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DOES INFRASTRUCTURE MITIGATE THE EFFECT OF URBAN CONCENTRATION ON POVERTY IN DEVELOPING COUNTRIES?

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Working Paper No. 800

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Abstract

The paper focuses on a poorly investigated issue, although highly challenging for developing countries, which is the nexus between urban concentration, poverty and infrastructure. A system of equations is estimated including poverty, urban concentration and growth as dependent and explanatory variables, distinguishing poverty in rural and urban areas and considering infrastructure as potentially affecting each endogenous variable. The results show that urban concentration is associated with higher poverty in both rural and urban areas and higher national income growth. In turn, a higher income is associated with lower poverty in both urban and rural areas. Road infrastructure is associated with lower poverty in both areas and ICT infrastructure significantly increases income growth. Paved roads significantly reduce urban concentration. The net effects on poverty are computed via simulations. The latter shows that the contributions of the ICT infrastructure to national poverty and to the urban-rural poverty gap reductions are positive and significant but much lower than the one of "paved roads".

JEL Classification: R12, R23, H54, O18, O15

Keywords: Urban concentration, growth, poverty, infrastructure, developing countries

ملخص

تركز الورقة على مسألة لم تتلقى اهتمام بحثى جيد، وذلك على الرغم من أنها تمثل تحديا كبيرا للبلدان النامية ، وهى العلاقة بين التركز الحضري والفقر و البنية التحتية. ونقدر نظام المعادلات بما فيها الفقر و التركز الحضري والنمو و المتغيرات التابعة وعوامل توضيحية اخرى، وذلك للتفرقة بين الفقر في المناطق الريفية والحضرية والنظر في البنية التحتية والتى يحتمل أن تؤثر في كل متغير ذاتيا . وتبين النتائج أن التركز الحضري يرتبط مع ارتفاع حدة الفقر في كل من المناطق الريفية والحضرية ونمو الدخل. وفي المقابل، يرتبط الدخل الأعلى بانخفاض الفقر في كل من المناطق الحضرية والريفية . وترتبط البنية التحتية للطرق بانخفاض الفقر في كل المناطق والبنية التحتية لتكنولوجيا المعلومات والاتصالات تزيد بشكل كبير مع نمو الدخل . الطرق الممهدة تقلل إلى حد كبير من التركز الحضري . ويتم احتساب صافي الآثار على الفقر عن طريق المحاكاة . ويبين هذا الأخير أن تكون مساهمات البنية التحتية لتكنولوجيا المعلومات والاتصالات فى الفقر الوطني و تخفيض فجوة الفقر بين الريف والحضر هي إيجابية وهامة ولكنها أقل بكثير من واحد من " الطرق الممهدة. "

1. Introduction

Urban concentration[1], that is agglomeration of population in large cities, is already very high or steadily increasing in many parts of the world. It represented around 35% of total population in Latin America. Where it is still low [around 12% in Sub-Saharan Africa (SSA)], it is expected to increase. SSA is seen by the United Nations as the fastest urbanizing region of the world and will be predominantly urban by 2030 (Dudwick et al. 2011). In Middle East and North Africa (MENA), urban concentration is presently around 20%.

In parallel, income inequality seems to be widening between regions of the same country and poverty of people living in cities seems to be worsening. A number of researches documents that poverty is becoming more and more an urban phenomenon, especially in the developing world. Ravallion et al. (2007) showed that rural poverty over the world is higher than urban poverty but that the number of rural poor decreased while the number of urban poor increased between 1993 and 2002. Regarding Arab countries, while the severity of poverty is lower in comparison to other developing countries, it is increasing more rapidly. As in other regions, the severity of poverty is higher in rural areas but increases more rapidly in urban rears.

The evolution of urban concentration stems mainly from two major factors: intra-country migration and natural increase. Although figures on internal migration are hardly available, one can deduce from the speed of urbanization that the former factor plays the most important role (Lucas 2004). Following Brockerhoff (1995), migration from rural areas accounted for more than half of urban growth in Africa between 1960 and 1970 and of about 25% between 1980 and 1990. In Brazil, over 20 million rural people came to urban areas over the period 1950-1970. In India, migration from rural to urban areas counted for 30% (around 20.5 million) of urban growth during the 1990s. For Egypt, Wahba (2007) found that internal migration is important and increasing.

Empirical studies on the determinants of urban concentration and rural-urban migration highlighted the role of various factors. Brueckner and Fansler (1983) found that income difference between rural and urban areas, population and agricultural rental positively affect urbanization in the US. In a recent related paper, Sekkat (2012) used a system of equations to examine more deeply the relationship between urban concentration and poverty in developing countries. The system includes poverty, urban concentration and growth as dependent and explanatory variables, distinguishes poverty in rural and urban areas and allows feedback. His results showed that the relationship between urban concentration and poverty is not straightforward and involves three opposite effects. A direct effect by which urban concentration increases poverty in both urban and rural areas. An indirect effect by which urban concentration reduces poverty in both areas: it fosters growth which translates in higher per capita income which, in turn, reduces poverty in both areas. Finally, there is a feedback effect by which a higher gap between rural and urban poverty increases urban concentration.

While confirming the role of income, McGrath (2005) showed that transportation costs play an important role in mitigating the effect of urban concentration on poverty. Davis and Henderson (2003) and Deng et al. (2008) supported this finding. Beside transport, the development of information and communication technology (ICT; e.g. mobile phones, access to internet etc.) can also affect migration from rural to urban areas**.** Indeed, evidence points to the role of such technology as a way of mitigating the isolation of rural areas by making some tasks performable at distance and reducing the necessity of moving to urban areas (Aker and Mbiti 2010 and Rossoto et al. 2005).

[1] In what follows we will use the terms urban concentration and urbanization indifferently to talk about high agglomeration of population is large cities.

While there are a number of papers dealing with urbanization and growth, growth and infrastructure or growth and poverty, none, to our best knowledge, investigates econometrically the nexus between urban concentration, growth, poverty and infrastructure. Beside the academic novelty of this question, it could have important implications from a policy point of view. Identifying such a nexus would allow examining whether and how investment in infrastructure could contribute to the reduction of poverty and drawing policy recommendations. To this end, this paper presents the estimation results of a system of equations including poverty, urban concentration and growth as dependent and explanatory variables, distinguishing poverty in rural and urban areas and considering infrastructure as potentially affecting urban concentration, growth, rural poverty and urban poverty. It also allows for feedback among variables and collects primary data to construct valid instruments.

The rest of the paper is organized as follows. Section 2 discusses the relation to the literature. Section 3 is devoted to a descriptive analysis. Section 4 presents the methodology that is applied in the econometric analysis of section 5 and the simulation analysis of section 6. Section 7 concludes.

