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# DOES INFRASTRUCTURE ALLEVIATES POVERTY IN DEVELOPING COUNTRIES?

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**Abstract**
Infrastructure has largely been ignored in the assessment of poverty in developing countries. This paper attempts to make some contribution in the establishing the ingredients to alleviate poverty by exploring the impact of infrastructure on the urban poor in sample of 20 developing countries, over the period 1980-2005. The results from the static fixed effect and also the dynamic GMM model both reveal that transport and communication infrastructure are indeed an efficient tool in fighting urban poverty. Panel causality analysis also validated the results. Hence the main policy concern is how to improve access of the urban poor to such an asset.

*Key Words:* Urban Poverty, Infrastructure, Developing Countries
*JEL:* H54, I30

## 1. Introduction

Current thinking on poverty alleviation has focused on the promotion of opportunity (access to resources, services, and productive employment), enhancing security (reducing vulnerability to shocks), and facilitating empowerment (increasing the participation of poor people in decision making) through access to transport infrastructure. Many people, and not only transport planners, believe firmly that transport improvements alleviate poverty. However, with the exception of resettlement studies, few studies have been done to date on the impacts of urban transport infrastructure, on the poor in the context of developing countries. Moreover, as the World Bank Poverty Reduction Sourcebook (2001) puts it: “Little evidence exists

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on the direct impact and final incidence of net benefits of transport projects."

Most of the existing work on transport and poverty reduction has concerned roads, particularly rural roads and not much research has been done on poverty reduction impact of urban transport. It must also be noted that in most studies the role of transport infrastructure in reducing disparity across regions has been exploited in other words they have concentrated on the impact of transport on inequality rather than absolute poverty. Alongside, most of the existing studies have largely ignored model uncertainty altogether and led to overconfident inferences[1]. The present paper takes a step towards filling these gaps in the context of 20 developing countries over the period 1980-2005. It uses both static and dynamic panel data (Generalised Methods of Moments) framework together with panel causality analysis (Hurlin and Venet, 2001 panel data Granger causality procedure) to overcome the largely ignored element of endogeneity and dynamic issues in poverty modelling.

The rest of the paper is structured as follows: Section 2 deals with the theoretical underpinnings of the direct role of transport in poverty alleviation and also reviews the major studies in the literature, Section 4 explains the model specification, data collection, Section 4 discusses the empirical results and Section 5 concludes.

## 2. Literature and Empirical Review
### 2.1 Theoretical Underpinnings

The process through which the benefits of transport investments and policies lead to improvements in the standard of living of the low-income groups often involves many links. However in the case of urban poverty the impact of transport can be summarised according to five major dimensions namely the 'income poor', 'accessibility poor', 'time poor', 'safety poor' and 'energy poor'. The "income poor" make fewer trips, and more of their trips are undertaken on

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[1] See, for example, Leamer (1978), and Raftery (1988,1996).

foot. A study of low income households in Temeke, Tanzania, 8 kilometers from the center of Dar es Salaam estimated that households spent between 10 and 30 percent of their incomes on transport, with an average of 25 percent (Howe and Richards, 1984). The upper limit was very income constrained, while many low income earners in the formal sector claimed that they could only afford public transport in the period immediately after being paid. Later, after their pay was exhausted, they walked.

Generally, the urban poor are increasingly situated at the periphery of cities where access to city facilities and job opportunities is restricted, making them “accessibility poor.” For the poor, the lack of affordable access deprives them of the ability to take advantage of job opportunities and even of very basic social services. Reliable access to schools and health services for the poor contributes directly to their accumulation of human capital, which is a key factor in sustainable poverty alleviation. In as much as jobs and basic social services are relatively highly valued by the poor, it can be said that the associated basic transport access is of high value to the poor. In this sense, improvements in transport conditions can have greater welfare implications for the poor than for the rich.

In addition in many developing countries, the urban poor are concentrated on the periphery of urban areas which is far from their workplaces. Many poor workers take several part-time, low-paid jobs at different locations, simply to maintain the very basic level of household income. Many school children have to help their poor parents after school hours to raise household income. Their ability to obtain employment and education is highly dependent on the costs and availability of public transport. Because residential relocation is often very difficult for the poor due to high moving costs and lack of affordable alternative locations, providing affordable public transport can have an immediate impact on the personal welfare of the urban poor.

