

# Transport Investment and poverty reduction: the African experience using dynamic panel data estimates

Boopen Seetanah

*University of Mauritius, Mauritius, b.seetanah@uom.ac.mu*

*“Good roads, canals and navigable rivers, by diminishing the expense of carriage, put the remote parts of the country more nearly on a level with those in the neighbourhood of the town. They are upon that account the greatest of all improvements.” (Adam Smith, The Wealth of Nations, 1776).*

## **Abstract**

This paper focuses on transport infrastructure as an element in poverty alleviation for the case of a sample of 21 African economies for the period 1980-2007. Using an aggregate poverty function at the macroeconomic level, both the static and dynamic panel estimates suggest a pro-poor impact of transport infrastructure. Growth of the country, financial development, human capital, communication infrastructure and employment are all found to be important ingredients in the poverty fight while inequality exacerbates it. The GMM estimates interestingly validated that poverty is essentially a dynamic phenomenon and constitutes a vicious cycle and a dynamic phenomenon. Further analysis using panel causality consolidated

the importance of transport in poverty reduction and suggested no causal effect from poverty to transport infrastructure.

**Keywords:** Transport Infrastructure, Poverty, GMM

## **Introduction**

Infrastructure is a key element of poverty alleviation (see Van de Walle, 1998; Datt and Ravallion, 2002; Bhattarai, Sakhitavadivel & Hussain, 2002 and Ali and Pernia, 2003<sup>1</sup>). It often acts as a catalyst to productivity and development and also enhances the impact of interventions to improve the poor's access to other assets including human, social, financial, and natural assets.

The current work focuses on one important element of infrastructure in poverty reduction, namely transportation infrastructure. The latter has remained a priority area of attention in developing countries and has been argued to be the backbone of sustainable economic growth and poverty reduction (Howe and Richards, 1984; Booth, Hanmer and Lovell 2000; Kwon, 2001, 2005). This is particularly true for road infrastructure (Fan, Hazel and Thorat, 1999; Kwon, 2001; Balisacan & Pernia, 2002; Fan, Zhang and Zhang 2002 and Warr, 2005).

In fact, transport infrastructure investment has long been assumed to contribute indirectly to poverty reduction, channelled through economic growth. Recent empirical studies provide considerable evidence to substantiate the claim that transport infrastructure's impact at the macro level is critical to ensuring sustained growth in output, employment, and income that

---

<sup>1</sup> Ali and Pernia (2003), in a review of the econometric literature insist on three key infrastructure sectors in the fight against poverty namely transport infrastructure, irrigation and electricity.

are prerequisites for achieving long-term poverty reduction (Aschauer, 1989; Fernald, 1999; Canning and Bennathan, 2000; Pereira, 2000 among others). However, apart from its indirect contributions to poverty reduction through increased economic growth, there is an increasing belief that transport infrastructure can have a direct contribution. For instance, road infrastructure is needed to interconnect all growth generating sectors in different regions and achieve a better and wider distribution of the economic growth benefits. In particular, building a road network is a prerequisite to the development of remote and environmentally difficult areas. Roads link the rural population to the economic mainstream, thus making the poor better off through increased agricultural outputs and income, and improved living conditions. Better rural transport also allows farmers to introduce improved farming practices, lowers the cost of inputs and transporting crops to markets, facilitates the transition from subsistence farming to cash-crop farming and a market economy, and increases the non-farm income opportunities of the rural poor. In addition, linking the depressed rural areas to the economic centres will also make education and health facilities more easily available to them. The provision of transport services, including the construction and maintenance of transport infrastructure, yet generates demand for labour, mostly unskilled, and provides income-earning opportunities for the poor. At its worst, transport infrastructure appears to give rise to a number of negative externalities (Riverson, Gaviria, and Thricutt, 1991; Fishbein, 2001; Mahapa and Mashiri, 2001) particularly related to environment.

While the role of roads in economic development and poverty reduction is widely recognized, in-depth understanding of the precise direct nature coupled with reliable empirical evidences has received little attention in the literature (see Warr, 2005; Balisacan & Pernia, 2002; Fan, Zhang & Zhang, 2002 and Kwon 2005 among the few). Better knowledge of how much and in what ways road infrastructure influence the process of poverty reduction is essential for implementing road investment appropriately. This paper attempts to supplement the body of

literature and investigate the link between transportation infrastructure and poverty at the macro economic level for the case of sample of African economies for which data could be available. It uses an aggregate poverty function, extended for the sake of the study with transport capital of the respective countries, for the period 1980-2007. Moreover to account for the possibility of dynamics in poverty modelling, we use a dynamic panel data framework, namely the Generalised Method of Moments and consolidate our results through panel causality analysis.

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

### **Related Literature**

Most studies in the literature highlighted the importance of roads in promoting economic growth and development (and thus indirectly on poverty). However, few of them provided information on the direct distributional and poverty impacts of road investments. For instance earlier work from Khandker (1989) who studied a panel dataset covering 85 districts in India over the period 1961-81 and using a reduced-form estimation technique found that government investment in roads had a positive effect on crop output, rural non-farm employment, and agricultural wages, all of which were beneficial to the poor. Relying on a sample of 129 villages in Bangladesh, Ahmed and Hossain (1990) estimated the impact of rehabilitated rural infrastructure and established a strong positive effect of infrastructure on the incomes of the poor. Ahmed and Hossain estimated that infrastructure endowment increased household income by 33 percent, almost doubled wages, and increased income

from business and industries by 17 percent. Dercon and Krishnan (1998) also reported that households with greater human and physical capital and with better access to roads had lower poverty levels and further noted that these factors reduce fluctuations in poverty over different seasons for rural Ethiopia.

