastructure complements urban labor but to some degree those can be substituted by the combination of rural infrastructure and labor. Our third modification to Devaranjan et al.'s framework is the

[2] One possible explanation for the mixed results is the inconsistency in econometric models and data samples, for example cross-country versus time-series, used in those studies.
[3] Here government infrastructure can be interpreted as public education and health systems, roads, electricity, and other inputs to production.

introduction in the production function of a composite efficiency-enhancing multiplicative term which captures long-run growth from technological innovations made possible by urban agglomeration economies (Henderson, 1988).

After we obtain the theoretical predictions for growth in per capita income and consumption, we then link those results to poverty reduction outcomes, this time building on the analytical framework of pro-poor growth developed by Kakwani and Pernia (2000); Ravallion and Chen (2003); and Kraay (2006).

3.1 The behavior of production units

We assume per capita production y to be a function of private capital stock k, and two types of government infrastructure: urban G_u and rural G_r, which are combined with labor measured by the urban N and rural 1-N shares of population respectively. We also include a multiplicative term for the technological level A and the shift factor $g(N)$. The shift factor is assumed to be a concave function of urbanization, capturing external agglomeration economies. We assume output to be positively related to k, G_u, and G_r. Thus, the functional form for the per capita production is as follows:

$$y = A \cdot g(N) \cdot f(k, N \cdot G_u, (1-N) \cdot G_r), \qquad (3.1)$$

where A is a positive constant; $0 \leq N \leq 1$; and $f_k > 0$; $f_u > 0$; $f_r > 0$; $g_N > 0$; $g_{NN} < 0$.

Furthermore, to facilitate the analytical derivations, we parameterize (3.1) in a form where capital is complementary with the composite public infrastructure but the latter can exhibit varying degrees of substitutability between urban and rural components:

$$y = A \cdot g(N) \cdot k^{\alpha} \cdot \left[\beta(NG_u)^{-\xi} + \theta((1-N)G_r)^{-\xi}\right]^{-\frac{1-\alpha}{\xi}}, \qquad (3.1a)$$

where $0 \leq \alpha \leq 1$; $\xi \geq -1$; $\beta \geq 0$; $\theta \geq 0$.

Following Devaranjan, et al. (1996), the budget constraint for the government is assumed balanced and where infrastructure expenditures are financed through a flat rate income tax. The budget constraint thus is:

$\tau \cdot y = G_u + G_r = G,$ (3.2)

where G is total government infrastructure expenditures and τ is the flat tax rate.

Let us now assume the share λ of total government infrastructure expenditures accounted for by urban areas to be a function of the level of population urbanization N. Thus, the new budget constraint is given by:

$\tau \cdot y = \lambda(N) \cdot G + (1 - \lambda(N)) \cdot G,$ (3.3)

where $0 \leq \lambda(N) \leq 1$; $\lambda_N > 0$.

3.2 The behavior of consumption

The life-time utility of the representative consumer is given by

$$U = \int_0^\infty u(c) e^{-\rho t} dt, \qquad \text{where } u_c > 0,\ u_{cc} < 0 \tag{3.4}$$

Following Ramsey's growth model, U is maximized subject to

$$\dot{k} = (1-\tau) y - c, \tag{3.5}$$

where c is consumption and ρ is the rate of time preference, and both are strictly positive.[4]

Substituting Equations (3.1) and (3.3) into Equation (3.5) yields the new budget constraint:

$$\dot{k} = (1-\tau) \cdot A \cdot g(N) \cdot f(k, N \cdot G_u, (1-N) \cdot G_r) - c. \tag{3.6}$$

To make derivations more tractable, we specify the utility function in the commonly used Constant Relative Risk Aversion (CRRA) form. This function, with the constant elasticity of marginal utility, is expressed as following:

$$u(c) = \frac{c^{1-\sigma}}{1-\sigma}, \tag{3.7}$$

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[4] See Blanchard and Fischer (1989).

where $0 < \sigma < 1$ is the constant elasticity of substitution between consumption in any two periods.

Solving the Hamiltonian system with the life-time utility function specified by (3.7) and (3.4) subject to the budget constraint (3.6) yields the following:[5]

$$\mu = \frac{\dot{c}}{c} = \frac{(1-\tau)\cdot A\cdot g(N)\cdot f_k(k, N\cdot G_u, (1-N)\cdot G_r) - \rho}{\sigma}, \tag{3.8}$$

where μ is the marginal value as of time zero of an additional unit of consumption. Equation (3.8) gives the long-term steady-state growth rate for consumption, production and infrastructure expenditures (hereafter, the growth rate). For the specific functional form described in (3.1a), this growth rate can be expressed in extensive form as a function of *N*:[6]

$$\mu = \frac{\dot{c}}{c} = \frac{\frac{\alpha(1-\tau)}{\tau}(A\tau)^{\frac{1}{\alpha}}\left\{g\left[\beta(N\lambda)^{-\xi} + \theta((1-N)(1-\lambda))^{-\xi}\right]^{\frac{(\alpha-1)}{\xi}}\right\}^{\frac{1}{\alpha}} - \rho}{\sigma}. \tag{3.9}$$

3.3 The effect of urbanization on the growth rate

Equation (3.9) suggests that the growth rate is a function of urbanization. Being a fixed fraction of the national income (by construction in our model), the total government infrastructure expenditures are also a function of urbanization. From Equation (3.9) we are able to evaluate the impact of urbanization on the growth rate:

$$\frac{d\mu}{dN} = \frac{\frac{\alpha(1-\tau)}{\tau}(A\tau)^{\frac{1}{\alpha}}}{\sigma}\frac{d}{dN}\left\{g\left[\beta(N\lambda)^{-\xi} + \theta((1-N)(1-\lambda))^{-\xi}\right]^{\frac{(\alpha-1)}{\xi}}\right\}^{\frac{1}{\alpha}}. \tag{3.10}$$

What we are interested in is the sign of the RHS of Equation (3.10). The common factor term is always positive. Therefore, the sign of this derivative is determined by the sign of the expression in the brackets

[5] The derivations are available upon request.
[6] See Appendix A for the derivations.

$$\frac{d}{dN}\left\{g\left[\beta(N\lambda)^{-\xi}+\theta((1-N)(1-\lambda))^{-\xi}\right]^{\frac{(\alpha-1)}{\xi}}\right\}.$$

The latter is in turn determined by the sign of the following expression

$$\frac{g^{'}(N)}{g(N)}\left[\beta(N\lambda)^{-\xi}+\theta((1-N)(1-\lambda))^{-\xi}\right]+\frac{(\alpha-1)}{\xi}\frac{d}{dN}\left[\beta(N\lambda)^{-\xi}+\theta((1-N)(1-\lambda))^{-\xi}\right].$$

The first term represents the "channeled effect" of enhancing the level of technology through urbanization (external agglomerative economies) on the long-run growth rate. The second term represents the "channeled effect" of urbanization on the growth rate through the "economic infrastructure effect." Thus the sign of the impact of urbanization *N* on the growth rate is determined by the trade-off between the positive impact on agglomeration economies and the impact on the productivity of public infrastructure. The latter is in turn determined by a trade-off between declining rural production due to the outflow of population and public infrastructure and increasing urban production. It can be shown that the decline in rural production can outweigh gains in urban production only if the elasticity of substitution between the rural and urban sectors, which is equal to 1/ (1+ ξ), is less than two (i.e. $\xi \geq -0.5$).[7] Thus, when complementarity between rural and urban sectors is low, the impact of urbanization on growth is always positive. However, for higher levels of complementarity between the rural and urban sectors, urbanization up to a certain level has a positive impact on growth but it starts to hinder growth when urbanization increases beyond that point. This is because of the feedback from urbanization in raising rural productivity and thus narrowing the rural-urban productivity gap and thus gains from urbanization. Thus, our theoretical model identifies conditions under which the relationship between the level of urbanization and growth rate exhibits an inverse U-shape.

[7] See Appendix B for further details.

3.5 The effect of urbanization on the incomes of the poor

Having established the impact of urbanization on growth, in this subsection our focus shifts to how urbanization affects the poor. We consider an aggregate measure of poverty:

$$P_t = \int_0^{H_t} f(y_t(p))dp ,$$

where $y_t\ (p)$ is the income of the p^{th} percentile; H_t is the fraction of the national population below the poverty line z, and $f(y)$ is some measure of the severity of poverty at the income level y, such as in the Foster, Greer and Thorbecke (FGT) index:

$$f(y) = \left(1 - \frac{y}{z}\right)^{\theta} .$$

Following Kraay (2006), by using Leibniz's rule we can show that the change in poverty can be expressed as follows:

$$\dot{P} = f(H_t) \cdot \dot{H}_t + \int_0^{H_t} \frac{df(y_t(p))}{dy} \cdot \dot{y}_t(p)dp , \qquad (3.11)$$

which is a sum of the change in poverty headcount and the change in severity of poverty at various percentiles of income below the poverty line.