To deal with problem of accessibility, subsidised provision of infrastructure is often proposed as a means of redistributing resources from higher income households to the poor. However its effectiveness depends on whether subsidies actually reach the poor (World Bank, 1994). Such subsidies are vulnerable to misuse and to capture by the wealthier parts of the population. Moreover rail and metro investments may work against the poor by increasing land values in transport corridors and forcing the poor out of rental housing, to relocate on the urban fringe. Even when subsidised the latter investments may benefit only poor people living in the inner city may benefit, but those in peripheral areas lose because transit operators will reduce or withdraw services (Estache et al. 2001).

The journey to work may be relatively long. Even if it is not, it will use slow modes and may be very time-consuming, so they are also "time poor." For poor people, and particularly for women, children, and the elderly, trip making is often deterred because of their vulnerability as pedestrians, both to traffic accidents and to personal violence, making them "safety poor." Finally, there is evidence that long walking distances and times also creates tiredness and boredom that reduces their productivity by adding an "energy-poverty" dimension to their deprivation.

## 2.2 Related Literature

Based on data from 73 rural provinces in the Philippines, road infrastructure endowments proved to be by far the strongest predictor of successful poverty reduction. The model also included changes in access to electricity, but this did not prove to be a significant determinant of poverty reduction ( Calderón and Servén, 2003).

Another study assessed public expenditures in the 25 provinces of Indonesia from 1976 to 1996. It considered government investments in irrigation, roads, health, science and technology, agriculture and forestry, and education. The rate of decline in poverty was found to be most sensitive to road investments, followed by education, agriculture, and irrigation. In addition to the indirect effects of roads on poverty through intervening variables, the study isolated a significant direct effect of road density in reducing poverty in Indonesia. Thus, road capital may be considered one of the assets of the poor, improving the functioning of labor and product markets. (Asian Development Bank, Economics and Development (ADB) Resource Center, 1999)

Jacoby (1998) studied the Nepal's case and found that providing extensive rural road networks resulted in substantial benefits, with the poor capturing an appreciable share. However, the poor's share was often not large enough to significantly reduce income inequality as the benefits from road extension could be greater for landholdings of the
rich. Thus, the distribution of benefits from road extension appeared to be ambiguous.

Kwon (2000) used Indonesian data to estimate a growth elasticity with respect to poverty incidence of 0.33 for good-road provinces and .0.09 for bad-road provinces. This implies that poverty incidence falls by 0.33% and 0.09%, respectively, for every 1% growth in provincial GDP. Provincial roads also appear to directly improve the wages and employment of the poor, such that a 1% increase in road investment is associated with a 0.3% drop in poverty incidence over five years. In another study on Indonesia, Balisacan, Pernia, and Asra (2002), using more disaggregative district-level data, also revealed a significant effect of roads on the average incomes of the poor via growth.

Escobal (2001) also established the link between roads and income diversification by studying off-farm activities in rural Peru. Using a Tobit doubled-censored estimation, the author showed that access to roads, along with other public assets such as rural electrification and education, was a significant determinant of income diversification. He also found that access to roads and other public assets raises the profitability of both farm and non-farm activities.

A study by Fan et al. (2002), using provincial data, examined the effects of different types of government expenditures on growth and rural poverty in People's Republic of China (PRC). They found that roads significantly reduce poverty incidence through agricultural productivity and nonfarm employment. Research on Viet Nam showed that poor households living in rural communes with paved roads have a 67% higher probability of escaping poverty than those in communes without paved roads (Glewwe et al. 2000). Likewise, an evaluation of a World Bank-funded rural road rehabilitation project in Viet Nam finds that the strongest positive impact was for the poorest households (Van de Walle and Cratty 2002).

Fan and Kang (2004) used Chinese provincial-level data for 1982–99 to develop an analytical framework that extends earlier work by Fan et al. (2002). The authors differentiated among roads of different quality, and by disaggregating the measured effects of road investments by rural and urban areas. The results showed that road development, together with agricultural research and development, irrigation, education, electricity, and telecommunications, made significant contributions to economic growth and poverty reduction, though to varying degree across regions. The most significant finding of this study was that low-quality, rural roads have benefit–cost ratios for national GDP that are approximately four times larger than the benefit– cost ratios for high-quality roads. Same was found for high-quality roads.
Lately Warr's (2005) study on road and rural poverty in Lao PDR also showed that all-weather roads had a positive and highly significant impact on poverty. Specifically they found that all-weather road access lowered poverty incidence by around six percent, and about 13 percent of the decline in rural poverty incidence between 1997–98 and 2002–03 can be attributed to improved road access alone.