A subsequent study by Fan et al. (2002), using provincial data for the People's Republic of China between 1970 and 1997 and accounting for endogeneity found that roads significantly reduced poverty incidence through agricultural productivity and nonfarm employment. In fact, for every 10,000 yuan invested on rural roads, 3.2 poor persons are estimated to be lifted out of poverty. Jalan and Ravallion (2002) confirmed the positive effect of roads on the consumption expenditure of rural farm households in poor regions of China.

More recently Jacoby (2000) analyzed the distributional effects of rural roads in Nepal using household survey data and found that providing improved road access to markets would generate substantial total benefits, a large share of which would be captured by poorer households. However, the benefits would not be large enough or targeted enough to significantly reduce income inequality. 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.

Kwon (2001, 2005)<sup>2</sup> for the case of Indonesian showed that provinces with adequate road services were more likely to receive better irrigation services and produce more crops and

---

<sup>2</sup> In an earlier study by the Asian Development Bank (1999), which looked at public expenditures (irrigation, roads, health, science and technology, agriculture and forestry, and education) in the 25 provinces of Indonesia from 1976 to 1996, the rate of decline in poverty was found to be most sensitive to road investments, followed by education, agriculture, and irrigation.

that people in these provinces were also found to have more job opportunities in the non-farm sector, either because they had easier access to labour markets or had more jobs available to them in the region. Balisacan and Pernia, (2002) confirmed the findings in a parallel research on the Philippines and Calderón and Servén (2003) showed that road infrastructure endowments proved to be by far the strongest predictor of successful poverty reduction. Likewise, a study on roads and poverty in the People's Republic of China (PRC) revealed that road development contributed significantly to growth and poverty reduction (Kwon, 2005). Datt and Ravallion yet found that state government development spending, including transportation, has a large and statistically significant effect on poverty reduction for the case of India. Studies from Glewwe et al. (2000) and Van de Walle and Cratty (2003) for the case of Vietnam and Warr's (2005) for Lao PDR showed that all-weather roads had a positive and highly significant impact on poverty.

Qualitative research employing interviews and focus group discussions also lent additional insights. One such study in two provinces of the Central Highlands of Vietnam noted that the benefits of rural roads were generally perceived as largely social rather than economic in nature (Songco, 2002). In an earlier study Khandker, Levy, and Filmer (1994) observed that increases had occurred in agricultural production and land productivity as well as in the use of agricultural inputs and extension services following road improvements in Morocco.

As discussed in Riverson, Gavia, and Thriscutt (1991), Fishbein (2001), and Mahapa and Mashiri (2001), rural road projects do not always improve the well-being of local communities and help the poor. For instance Fishbein (2001), in his review of the role of rural infrastructure in Africa's rural transformation process, found that the use of public funds has been inefficient and has left many people without basic access to roads. Riverson et al. (1991) in his review of World Bank projects that involved rural roads in Sub-Saharan Africa

found that the approaches used for planning and evaluation of rural roads had not paid sufficient attention to maintenance and had not fostered community participation. Howe (1981, 1997), Howe and Richards (1984), and Van de Walle (2000) reached similar conclusions.

Thus from the foregoing brief theoretical and empirical literature review, transportation is found to be a non negligible element in economic development and particularly in alleviation of poverty. The proposed study is meant to supplement the few existing literature by analyzing the relative economic importance of transport infrastructure and in bringing new evidence and insights in the debate from a sample of African Economies.

### **Methodology**

The transport infrastructure and poverty link is modelled at the macro economic level for our sample of African economies using the following aggregate poverty function (consistent with the works from Datt and Ravallion, 2002; Ravallion and Datt, 1996 and Ghura, Leite, and Tsangarides, 2004) as per equation 1 which is our basic model. The explanatory variables of the poverty model encompass the following determinants namely: GDP per capital (GDP), income inequality (INEQ), employment and wages (EMP), human capital (HC), financial development (FD). The model has been augmented to include transport infrastructure, TRAN (the variable of interest for this study) and also communication infrastructure (COM), a control variable for infrastructure availability.

The basic economic model is thus specified as follows

$$POV = F (GDP, INEQ, EMP, FD, HC, TRAN, COM) \quad (1)$$

We also specify another economic model extended with more control variables namely openness (XP), foreign direct investment (FDI), cost of living (CPI) and share of Agriculture to GDP (AGRI).

$$POV = F (GDP, INEQ, EMP, FD, HC, XP, FDI, AGRI, TRAN, COM) \quad (2)$$

Our main results will be derived from the economic model (1). Due to the relatively constraint number of observations in our data set, we need to be very cautious about the results from the extended model of equation (2), but they are still reported to consolidate our results.

POV is the dependent variable and measures the level of poverty in the country. The only consistent measure available is head count ratio and the data was obtained from various World Development Indicators issues<sup>3</sup>.

### ***Explanatory Variables: Macroeconomic Determinants of Poverty***

The explanatory variables and their rationales are provided next.

**GDP:** In the long run economic growth is the key to the alleviation of absolute poverty since it creates the resources to raise incomes. However, if per capita GDP increases but all of the increase in income accrues to households at the top and/or middle of the income distribution, poverty may not decrease. The poverty-reducing effect of growth may be mitigated or offset, in other words, by a rise in inequality. In the literature the positive effect of growth on

---

<sup>3</sup> It should be noted that since the head count ratio is available only when household budget survey are carried out, the data was interpolated to have annual figures. We also attempted to use a 4-year average period and obtained similar estimates on the overall.



poverty alleviated has been established by Deolalikar (2002), Alarcón (2004) and Khan (2001) among others but they also stressed that income inequality has a sharply negative effect. Real GDP per capita (GDP) is the measure used to account for the above. Such measure also simultaneously captures macroeconomic performance which is also commonly considered to be a key determinant of poverty (Blank, 1997; Brady 2003b; DeFina 2004; Freeman 2001; Gundersen and Ziliak 2004; Iceland 2003; Mishel, Bernstein, and Allegretto 2005; Sawhill 1988). Data was available from the International Monetary Fund's International Financial Statistics (IFS)