2. Relation to the Literature

While urban concentration comes mainly from intra-country migration and natural increase, the former seems to play the most important role. Migration from rural to urban areas has been the focus of economic literature. Early contributions (e.g. Brueckner 1990) saw such migration simply as the result of the differences in income and market opportunities between urban and rural areas. Others (Mijiyawa et al. 2011; Ades and Glaeser 1995; Davis and Henderson 2003) emphasized political economy factors such as federalism and democratization. They argued that political institutions and policies may encourage over-concentration. The concerned cities are, in general, national capitals (e.g. Paris, Mexico City, Cairo) but non-capitals could also be concerned (e.g. São Paulo or Casablanca) because of other reasons such as access to ports, existence of local amenities, cost and availability of public goods etc.

Urban concentration may drive income inequality to widen between regions of the same country and poverty of people living in cities to worsen. The best way to address these issues is to make the lagging regions attractive to producers, investors, traders and consumers. This includes better access to social services and improved business climate to enhance the private sector's interest in non-leading areas. But of prime importance is to break the isolation of lagging areas by improving their connections to the poles of development. Here transport and ICT infrastructure can play a crucial role.

Since the seminal work by Aschauer (1989) showing the role of infrastructure in the development processes, several studies have been carried out to investigate the link between infrastructure and poverty. For instance, McGrath (2005), while confirming the results by Brueckner and Fansler (1983), showed that transportation costs play an important role in reducing urban concentration. Davis and Henderson (2003) supported this finding by showing that investment in interregional infrastructure facilitates urban de-concentration even after controlling for the role of democratization, federalism, and political regime. Canning and Bennathan (2000) studied the impact of infrastructure investment in electricity generation and paved roads in 41 countries. They found positive return to both types of investment. However, infrastructure in isolation has limited impacts on economic growth and should be accompanied by physical and human capital investment to maximize the return. Fan et al. (2000), focusing on Indian states, find that agricultural R&D, rural roads and rural education all have negative and statistically significant effects on rural poverty; with agricultural R&D and rural roads having by far the largest impact. Focusing on China, which has been experiencing very fast urbanization since two decades, Deng et al. (2008) confirmed the powerful role of income growth but also highlighted the importance of transportation costs. Fan and Chan-Kang (2008) used a system of equations approach to estimate the impact of road investments on overall economic growth, rural and urban growth, and rural and urban poverty reduction across Chinese provinces. Rural roads appear to benefit more national GDP than urban roads. The former also raises far more rural and urban poor above the poverty line than the latter. Finally, the study revealed a trade-off between growth and poverty reduction when investing in different parts of China. Road investments yield their highest economic returns in the eastern and central regions of China, while their contributions to poverty reduction are greatest in western China. Fan et al. (2002) analyzed similar effects across Chinese provinces, distinguishing between expenditure on rural education, targeted poverty alleviation, telecommunications, irrigation, power generation, agricultural R&D and rural roads. They found that spending on rural roads has the largest impact on poverty.

Beside transport, the development of information and communication technology (ICT; e.g. mobile phones, access to internet, etc.) can also affect migration from rural to urban areas. Indeed, evidence points to the role of such technology as a way of mitigating the isolation of rural areas by making some tasks performable at a distance and reducing the necessity of moving to urban areas. Various examples of successful reliance on ICT are discussed in World Bank (2011) which highlights experiences in Brazil, Egypt and Tunisia among others. Aker and Mbiti (2010) discussed the impact of mobile phone usage in SSA. Such usage has grown significantly over the past decade and now covers 60 percent of the population. They cited empirical evidence showing that mobile phones have the potential to benefit consumer and producer welfare, and perhaps broader economic development. Calderon and Servén (2004) studied the link between infrastructure development and the distribution of income using an equation à la Barro (1991) and roads, railways, telecommunications, and energy indicators. They found that both quantity and quality of infrastructure are negatively linked with income inequality. Jensen (2007) focused on the impact of mobile phone introduction throughout Kerala, a state in India with a large fishing industry. Using micro-level survey data, he showed that the adoption of mobile phones by fishermen and wholesalers was associated with a dramatic reduction in price dispersion and the complete elimination of waste. Both consumer and producer welfare increased.

3. Descriptive Analysis

Figure 1 presents the average urban concentration, defined as the share of total population living is cities of more than 1 million inhabitants, around the world. It shows that Latin America is the most concentrated region in the world (just below 35%) followed by the MENA region (around 20%). SSA is the least concentrated region (around 12%).

In the MENA region, the most concentrated country is Lebanon (above 40%), followed by Syria (above 30%) and Iraq (around 23%). The least concentrated countries are Algeria and Yemen (around 8%).

In parallel to the evolution of urban concentration, income inequality seems to be widening between regions of the same country and poverty of people living in cities seems to be worsening. A number of research papers document that poverty is becoming more and more an urban phenomenon, especially in the developing world. Ravallion et al. (2007) showed that rural poverty across the world is higher than urban poverty but that the number of rural poor has decreased while the number of urban poor has increased between 1993 and 2002.

Here we focus on poverty as measured by the share of urban population (in % of urban population) living below the urban poverty line and similarly for rural areas. Both are draw from the World Development Indicators (WDI) of the World Bank. Figure 3 shows that rural poverty is highest in Latin America where the gap between rural and urban areas is also the largest. SSA ranks second in terms of poverty with also a large gap between rural and urban areas. The MENA exhibits a much lower poverty level as well as a lower gap between rural and urban areas.

Among MENA countries, poverty is highest in Yemen and lowest in Tunisia. However, both countries exhibit the largest gaps between rural and urban areas. In Egypt, poverty is similar to the rest of the countries but it is the only one where urban poverty is higher than rural. The gap between rural and urban poverty is also marked in Algeria and Morocco.

4. Methodology

The discussion in the previous sections suggests that urban concentration might affect poverty directly and indirectly through the relationships "concentration-macroeconomic growth" and "macroeconomic growth-poverty". Both the direct and the indirect effects may be positive or negative depending on a number of factors. Moreover, the relationships may be non-linear i.e. depends on the level of urban concentration. Finally, infrastructure plays an important role in shaping such relationships. The proposed methodology investigates how infrastructure affects the relationship between urban concentration and poverty. As the literature suggests that the impacts may also differ between rural and urban areas, the analysis will distinguish between the impacts on the two areas. The objective is to provide recommendations in order to limit the potential negative effect of urban concentration on poverty in rural and urban areas. The focus is on transport and ICT infrastructure.