For the same growth in the average income level, the aggregate measure of poverty, the FGT index, can change in very different ways. As Kakwani et al. (2004) put it, “the Lorenz curve can change in an infinite number of ways and thus the ex-ante analysis of change in poverty is not possible under general situations.” Therefore, in this analysis, we will assume the same growth rate at each percentile of income so that the shape of the Lorenz curve does not change, i.e., the poor and the non-poor proportionally benefit from the shift in the average income. It implies that the poverty headcount H_t is a non-increasing function of urbanization N , as in Ravallion (2001).

However, even when growth preserves the shape of the Lorenz curve, different shapes of the curve can result in different rates of poverty reduction. It can be shown that, when the Lorenz curve has the a parabolic shape, that is y''(p)=0, then in the steady state, the poverty reduction rate is equal to the income growth rate: [8]

[8] See Appendix C for further details.

$$\frac{\dot{P}}{P} = -\mu$$
.

For a different shape of the Lorenz curve where $\frac{y_t'(p)}{y}$ is the same at each percentile *p*, for example the Chotikapanich (1993) shape, poverty reduction takes place according to the following formula:

$$\dot{P} = -\mu \cdot \frac{1}{k}\left(1 - \frac{y_t(0)}{z}\right)^{\theta}.$$

Thus, for the Chotikapanich shape of the Lorenz curve, the reduction of the headcount (i.e., θ=0) is proportional to the average income growth. However, other FGT measures (i.e., θ>0) do not have a steady state for this shape, because the rate of poverty reduction is declining as the income at the bottom of the distribution $y_t\ (0)$ approaches the poverty line *z*. For another common shape of the Lorenz curve, the one corresponding to the Pareto distribution, it is the share of non-poor that is increasing at a rate proportional to the income growth rate μ. For other FGT indices a steady state does not exist and thus they cannot be subjected to comparative statics analysis.

In summary, for those shapes of the Lorenz curve—assuming that the shapes are preserved with economic growth—that the FGT indices have a steady state, poverty reduction is proportional to the income growth rate and therefore follows a U-shape whenever the average income growth exhibits a U-shape. The corollary of our analysis is that under sufficient complementarity between the rural and urban sectors, up to a certain point, urbanization improves poverty reduction but the effect gets reversed thereafter.

4. Empirical estimation strategy

4.1 Specification of the estimation equation

Our goal in this section is to estimate the effects of urbanization on poverty reduction outcomes. The analysis makes three important contributions to the existing empirical literature. First, based on the U-shape relationship implied by our theoretical model, we include urbanization in a quadratic form as the explanatory variable of interest in the poverty regressions. Second, we allow urbanization to be endogenous with poverty when examining its effects. A number of previous studies have found a direct relationship between urbanization and the monetary dimension of well-being, especially the rate of economic growth (Wheaton and Shishido 1981; Jones and Kone 1996; Handerson 2003). However, all these studies treat urbanization as strictly exogenous. Third, we go beyond the impact of urbanization on poverty indicators and look at the specific channels for how the linkages take place including education attainment, health status, and labor productivity. Linking urbanization to poverty reduction through these channels can help policy-makers better utilize available resources through better aimed government policies.

We set out to estimate the relationship between urbanization and poverty reduction outcomes in the following general form:

$$Poverty_{it} = f(Urban_{it}, Urban_{it}^2, X_{it}) + u_{it}, \qquad (4.1)$$

where $Poverty_{it}$ is a poverty indicator; $Urban_{it}$ is the urbanization rate; $Urban_{it}^2$ is the urbanization rate squared; X_{it} is a set of control variables; and $u_{it} = n_i + \nu_{it}$ is a composite error of unobserved country-specific effects (η_i) and a vector of idiosyncratic disturbances (ν_{it}).

For our panel (GMM-IV[9]) estimation we use four alternative specifications of this general relationship:

$$Poverty_{it} = \beta_0 + \beta_1 Urban_{it} + \beta_2 Urban_{it}^2 + \beta_j X_{it} + u_{it}, \qquad (4.2)$$

$$Poverty_{it} = \beta_0 + \beta_1 Urban_{it} + \beta_j X_{it} + u_{it}, \qquad (4.3)$$

$$Poverty_{it} = \beta_0 + \beta_1 Urban_{it} + \beta_j X_{it} + \\ + \beta_2 UrbanEASIA + \beta_3 UrbanMENA + \beta_4 UrbanLAC + u_{it}. \qquad (4.4)$$

The terms capturing interactions between urbanization and the regional dummy variables are introduced in Equation (4.4): East Asia (*UrbanEASIA)*, Middle East and North Africa *(UrbanMENA)*, and Latin America and the Caribbean *(UrbanLAC)*. Note that Sub-Saharan Africa is our default region as in Fay and Opal (2000). Our set of control variables includes economic and socio-demographic variables, and variables capturing government institutions relevant for the regression of a specific poverty indicator.

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[9] See details in Baum et al. (2003)

For the dynamic panel GMM estimation[10] (the growth model) the specification is as follows:

$$Povertyg_{it} = \beta_0 + (\alpha - 1)iPoverty_{it} + \beta_2 Urban_{it} + \beta_3 Urban_{it}^2 + \beta_j X_{it} + u_{it}\,, \quad (4.5)$$

where $Povertyg_{it} = \ln Poverty_{it} - \ln Poverty_{i,t-1}$ is the rate of change in the poverty indicator; $iPoverty_{it} = \ln Poverty_{i,t-1}$ is the lagged value of the poverty indicator; and all other notation remains as explained above.

For the poverty indicators capturing improvements in human well-being (poverty reduction) such as the HDI, the testable hypothesis is that the coefficient at the linear term for urbanization is positive ($\beta_1 > 0$) while that at the quadratic term is negative ($\beta_2 < 0$). The opposite signs are hypothesized for regressions using the FGT-class indicators as the dependent variable. In Equations (4.2) and (4.5), the optimal degree of urbanization is, therefore, given by[11]

$$Urban^* = -\frac{\beta_1}{2\beta_2}\,. \quad (4.6)$$

4.2 Several econometric issues

Before we proceed with the estimation we need to deal with a number of econometric challenges. First, some of our regressors can be endogenous due to correlation with some unobserved factors such as economic shocks or unexpected political events. For example, random shocks such as economic crises in a country may have an impact on rural-urban migration. Higher unemployment or job-seeking uncertainty is likely to affect the patterns of migration. Urban dwellers would prefer to migrate to their native rural areas for jobs in the agricultural sectors or to move to a

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[10] See details in Bond et al. (2001) and Bond (2002).

[11] For example, for Equation (4.2) this expression is derived by simply equating to zero the partial derivative with respect to urbanization ($Urban$): $\frac{\partial HDI}{\partial Urban} = \beta_1 + 2\beta_2 \overline{Urban}$, where $\overline{Urban}$ represents the mean value of urbanization in our sample.

neighboring country if there is a free labor movement regime or lax border controls. In this situation, the standard estimation methods of panel data analysis (fixed or random effects) can produce biased estimates. We address this endogeneity problem issue by using an appropriate set of instruments in the framework of the generalized method of moments (GMM-IV).[12]

Another empirical issue is that the standard errors of the IV estimators can suffer from the presence of heteroskedasticity[13] of unknown form leading to invalid statistical inferences. We address this issue in our poverty regressions by testing for heteroskedasticity and computing robust standard errors in the GMM-IV framework, as discussed in the next section.

4.3 Data

Our data are an unbalanced panel data set. The overall number of countries in the panel is 143 which are observed at 5-year intervals spanning from 1960 to 2005. The number of longitudinal observations varies between series of six to nine time periods. See Appendix D for details and the definitions of variables and the sources of the data.

5. Empirical results

This section reports the results from testing the hypotheses derived in our theoretical framework. First, we present the results on the impact of urbanization on non-monetary aspects of poverty reduction. Second, we report the findings regarding the effect of urbanization on income growth of the poor. Third, we present evidence on the "channeled effects" of urbanization on poverty reduction outcomes.

[12] See the discussion of the appropriate set of instruments in the empirical results section.
[13] Under heteroskedasticity, the variance of the error term is not constant but might vary with the values of the regressors.

5.1 Urbanization and human development

In Table 1, we report the estimation results for the regressions specified by Equations (4.2)–(4.4) respectively, with HDI as the dependent variable representing poverty reduction outcomes. Results of fixed and random effects estimations are reported in columns (1) and (2), respectively. The coefficients on urbanization and urbanization squared are both statistically significant at the 1% level and suggest a concave shape for the relationship between urbanization and poverty. In general, these results support our hypothesis that there is an optimal degree of urbanization for poverty reduction outcomes.