**INEQUALITY:** The progress in reducing rates of poverty through economic growth depends crucially on its distributional characteristics. This is particularly true for statistical measures of poverty as relatively high numbers of people are clustered around typical poverty lines. In theory, a country could enjoy a high average growth rate without any benefit to its poorest households, if income disparities grew significantly, that is, if the rich got richer while the incomes of the poor stagnated or declined. This is unlikely, however, as income distribution tends to be stable over time, and rarely changes so much that the poor would experience an absolute decline in incomes while average incomes grow in a sustained fashion. Danziger and Gottschalk (1995) and Iceland (2003) found that declining economic inequality served to reduce poverty. Freeman (2001) and Gundersen and Ziliak (2004) also found that income inequality was associated with higher poverty. The variable used to proxy for inequality (INEQ) is the Gini coefficient. The data source is from the World Income Inequality Data Base, UNDP.

**EMPLOYMENT:** The potential link between the employment and unemployment rates, work hours, and poverty is easy to understand. 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). Along with government benefits, earnings from paid work are thus likely to be the chief income source. Annual earnings are a function of two things: hours worked and wage levels. As GDP per capita rises, employment increases, or unemployment declines, work hours and/or wage levels for those at the bottom of the distribution may increase, thereby reducing poverty. However, if the majority of the new jobs go to individuals in high- and/or middle-income households, there will be no gain for those in low-income households and hence no decline in poverty.

High employment and low unemployment may also reduce poverty by boosting wage levels at the low end of the distribution. In fact this can also lead to pressure on employers to bid up wages for job seekers. For example, Bernstein and Baker (2003) argued that real wage levels at the low end of the labour market were flat or declining in the United States for most of the 1980s and the first half of the 1990s due to moderate-to-high joblessness, but that the low unemployment rate of the late 1990s sparked an increase in low-end wages. Iceland, Kenworthy and Scopilliti (2005) also recently highlighted the importance of employment for poverty reduction. To capture the employment effect (EMP), we use the employment level of the country (Data source: International Financial Statistics (IFS) and International Labour Organisation (ILO)).

**FINANCIAL DEVELOPMENT:** By facilitating access to credit and improving risk-sharing and resource allocation, financial sector development may benefit the poor. Lack of access to credit due to insufficient assets and the unacceptability of labour income as collateral, prevents the poor from both smoothing their consumption in bad times and also in investing in riskier but more productive technologies. Thus financial development helps to mitigate the above. It must however be noted that the main channel through which financial development

help reduce poverty is economic growth (Loayza et al, 2002). In this study, financial sector development (FD) is measured by the ratio of broad money to GDP and was computed from the International Financial Statistics.

**HUMAN CAPITAL:** The role of human capital, in the form of education, experience, skills, training and health, has often been emphasised as a particularly important determinant of income or production (Mincer, 1958 and Schultz, 1988). Given a conducive environment, the productivity of the labour supplied by the poor is an important determinant of their ability to benefit from the enhanced opportunities and an important determinant of labour productivity is human capital in the form of for example education, health. Studies from Witter (1996) and Lipton and Ravallion (1996) among others have shown that secondary education reduces probability of being poor in comparison with both primary and higher education. It should be noted that education may affect economic welfare in many different ways. For instance, it may influence both returns within economic activities and access to such activities. In addition education may limit fertility and thus reduce the number of dependent children. Thus, education may raise income, increase access to non-farm employment, improve the ability to set up a household business and improve productivity in farming. Moreso, due to the lack of education and skills, the poor tend to be less mobile (across sectors and regions) than better educated workers and are therefore often unable to switch jobs and capitalize on available employment opportunities. The proxy used for human capital is the secondary enrolment ratios. These are standard measures used in the literature (see Barro, 1998, Sachs and Warner, 1995). Secondary enrolment ratio was from obtained World Development Indicators (various issues) and individual countries CSO web sites. Extrapolation was kept to a minimum.

TRANSPORTATION: The theoretical and empirical underpinnings of the role of transport on alleviating poverty have already been discussed in section II. Since data on transportation investment flows or stocks were unavailable (or only available for some years) for most countries in the sample, the study uses physical infrastructure measured on an annual basis, in kilometres of paved road per square kilometre of area, ROADS (see Canning, 1998, Canning and Bennethan, 2000). Such proxy is judged to be the only reliable variable for the purpose of our study. The data on road kilometres was extracted from Canning database (A database of World Infrastructure stocks, 1950-95) and extended<sup>4</sup> to have a complete series up till 2003.

We also added another measure of infrastructure, as a control variable, in the recipient countries to better gauge the effect of transport infrastructure, namely a proxy for communication infrastructure. This is measured as the number of telephones available per 1,000 people (COM). Canning (1999) data base and World Development Indicators (various issues) provided the source for this data.

### ***Additional Determinants (Model 2)***

The additional variables included in model 2 above are namely:

XP: the export as a % of GDP is a measure of the level of openness. This is a standard measure for openness used in the literature (see Sachs and Warner, 1995 and Edwards, 1998) and obtained International Monetary Fund's International Financial Statistics (IFS). Openness has a poverty reduction effect as 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.

---

<sup>4</sup>We used various sources including World Development Report (WRD), individual countries CSO publications and The International Road Federation (IRF) statistics.

AGRI: is the share of agriculture in GDP. 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 theoretically evident.

FDI: foreign direct investment flows, is also another pro-poor variable, especially for these types of economies. In fact 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.

The main sources of these additional data series are from the International Monetary Fund's International Financial Statistics (IFS) (various issues), World Development Indicators (various issues), from African Development Bank, Selected Statistics on African Countries (2000) and Penn World Table.