## 3. Methodology

In this study the impact of transport infrastructure (and also communication infrastructure) on urban poverty is assessed from a macroeconomic perspective. The lack of clear theoretical guidance on the choice of regressors, for the poverty equation, leads to a wide set of possible specifications and model uncertainty which in turn often results in contradictory conclusions. A challenge therefore is to motivate which macroeconomic variables to include in the poverty equation. The fact that a certain variable is available in the data set seldom provides sufficient justification for including it in the model. As a result we report three different specifications[2] for the urban poverty equation and compare the results, based on the works from Datt and Ravaillon, 2002; Ravallion and Datt, 1996 and Ghura, Leite, and Tsangarides, 2004. The sample set includes data from 20 developing countries[3] spanning over the years 1980-2005.

MODEL1:

$$POV = f(EDU, CPI, UNEM, GOVREV, GDP, XP, AGRI, FDI, ROAD, TELEP)$$

MODEL2:

$$POV = f(EDU, CPI, UNEM, GOVREV, GDP, XP, AGRI, FDI, ROAD, TELEP, HEALTH, FD)$$

MODEL3:

$$POV = f(EDU, CPI, UNEM, GDP, XP, AGRI, FDI, GOVEXP, HEALTH, FD)$$

Where
POV = the headcount urban poverty index
EDU = literacy rate
CPI = inflation rate
UNEM = unemployment rate
GDP = gross domestic product
XP = exports as a % of GDP
AGRI = share of agriculture in GDP
FDI = foreign direct investment flows
GOVEXP = government capital expenditure
HEALTH = life expectancy rate at birth
FD = financial development (M2 as a % of GDP)

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2 We have tried many other specifications but are reporting three of them whose results have passed the Bayesian robustness check.

3 Benin, Brazil, Burundi, Cameroon, Chile, Egypt, Ghana, India, Indonesia, Kenya, Mauritius, Mexico, Nigeria, Pakistan, Senegal, South Africa, Tanzania, Thailand, Uganda, Zambia. These countries were chosen based on data availability.

TELEP= fixed telephone line per 1000 people

*Econometric Specification*

MODEL1

$$pov_{it} = \alpha_{it} + \beta_1 edu_{it} + \beta_2 cpi_{it} + \beta_3 unem_{it} + \beta_4 govrev_{it} + \beta_5 gdp_{it} + \beta_6 xp_{it} + \beta_7 agri_{it} + \beta_8 fdi_{it} + \beta_9 road_{it} + \beta_{10} telep_{it} + \varepsilon_{it}$$

**(1)**

MODEL2:

$$pov_{it} = \alpha_{it} + \beta_1 edu_{it} + \beta_2 cpi_{it} + \beta_3 unem_{it} + \beta_4 govrev_{it} + \beta_5 gdp_{it} + \beta_6 xp_{it} + \beta_7 agri_{it} + \beta_8 fdi_{it} + \beta_9 road_{it} + \beta_{10} telep_{it} + \beta_{11} health_{it} + \beta_{12} fd_{it} + \varepsilon_{it}$$

**(2)**

MODEL3:

$$pov_{it} = \alpha_{it} + \beta_1 edu_{it} + \beta_2 cpi_{it} + \beta_3 unem_{it} + \beta_4 gdp_{it} + \beta_5 xp_{it} + \beta_6 agri_{it} + \beta_7 fdi_{it} + \beta_8 gov\exp_{it} + \beta_9 health_{it} + \beta_{10} fd_{it} + \varepsilon_{it}$$

**(3)**

Where i is the respective countries in the sample and t denotes the years. The lower case variables are expressed in the natural logarithmic and ε refers to the error terms.

## 4. Result Findings

In this section both cross section and random effects/fixed effects techniques are used. We start by running the cross section regressions as a preliminary exercise (averaged over the sample period 1980-2005) for all the three specifications[4]. The results revealed that in the first specification the education, inflation, government revenue, share of agriculture in GDP and length of road paved proved to be statistically significant at 5% and also have the

[4] Results from cross-section regressions are available upon request from authors.

expected signs. In the second model now exports, GDP, health, financial development and unemployment also turn out to be a significant policy variable in reducing urban poverty. The third specification results show that only the coefficient on health is statistically significant but does not have the expected sign and reveal that health expenditure is not pro-poor.