As discussed previously, to address the endogeneity and heteroskedasticity problems, we turn to GMM-IV estimation, using the lagged values of the independent variables as internal instruments in this estimation.[14] Column (3) of Table 1 presents the results of the GMM-IV estimation.[15] The coefficients on both urbanization variables are statistically significant at the 5% level. The implied optimal level of urbanization is (0.481/2x0.355) = 0.677. At the optimal level of urbanization, a one-standard deviation (0.203) increase in urbanization over five years makes the HDI drop by 0.015 (or 0.1 of the standard deviation) over the same period, ceteris paribus.[16]

Columns (4) and (5) of Table 1 demonstrate how the estimates of the urbanization impact on poverty weaken when we fail to control for the distance from the optimum. The economic interpretation of Column (4) results imply that one-standard deviation (0.203) increase in urbanization over five years makes HDI drop by 0.01 (or 0.07 standard deviation).[17] This misspecification is somewhat mitigated in the regression reported in Column (5), by including an interaction term for each of four regional dummies to control for the distance from the optimal level of urbanization for the region

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[14] See Wooldridge (2002) pp 282-283 for the Wooldridge autocorrelation test. Note that Drukker (2003) provides simulation results showing that the test has good size and power properties in reasonably sized samples. He has also proposed a user-written program, *xtserial*, to perform this test in STATA. The test for autocorrelation in panel data yields the following results: F (1, 34) = 2.514, Prob > F =0.1221. This means that the hypothesis that there is no first-order autocorrelation in the data cannot be rejected at the 10% significance level.

[15] We test the presence of heteroskedasticity for the IV approach to see whether we will look for GMM or IV by using *ivhettest* in STATA. The results are Pagan-Hall general test statistic = 7.491, *p*-value = 0.0062. This means that the hypothesis that the disturbance is homoskedastic can be rejected at the 1% significance level.

[16] The figure 0.015 is the difference of amount derived by substituting the different levels of urbanization in the quadratic form of urbanization. That is $0.015 = \{(0.481\text{x}0.677)-(0.355\text{x}0.677^2)\}-\{(0.481\text{x}0.880)-(0.355\text{x}0.880^2)\}$, where one standard deviation (0.203) is obtained from the descriptive statistics based on the sample in this estimation.

[17] For this model specification, we also test for autocorrelation in panel data yielding the following results: F (1, 34) = 2.978, Prob > F = 0.0935. This means that the hypothesis that there is no first-order autocorrelation in the data cannot be rejected at the 5% significance level.

as a whole. Holding other things constant, the magnitude of the effect of urbanization on the HDI varies across regions and can be characterized as follows. In East Asia, one-standard deviation (0.203) increase in urbanization is associated with an increase in the HDI of (0.103–0.102) x0.203 = 0.0002 (or 0.001 standard deviation). In the Middle East and North Africa, a one-standard deviation (0.203) increase in urbanization is associated with an increase in the HDI of (0.103–0.096) x0.203 = 0.0014 percentage points (or 0.009 standard deviation). In Latin America and the Caribbean a one-standard deviation (0.203) increase in urbanization is associated with an increase in the HDI of (0.103–0.066) x0.203 = 0.00751 (or 0.049 of the standard deviation). Note that in the default region of Sub-Saharan Africa, a one-standard deviation (0.203) increase in urbanization is associated with an increase in the HDI of 0.103x0.203 = 0.021 (or 0.136 of the standard deviation).[18] The evidence supports our hypothesis that the impact of further urbanization on poverty reduction outcomes depends on the position of the status quo vis-à-vis the optimum.

5.2 Urbanization and pro-poor growth

In Table 2 we report the results of the dynamic panel analysis of reduction in monetary poverty (Equation 4.5) using the two-step approach to the system GMM estimation.[19] The system GMM estimator addresses with a set of "internal instruments" the endogeneity problems concerning both the lagged dependent variable and potentially endogenous explanatory variables including urbanization. More specifically, we use the second and further lags of the dependent variable and potential endogenous regressors as a set of instrumental variables.

Columns (1)—(3) of Table 2, present the results of the dynamic panel estimation using as a dependent variable three alternative poverty indicators from the FGT class: the headcount index (HI), the poverty gap (PG), and the squared poverty gap (SPG),

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[18] The impact of urbanization in South Asia and Eurasia is not statistically significantly different from that in the default region.

[19] According to Arellano and Bond (1991) and Blundell and Bond (1998), although the two-step approach is asymptotically more efficient, the two-step standard errors tend to be severely downward biased. Roodman (2006) proposed a user-written program on STATA, *xtabond2,* to compensate this disadvantage and to make available a finite-sample correction to the two-step covariance matrix derived by Windmeijer (2005). This can make the two-step robust approach more efficient than the one-step robust estimator leading to more accurate inference.

respectively. Unlike the estimations presented earlier, here the data sample does not include developed countries. Similar to the static panel analysis, we can use the estimated coefficients to infer the optimal level of urbanization.

For the HI regression, reported in Column (1) of Table 2, the coefficients for the urbanization terms, which are statistically significant at the 5% level, imply the optimal degree of urbanization of (15.354/2x15.650) = 0.491. At the optimal level of urbanization, a one-standard deviation (0.19) increase in urbanization over five years makes the rate of HI reduction drop by 53.8 percent over the same period, ceteris paribus. Thus under a suboptimal level of urbanization we have a significantly smaller rate of reduction in the number of people living below U.S. 1$ income/consumption per day

In Column (2) of Table 2 we employ the rate of PG change as the dependent variable. The table reports estimated coefficients for both urbanization terms that are statistically significant at the 10% level. The implied optimal level of urbanization is (12.990/ (2x13.739)) = 0.473. A one-standard deviation (0.190) change from the optimal level of urbanization leads the PG reduction rate to drop by 49.7 percent over five years, all else constant. Recall that the PG index measures how far the mean aggregate income or consumption of the poor falls below the established poverty line, i.e., the depth of poverty.

In Column (3) of Table 2, we utilize the SPG change as the dependent variable. Recall that the SPG index is a distributional measure that captures differences in income levels among the poor, i.e., the severity of poverty in terms of inequality among the poor. The coefficients for both urbanization terms are statistically significant at the 10% level. They imply an optimal level of urbanization of (29.685/ (2x29.684)) = 0.500. A one-standard deviation (0.190) increase in urbanization over five years leads the SPG reduction rate to drop by 107.2 percent over the same time period, all other things constant. This means that inequality among the poor will be improving much slower when the country is away from the optimal level of urbanization.

5.3 Urbanization and the channels for poverty reduction outcomes

In this subsection, we present and discuss the results of our estimation of the "channeled effects" of urbanization for three potential channels for poverty reduction: education, health, and productivity.

Basic Education Outcomes

We estimate the effect of urbanization on basic education using the specification described by Equation (4.2). We use primary school net enrollment and the youth literacy rate as the dependent variables while including the quadratic form of urbanization and a set of controls as the explanatory variables in the regressions.

The potential endogeneity of some of our regressors such as GDP per capita, public expenditure on education and urbanization are treated by a set of appropriate instruments used in the literature (Pritchett and Summer 1996; Filmer and Pritchett 1997):[20] income is instrumented by whether or not the country's primary export is oil; public expenditure on education is instrumented by the education share in total expenditures of the country's geographic neighbors. Selecting instruments for urbanization is based on the idea that rural-urban migration in one country would correlate with the level of urbanization in neighborhood countries. For example, external economic shocks affecting urban employment in one country are likely to affect the neighboring countries and their urbanization patterns in a similar fashion. Therefore, to instrument urbanization in a country, we use the urbanization level of its geographic neighbors.

Columns (1) and (2) of Table 3 report the estimates of the effect of urbanization on basic education. Column (1) presents the results from GMM-IV estimation using the primary school net enrollment as the dependent variable. The implied optimal level of urbanization is (3.379/ (2x2.730)) = 0.619. At the optimal level of urbanization, a one-standard deviation (0.225) increase in urbanization over five years makes the primary school net enrollment drop 13.8 percentage points (or 1.15 standard deviations) over the

[20] The test for autocorrelation in panel data yields the following results: F (1, 30) = 621.914, Prob > F = 0.0000. This means that the hypothesis that there is no first-order autocorrelation in the data can be rejected at the 1% significance level. Their internal lagged values are not an appropriate set of instruments for the GMM-IV estimation.

same time period, ceteris paribus. Column (2) reports the results of the GMM-IV estimation using the youth literacy rate as the dependent variable. The implied optimal level of urbanization is (2.813/ (2x1.788)) = 0.787. A one standard deviation (0.205) increase in urbanization over five years is associated with a drop in the youth literacy rate of 7.5 percentage points (or 0.413 standard deviation) over the same time period, all else constant.