The econometric functions are thus written as follows:

*Model 1*

$$POV = \alpha + \beta_1 GDP + \beta_2 INEQ + \beta_3 EMP + \beta_4 FD + \beta_5 HC + \beta_6 TRAN + \beta_7 COM + \varepsilon \quad (3)$$

*Model 2*

$$\text{POV} = \alpha + \beta_1 \text{GDP} + \beta_2 \text{INEQ} + \beta_3 \text{EMP} + \beta_4 \text{FD} + \beta_5 \text{HC} + \beta_6 \text{XP} + \beta_7 \text{FDI} + \beta_8 \text{AGRI} + \beta_9 \text{TRAN} + \beta_{10} \text{COM} + \varepsilon \quad (4)$$

The small letters denote the log of the respective variables. The sample set includes data from 21 African countries<sup>5</sup> spanning over the years 1980-2007.

Where  $i$  is the respective countries in the sample and  $t$  denotes the years. The lower case variables are expressed in the natural logarithmic (for ease of interpretation) and  $\varepsilon$  refers to the error terms.

### **Panel Unit Root Test**

A central issue before making the appropriate specification, often ignored by past researchers, is to test if the variables are stationary or not. We thus carry out panel unit root tests on the dependent and independent variables. We follow the approach of Im, Pesaran, and Shin (IPS) (1995) who developed a panel unit root test for the joint null hypothesis that every time series in the panel is non stationary. This approach is based on the average of individual series ADF test and has a standard normal distribution once adjusted in a particular manner.

Results of this test applied on our time series in levels are reported in Table 1. In every case we reject a unit root in favour of stationarity (the results were also confirmed by the Fisher-ADF and Fisher-PP panel unit root tests) at the 5 percent significance level and it was deemed safe to continue with the panel data estimates of the above econometric specification.

---

<sup>5</sup>Benin, Burkina Faso, Burundi, Cameroon, Egypt, Ethiopia, Gambia, Ghana, Kenya, Madagascar, Malawi, Mauritius, Niger, Nigeria, Rwanda, Senegal, South Africa, Tanzania, Uganda, Zambia, Zimbabwe. These countries were chosen based on data availability.

**TABLE 1. Panel Unit Root Tests on Levels of Variables**

<b>Variables</b>	<b>IPS Statistics</b>
POV	-4.34
GDP	-4.23
INEQ	-3.99
EMP	-4.81
FD	-5.76
HC	-4.23
TRAN	-4.86
COM	-4.21

Variables are in natural logarithmic forms. The test statistic, calculated as the difference between the average  $t$ -value and the expected value, and adjusted for the variance, has a  $N(0,1)$  distribution under the null of non-stationarity, with large negative values indicating stationarity (Canning, 1999).

### **Findings & Analysis**

In this section, both static panel (random effects/fixed effects) and dynamic panel (first step Generalised Methods of Moments (GMM)) techniques are used for both specifications.

#### ***Fixed/Random Effects Estimates***

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 case 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. The Hausman test results favour the fixed effects model in both cases.

**TABLE 2. Panel Data (Fixed Effects Estimates)**

Dependent variable POV = (ln of POV).

Variable	Model 1	Model 2
CONSTANT	3.34 (1.21)	2.12 (.56)
GROWTH	-.64 (-1.99)*	-.54 (-1.76)*
INEQ	.23 (1.88)*	.12 (1.79)*
EMP	-.26 (2.22)**	-.22 (1.76)*
FD	-.15 (-1.79)*	-.08 (-2.29)**
HC	-.41 (-1.89)*	-.27 (-1.92)*
TRAN	-.24 (-2.14)**	-.21 (-2.05)*
COM	-.11 (-1.86)*	-.08 (-1.87)*
XP		-.14 (-1.84)*
FDI		-.084 (-2.01)*
AGRI		-.09 (-1.84)*
R <sup>2</sup>	.57	.61
Number of observations	504	504
Hausman Test	Prob>Chi2 = .002	Prob>Chi2 = .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 (column 2), it is revealed that transport capital has been an element in reducing poverty for the sample of countries. The reported statistically



significant coefficient of -.24 suggest that a 10% increase in transportation capital of the country is associated with a 2.4 percent decrease in the poverty level. Communication infrastructure also negatively affects poverty. The remaining explanatory variables, namely human capital, financial development, employment and inequality are confirmed to have been potential elements in poverty reduction. The results from the other specification do not differ much from the first one. In fact when openness level, FDI inflows and share of agriculture to the economy are added as additional explanatory variables, they proved to be pro-poor and statistically significant.

### *Dynamic Panel Data Estimates*

It must be noted that poverty is essentially a vicious circle and a dynamic phenomenon and tends to be exacerbated with time if not taken care of. Those who were in the poverty trap last year are very likely to still be in it this year. Consequently, we make use a dynamic panel data approach that helps to minimise such endogeneity problems as well as control for lagged and feedback effects.

Thus building from model 1 above, we incorporate possibility of endogeneity and dynamics into the model by rewriting the econometric equation as an AR (1) model in the following.

$$POV_{it} - POV_{it-1} = \alpha_t + \nu POV_{it-1} + \beta x_{it} + \mu_{it} \quad (5)$$

where the LHS is the log difference in poverty index over a period ( $POV_{it}$ );  $x_{it}$  = 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.