The limitations of using a single-equation OLS cross sectional regression model[5] and pooled OLS are known (see Kennedy, 2003). To overcome these short comings, panel data techniques are advised. Hence the next step involves estimating a panel regression for each of the three specifications.

With panel data, the issue is whether to use a random effects or fixed effects estimation approaches. Accordingly, to determine which of these estimators are more appropriate to use in the present case, both a fixed effects (FE) and random effects (RE) estimator were initially used to estimate the equation and the Hausman specification test was performed in each cases to evaluate the assumption in the random effects model.

In fact the Hausman tests the null hypothesis that the coefficients estimated by the efficient random effects estimator are the same as the ones estimated by the consistent fixed effects estimator[6]. The Hausman test results favour the fixed effects model in all the three cases. The p-value values, reported in Table 2 below, show that the respective the Hausman test favours the fixed effects approach in all the three cases. Note that it has been argued that since panel data

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5 The most serious limitations being that simple cross section may produce biased and inconsistent estimates since they may not take into consideration the endogeneity of some of the regressors. It ignores dynamics and throws away information (Attanasio et al, 2000) and may suffer from omitted variable bias

6 For a detailed treatment of the fixed and random effects model see among other Green (1997).

techniques are employed, the issue of non-stationarity of the variables is less serious (Garcia Mila, McGuire and Porter, 1996).

**Table 2: Panel data (Fixed estimates)** Dependent variable pov = ln (POV).

| *Variable* | *Model 1* | *Model 2* | *Model 3* |
|---|---|---|---|
| *constant* | *2.07 (1.19)* | *-0.21(-0.07)* | *5.62-(2.11)** |
| *edu* | *-0.56 (-1.84)** | *-0.64-(1.74)** | *-0.11-(2.29)*** |
| *cpi* | *0.019 (1.83)** | *0.054(2.14)*** | *0.07(1.94)** |
| *unem* | *0.28 (1.93)** | *0.35(1.77)** | *0.35(1.12)* |
| *fdi* | *-0.049 (-* | *-0.08(-2.61)**** | *-0.04(-1.7)** |
| *govrev* | *1.77)** | *-0.16-(1.94)** | *-0.33(-* |
| *gdp* | *-0.23 (-1.87)** | *-0.57(-2.33)*** | *2.56)**** |
| *xp* | *-0.47 (-2.14)*** | *-0.32(-1.84)** | *-0.73(-1.96)** |
| *Agri* | *-0.31 (-1.83)** | *-0.08(-1.65)** | *-0.13(-2.15)** |
| *road* | *-0.17 (-1.76)** | *-0.26(-2.16)*** | *-0.15(-2.19)*** |
| *telep* | *-0.23 (-2.15)** | *-0.09(-1.95)** | |
| *health* | *-0.05 (-1.86)** | *-0.45(-2.33)**** | |
| *fd* | | *-0.21(-1.94)** | *-1.37( -2.15)*** |
| *govtexp* | | | *-0.95 (-1.83)** |
| | | | *-0.15-(1.96)** |
| $R^2$ | *0.56* | *0.44* | *0.52* |
| *Number of* | *520* | *520* | *520* |
| *observations* | *Prob>Chi2* | *Prob>Chi2* | *Prob>Chi2* |
| *Hausman Test* | *=0.000* | *=0.000* | *=0.004* |

*significant at 10%, ** significant at 5%, ***significant at 1%. The small letters denotes variables in natural logarithmic and t values are in parentheses. The quantities in brackets are the heteroskedastic robust t/z-values.

From the fixed effect findings of model 1 it can be noted that, the higher the literacy rate the lower is urban poverty. This can be explained by the fact that education is an important determinant of labour productivity which in turn significantly affects the ability of the urban poor to benefit from enhanced opportunities. Moreso, higher education helps the urban poor to be more mobile and switch jobs and capitalize on available opportunities. However the coefficient is not statistically significant.