4.1 The model

We suggest estimating simultaneously the following four equations system:

$$\ln\left(yr^{P}{}_{i,t}\right) = \alpha_0 + \alpha_1 \ln\left(y_{i,t}\right) + \alpha_2 \ln(Concentration_{i,t}) + \alpha_3 \ln(Infrastructure_{i,t}) + v_{i,t} \quad (1)$$

$$\ln\left(yu^{P}{}_{i,t}\right) = \eta_0 + \eta_1 \ln\left(y_{i,t}\right) + \eta_2 \ln(Concentration_{i,t}) + \eta_3 \ln(Infrastructure_{i,t}) + \mu_{i,t} \quad (2)$$

$$\begin{aligned} \ln\left(y_{i,t}\right) - \ln\left(y_{i,t-1}\right) &= \beta_0 + \beta_1 \ln\left(y_{i,t-1}\right) + \beta_2 \ln\left(S_{Ki,t}\right) + \beta_3 \ln\left(S_{Hi,t}\right) + \beta_4 \ln\left(\delta + g^* + n_{i,t}\right) \\ &+ \beta_5 \ln(Concentration_{i,t}) + \beta_6 \ln\left(Infrastructure_{i,t}\right) + \varepsilon_{i,t} \end{aligned} \quad (3)$$

$$\ln\left(Concentration_{i,t}\right) = \gamma_0 + \gamma_1\left(yu^{P}{}_{i,t-1} - yr^{P}{}_{i,t-1}\right) + \gamma_2 \ln\left(Concentration_{i,t-1}\right) + \gamma_3 \ln(Infrastructure_{i,t}) + \xi_{i,t} \quad (4)$$

where

yr^P	is poverty headcount ratio at rural poverty line (% of rural population)
yu^P	is poverty headcount ratio at urban poverty line (% of urban population)
y	is average national per capita income

Concentration: is an indicator of urban concentration

Infrastructure: is an indicator of infrastructure

S_K	is the rate of savings in physical capital,
S_H	is the rate of saving in human capital,
g^*	is the rate of exogenous technical progress,
n	is the population growth rate,
δ	is the depreciation rate of physical capital

v, μ, ε, ξ are error terms

indices *i* and *t* refer to the country and time respectively.

Equations 1 to 4 are standard in the literature. The only novelty here is to estimate them simultaneously and incorporate the relationships with infrastructure. Since one objective of the paper is to draw useful policy recommendations, we need to disentangle the various channels through which urban concentration affects poverty. Hence, we must estimate the four equations simultaneously instead of one reduced from linking poverty and concentration.

Equations 1 and 2 are direct extensions of Dollar and Kraay (2002). The parameters α_1 and η_1 measure the elasticity of poverty in rural and urban areas respectively, with respect to national income. Equation 3 is in the tradition of Barro (1991) and Mankiw et al. (1992). The lagged per capita income $y_{i,\,t-1}$ captures the possible conditional convergence of income. The variable S_K is the investment in physical capital which is expected to have a positive impact on the growth rate. The variable S_H is the rate of saving in human capital which should have a positive impact on growth. Equations 1 to 3 incorporate urban concentration in levels. Given the above mentioned non-linearity of the relationship between urbanization and growth we have also included the square of urban concentration. However, this variable didn't prove significant and we disregarded it. One possible explanation is that we are focusing on developing countries and the threshold income level for above which nonlinearity emerges is not in our sample. Finally, Equation 4 is inspired by Brueckner (1990) and Deng et al. (2008) and relates urban concentration to the differences in poverty of urban and rural populations. A high difference in poverty should increase urban concentration.

4.2 Implementation

4.2.1 Data

The four equations system will be estimated using data for the largest available sample of developing countries and time coverage. As an indicator of urban concentration, we use the share of population in urban agglomerations of more than 1 million in total population. As indicators of infrastructure we use the ratio of the total number of kilometers of roads in a country over its surface, the share of paved roads in total roads, the number of internet users per 100 people and the number of mobile cellular subscriptions per 100 people. The rate of saving in physical capital and the rate of saving in human capital will be measured by the ratio of investment to GDP and the secondary school enrolment ratio respectively. Following Mankiw et al. (1992), it is assumed that $g^*+\delta$ is equal to 0.05. All these variables are readily available from the World Development Indicators (2011) of the World Bank.

4.2.2 Estimation

Traditional estimations of the equations consisted in running a simple OLS on the time average of the variables for each country; i.e. cross-section data. This has, however, the inconvenience of not using the information contained in the time dimension of the sample. To meet this shortcoming, one would ideally use the recent development in the panel-cointegration methodology which allows dealing with the growth and the cycle mixture in economic series. By controlling for the cycle component, the main determinants of the long-run components are accurately identified. While we could get enough time and country dimensions to justify the use of such a methodology, key variables such as the indicator of human capital are impacted by the existence of missing observations through time. The panel-cointegration methodology cannot, therefore, be used here. To try grapping as much as possible of the information in the time dimension of the sample, we will use the alternative strategy consisting of 5 year averages of each variable.[2]

The equations are in general augmented with additional explanatory variables. The choice of such variables is not easy. For instance, Duarluf et al. (2005) showed that the number of regressors that can be potentially added to a growth regression approaches the number of countries available in the broadest samples. This plethora of potential regressors illustrates one of the fundamental problems with empirical growth research, namely, the absence of any consensus on which growth determinants should be included in a regression. Some economists suggest that one should focus on a "core" set of explanatory variables that have proved to be consistently associated with the studied phenomenon and evaluate the importance of the variable of interest (here urban concentration and infrastructure) conditional on the inclusion of the core set.

It remains that the equations don't directly control for a number of factors among which political economy has been found to play an important role. For instance, Davis and Henderson (2003) found that urban concentration is affected significantly by democratization, federalism, and whether a country was a former planned economy. Esfahani and Ramirez (2003) showed that the quality of institutions as measured by democracy, centralization and contract enforcement plays a particularly important role in infrastructure growth. However, taking explicitly into account of all these factors is beyond the scope of this paper and might even induce confusion. The econometric approach adopted is expected to limit the inconvenience.

Estimation using traditional methods such as OLS, fixed or random effects methods may, however, result in inconsistent parameter estimates because of simultaneity issues. For instance, Davis and Henderson (2003) found a reverse relationship between growth and urbanization i.e. growth drives urbanization. The causal relationship between poverty and the average incomes is also possibly bi-directional. To address these problems, we use the simultaneous equations system GMM estimation method (Arellano and Bond 1991; Blundell and Bond 1998). The method uses lagged values of regressors as instruments for right-hand-side variables and also introduces lagged endogenous (left-hand-side) variables as regressors. Here, we also use the geographical characteristics of the country, which are truly exogenous, as additional instruments. The latter include the share of the country's surface occupied by plains, hills, mountains etc. As shown by Greene (2003), the inclusion of the lagged dependent variables among instruments in GMM system estimation takes account of country fixed effects (dummies). This way, a large part of the political economy variables discussed above is controlled for. To gauge the validity of our estimates we use the test of overidentifying restrictions.

5. Estimation Results

Table 1 presents the results of the estimation using the GMM system estimation method. The results with the OLS and fixed effects method are available from the author. The period of observation is 1980-2009 and all variables are 5-year averages. The names of the 65 countries in the sample are given in appendix A. The overidentifying restrictions test supports the GMM results. With each infrastructure indicators the coefficients of the control variables (all explanatory variables excluding urban concentration and infrastructure) are almost always significant with the expected signs (except human capital in the growth equation).

Regarding the effects of urban concentration, the results show that higher urban concentration is associated with higher poverty in both rural and urban areas and the levels of the

[2] When an observation is missing for a given year, the average is computed over the remaining years.

corresponding coefficient seem higher for urban areas. In the growth equation, the coefficients of urban concentration are non-significant when ICT indicators are used but are significant and positive with roads indicators suggesting that higher urban concentration induces higher growth. In turn, a higher national income is associated with lower poverty in both urban and rural areas (except when the indicator for total roads is used). The levels of coefficients seem higher for urban areas.