Equivalently, equation 5 can be written as

$$\text{POV}_{it} = \alpha_t + (v + 1)\text{POV}_{it-1} + \beta x_{it} + \mu_{it} \quad (6)$$

In first differences it yields

$$\Delta \text{POV}_{it} = \alpha_t + (v + 1) \Delta \text{POV}_{it-1} + \beta \Delta x_{it} + \Delta \mu_{it} \quad (7)$$

A problem of endogeneity might exist if  $\text{POV}_{t-1}$  is endogeneous to the error terms through  $u_{it-1}$ , and it will therefore be inappropriate to estimate the above specification by OLS. To overcome this problem of endogeneity, an instrumental variable need to be used for  $\Delta y_{it-1}$  and the GMM estimators (Arellano and Bond's, 1991) is used. Moreover, the first step GMM estimator will be employed used since it has been shown to result in more reliable inferences. The asymptotic standards errors from the two step GMM estimator have been found to have a downward bias (Blundell and Bond, 1998).

The results from estimating both models, using the Arellano-Bond (1991) first step GMM estimator are contained in table 5. The estimated equation passes the diagnosis test related to Sargan Test<sup>6</sup>, a test for overidentifying restrictions. The reported p – values for the Sargan test on overidentification suggests no invalid overidentifying restrictions. Furthermore, using

---

<sup>6</sup>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.

the Arellano-Bond test of 1<sup>st</sup> order and 2<sup>nd</sup> 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
CONSTANT		-.012 (.85)
dPOV <sub>t-1</sub>	.23 (1.33)	.17 (3.64)***
dGROWTH	.25 (4.32)***	-.23 (-2.06)*
dINEQ	-.29 (-2.28)**	.11 (1.87)**
dEMP	.19 (1.77)*	-.29 (-2.02)*
dFD	-.21 (-1.86)*	-.09 (-2.5)***
dHC	-.06 (-1.84)*	-.19 (1.97)*
dTRAN	-.28 (-1.97)*	-.16 (-2.17)*
dCOM	-0.23 (-2.32)**	-.08 (-1.69)*
dXP	-.12 (-1.77)*	-.26 (-2.13)*
dFDI		-.08 (-2.21)**
dAGRI		-.16 (-2.17)**
<u>Diagnosis tests</u>		
Sargan Test of Overidentifying restrictions	prob>chi2 = .25	prob>chi2 = .21
Arellano-Bond test of 1 <sup>st</sup>		

order autocorrelation Arellano-Bond test of 2 <sup>nd</sup> order autocorrelation	prob>chi2 = .22	prob>chi2 = .26
	prob>chi2 = .76	prob>chi2 = .81

\*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.

Results from the dynamic panel estimation validates the view that transport infrastructure has been instrumental in poverty alleviation. This result is consistent with those of Khandker (1989), Datt and Ravallion (2002), Fan and Kang (2004) and Warr (2005) among others. This pro-poor impact in the context of Africa can be attributed to the fact that road infrastructure may help the poor to get connected to core economic activities, allowing them to access additional productive opportunities (as walking is the main mode of transport used by at least half of the urban population and accounts for around 80% of all trips among the poor), education and health. Moreover investment in roads promotes growth and new jobs. Communication infrastructure is also reported to have contributed significantly in poverty alleviation, though with a lower impact than transport. Better and improved telecommunication infrastructure thus helps the urban poor to seize opportunities and participate in economic activities which in turn improve their well-being.

The findings further confirm that in the long run economic growth is the key to the reduction of absolute poverty in Africa since it creates the resources to raise incomes. However the poverty-reducing effect of growth tends to be mitigated by a rise in inequality as witness by the negative and significant coefficient of *INEQ*. The relatively high and significant coefficient of human capital confirms that the latter 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. Employment and to a lower extent financial development have had positive effect on poverty fight and are overall confirming the literature.

Interestingly the positive and significant coefficient of  $POV_{t-1}$  from the table suggests that poverty is a vicious cycle and a dynamic phenomenon, since the responsiveness of current period poverty measures with respect to their respective last year values is relatively high and significant. In fact the value of the coefficient of the lagged dPOV is .25 in the first specification implying a coefficient of partial adjustment of .75, meaning that dPOV in one year is 75 percent of the difference between the optimal and the current level of dPOV. 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.

Referring to model 2, with the inclusion of three additional explanatory variables, the overall results from model 1 tends to be generally confirmed, though some alterations of the magnitudes of the coefficients are observed. Thus more export oriented countries appear to better combat poverty and this positive link may be consistent with the theoretical prediction discussed earlier. The results for agricultural sectors contribution is not surprising given the high importance of agriculture in contributing towards GDP in these economies. Lastly FDI remains another pro-poor variable (though having a relatively small impact coefficient) through its growth quality and generating potentials, improvement in asset and income distribution, of social safety nets and provision of basic services for the poor.

### ***Causality Test and Reverse Effects***

Existing work on the macro economic link between transport and poverty has failed so far to address the reverse effect of poverty on provision of public transport amenities. Pereira and Roca Sagales (2003) argued that increased poverty and unemployment has often led to short term policy packages that involved increased public investment (including transport) in trying to mitigate and counter these plagues. Therefore, the potential for reverse causality exists, and government investment in infrastructure might thus be a mere reaction to increase poverty in an attempt to relieve those affected and also to allocate limited financial resources where it appears to be socially the best.

We therefore further conducted causality analysis 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 (consolidating the result of the previous analysis) as well as direction of any causality between transport and growth for our sample of African countries.

In a bi-variate framework, the first variable is said to cause the second variable in the Granger sense if the forecast for the second variable improves when lagged values for the first variable are taken into account (Granger, 1969). In this context, we employed the Hurlin and Vent (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)<sup>7</sup>,

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

where SN denotes the total number of observations, p is the optimum lag length, RSS<sub>2</sub> denotes the restricted sum of squared residuals obtained under the null hypothesis, and RSS<sub>1</sub> is the unrestricted sum of squared residuals computed. The above procedure was applied to different pairs of variables and the results are summarized in table 4.