Inflation and unemployment as expected are positively associated with higher urban poverty. In the case of inflation, given that the poor are less likely to have access to financial hedging instruments, which can be used to protect the real value of their wealth, they are worst off. The potential link between unemployment rates and urban poverty is also easy to see. Those most vulnerable to poverty usually have no investment income and receive little or no income in the form of interpersonal transfers from family or friends (Atkinson, Rainwater, and Smeeding 1995; Kenworthy 2004). As such employment is the chief income source for these people. The results also suggest that a decline in the unemployment rate implies persons in low-income households finding jobs.

Moreoever, the elasticity of urban poverty with respect to government revenue is negative 0.23 indicating that when government revenue increases by 1% urban poverty is reduced by 23%. This gives an indication that in the countries sampled government revenue is used to redistribute income to the poor either in the form of direct of indirect targeting.

The findings further confirm that indeed in the long run economic growth is the key to the alleviation of absolute poverty since it creates the resources to raise incomes. Alongside the coefficient is statistically significant implying that the poverty-reducing effect of growth is not mitigated or offset, in other words, by a rise in inequality. The impact of economic growth on poverty reduction would have been smaller or insignificant if economic growth is associated with worsening distribution of income. In addition the more export oriented a country is in the group the better it is placed at reducing urban poverty. The positive link can be partly explained through the fact exports positively affect the prices paid and received by the poor, the returns to the factors of production that the poor have to offer, and also the resources available to the government for welfare programmes.

Given the high importance of agriculture in contributing towards GDP in these economies, the positive impact that this sector has on the urban poor is evident. Another pro-poor variable is the flows of FDI in these economies. Apart from its potential in generating growth, FDI also improves the quality of growth by reducing the volatility of capital flows and incomes, improves asset and income distribution at the time of privatisation, improves social and environmental standards and helps improve social safety nets and basic services for the poor. It should be noted that among the different types of private cross-border financial flows, FDI is the least volatile, most available to poor countries and least likely to saddle taxpayers in poor countries with unbearable debt service obligations and therefore FDI is most conducive to promote sensible development for the poor. However it must be noted that the elasticity of urban poverty with respect to FDI is still low at a value of 0.042.

Telecommunication also proved to be a tool towards fighting urban poverty with an elasticity value of 0.05. Better and improved telecommunication infrastructure helps the urban poor to seize opportunities and participate in economic activities which in turn improve their well-being.

Results on our main variable of interest, that is length of paved road, show that such a form of transport infrastructure positively contributes towards reducing urban poverty. These result is consistent with those of Khandker (1989), Datt and Ravaillion (2002), Fan and Kang (2004) and Warr (2005) among others. This pro-poor impact can be explained via several channels. First road infrastructure may help the urban poor get connected to core economic activities, thus allowing them to access additional productive opportunities, given that walking is the main mode of transport used by at least half of the urban population and accounts for 80% to 90% of all trips among the poor. Another channel is that investment in roads promotes growth and new jobs. Though the results are as expected, the coefficient is not statistically significant and the elasticity figure is quite low (0.23).

The results from the other two specifications do not differ much from the first one. However though the coefficient of unemployment still has the same sign in the thirds specification it is no more statistically significant. When both health and financial development are added as additional explanatory variables, they proved to be pro-poor and statistically significant. In the third specification when government expenditure is used as a proxy for paved road length and fixed telephone lines per 1000 persons, the findings reveal that it is pro-poor and statistically significant, though the elasticity figure is lower compared to that of paved road length in specifications 1 and 2.

*Dynamic Panel Analysis*

It should be noted that poverty is essentially a dynamic phenomenon and a vicious cycle and tends to be exacerbated with time if not taken care of. Those who were in the poverty trap last year are more likely to still be in it this year. Consequently, we make use a dynamic panel data approach that helps minimise such endogeneity problems as well as control for lagged and feedback effects. The incorporation of endogeneity and dynamics into the model results in the following specification (see Arellano and Bond, 1991)

$$pov_{it} = \alpha_t + (\nu + 1)\, pov_{it-1} + \beta x_{it} + \mu_{it} \qquad (4)$$

We can also write the above in first differences

$$\Delta pov_{it} = \alpha_t + (\nu + 1)\Delta pov_{it-1} + \beta \Delta x_{it} + \Delta \mu_{it} \qquad (5)$$

Where $x_{it}$= the vector of explanatory variables in model 1 as specified above and $\alpha_t$ = the period specific intercept terms to capture changes common to all sectors; $\mu_{it}$ = the time variant idiosyncratic error term.