The coefficient of the lagged dependent variable in the urban concentration equation indicates a high degree of persistence over time which is not surprising. Urban concentration depends on the poverty gap between rural and urban areas only when the ICT indicators are used suggesting that urban concentration is higher the higher rural poverty is compared to urban poverty like in Brueckner (1990).

Turning to the effects of infrastructure, interesting contrasts appear across the results pertaining to each indicator. Road infrastructure is associated with lower poverty in both areas while ICT indicators are associated with higher poverty in both areas. Moreover, the road infrastructure doesn't seem to significantly affect growth while ICT does. Finally, only paved roads significantly reduce urban concentration. Across specifications, there is always at least one coefficient of infrastructure which is significant.

Overall, the results confirm that the relationship between urban concentration and poverty is not straightforward and involves opposite effects and that infrastructure has either a direct or an indirect impact on such relationship both at the national level and regarding the gap between rural and urban areas. The net effect of infrastructure on national poverty and on the gap between rural and urban poverty depends, therefore, on the levels of the variables at play and can only be approached via simulations.

6. Simulation Results

The analysis in the previous section shows that the relationship between urban concentration and poverty is not straightforward and involves opposite effects. It also shows that infrastructure plays either directly or indirectly an important role in poverty both at the national level and regarding the gap between rural and urban areas. The net effect of infrastructure on national poverty and on the gap between rural and urban poverty depends, therefore, on the levels of the variables at play and can only be approached via simulations. We simulate the impacts using equations 1 to 4 together with the estimated coefficients and the exogenous variables. We start by focusing on the impact at the national level and, then, we examine the impact on the gap between rural and urban areas.

Figure 5 plots the net impact of infrastructure on poverty at the national level against the level of urban concentration in the sample (average over 2005-2009). More precisely, the y-axis gives the ratio of the simulated national poverty rate under the assumption of no infrastructure (i.e. setting the infrastructure variable at zero) over the simulated national poverty rate with the observed level of infrastructure. It tells us whether the national poverty rate under the assumption of no infrastructure is, let's say, twice the observed poverty rate. For instance, a number equals to 2 means that the rate without infrastructure would have been twice higher. The figure shows that all values on the y-axis are above one except when the indicator "roads total" is used meaning that with the other indicators of infrastructure national poverty is higher without infrastructure. The contributions of the ICT variables to national poverty reduction are positive but much lower than the one of "paved roads". For illustration, we drew trend lines on the basis of the indicator "paved roads". With a linear trend the R^2 is 9%. With a polynomial trend the R^2 is 10%. Both trends suggest that while national poverty is lower with paved roads, the difference is slightly decreasing as the level of urban concentration increases. For instance, at the level of urban concentration of 5%, the national poverty rate would have been two times higher if this infrastructure was removed. At the level of urban concentration of 34%, the national poverty rate would have been 1.8 times higher if this infrastructure was removed.

An important issue often subject to debate when dealing with urbanization and poverty concerns disparities between rural and urban areas. Metropolitan areas (Amman, Cairo, Casablanca, and Tunis) and coastal regions (Aqaba, Alexandria, and Tangier) are considered as capturing most of the gains from growth. Peripheral geographic areas, particularly rural, seem to lag behind. The resulting regional polarization might pose important problems in terms of social cohesion, political stability and even growth. Expressed in terms of this paper's framework this issue becomes about whether infrastructure reinforces the gap between urban and rural poverty in developing countries. To this end, figure 6 plots the difference of the net effect of infrastructure on poverty in urban and rural area against the level of urban concentration in the sample. More precisely, the y-axis gives the difference between the simulated rural-urban poverty gap using the observed level of infrastructure (call it Δf) and a similar gap under the assumption of no urban concentration (call it Δnf). The difference is taken in percentage of Δnf; that is $(\Delta f - \Delta nf) / \Delta nf * 100$. A negative figure means that infrastructure reduces the gap between urban and rural areas. The evolution shows how the difference in the gaps evolves as one moves from one level of urban concentration to the next higher level. Interestingly, the figure suggests that, taking all effects into account, infrastructure reduces the poverty gap between urban and rural areas except when the indicator "roads total" is used. As before, the contributions of the ICT variables to the urban-rural gap reduction are positive but much lower than the one of "paved roads". We, again, draw trend lines for illustration. With a linear trend the R^2 is nil. With a polynomial trend the R^2 is very low 2%. When the outliers are removed the results remain basically unchanged. Both trend lines suggest a relatively stable contribution of paved roads to the reduction in the poverty gap between urban and rural areas.

While figures 5 and 6 were useful in highlighting the respective importance of the various indicators of infrastructure for poverty reduction, they may have hidden the non-negligible contributions of ICT due to the scale driven by the high importance of "paved roads". Figures 7 and 8 are similar to figures 5 and 6 respectively except that they focus on ICT indicators. They show that national poverty would have been 1.02 to 1.20 times without ICT and that the gap between urban and rural poverty would have been 10% to 25% higher without ICT. Both numbers are far from being negligible.

7. Conclusion

The paper focuses on a poorly investigated issue—one that is highly challenging for developing countries—which is the nexus between urban concentration, poverty and infrastructure. To this end, it presents the estimation results of a system of equations including poverty, urban concentration and growth as dependent and explanatory variables, and distinguishing poverty in rural and urban areas and considering infrastructure as potentially affecting urban concentration, growth, rural poverty and urban poverty. It also allows for feedback among variables and collects primary data to construct valid instruments. As an indicator of urban concentration, it uses the share of population in urban agglomerations of more than 1 million in total population. As indicators of infrastructure it uses the ratio of the total number of kilometers of roads in a country over its surface, the share of paved roads in total roads, the number of internet users per 100 people, and the number of mobile cellular subscriptions per 100 people.

The estimation results show that higher urban concentration is associated with higher poverty in both rural and urban areas. However, urban concentration has a significant positive impact on income growth. In turn, a higher income is associated with lower poverty in both urban and rural areas. As a feedback, urban concentration is lower with higher urban poverty as compared to rural poverty. Hence the relationship between urban concentration and poverty is not straightforward and involves opposite effects. Regarding the effects of infrastructure, there is always at least one coefficient of infrastructure which is significant across specifications. Road infrastructure is associated with lower poverty in both rural areas while ICT infrastructure significantly increases income growth. Finally, only paved roads significantly reduce urban concentration.

Given the complexity of the interactions, the net effect of infrastructure on national poverty and on the gap between rural and urban poverty can only be approached via simulations. The latter show that the contributions of the ICT infrastructure to national poverty reduction are positive but much lower than the one of “paved roads”. Similar effects appear regarding the contributions to the urban-rural gap reduction. However, ICT infrastructure has a non-negligible contribution to the reduction of both national poverty and the urban-rural poverty gap.