**TABLE 4. Granger Causality Analysis of Different Pairs Variables**

(The symbol '→' indicates direction on Granger Causality)

Hypothesis (H1)	W Statistics
TRAN → POV	3.44***
COM → POV	3.63***
GROWTH → POV	2.46***
INEQ → POV	2.91***
EMP → POV	2.33***
FD → POV	3.55***
HC → POV	2.44***
XP → POV	2.64***
FDI → POV	3.57***
AGRI → POV	3.241***
POV → TRAN	.245
POV → COM	.73
POV → GROWTH	2.33***

<sup>7</sup> This procedure is consistent with a standard Granger causality where the variables entered into the system need to be time-stationary.

---

<b>POV → INEQ</b>	3.23***
<b>POV → EMP</b>	.342
<b>POV → FD</b>	.64
<b>POV → HC</b>	2.99***

\*\*\* significant at 5%

Our findings can be summarised as follows. Transport, as proxied by length of paved road per square kilometre) is confirmed to have granger caused poverty alleviation and thus confirms the previous results. This is also observed for communication infrastructure. The causality test also validates the fact that the other explanatory variables, that is, growth, inequality, employment, financial development and human capital among others have causal impact on poverty.

As far as reverse causation is concerned there is no evidence that poverty may have trigger transport or communication investment. This tends to mean that generally African governments have not been responding to increased poverty as stipulated above. Interestingly, a bi-causal relationship is obtained between poverty and variables such as growth, inequality and human capital suggesting that poverty may have negative impact on these elements.

### **Conclusion**

Transport infrastructure has remained a priority area of attention in developing countries and has been argued to be the backbone of sustainable economic growth and poverty reduction. This is especially true for roads in the context of Africa. This paper thus focused on transport infrastructure as an element of infrastructure in poverty reduction and investigated the link at the macro economic level for the case of sample of a sample of 21 African economies.



Employing an aggregate poverty function for the period 1980-2007, the static panel estimates suggested a pro-poor impact of transport infrastructure for the continent. Same is found for communication infrastructure. Growth of the country, financial development, human capital and employment were all reported to be important elements in the fight against poverty while inequality exacerbated it. Using dynamic panel data framework, namely the GMM, the results are generally validated and interestingly the positive and significant coefficient of the lagged dependent suggests that poverty is a vicious cycle and a dynamic phenomenon. Panel causality analysis was further employed to consolidate the importance of transport in poverty allocation.

Results from our analysis hence provide evidence to African policymakers of the positive effect of road infrastructure on poverty and is believe to be useful in helping them in allocating scarce resources and in their fight against poverty.

## References

Acemoglu, J and Robinson B. (2001) 'The Colonial Origins of Comparative Development: An Empirical Investigation', *American Economic Review*, vol. 91, December, pp. 1369-1401.

Ahmed, R., and Hossain, M. (1990) 'Developmental Impact of Rural Infrastructure in Bangladesh', *Research Report*, no. 83, International Food Policy Research Institute, Washington D.C.

Alarcon, D. (2003) 'The MDGs in National Policy Frameworks', *Development Policy Journal*, vol. 3, April, pp. 37-46.

Ali, I., and Pernia, E.M. (2003) 'Infrastructure and Poverty Reduction. What is the Connection?', *ERD Policy Brief*, Asian Development Bank.

Arellano, M., and S. Bond. (1991) 'Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations', *Review of Economic Studies*, vol. 58, pp. 277–297.

Aschauer, D. A. (1989) 'Is public expenditure productive?', *Journal of Monetary Economics* vol. 23, pp. 177–200.

Asiedu, E. (2002) 'On the Determinants of Foreign Direct Investment to Developing Countries: Is Africa Different?', *World Development*, vol. 30, no. 1, pp. 107–19.

Asian Development Bank. (2005) 'Public Expenditure Commission Report', *ADB and Nepal, PERC/Nepal*, Manila

Atkinson, A. B., Rainwater, L., and Smeeding, T. (1995) 'Income Distribution in OECD Countries', Paris, *Organization for Economic Cooperation and Development*.

Balisacan, A. M., and Pernia, E.M. (2002) 'Probing Beneath Cross- National Averages: Poverty, Inequality, and Growth in the Philippines', *ERD Working Paper Series*, no. 7, Economics and Research Department, Asian Development Bank, Manila.

Barro, R. (1997) 'The Determinants of Economic Growth', MIT Press, Cambridge, Massachusetts.

Bates, R H. (1981) 'Markets and states in tropical Africa', Berkeley and Los Angeles: University of California Press.

Berg, E. (1981) 'Accelerated Development in Sub-Saharan Africa', World Bank.

Bernstein, J., and Baker, G. (2003) 'The Benefits of Full Employment', Washington, DC: Economic Policy Institute.

Bhattarai, M., Sakhitavadivel,R., and Hussain, I. (2002) 'Irrigation Impacts on Income Inequality and Poverty Alleviation', *International Water Management Institute Working Paper*, no. 39, Colombo.

Bhalla, S S. (2002) 'Imagine There's No Country: Poverty, Inequality, and Growth in the Era of Globalization', Washington: International Institute of Economics.

Blank, R. M. (1997) 'It Takes a Nation: A New Agenda for Fighting Poverty', Princeton: Princeton University Press.

Blundell, A., and S. Bond. (1998) 'Initial Conditions and Moments Restrictions in Dynamic Panel Data Models', *Journal of Econometrics*, vol. 87, pp. 115–144.

Booth, D., Hanmer, L., and Lovell, L. (2000) 'Poverty and Transport', A report prepared for the World Bank in collaboration with DFID Final Report, Overseas Development Institute.

Brady, D. (2003b) 'The Poverty of Liberal Economics', *Socio-Economic Review*, vol. 1, no. 3, pp. 369-409.

Calderón, C. and Servén, L. (2003) 'Macroeconomic Dimensions of Infrastructure in Latin America', mimeo

Canning, D. (1999) 'The Contribution of Infrastructure to Aggregate Output', *The World Bank Policy Research Working Paper*, Washington, DC.