The results from estimating all three models using the Arellano-Bond (1991) first step GMM estimator are contained in table below. The estimated equation passes the diagnosis test related to Sargan Test [7] which is a test for overidentifying restrictions. The reported p

[7] The null hypothesis of the Sargan test postulates that the over-identifying restrictions are not valid (i.e. the instruments of the endogenous variables are correlated with the error term), hence the model is not properly specified.

− values for the Sargan test on overidentification suggests no invalid overidentifying restrictions. Furthermore, using the Arellano-Bond test of 1st order and 2nd autocorrelation, we reject the presence of second-order autocorrelation of residuals (AR(2)) validating the use of suitably lagged endogenous variables as instruments.

**Table 3: Dynamic Panel Estimates (Generalised Methods of Moments)**

| *Variable* | *Model 1* | *Model 2* | *Model 3* |
|---|---|---|---|
| *Constant* | *0.001(1.34)* | *-0.12(-0.65)* | *0.04(0.43)* |
| $pov_{t-1}$ | *0.31(4.73)**** | *0.33(4.3)***-0.31(-* | *0.38(5.45)**** |
| *dedu* | *-0.42 (-* | *2.33)*** | *-0.27(-1.68)** |
| *dcpi* | *2.23)*** | *0.11 (2.11)*** | *0.055(1.87)** |
| *dunem* | *0.087(0.47)* | *0.16(-2.21)*** | *0.22(1.77)** |
| *dfdi* | *0.11(1.89)** | *-0.05(-2.11)*** | *-0.04(-1.43)* |
| *dgovrev* | *-0.12 (-1.87)** | *-0.16(1.98)** | *-0.18(-2.03)** |
| *dgdp* | *-0.11(-1.94)** | *-0.15-(2.23)*** | *-0.44(-1.64)** |
| *dxp* | *-0.19(-2.02)*** | *-0.35(-1.87)** | *-0.23(-1.86)** |
| *dagri* | *-0.38(-1.79)** | *-0.18(-1.98)** | *-0.08(-2.03)** |
| *droad* | *-0.21-(2.21)*** | *-0.19(-2.47)**** | |
| *dtelep* | *-0.14(-3.27)**** | *-0.049 (-1.71)** | |
| *dhealth* | *-0.07(-2.12)*** | *-0.45(-1.86)** | *-0.15(-1.99)** |
| *dfd* | | *-0.075(-0.59)* | *-0.13-(1.87)** |
| *dgovtexp* | | | |
| *Sargan* | *prob>chi2 =0.65* | *prob>chi2 =0.45* | *prob>chi2 =0.12* |
| *Arellano-Bond* | *prob>chi2 =0.43* | *prob>chi2 =0.43* | *prob>chi2 =0.44* |
| | *prob>chi2 = 0.64* | *prob>chi2 = 0.65* | *prob>chi2 = 0.46* |

*significant at 10%, ** significant at 5%, ***significant at 1%. The small letters denotes variables in natural logarithmic, d denotes variables in first difference and the heteroskedastic-robust z-values are in parentheses. Diagnosis tests: Sargan Test of Overidentifying restrictions. Arellano-Bond1: test of 1st order autocorrelation and test of 2nd order autocorrelation

Interestingly the positive and significant coefficient of $pov_{t-1}$ from the table suggests that poverty is a vicious cycle, since the responsiveness of current period poverty measures with respect to their respective last year values is high and significant, thereby confirming the existence of dynamism and endogeneity in the modeling framework. Such a trend is visible in all the three different models that are regressed. In fact the value of the coefficient of the lagged *dpov* is 0.31 in the first specification implying a coefficient of partial adjustment α of 0.31. This means that *pov* in one year is 69 percent of the difference between the optimal and the current level of *pov*. The results from the dynamic panel analysis validate the hypothesis that road infrastructure is pro-poor in our sample of countries even in the short run. Even in the dynamic model when government expenditure is used as a proxy for infrastructure, the responsiveness of poverty is lower compared to when length of paved road is used as an explanatory variable. This can be explained by the fact that the composition of public expenditure, may be affected by private sector participation in infrastructure. This may lead to elimination of subsidies in the provision of infrastructure services, and may also generate privatization revenues. Whether such revenues will help the poor depends on the extent to which they are used to implement a pro-poor expansion of infrastructure services (Estache, Gomez-Lobo and Leipziger, 2001). In the case of the other explanatory variables, the results from the dynamic model are consistent with those obtained from the fixed effect model, be it in terms of expected signs of the coefficients or their statistical significance.