Basic health outcomes

To examine the impact on poverty through health outcomes, we regress the infant mortality rate and life expectancy at birth on a quadratic form of urbanization and a set of control variables as described by Equation (4.2).

We address potential endogeneity problems with a strategy similar to the one we used for the estimation of the basic education channel. For the urbanization variable we use exactly the same instruments as in the education regression while for health spending we use the neighbors' health spending as a share of their total expenditure, instead of the share of education spending.[21]

Columns (1) and (2) of Table 4 present the estimates of the effect of urbanization on the two basic health outcomes. Tests for the IV heteroskedasticity do not reject homoskedasticity for either dependent variable. Column (1) presents the results for the infant mortality rate as the dependent variable.[22] The estimates imply an optimal level of urbanization of (455.392/ (2x366.150)) = 0.622. At the optimal level of urbanization, a one standard deviation (0.212) increase in urbanization over five years is associated with a rise in infant mortality of 16.456 infants per 1,000 live births (or 0.46 standard deviations) over the same time period, holding other things constant. Column (2) reports the results from using life expectancy at birth as the dependent variable. The implied optimal level of urbanization is (66.275/ (2x48.945)) = 0.677. A one standard deviation (0.206) increase in urbanization above the optimal level over five years is associated with

[21] The test for autocorrelation in panel data yields the following results: F (1, 40) = 48.290, Prob > F = 0.0000. This means that their internal lagged values are not an appropriate set of instruments for the GMM-IV estimation.
[22] The infant mortality rate is measured as the number of infant deaths between birth and the age of one per 1,000 live births

a drop in life expectancy at birth of 2.077 years (or 0.23 standard deviations) over the same time period , all else constant.

Potential productivity outcomes

In this subsection, we examine the "channeled effect" of urbanization on the productivity growth rate by means of the dynamic panel system GMM estimation based on Equation (4.5). The potential productivity channel is measured with value added per worker in agriculture and non-agricultural output as a share of GDP. It is important to note that in this estimation we treat all time-varying RHS variables as potentially endogenous. We use the second and further lags of the respective potential endogenous variables and the dependent variable as instruments.

Column (1) of Table 5 reports the results of the estimation using value added per worker in agriculture as the dependent variable The coefficients on the urbanization variables, which are significant at the 1% level, imply the optimal degree of urbanization of (2.345/(2x2.214)) = 0.530. At the optimal level of urbanization, a one-standard deviation (0.235) increase in urbanization is associated with a drop in the growth rate of value added per agricultural worker of 12.2 percent over the same time period, ceteris paribus.

Column (2) of Table 5 reports the impact of urbanization on the growth rate of the share of non-agricultural output in GDP. The coefficients on the urbanization terms are both statistically significant at the 1% level and imply an optimal degree of urbanization of (0.889/ (2x0.681)) = 0.653. At the optimal level of urbanization, a one-standard deviation (0.240) increase over five years in urbanization is associated with a drop in the growth rate of the share of non-agriculture output in GDP of 3.9 percent over the same period, ceteris paribus.

6. Conclusion

In this paper, we analyze theoretically and empirically the effect of the urbanization level on poverty reduction outcomes by considering a variety of dimensions in the concept of poverty. Our theoretical model suggests a U-shape relationship between the level of urbanization and poverty. We explore empirically the effects of urbanization on poverty reduction outcomes using a panel data set for a sample of 143 countries over the period of 1965-2005. Due to multi-dimensionality of poverty, we employ several estimation approaches to regress various poverty measures. First, to analyze the non-monetary aspects of poverty reduction, we use instrumental variables (IV) in the framework of the generalized method of moments (GMM) to examine the impact of urbanization on the Human Development Index, which takes into account basic human well-being achievements. We also attempt to examine relative differences among different regions of the world in terms of the impact of urbanization on poverty. Second, using the system GMM estimation, we investigate the effect of urbanization on the rate of reduction in the three monetary measures of poverty: the Headcount Index, the Poverty Gap, and the Square Poverty Gap. Finally we examine several potential transmission channels for the impact of urbanization through improvements in basic education, health (both using the IV estimation), and productivity enhancement (using the system GMM estimation).

In accordance with our theoretical predictions we find evidence of a U-shaped relationship between urbanization and poverty. According to our estimates, the optimal level of urbanization in terms of poverty reduction ranges from 47.3% to 78.7% of national population, depending on the poverty aspect. A related finding is that the impact of urbanization on poverty varies among regions of the world because of their different position relative to the optimal level. Furthermore, our empirical analysis also confirms a significant non-linear relationship between urbanization and poverty reduction through the channels of basic services provision (education and health) and productivity growth. Reallocation of labor and public resources from rural to urban areas appears to bring about economic gains or losses depending on whether the country is under- or over-urbanized.

Table 1: Estimates of Urbanization and Poverty Reduction Outcomes

Dependent Variable	Human Development Index (HDI)				
	Quadratic form			Linear form	
Independent Variable	(1) FE	(2) RE	(3) GMM	(4) GMM	(5) GMM
Urbanization	0.215 **	0.440 **	0.481 *	0.050 *	0.103 **
	(0.065)	(0.134)	(0.191)	(0.023)	(0.030)
Urbanization^2	-0.245 **	-0.334 **	-0.355 *		
	(0.052)	(0.092)	(0.142)		
GDP per Capita [a]	0.072 **	0.071 **	0.050 **	0.055 **	0.062 **
	(0.007)	(0.006)	(0.012)	(0.008)	(0.007)
Degree of Decentralization	0.029 #	0.032 *	0.068 #	-0.034	-0.072 *
	(0.016)	(0.015)	(0.041)	(0.034)	(0.033)
Openness	-0.003	0.002	0.047 *	-0.014	0.009
	(0.005)	(0.005)	(0.023)	(0.012)	(0.012)
ODA	0.028	-0.109	-0.209	-0.175	0.221
	(0.115)	(0.097)	(0.368)	(0.201)	(0.210)
Freedom	0.0001	0.0002	-0.004	-0.005	0.0008
	(0.001)	(0.001)	(0.006)	(0.004)	(0.004)
Population Density [a]	0.078 **	0.006	0.011	-0.014 **	-0.001
	(0.016)	(0.005)	(0.014)	(0.004)	(0.005)
Road Density [a]	0.002	0.004	-0.005	0.012 *	-0.007
	(0.002)	(0.003)	(0.012)	(0.006)	(0.007)
Urbanization x EASIA Dummy					-0.102 **
					(0.028)
Urbanization x MENA Dummy					-0.096 **
					(0.029)
Urbanization x LAC Dummy					-0.066 **
					(0.017)
Hansen Test (*p* -value)			0.5034	0.1401	0.2431
Time Dummies	Yes	Yes	Yes	No	No
No. of observations	232	232	142	116	116
R-squared	0.9464 (Within)				

** significant at 1%; * at 5%; # at 10%

[a] The variable is in the form of logarithm.

Numbers in parenthesis are robust standard errors.

Hausman Specification Test (1) vs (2) : chi(15) = 74.70 and Prob>chi2 = 0.0000

The null hypothesis of Hansen Test is that the instruments used are not correlated with the residuals.

Table 2: Estimates of Urbanization and Pro-poor Growth

Dependent Variable (Growth Rate)	Headcount Index (HI)	Poverty Gap (PG)	Square Poverty Gap (SPG)
Independent Variable	**(1)**	**(2)**	**(3)**
Urbanization	-15.354 *	-12.990 #	-29.685 #
	(6.619)	(7.676)	(18.064)
Urbanization^2	15.650 *	13.739 #	29.684 #
	(6.994)	(7.425)	(15.981)
Initial Level of Dependent Variable	-0.543 **	-0.426 #	-1.122 **
	(0.113)	(0.244)	(0.259)
Inflation [b]	-0.077	0.176	0.259
	(0.290)	(0.450)	(0.395)
Openness [a]	-0.066	-0.529	-0.272
	(0.485)	(0.374)	(1.121)
Agricultural Share [a]	0.994 *	1.223 #	1.980 #
	(0.491)	(0.729)	(1.042)
Schooling	0.035	0.142	0.058
	(0.113)	(0.108)	(0.253)
Government Consumption Share [a]	0.177		1.041
	(0.390)		(0.748)
Hansen Test (*p* -value)	0.990	0.989	0.994
Serial Correlation Test (*p* -value)	0.748	0.301	0.643
Time Dummies	Yes	Yes	Yes
No. of observations	117	117	117

** significant at 1%; * at 5%; # at 10%

[a] The variable is in the form of logarithm.

[b] The variable is in the form of logarithm (1+variable).

Numbers in parenthesis are robust standard errors.

The null hypothesis of Hansen Test is that the instruments used are not correlated with the residuals.

The null hypothesis of Serial Correlation Test is that the errors difference regression shows no second-order serial correlation.