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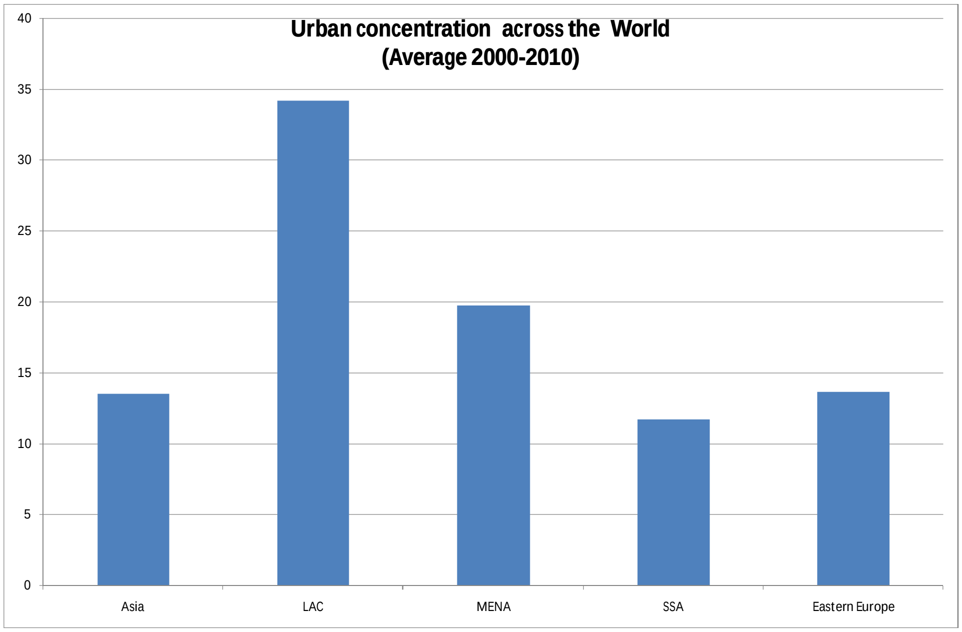
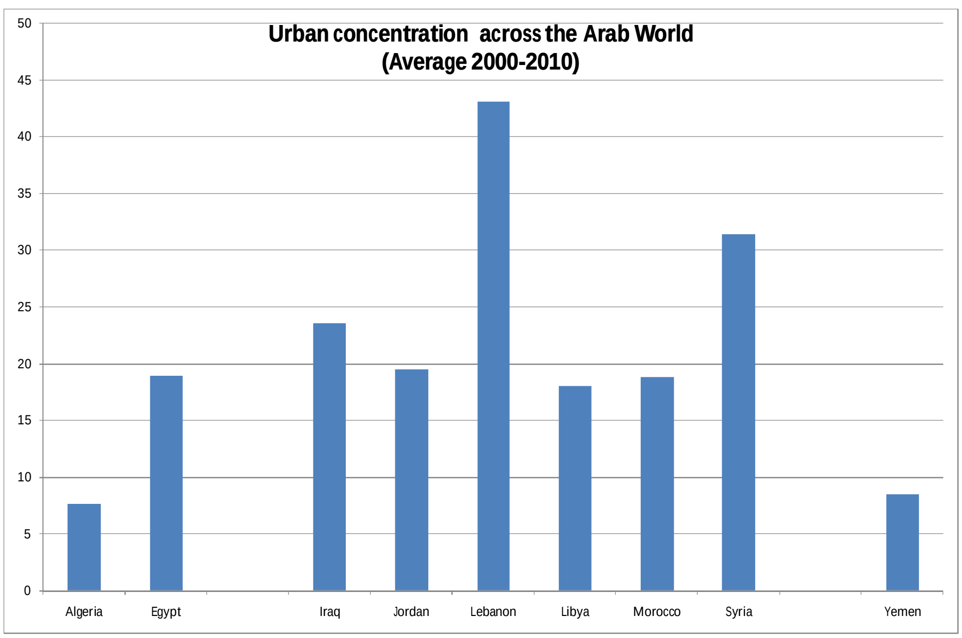
Figure 1: Urban Concentration around the World



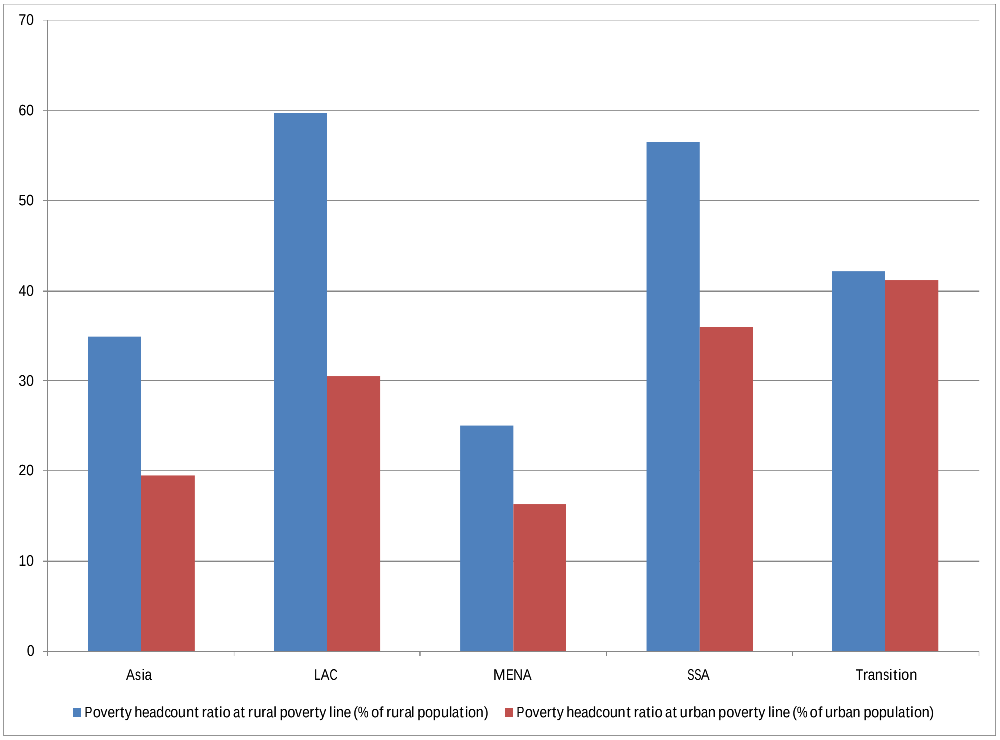
Source: : World Development Indicators (WDI), 2011