*Causality test and Reverse effects*

Existing work on the infrastructure poverty relationship using panel data has been to our knowledge inexistent and this is important as it may shed some lights on the possibility of reverse causation and in confirming the existing relationship. We further conduct a causality analysis of the mutual relationship between the two variables (and subsequently for a series of other pair of variables) using recent theoretical developments in Granger causality methods that have made tests using relatively short time series possible through the use of panel data (see also Larrain et al., 1997; Hurlin and Venet, 2001). This technique is thus used to conduct a dedicated test of both the existence as well as direction of any causality between tourist and growth for our sample of island countries.

We employ the Hurlin and Venet (2001) panel data Granger causality procedure. The introduction of a panel data dimension permits the use of both cross-sectional and time-series information to test any causality relationships between two variables. Indeed by increasing the number of observations, this procedure raises the degrees of freedom and improves the efficiency of Granger causality tests. Using Hurlin and Vent procedure we test the homogenous non-causality hypothesis, that is the null hypothesis states non-existence of causal relationships. If this null is rejected, there is evidence of Granger causality. In the general case, the test statistic is computed by the following Wald test proposed by Hurlin and Vent (2001)[8],

$$\mathbf{W} = \frac{(RSS_2 - RSS_1) / (N_p)}{RSS_1 \, [SN - N(1-p) - p]}$$

where SN denotes the total number of observations, p is the optimum lag length, $RSS_2$ denotes the restricted sum of squared residuals obtained under the null hypothesis, and $RSS_1$ is the unrestricted sum of squared residuals computed. The above procedure was applied to our data and the results are summarized in the table below

**Table 4: Granger Causality Analysis of different pairs of investment.** The symbol '→' indicates direction on Granger Causality.

| *Hypothesis (H1)* | *W Statistics* |
|---|---|
| ROAD → POV | 2.453*** |
| TELEP→POV | 2.547*** |
| EDU→ POV | 2.875*** |
| GDP→ POV | 2.879*** |
| CPI→ POV | 2.545*** |
| AGRI→ POV | 2.856*** |
| POV→GDP | 2.214*** |
| POV→ROADS | 3.23** |
| POV→TELEP | 2.214*** |
| POV→EDU | 3.11*** |

*** significant at 5%

[8] This procedure is consistent with a standard Granger causality where the variables entered into the system need to be time-stationary.

Our findings can be summarised as follows. Infrastructure, as measured by both proxies, is confirmed to help in the alleviation of poverty. The other determinants of poverty are also validated. Interestingly, there is a reverse causation from poverty to infrastructure as well and this can be explained by the fact that more poverty would implied less government funds for infrastructural development which is essentially a public good in Africa. Moreover, poverty also has a negative impact on GDP of the country thus signalling the existence of a vicious circle.

## 5. Conclusion

This study investigated the importance of infrastructure in the fight against poverty and has been conducted using rigorous panel data analysis for a sample of 20 developing countries for the period 1980-2005. Results from the static panel analysis confirm the theoretical link between infrastructure and poverty alleviation dynamic GMM estimation further validates our results. It further detected the presence of dynamism in poverty modeling. Causality analysis revealed that infrastructure is confirmed to help in the alleviation of poverty, in the same way as the other classical determinants of poverty. Interestingly, there is a reverse causation from poverty to infrastructure as well and this can be explained by the fact that more poverty would implied less government funds for infrastructural development. Moreover, it is apparent that their exists vicious circle as poverty is seen to have a negative impact on GDP of the country

The results hence provide evidence to policymakers of the positive effect of infrastructure on urban poverty and thus help them in allocating scarce resources and in their fight against poverty. It must be noted that whilst the urban poor may solve their land, housing, water and, in some cases, their sanitation needs themselves, addressing their transport solutions needs to be a collective effort if the solutions are to be affordable. Direct interventions targeting the transport needs of the urban poor are more difficult to implement, and may be less effective, than those targeting the rural poor.

Transport and other infrastructural subsidies are widely used to help the poor, but it is difficult to limit them to the poor. The dispersion of the urban poor makes it difficult to meet their transport needs with geographically targeted interventions. Hence other means of increasing access to the poor must be identified.

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