Table 3: Estimates for Urbanization and Education Outcomes

Dependent Variable	Education Outcomes: Primary School Net Enrollment (% aged >15)	Education Outcomes: Youth Literacy Rate (% aged 15-24)
Independent Variable	**(1) IV [b]**	**(2) IV [c]**
Urbanization	3.379 *	2.813 #
	(1.596)	(1.519)
Urbanization^2	-2.730 *	-1.788 #
	(1.261)	(1.086)
GDP per Capita [a]	-0.013	-0.067
	(0.043)	(0.113)
Population Density [a]	-0.023 #	0.022
	(0.012)	(0.037)
Education Expenditure Share	0.208 #	-0.380
	(0.123)	(0.348)
Hansen Test (*p* -value)	0.6028	0.6250
Time Dummies	Yes	Yes
No. of observations	116	81

** significant at 1%; * at 5%; # at 10%

[a] The variable is in the form of logarithm.

Numbers in parenthesis are robust standard errors.

The null hypothesis of Hansen Test is that the instruments used are not correlated with the residuals.

[b] The IV heteroskedasticity test yields *p*-value = 0.916. The hypothesis that the disturbance is homoskedastic can not be rejected.

[c] The IV heteroskedasticity test yields *p*-value = 0.374. The hypothesis that the disturbance is homoskedastic can not be rejected.

Table 4: Estimates of Urbanization and Health Outcomes

Dependent Variable	Health Outcomes	
	Infant Mortality Rate	**Life Expectancy at Birth**
Independent Variable	**(1)** **IV [b]**	**(2)** **IV [c]**
Urbanization	-455.392 *	66.275 *
	(204.355)	(39.140)
Urbanization^2	336.150 #	-48.945 #
	(187.948)	(29.263)
GDP per Capita [a]	-7.647	1.788
	(6.004)	(1.387)
Schooling	-0.608	0.226
	(2.959)	(0.438)
Health Expenditure Share	-26.733	-19.080
	(109.713)	(14.952)
Freedom	0.238	-1.019 **
	(1.620)	(0.333)
Hansen Test (*p* -value)	0.1172	0.1006
Time Dummies	Yes	Yes
No. of observations	115	112

** significant at 1%; * at 5%; # at 10%

[a] The variable is in the form of logarithm.

Numbers in parenthesis are robust standard errors.

The null hypothesis of Hansen Test is that the instruments used are not correlated with the residuals.

[b] The IV heteroskedasticity test yields *p* -value = 0.124. The hypothesis that the disturbance is homoskedastic can not be rejected.

[c] The IV heteroskedasticity test yields *p* -value = 0.494. The hypothesis that the disturbance is homoskedastic can not be rejected.

Table 5: Estimates of Urbanization and Productivity Outcomes

Dependent Variable (Growth rate)	Productivity Outcomes: Agriculture Value Added Per Worker	Productivity Outcomes: Non-Agricultural Outputs per GDP
Independent Variable	**(1)**	**(2)**
Urbanization	2.345 **	0.889 **
	(0.768)	(0.212)
Urbanization^2	-2.214 **	-0.681 **
	(0.842)	(0.214)
Initial Level of Dependent Variable	-0.401 **	-0.560 **
	(0.113)	(0.500)
Agricultural Labor Force [a]	-0.606 **	-0.035
	(0.145)	(0.021)
Openness [a]	0.041	0.078 **
	(0.077)	(0.019)
Schooling	0.038	0.005
	(0.029)	(0.534)
Precipitation [b]	0.043	
	(0.030)	
Hansen Test (*p* -value)	1.000	1.000
Serial Correlation Test (*p* -value)	0.309	0.977
Time Dummies	Yes	Yes
No. of observations	515	532

** significant at 1%; * at 5%; # at 10%

[a] The variable is in the form of logarithm.

[b] The values of this variable are normalized by calculting into the unit of metre.

Numbers in parenthesis are robust standard errors.

The null hypothesis of Hansen Test is that the instruments used are not correlated with the residuals.

The null hypothesis of Serial Correlation Test is that the errors difference regression shows no second-order serial correlation.

APPENDIX A

In this appendix we derive the growth rate in the extensive form as a function of urbanization *N,* for the specific functional form described in (3.1a).

Substituting (3.3) into

$$\mu = \frac{\dot{c}}{c} = \frac{(1-\tau)\cdot A\cdot g(N)\cdot k^{\alpha-1}\left[\beta\left(NG_u\right)^{-\xi} + \theta\left(\left(1-N\right)G_r\right)^{-\xi}\right]^{-\frac{1-\alpha}{\xi}} - \rho}{\sigma}$$

Yields

$$\mu = \frac{\dot{c}}{c} = \frac{(1-\tau)\cdot A\cdot g(N)\cdot\left(\frac{k}{G}\right)^{\alpha-1}\left[\beta\left(N\lambda\right)^{-\xi} + \theta\left(\left(1-N\right)(1-\lambda)\right)^{-\xi}\right]^{-\frac{1-\alpha}{\xi}} - \rho}{\sigma} \qquad \text{(A.1)}$$

Substituting (3.3) into (3.1a) yields

$$y = Agk^{\alpha}\left(\tau y\right)^{1-\alpha}\left[\beta\left(N\lambda\right)^{-\xi} + \theta\left(\left(1-N\right)(1-\lambda)\right)^{-\xi}\right]^{-\frac{1-\alpha}{\xi}}$$

which can be rearranged into

$$\left(\frac{G}{k}\right)^{\alpha} = Ag\tau\left[\beta\left(N\lambda\right)^{-\xi} + \theta\left(\left(1-N\right)(1-\lambda)\right)^{-\xi}\right]^{-\frac{1-\alpha}{\xi}} \qquad \text{(A.2)}$$

Substituting (A.2) into (A.1) yields

$$\mu = \frac{\dot{c}}{c} = \frac{\alpha(1-\tau)\frac{G}{\tau k} - \rho}{\sigma}$$

which can be further rearranged into

$$\mu = \frac{\dot{c}}{c} = \frac{\frac{\alpha(1-\tau)}{\tau}\left(A\tau\right)^{\frac{1}{\alpha}}\left\{g\left[\beta\left(N\lambda\right)^{-\xi} + \theta\left(\left(1-N\right)(1-\lambda)\right)^{-\xi}\right]^{\frac{(\alpha-1)}{\xi}}\right\}^{\frac{1}{\alpha}} - \rho}{\sigma}. \qquad \text{(A.3)}$$

APPENDIX B

In this appendix we show that the decline in rural production can outweigh gains in urban production only if the elasticity of substitution between rural and urban sectors, which is equal to 1/ (1+ ξ), is less than two (i.e. ξ≥-0.5).[23] Indeed, it can be shown that

$$\frac{(\alpha-1)}{\xi}\frac{d}{dN}\left[\beta(N\lambda)^{-\xi}+\theta((1-N)(1-\lambda))^{-\xi}\right]=$$

$$=(1-\alpha)\left\{\lambda'\left(\beta N^{-\xi}\lambda^{-\xi-1}-\theta(1-N)^{-\xi}(1-\lambda)^{-\xi-1}\right)+\left(\beta N^{-\xi-1}\lambda^{-\xi}-\theta(1-N)^{-\xi-1}(1-\lambda)^{-\xi}\right)\right\}. \qquad \text{(B-1)}$$

On the other hand the latter expression can be rewritten as,

$$(1-\alpha)\left\{\lambda'\left(\beta N^{-\xi}\lambda^{-\xi-1}-\theta\left(\frac{1-N}{1-\lambda}\right)^{-\xi}(1-\lambda)^{-2\xi-1}\right)+\left(\beta N^{-\xi-1}\lambda^{-\xi}-\theta(1-N)^{-2\xi-1}\left(\frac{1-\lambda}{1-N}\right)^{-\xi}\right)\right\}$$

The sign of the latter expression at the limit, as urbanization approaches one, depends on how fast provision of rural infrastructure diminishes, that is on the magnitude of λ′ (1) thereafter denoted as λ'_1.

<u>Case 1: 0< λ'_1≤∞</u>:

Using l'Hôpital's rule one can determine the limits of (1-N)/ (1-λ) and (1-λ)/ (1-N) to be 1/ λ'_1 and λ'_1, respectively, and thus derive the limit of expression (B-1) as:

$$(1-\alpha)\left\{\beta(\lambda'_1+1)-\theta\cdot 0^{-2\xi-1}\cdot(\lambda'_1)^{-\xi}\cdot\left(1+(\lambda'_1)^{2\xi+1}\right)\right\}$$

One can see that for -ζ>0.5, this limit is equal to

$(1-\alpha)\{\beta(\lambda'_1+1)\}$>0. For -ζ<0.5, this expression converges to minus infinity.