Canning, D., and Bennathan, E. (2000) 'The social rate of return on infrastructure investments', *World Bank Research project*, RPO 680-89, Washington, D.C.

Collier, P and Gunning, J. W. (1999) 'Explaining African Economic Growth', *Journal of Economic Literature*, vol. 37, March, pp. 64-111.

Cooper, R. N. (2005) 'A Half-Century of Development', *CID Working Paper*, no. 118

Danziger, S. H., and Gottschalk, P. (1995) 'America Unequal', New York and Cambridge, MA: Russell Sage Foundation and Harvard University Press.

Datt, G., and Ravallion, M. (2002) 'Has India's Post-Reform Economic Growth Left the Poor Behind', *Journal of Economic Perspectives*, vol. 16, no. 3, pp. 89-108.

DeFina, R. H. (2004) 'The Impacts of Unemployment on Alternative Poverty Rates', *Review of Income and Wealth*, vol. 50, pp. 69–85.

Deolalikar, A. B. (2002) 'Poverty, Growth, and Inequality in Thailand', *ERD Working Paper Series*, no. 8, Economic and Research Department, March, Manila: Asian Development Bank.

Dercon, S., and Krishnan, P. (1998) 'Changes in poverty in rural Ethiopia 1989–1995: Measurement, robustness tests and decomposition', *WPS/98-7*. Oxford: Center for the Study of African Economics.

Edmonds, G. (1998) 'Wasted Time: The Price of Poor Access', International Labour Organisation: Geneva

Escobal, J. (2001) 'The determinants of nonfarm income diversification in rural Peru', *World Development*, vol. 29, no. 3, pp. 497-508.

Fan, S., Hazel, P., and Thorat, S. (1999) 'Linkages Between Government Spending, Growth and Poverty in Rural India', *Research Report 110*, International Food Policy Research Institute, Washington D.C.

Fan, S., Zhang, L., and Zhang, X. (2002) 'Growth, Inequality and Poverty in China; The Role of Public Investments', *Research Report 125*, International Food Policy Research Institute, Washington D.C.

Fan, S., Nyange, D., Rao, N., (2005) 'Public investment and poverty reduction in Tanzania', *DSGD discussion papers*, no. 18, International Food Policy Research Institute (IFPRI), Available: <http://www.ifpri.org/divs/dsgd/dp/papers/dsgdp18.pdf>

Fan, S., and Chan-Kang, C. (2004) 'Road development, economic growth, and poverty reduction in China', *DSGD discussion papers*, no. 12 International Food Policy Research Institute (IFPRI), Available: [http://www.ifpri.org ... p/papers/dsgdp12.pdf](http://www.ifpri.org...p/papers/dsgdp12.pdf)

Fernald, J. G. (1999) 'Roads to prosperity? Assessing the link between public capital and productivity', *The American Economic Review*, vol. 89, no. 3, pp. 619–638.

Fishbein, R. (2001) 'Rural infrastructure in Africa: Policy direction', *Africa Regional Working Paper Series*, no. 18. World Bank, Washington, DC.

Freeman, R. B. (2001) 'The Rising Tide Lifts, Pp. 97-126 in *Understanding Poverty*', edited by Sheldon Danziger and Robert Haveman. New York and Cambridge, MA: Russell Sage Foundation and Harvard University Press.

Geda A. (2006) 'Openness, Inequality and Poverty in Africa', *DESA Working Paper*, no. 25, ST/ESA/2006/DWP/25 August 2006.

Ghura, D., Leite, C., and Tsangarides, C, G. (2002) 'Is Growth Enough? Macroeconomic Policy and Poverty Reduction', *IMF Working Paper*, no. 02/118.

Glewwe, P., Gagnolati, M., and Zaman, H. (2000) 'Who Gained from Vietnam's Boom in the 1990s? An Analysis of Poverty and Inequality Trends', *World Bank Working Paper*, no. 2275, Washington, D.C.

Granger, C.W.J. (1969) 'Investigating casual relations by economic models and cross-spectral methods', *Econometrica*, vol. 37, pp. 24-36.

Gundersen, C, and J P. Ziliak. (2004) 'Poverty and Macroeconomic Performance across Space, Race, and Family Structure', *Demography*, vol. 41, pp. 61-86.

Howe, J. D. (1981) 'The impact of rural roads on poverty alleviation: A review of the literature', *World Employment Program Research Working Paper*, no. 106, Geneva: International Labor Organization.

Hine, J.L. (1993) 'Transport and marketing priorities to improve food security in Ghana and the rest of Africa', International Symposium: Regional Food Security and Rural Infrastructure, Giessen.

Howe, J., and Richards, P. (1984) 'Rural roads and poverty alleviation', London: Intermediate Technology.

Howe, J. D. (1997) 'Transport for the poor or poor transport?: A general review of rural transport policy in developing countries with emphasis on low-income area', Geneva: International Labor Organization.

Hurlin, C. and Venet, B. (2001) 'Granger causality tests in panel data models with fixed coefficients', *Working Paper*, EURISCO, Universite Paris IX Dauphin.

International Road Federation (IRF) (1992) 'World Transport Statistics 1988-1992', Geneva: IRF

Iceland, J., Kenworthy, L., and Scopilliti, M. (2005) 'Macroeconomic performance and poverty in the 1980s and 1990s: a state-level analysis', Madison: University of Wisconsin, Institute for Research on Poverty Available: [www.irp.wisc.edu/publications/dps/pdfs/dp129905.pdf](http://www.irp.wisc.edu/publications/dps/pdfs/dp129905.pdf).

Iceland, J. (2003) 'Poverty in America', Berkeley: University of California Press.

Im, K., Pesaran, H., and Shin, Y. (1995) 'Testing for Unit Roots in Heterogeneous Panels', *DAE Working Papers Amalgamated Series*, no. 9526, University of Cambridge.