Figure 2: Urban Concentration in Arab Countries



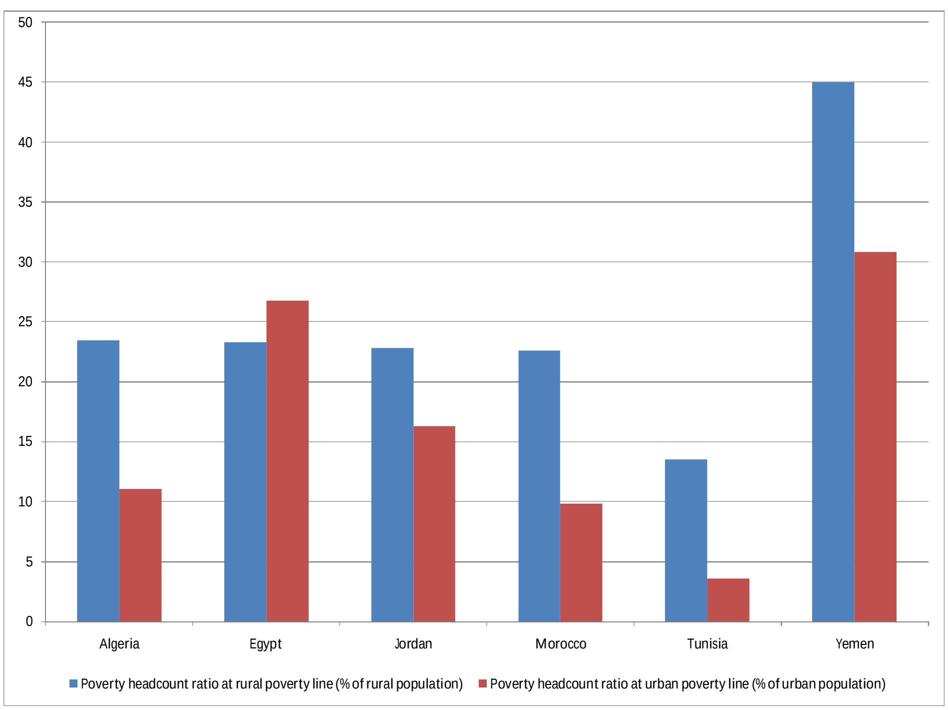
Source: World Development Indicators (WDI), 2011

Figure 3: Rural and Urban Poverty around The World (Average 1990-2010)



Source: World Development Indicators (WDI), 2011

Figure 4: Rural and Urban Poverty in MENA Countries (Average 1990-2010)



Source: World Development Indicators (WDI), 2011

Figure 5: Simulated Net Impact of Infrastructure on Poverty (National Level)

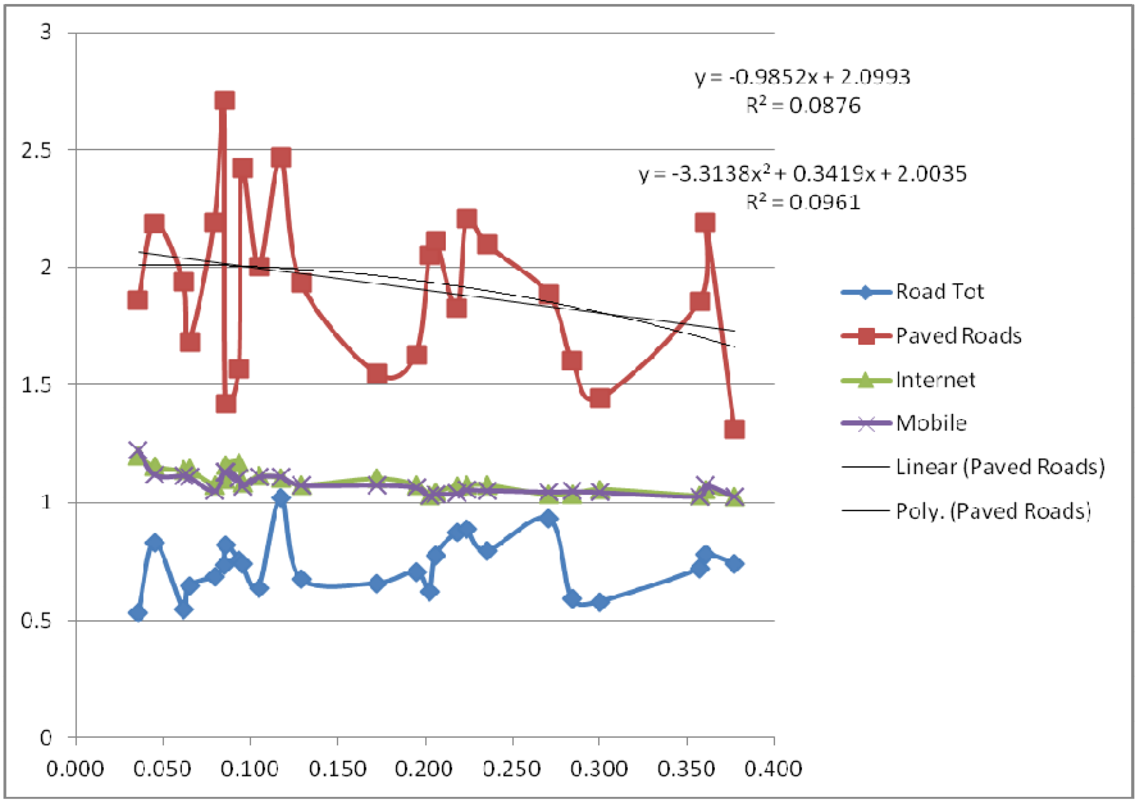
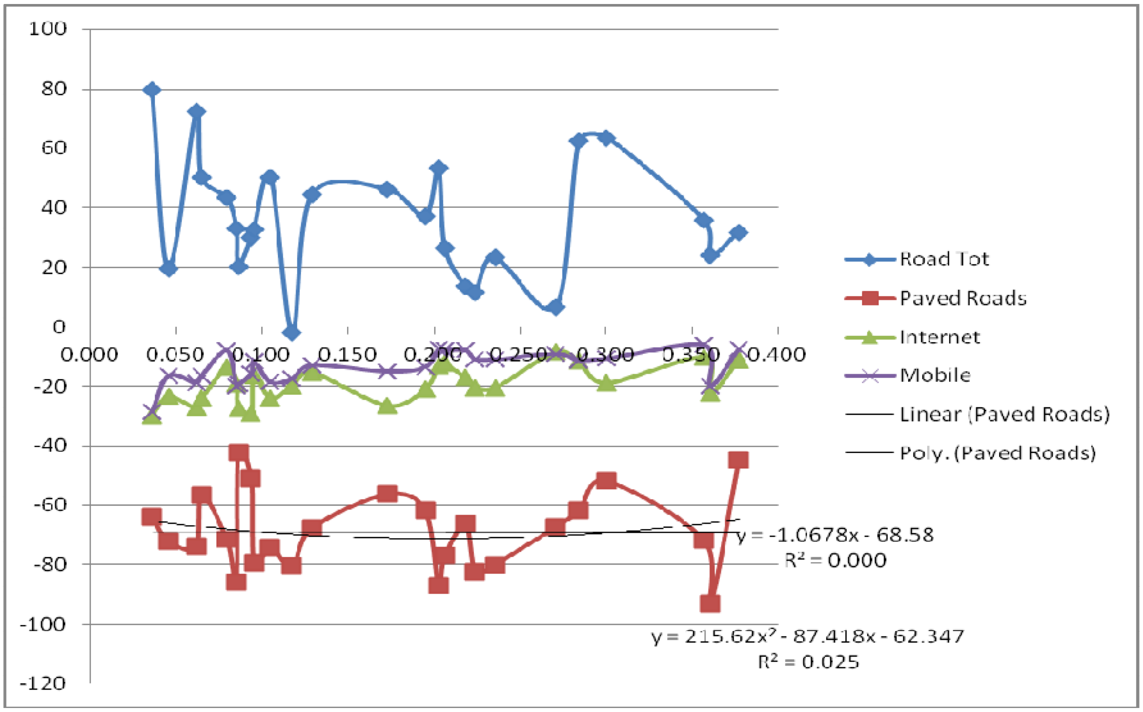