<u>Case 2: λ'_1=∞</u>:

For -ζ>0.5, expression (B-1) converges to

[23] One has to recall that by definition ξ≥-1.

$$(1-\alpha)\left\{\lambda_1^{'}\cdot\left(\beta-\theta\left(\frac{1}{\lambda_1^{'}}\right)^{-\xi}\cdot 0\right)+\left(\beta-\theta\cdot 0\cdot\left(\lambda_1^{'}\right)^{-\xi}\right)\right\},$$

which can be further rearranged

into $(1-\alpha)\left(\lambda_1^{'}\right)^{-\xi}\left\{\left(\lambda_1^{'}\right)^{1+\xi}\cdot\left(\beta-\theta\left(\frac{1}{\lambda_1^{'}}\right)^{-\xi}\cdot 0\right)+\left(\frac{\beta}{\left(\lambda_1^{'}\right)^{-\xi}}-\theta\cdot 0\right)\right\}=(1-\alpha)\cdot\infty\{\infty\cdot\beta\}=\infty$.

For 0<-ζ<0.5, expression (B-1) converges to

$$(1-\alpha)\left\{\lambda_1^{'}\cdot\left(\beta-\theta\left(\frac{1}{\lambda_1^{'}}\right)^{-\xi}\cdot\infty\right)+\left(\beta-\theta\cdot\infty\cdot\left(\lambda_1^{'}\right)^{-\xi}\right)\right\}=$$

$$(1-\alpha)\left\{\left(\lambda_1^{'}\right)^{1-\xi}\cdot\left(\beta\cdot\left(\lambda_1^{'}\right)^{\xi}-\theta\cdot\infty\right)+\beta-\theta\cdot\infty\cdot\left(\lambda_1^{'}\right)^{1+\xi}\right\}=(1-\alpha)\cdot\{\infty\cdot(\beta\cdot 0-\infty)+\beta-\theta\cdot\infty\cdot\infty\}=-\infty$$

For -ζ<0, expression (B-1) converges to

$$(1-\alpha)\left\{\lambda_1^{'}\cdot\left(\beta-\theta\left(\frac{1}{\lambda_1^{'}}\right)^{-\xi}\cdot\infty\right)+\left(\beta-\theta\cdot\infty\cdot\left(\lambda_1^{'}\right)^{-\xi}\right)\right\}=$$

$$(1-\alpha)\{\infty\cdot(\beta\cdot-\theta\cdot\infty)+(\beta-\theta\cdot\infty\cdot 0)\}\leq(1-\alpha)\cdot\{\infty\cdot(\beta\cdot 0-\infty)+\beta\}=-\infty.$$

<u>Case 3: λ′₁=0</u>:

For -ζ>0.5, expression (B-1) converges to

$$(1-\alpha)\left\{\lambda_1^{'}\cdot\left(\beta-\theta\left(\frac{1}{\lambda_1^{'}}\right)^{-\xi}\cdot 0\right)+\left(\beta-\theta\cdot 0\cdot\left(\lambda_1^{'}\right)^{-\xi}\right)\right\},$$

Which can be further rearranged into

$$(1-\alpha)\left\{\left(\lambda_1^{'}\cdot\beta-\theta\cdot\left(\lambda_1^{'}\right)^{1+\xi}\cdot 0\right)+\left(\beta-\theta\cdot 0\cdot\left(\lambda_1^{'}\right)^{-\xi}\right)\right\}=(1-\alpha)\cdot\beta.$$

For -ζ<0, expression (B-1) converges to

$$(1-\alpha)\left\{\left(\lambda_1^{'}\cdot\beta-\theta\cdot\left(\lambda_1^{'}\right)^{1+\xi}\cdot\infty\right)+\left(\beta-\theta\cdot\infty\cdot\left(\lambda_1^{'}\right)^{-\xi}\right)\right\}=(1-\alpha)\beta\left\{\left(\lambda_1^{'}+1\right)-\theta\cdot\infty\cdot\left(\lambda_1^{'}\right)^{-\xi}\left(\left(\lambda_1^{'}\right)^{1+2\xi}+1\right)\right\}$$

$$=(1-\alpha)\beta\{(0+1)-\theta\cdot\infty\cdot\infty(0+1)\}=-\infty\ .$$

For 0<-ζ<0.5, expression (B-1) can be rewritten as

$$(1-\alpha)\left\{\lambda'\left(\beta N^{-\xi}\lambda^{-\xi-1}-\theta\left(\frac{1-N}{1-\lambda}\right)^{-\xi}(1-N)^{-2\xi-1}\left(\frac{1-\lambda}{1-N}\right)^{-2\xi-1}\right)+\left(\beta N^{-\xi-1}\lambda^{-\xi}-\theta(1-N)^{-2\xi-1}\left(\frac{1-\lambda}{1-N}\right)^{-\xi}\right)\right\}$$

which converges to

$$(1-\alpha)\left\{\left(\lambda_1'\cdot\beta-\theta\cdot(1-1)^{-2\xi-1}\cdot\left(\lambda_1'\right)^{-\xi}\right)+\left(\beta-\theta\cdot(1-1)^{-2\xi-1}\cdot\left(\lambda_1'\right)^{-\xi}\right)\right\}=(1-\alpha)\left\{\beta-2\theta\cdot(1-1)^{-2\xi-1}\cdot\left(\lambda_1'\right)^{-\xi}\right\}$$

The latter limit is determined by the limit of $(1-N)^{-2\xi-1}\cdot\left(\lambda_1'\right)^{-\xi}$, that is by how fast the provision of rural infrastructure diminishes, as we approach complete urbanization (N →1). If this limit is infinity, that is slowing down of the dismantlement of rural infrastructure is not enough to offset the rate of decline in rural population, then expression (B-1) converges to negative infinity. Otherwise it has a finite limit, which can be either positive or negative.

All in all, regardless of the magnitude of λ′(1), the sign of expression (B-1), and therefore, the impact of urbanization on growth is always positive, if ζ<0.5, that is_if complementarity between rural and urban sectors is low. For higher complementarity between rural and urban sectors, the sign of expression (B-1), and therefore, the impact of urbanization on growth becomes negative as urbanization increases. More specifically, expression (B-1) converges to negative infinity when the elasticity of substitution between rural and urban sectors is less than two (i.e. ξ>-0.5), except when the decline in the provision of rural infrastructure significantly slows down at the limit, in which case the elasticity of substitution between rural and urban sectors has to be less than one (i.e. ξ>0).

APPENDIX C

In this appendix we show how the rate of poverty reduction is related to the growth rate of the average income, assuming that the growth does not change the shape of the Lorenz curve.

From (3.11) recall it follows that

$$\overset{\bullet}{P} = f(H_t)\cdot \dot{H}_t + \int_0^{H_t} \frac{df(y_t(p))}{dy}\cdot \dot{y}_t(p)dp = f(H_t)\cdot \dot{H}_t + \int_0^{H_t} \frac{-\theta}{z}\left(1-\frac{y_t(p)}{z}\right)^{\theta-1}\cdot \mu \cdot y(p)dp$$

Case 1: If $y''(p)=0$, i.e. $y'(p)$ is the same at each percentile p, then the Lorenz curve is described by $L(p)=p^2$ and $y_t(p) = 2\cdot \bar{y}_t \cdot p$.

<u>For Poverty Headcount (θ =0), we have</u> $\overset{\bullet}{P} = \frac{dH_t}{dt} = \overset{\bullet}{H}$

But $y_t(H_t) = z$. Therefore, $\frac{\partial y_t(H_t)}{\partial p}\frac{dH}{dt} + \frac{\partial y_t(H_t)}{\partial t} = 0$, which implies $\frac{dH}{dt} = -\frac{\frac{\partial y_t(H_t)}{\partial t}}{\frac{\partial y_t(H_t)}{\partial p}} = -\frac{z\mu}{\frac{\partial y_t(H_t)}{\partial p}}$, as $\frac{dH}{dt} = -\frac{\frac{\partial y_t(H_t)}{\partial t}}{\frac{\partial y_t(H_t)}{\partial p}} = -\frac{z\mu}{\frac{\partial y_t(H_t)}{\partial p}}$.

Therefore, $\overset{\bullet}{H} = -\frac{z\mu}{y'}$.

For the given shape of the Lorenz curve, $\frac{\partial y_t(H_t)}{\partial p}$ does not depend on p but changes with t. Thus

$$H = \int_0^{H_t} dp = \frac{1}{y'}\int_0^{H_t} dy = \frac{z}{y'}$$

Therefore $\frac{\overset{\bullet}{H}}{H} = -\frac{z\mu}{y' * H} = -\mu$.

To consider other FGT indices, that is θ>0, let us denote $v = -\frac{z}{y'\theta}\left(1-\frac{y_t(p)}{z}\right)^{\theta}$ so that $dv = \left(1-\frac{y_t(p)}{z}\right)^{\theta-1}$.