Jalan J., Ravallion, M. (2002) 'Geographic Poverty Traps? A micro Model of Consumption Growth in Rural China', *Journal of Applied Econometrics*, vol. 17, pp. 329-346.

Jacoby, H. (2000) 'Access to markets and the benefits of rural roads', *Economic Journal*, vol. 110, pp. 713-737.

Jones, B.F. & B.A. Olken. (2005) 'Poverty in Africa', *Quarterly Journal of Economics*, vol. 120, pp. 835-864.

Kenworthy, L. (2004) 'Egalitarian Capitalism', New York: Russell Sage Foundation.

Khan, A. R. (2001), 'Employment policies for poverty reduction, Issues in Employment and Poverty', *Discussion Paper 1*, Recovery and Reconstruction Office, Geneva: International Labour Office.

Khandker, S. (1989) 'Improving rural wages in India', *Policy, Planning, and Research Working Paper*, no. 276. Washington, D.C.: World Bank.

Khandker, S R., and Filmer, D. (1994) 'Schooling and Cognitive Achievements of Children in Morocco', *World Bank Discussion Paper 264*, Washington DC: World Bank. Available: [http://www.wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/1994/10/01/000009265\\_3970311124059/Rendered/PDF/](http://www.wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/1994/10/01/000009265_3970311124059/Rendered/PDF/)

Kwon, E. (2001) 'Infrastructure, growth, and poverty reduction in Indonesia: A cross-sectional analysis', Mimeo. Manila: Asian Development Bank.

Kwon, H. (2005) 'Transforming the developmental welfare state in East Asia. Development and Change', vol. 36, no. 3, pp 477-497.

Lipton, M., and Ravallion, M. (1993) 'Poverty and Policy', *Working Paper WPS 1130*, World Bank, Washington, D.C: Poverty and Human Resources Division, Policy Research Department.



Loayza, N., Fajnzylber, P., and Calderòn, C. (2002) 'Economic Growth in Latin America and the Caribbean. Stylized Facts, Explanations, and Forecasts', Latin America Regional Studies Program, Washington, D.C.: the World Bank.

Maddison A. (2001) 'The World Economy: A Millennial Perspective', Paris: OECD.

Maddison, A. (2002) 'Introduction: Measuring Asian Performance', in A. Maddison et al. (eds.), *The Asian Economies in the Twentieth Century*, Cheltenham, Edward Elgar.

Malmberg, C., Ryan, A., and Pouliquen, L. (1997) 'Rural infrastructure services for development and poverty reduction', Washington, D.C.: World Bank. Available: <<http://www.worldbank.org/wb/sdruralpoverty/infrastructure/pdf/malmberg.pdf>>

Mahapa, S. M., and Mashiri, M. (2001) 'Social exclusion and rural transport: gender aspects of a road improvement project in Tshitwe, Northern Province', *Development Southern Africa*, vol. 18, no. 3, pp. 365–376.

Mincer, J. (1958) 'Investment in Human Capital and Personal Income Distribution', *Journal of Political Economy*, pp. 281–302.

Mincer, J. (1958) 'Investment in Human Capital and Personal Income Distribution', *Journal of Political Economy*, pp. 281–302.

Pereira, A.M. (2000) 'Is all public capital equal?', *Review of Economics and Statistics*, vol. 82, no. 3, pp. 513-518

Pereira, A. M. and O Roca-Sagales. (2003), 'Spillover effects of public capital formation: evidence from the Spanish Regions', *Journal of Urban Economics*, vol. 53, pp 238-256

Ravallion, M., and Datt, G. (1996) 'How Important to India's Poor is the Sectoral Composition of Economic Growth?', *World Bank Economic Review*, vol. 10, no. 1, pp. 1-25.

Riverson, J., Gaviria, J., and Thriscutt, S. (1991) 'Rural Roads in Sub-Saharan Africa: Lessons from World Bank Experience', *Technical Paper 141*, Washington, D.C.: World Bank.

Sachs, J, and A Warner. (1995) 'Economic Reform and the Process of Global Integration', *Brookings Papers on Economic Activity*, vol. 1, pp. 1-118.

Scott, C.D. (2000) 'Mixed Fortunes: A Study of Poverty Mobility among Small Farm Households in Chile, 1968- 86', *Journal of Development Studies*, August.

Songco, J.A. (2002) 'Do rural infrastructure investments benefit the poor? Evaluating linkages: A global view, a focus on Vietnam', *World Bank Policy Research Working Paper Series*, no. 2796, Available: multi\_page.pdf

Schultz, T.P. (1988) 'Education Investments and Returns', *In Handbook of development economics*, vol. 1, Ed. H. Chenery and T. N. Srinivasan. Amsterdam: North-Holland Press.

Timmer, C. P., Falcon, W., and Pearson, S. (1983) 'Food Policy Analysis', Baltimore: Johns Hopkins University Press

Van de Walle, D., and Cratty, D. (2003) 'Is the Emerging Non-Farm Market Economy the Route Out of Poverty in Vietnam?', *Policy Research Working Paper*, no. 2950, January, Available: <http://www-wds.worldbank.org/>

Van de Walle, D. (1998) 'Targeting Revisited', *The World Bank Research Observer*, vol. 13, no. 2, pp. 231-248.

Van de Walle, D. (2000) 'Choosing rural roads investments to help reduce poverty', *Infrastructure Working Paper*, no. 2458. Washington, D.C.: Development Research Group, World Bank.

Warr, P. (2005) 'Roads and Poverty in Rural Laos', *Departmental Working Papers 2005-04*, Australian National University, Economics RSPAS series.

World Bank (2004a), *World Development Indicators*, CD-ROM.

*World Development indicators*, (2008), CD-ROM.