Figure 6: Simulated Difference in The Total Impact of Infrastructure on Poverty (Rural Versus Urban)



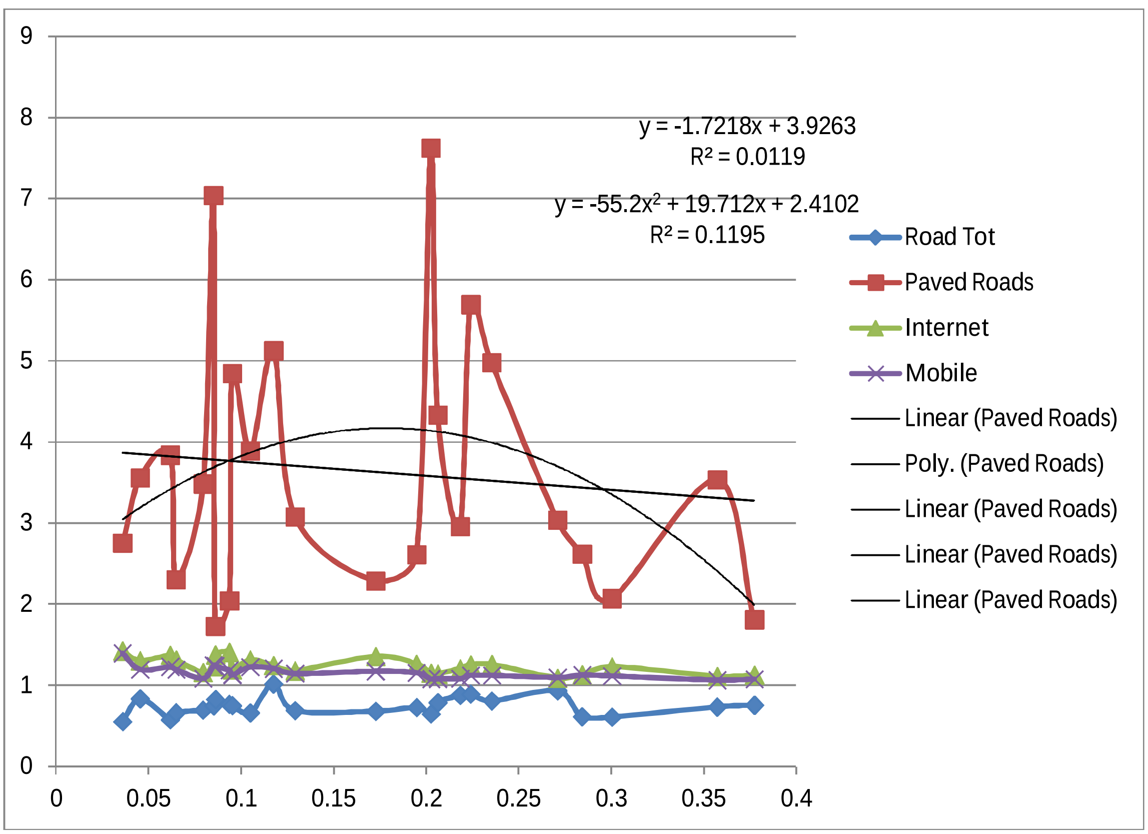


Figure 7: Simulated Net Impact of ICT on Poverty (National Level)

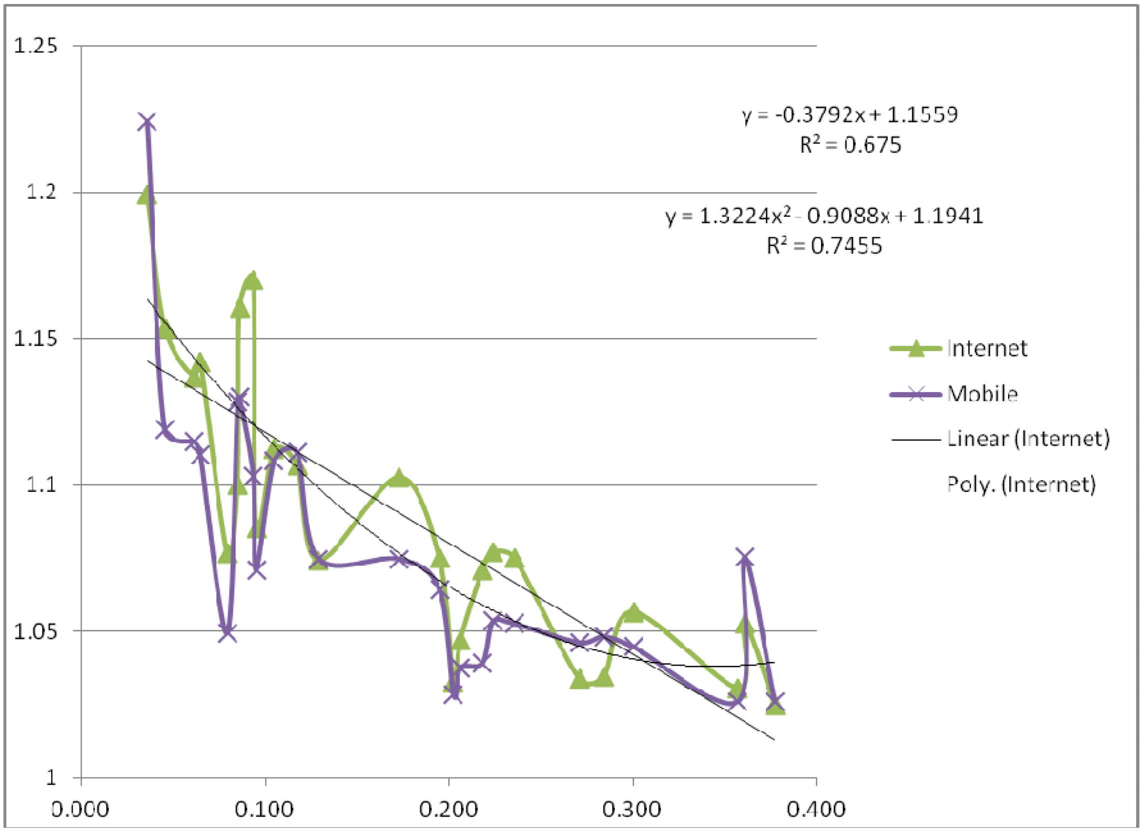


Figure 8: Simulated Difference in the Total Impact of ICT on Poverty (Rural Versus Urban)