Integrating by part yields

$$\dot{P} = -\mu \frac{\theta}{z}\int_0^{H_t} y dv = -\mu \frac{\theta}{z}\left\{ -\frac{z}{y^{'}\theta} y \left(1-\frac{y_t(p)}{z}\right)^{\theta}\Bigg|_0^H - \int_0^H \frac{-z}{y^{'}\theta}\left(1-\frac{y_t(p)}{z}\right)^{\theta} dy \right\}$$

$$= -\mu \frac{1}{y^{'}} \int_0^{H_t} \left(1-\frac{y_t(p)}{z}\right)^{\theta} dy = -\mu \frac{-z}{(\theta+1)y^{'}} \int_0^{H_t} d\left(1-\frac{y_t(p)}{z}\right)^{\theta+1} =$$

$$= \mu \frac{z}{(\theta+1)y^{'}} \left(1-\frac{y_t(p)}{z}\right)^{\theta+1}\Bigg|_0^H = -\mu \frac{z}{(\theta+1)y^{'}}\left(1-\frac{y_t(0)}{z}\right)^{\theta+1}.$$

Similar integration by part yields

$$P = \int_0^{H_t} \left(1-\frac{y_t(p)}{z}\right)^{\theta} dp = \frac{-z}{(\theta+1)y^{'}} \int_0^{H_t} d\left(1-\frac{y_t(p)}{z}\right)^{\theta+1} = \frac{-z}{(\theta+1)y^{'}}\left(1-\frac{y_t(p)}{z}\right)^{\theta+1}\Bigg|_0^H =$$

$$= \frac{z}{(\theta+1)y^{'}}.$$

Combining the two expressions and recalling that $y_t(0) = 0$, for the considered shape of the Lorenz curve, yields

$$\frac{\dot{P}}{P} = -\mu \frac{z}{P(\theta+1)y^{'}} = -\mu.$$

Case 2: If the shape of the Lorenz curve is such that $\frac{y_t'(p)}{y}$ is the same for each p, for example Chotikapanich (1993).

For Poverty Headcount ($\theta = 0$), as already derived for Case 1, we have $\dot{P} = \dot{H} = -\frac{z}{y^{'}(H)}\mu$.

To consider other FGT indices, that is $\theta > 0$, let us denote $v = -\frac{yz}{y^{'}\theta}\left(1-\frac{y_t(p)}{z}\right)^{\theta}$, so that

$$dv = y\left(1-\frac{y_t(p)}{z}\right)^{\theta-1}.$$

Integrating by part yields

$$\dot{P} = -\mu \frac{\theta}{z}\int_0^{H_t} dv = -\mu \frac{\theta}{z}\left(\frac{-yz}{y^{'}\theta}\right)\left(1-\frac{y_t(p)}{z}\right)^{\theta}\Bigg|_0^H = -\mu * \frac{y(0)}{y^{'}(0)}\left(1-\frac{y_t(0)}{z}\right)^{\theta}$$

In particular, for the Chotikapanich (1993) shape

$$y(p) = \bar{y}\frac{ke^{kp}}{e^k - 1}$$

and

$$y'(p) = \bar{y}\frac{k^2 e^{kp}}{e^k - 1} = ky(p).$$

Therefore

$\frac{y(p)}{y^{'}} = \frac{1}{k}$ and

$$\dot{P} = -\mu * \frac{1}{k}\left(1-\frac{y_t(0)}{z}\right)^{\theta}$$, where

$$y(0) = \bar{y}\frac{k}{e^k - 1}.$$

Case 3: For the shape of the Lorenz curve corresponding to the Pareto distribution, we have $y(p) = \bar{y}\frac{(1-p)^{\frac{1}{\gamma}-1}}{\gamma}$ so that $y'(p) = -\bar{y}\left(\frac{1}{\gamma}-1\right)\frac{(1-p)^{\frac{1}{\gamma}-2}}{\gamma} = \left(1-\frac{1}{\gamma}\right)\frac{1}{1-p}y(p)$ and $\frac{y(p)}{y^{'}} = \frac{1-p}{\left(1-\frac{1}{\gamma}\right)}$ and $y(0) = \frac{\bar{y}}{\gamma}$.

<u>For Poverty Headcount (θ =0), as already derived for Case 1, we have</u> $\dot{P} = \dot{H} = -\frac{z}{y^{'}(H)}\mu = -\frac{1-H}{\left(1-\frac{1}{\gamma}\right)}\mu$.

Therefore

$$\frac{1}{1-H}\frac{d(1-H)}{dt}=\frac{\mu}{\left(1-\frac{1}{\gamma}\right)}.$$

To consider other FGT indices, that is θ>0, let us denote

$$v=\left(1-\frac{y_t(p)}{z}\right)^{\theta}$$ so that

$$dv=\frac{-\theta\cdot y'}{z}\left(1-\frac{y_t(p)}{z}\right)^{\theta-1}.$$

Integrating by part yields

$$\dot{P}=-\mu\frac{\theta}{z}\int_0^{H_t}\frac{-yz}{y'\theta}\frac{-\theta y'}{z}\left(1-\frac{y_t(p)}{z}\right)^{\theta-1}dp=\mu\int_0^{H_t}\frac{1-p}{\left(1-\frac{1}{\gamma}\right)}dv=$$

$$=\mu\left\{\frac{1-p}{\left(1-\frac{1}{\gamma}\right)}\left(1-\frac{y_t(p)}{z}\right)^{\theta}\Bigg|_0^H+\frac{1}{\left(1-\frac{1}{\gamma}\right)}\int_0^{H_t}\left(1-\frac{y_t(p)}{z}\right)^{\theta}dp\right\}=\mu\frac{\gamma}{\gamma-1}\left\{P-\left(1-\frac{y_t(0)}{z}\right)^{\theta}\right\}$$

.

APPENDIX D

DATA DESCRIPTION AND SOURCES

Table D1: The Description and Sources

Variable	Variable Description	Data Source
A) Measures of Poverty		
Human Development Index (HDI) *	The index of a country ranges between 0 and 1. Its calculation is based on 3 components: Health through life expectancy at birth, Education through the adult literacy rate and the gross schooling enrollment rate, and Income through a decent standard of living measured by GDP per capita. A higher rating index indicates that a country has a higher level of human development.	The 2007/2008 Human Development Report; The United Nations Development Programmed (UNDP: accessed November 2007)
Headcount Index *	The proportion of population that is poor as the percentage of the population living below a certain threshold, i.e., people with their incomes or consumptions below the established poverty line or, in short, the incidence of poverty.	*PovCalNet*; The World Bank (accessed May 2007)
Poverty Gap *	The degree to which the mean aggregate income or consumption of the poor differs from the established poverty line, i.e., the depth of poverty.	*PovCalNet*; The World Bank (accessed May 2007)
Square Poverty Gap *	The distributional measure captures differences in income levels among the poor, i.e., the severity of poverty to reflect inequality among the poor.	*PovCalNet*; The World Bank (accessed May 2007)
B) Measures of Urbanization		
Urban Percentage	A country rated on a scale of 0 to 1. This index means that urban population as a percentage of total population is the proportion of a country's total national population that resides in urban areas. Any person not residing in an area classified as urban is counted in the rural population. Definitions of urban populations vary slightly from country to country. A country with a relatively higher urban percentage indicates more urbanized people living in urbanized areas than those in the other country.	The World Urbanization Prospects: The 2005 Revision; Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat (accessed May 2007)

Variable	Variable Description	Data Source
C) Channels of Poverty Reduction Outcomes		
Primary School Net Enrollment *	The primary school net enrollment ratio defined as the total primary school enrollment (both sexes) of the official primary school age group expressed as a percentage of the population from the same age group. In this study, we use the net enrollment educational attainment of the total population aged 15 and over.	Barro, J. Robert and Jong-Wha Lee, 2000 (accessed May 2007)
Youth Literacy Rate *	The percentage of the population aged 15-24 years who can both read and write, with comprehension, a short, simple statement concerning an individual's everyday life	The 2007 World Development Indicators CD-ROM; The World Bank
Infant Mortality Rate *	The probability of a child dying between birth and the age of one, expressed per 1,000 live births. The indicator is used as a measure of children's well-being and the level of effort being made to maintain child health.	The 2007 World Development Indicators CD-ROM; The World Bank
Life Expectancy at Birth *	The average number of years a new born infant would be expected to live if health and living conditions at the time of its birth remained the same throughout its life. It also reflects the quality of care they receive when they are sick.	The 2007 World Development Indicators CD-ROM; The World Bank
Agricultural Value Added per Worker *	A measure of agricultural productivity is in terms of constant 2000 U.S. $. Value added in agriculture measures the outputs of the agriculture sector less the value of intermediate inputs. Agriculture comprises value added from forestry, hunting, and fishing as well as cultivation of crops and livestock production.	The 2007 World Development Indicators CD-ROM; The World Bank
Non-agricultural Outputs per GDP	A measure of non-agricultural outputs as a percentage share of GDP. Non-agricultural sectors comprise of occupations in industry and service sectors.	The 2007 World Development Indicators CD-ROM; The World Bank