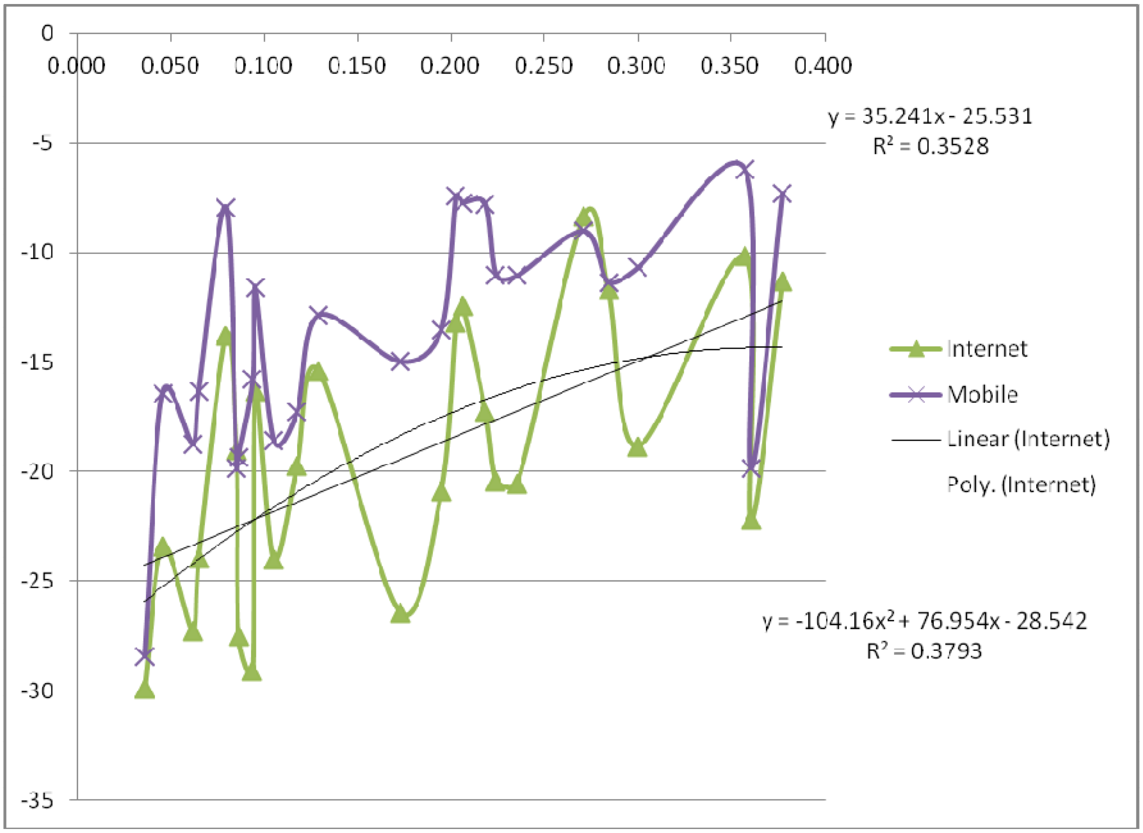


Table 1: Estimation Results (Estimation Method: GMM System)

Parameter	Roads Total	Paved Roads	Internet	Mobile
			Urban Poverty	
Constant	6.968	7.984	8.833	8.268
	4.949	**6.088**	**8.687**	**8.430**
National per capita income	-0.372	-0.441	-0.522	-0.471
	-2.746	**-3.412**	**-5.165**	**-4.798**
Urban concentration	0.628	0.530	0.750	0.673
	3.000	**2.925**	**5.465**	**5.031**
Infrastructure	-0.195	-0.082	0.007	0.014
	-3.363	**-1.381**	**0.288**	**0.659**
Number of observations	68	62	70	74
Number of countries				
Adjusted R2	0.12	0.07	0.07	0.05
			Rural Poverty	
Constant	5.201	6.505	7.385	7.261
	5.682	**8.216**	**11.447**	**11.737**
National per capita income	-0.130	-0.168	-0.314	-0.312
	-1.448	**-2.038**	**-5.006**	**-5.159**
Urban concentration	0.368	0.297	0.463	0.431
	2.937	**2.864**	**4.817**	**4.646**
Infrastructure	-0.185	-0.251	0.030	0.032
	-5.415	**-5.639**	**1.429**	**2.077**
Number of observations	68	62	70	74
Number of countries				
Adjusted R2	0.12	0.27	0.08	0.06
			National Growth	
Constant	0.369	0.300	0.256	0.261
	5.739	**4.058**	**4.897**	**5.376**
Initial per capita income	-0.027	-0.024	-0.016	-0.016
	-4.839	**-4.140**	**-4.014**	**-3.697**
Investment ratio	0.042	0.037	0.032	0.018
	3.934	**2.621**	**3.464**	**1.812**
Human Capital	0.001	0.005	-0.002	-0.008
	0.144	**0.569**	**-0.334**	**-1.027**
Population growth	-0.248	-0.212	-0.218	-0.265
	-3.942	**-4.236**	**-5.415**	**-6.708**
Urban concentration	0.019	0.016	-0.001	-0.002
	2.634	**2.063**	**-0.335**	**-0.429**
Infrastructure	0.003	0.002	0.004	0.004
	1.309	**0.704**	**4.377**	**4.936**
Number of observations	68	62	70	74
Number of countries				
Adjusted R2	0.56	0.53	0.53	0.54
			Urban concentration	
Constant	0.027	0.081	-0.042	-0.041
	1.031	**1.499**	**-2.912**	**-2.365**
Difference: urban poverty		-0.001	-0.002	-0.003
and rural poverty	0.000			
	-0.057	**-1.028**	**-5.546**	**-4.938**
Urban concentration, t-1	0.988	0.989	0.990	0.991
	111.492	**116.158**	**108.967**	**111.753**
Infrastructure	0.003	-0.027	-0.002	-0.001
	0.461	**-2.711**	**-1.013**	**-0.602**
Number of observations	68	62	70	74
Number of countries				
Adjusted R2	0.99	0.99	0.99	0.99
Test of overidentifying restrictions P-Value	0.11	0.43	0.20	0.14

Appendix A: List of Countries in the Sample

Afghanistan	Mali
Algeria	Mexico
Angola	Morocco
Argentina	Mozambique
Armenia	Myanmar
Azerbaijan	Nicaragua
Bangladesh	Niger
Belarus	Nigeria
Bolivia	Pakistan
Brazil	Panama
Bulgaria	Paraguay
Burkina Faso	Peru
Cambodia	Philippines
Cameroon	Senegal
Chile	Sudan
China	Syrian Arab Republic
Colombia	Tanzania
Congo, Dem. Rep.	Thailand
Congo, Rep.	Togo
Costa Rica	Uganda
Cote d'Ivoire	Ukraine
Dominican Republic	Uzbekistan
Ecuador	Vietnam
Egypt, Arab Rep.	Yemen, Rep.
El Salvador	Zambia
Ethiopia	
Georgia	
Ghana	
Guatemala	
Guinea	
Haiti	
Honduras	
India	
Indonesia	
Iran, Islamic Rep.	
Iraq	
Jordan	
Kazakhstan	
Kenya	
Lebanon	
Liberia	
Libya	
Madagascar	
Malaysia	