Variable	Variable Description	Data Source
D) Other Explanatory Variables		
GDP per Capita*	GDP per capita is gross domestic product divided by mid-year population. GDP 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. Data are in 2000 constant U.S. dollars.	The 2007 World Development Indicators CD-ROM; The World Bank
Degree of Decentralization	An indicator is as a percentage of a sub-national share of expenditures of the total expenditures. The indicator is measured on a scale of 0 to 1.	The 1972-1989 historical and the 2007 GFS CD-ROMs; The International Monetary Fund (IMF) and The World Bank Decentralization Thematic Group
Openness	Openness is calculated from the summary of import and export as a percentage of GDP. This indicator exhibits a country’s openness to international trade.	The 2007 World Development Indicators CD-ROM; The World Bank
Official Development Assistances (ODA) *	ODA is as a percentage of GNI that is the percent of a country's Gross National Income (GNI) received in the form of aid from other countries. The ratio is measured between 0 and 1. Gross National Income or GNI (formerly GNP) is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of outputs plus net receipts of primary income (compensation of employees and property incorporation).	The 2007 World Development Indicators CD-ROM; The World Bank
Population Density	A number of population per squared kilometer	The 2007 World Development Indicators CD-ROM; The World Bank
Road Density	A length of road per squared kilometer	The World Road Statistics (WRS); the International Road Federation (IRF: accessed May 2007) and the 2007 World Development Indicators CD-ROM; The World Bank

Variable	Variable Description	Data Source
Freedom	A simple average of the index of political rights and the index of civil liberties by the author. Political rights measure a country rating on a scale of 1 to 7 that indicates the degree of political rights in regards to the existence of free and fair elections, competitive parties or other political groupings, an opposition that plays a significant role in political decision-making, and the rights of minority groups to self-government. A rating of 1 indicates the highest level of political rights (closest to the ideals) suggested in the survey. Civil liberties measure a country rating on a scale of 1 to 7 that indicates the degree of civil liberties in regard to aspects such as the degree of freedom of expression, assembly, association, education, religion, and an equitable system of rule of law. A rating of 1 indicates the highest level of civil liberties.	Freedom in the World 2005; Freedom House (accessed May 2007)
Inflation	The index refers to a general rise in prices for goods and services measured against a standard of purchasing power	The 2007 World Development Indicators CD-ROM; The World Bank
Agricultural Share of GDP	The percentage share of agriculture of GDP	The 2007 World Development Indicators CD-ROM; The World Bank
Years of Schooling	A measure of education attainment in terms of the average years of schooling for the total population over the age of 15 years	Barro, J. Robert and Jong-Wha Lee, 2000 (accessed May 2007)
Government Consumption Share of GDP *	The percentage share of general government final consumption expenditure of GDP This consumption includes all government current expenditures for purchases of goods and services (including compensation of employees)	The 2007 World Development Indicators CD-ROM; The World Bank
Education Expenditure Share	The percentage share of education spending of the total expenditure	The 1972-1989 historical and the 2007 GFS CD-ROMs; The International Monetary Fund (IMF)
Health Expenditure Share	The percentage share of health spending of the total expenditure	The 1972-1989 historical and the 2007 GFS CD-ROMs; The International Monetary Fund (IMF)

Variable	Variable Description	Data Source
Agricultural Labor Force	The percentage share of agricultural labor force of the total labor force	Food and Agriculture Organization (FAO); the United Nations (accessed May 2007)
Precipitation	The yearly long run average rainfall	The Tyndall for Climate Change Research (accessed May 2007)
E) Country Classifications		
List of countries' primary export is oil.	Whether a country in our sample is a member of the Organization of the Petroleum Exporting Countries (OPEC).	The Organization of the Petroleum Exporting Countries (accessed May 2007)
Classifications of countries by income level and region	Whether a country in our sample is a member of high income countries and in which region a country is categorized.	The World Bank (accessed May 2007)

* Definitions based on The World Bank (http://www.worldbank.org: accessed May 2007)

Table D2: Descriptive Statistics for Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
A) Urbanization and Poverty Reduction Outcomes (83 countries, 7 time periods: 1975-2005)					
Human Development Index (HDI)	513	0.749	0.154	0.256	0.968
Urbanization	513	0.603	0.203	0.063	0.973
GDP per Capita (1000 U.S. $)	512	7.860	9.420	0.111	52.182
Degree of Decentralization	286	0.250	0.164	0.004	0.642
Openness	497	0.745	0.419	0.115	2.939
Official Development Assistances (ODA)	471	0.025	0.054	0	0.654
Population Density	513	104.998	131.880	1.219	1,023.404
Road Density	391	0.936	3.081	0.023	41.474
Freedom	494	2.902	1.773	1	7
B) Urbanization and Pro-poor Growth (89 countries, 5 time periods: 1980-2000)					
Headcount Index (HI)	236	0.158	0.185	0	0.741
Poverty Gap (PG)	236	0.0565	0.082	0	0.411
Square Poverty Gap (SPG)	236	0.029	0.050	0	0.288
Urbanization	236	0.491	0.190	0.050	0.905
Inflation	217	1.847	5.515	0.972	75.817
Openness	231	0.696	0.368	0.132	1.988
Agricultural Share of GDP	232	0.204	0.121	0.023	0.563
Years of Schooling	179	5.556	2.133	0.670	10.500
Government Consumption Share of GDP	229	0.138	0.051	0.042	0.294

Variable	Obs	Mean	Std. Dev	Min	Max
C) Urbanization and Primary School Net Enrollment (66 countries, 6 time periods: 1975-2000)					
Primary School Net Enrollment	381	0.370	0.152	.005	.759
Urbanization	381	0.563	0.225	.032	.971
GDP per Capita (1000 U.S. $)	374	7.777	8.846	0.086	37.164
Population Density	381	103.640	125.580	1.808	946.490
Education Expenditure Share	228	0.138	0.066	0.009	0.429
D) Urbanization and The Youth Literacy Rate (69 countries, 7 time periods: 1975-2005)					
Youth Literacy Rate	448	0.873	0.182	0.146	0.999
Urbanization	448	0.516	0.205	0.032	0.964
GDP per Capita (1000 U.S. $)	408	3.106	3.838	86.026 3	26.178
Population Density	448	100.248	147.136	0.924	1097.327
Education Expenditure Share	202	0.145	0.056	0.015	0.367
E) Urbanization and The Infant Mortality Rate (83 countries, 7 time periods: 1975-2005)					
Infant Mortality Rate	561	37.882	35.74708	2	155.400
Urbanization	561	0.578	.2116523	0.032	0.973
GDP per Capita (1000 U.S. $)	534	7.253	8.843	86.026	3.997
Years of Schooling	433	6.245	2.648	0.350	12.050
Health Expenditure Share	298	0.110	0.079	0.003	0.489
Freedom	519	3.071	1.866	1	7

Variable	Obs	Mean	Std. Dev.	Min	Max
F) Urbanization and Life Expectancy at Birth (83 countries, 7 time periods: 1975-2005)					
Life Expectancy at Birth	522	68.71599	9.008231	35.158	81.237
Urbanization	522	0.593	0.206	0.043	0.973
GDP per Capita (1000 U.S. $)	499	7.683	9.038	0.086	39.968
Years of Schooling	398	6.585	2.562854	0.890	12.050
Health Expenditure Share	284	0.114	0.082	0.003	0.489
Freedom	484	2.983	1.867	1	7
G) Urbanization and Agriculture Value Added per Worker (105 countries, 8 time periods: 1965-2000)					
Agriculture Value Added per Worker (1000 U.S. $)	665	4.606	8.043	0.074	47.225
Urbanization	665	0.468	0.235	0.023	0.949
Agricultural Labor Force	659	0.424	0.281	0.018	0.947
Openness	656	0.634	0.363	0.053	2.289
Years of Schooling	612	5.034	2.859	0.170	12.050
Precipitation	665	1.159	0.791	0.0229	3.726
H) Urbanization and The Non-agricultural Share of GDP (105 countries, 9 time periods: 1960-2000)					
Non-agricultural Share of GDP	698	0.218	0.164	0.007	0.931
Urbanization	698	0.456	0.240	0.024	0.949
Agricultural Labor Force	647	0.430	0.284	0.018	0.947
Openness	681	0.634	0.363	0.053	2.289
Years of Schooling	638	4.953	2.909	0.170	12.050

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