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Infrastructure and Poverty Reduction

Implications for Urban Development in Nigeria

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Abstract

The paper investigates the impact of infrastructural development on poverty reduction in Nigeria. Specifically, the relative effects of physical and social infrastructure on living standards or poverty indicators are examined, with a view to providing empirical evidence on the implications of increased urban infrastructure for the urban poor. The paper employs secondary data for the period 1970:1 to 2005:4 and the structural vector autoregressive (SVAR) technique is adopted in the analysis. The study unequivocally finds that infrastructural development leads to poverty reduction. Results also show that though infrastructure in general reduces poverty, social infrastructure explains a higher proportion of the forecast error in poverty indicators relative to physical infrastructure. This suggests that massive investment in social infrastructure in cities would drastically reduce poverty in the urban areas.

Keywords: infrastructure, poverty reduction, urban development, Nigeria

JEL classification: R0, O10

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Acronyms

ADF	augmented-Dickey-Fuller test
AIC	Akaike information criterion
FEVD	forecast error variance decomposition
IRFs	impulse response functions
PP	Philips-Perron test
SBC	Schwarz Bayesian criterion
SVAR	structural vector autoregressive
SVECM	structural vector error correction model
UN MDGs	United Nations Millennium Development Goals
VAR	vector autoregressive approach

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1 Introduction

Recently the issue of poverty reduction has been at the centre of global policymaking. The drive to eradicate extreme poverty in developing countries has become more urgent, given the need to attain the United Nations Millennium Development Goals (UN MDGs) by 2015. Poverty eradication, being the first of the eight goals, becomes crucial, since more than one billion people live on less than US$1 per day (UN 2002). Poverty is a multidimensional concept involving the lack of social and cultural, as well as economic, means necessary to procure a minimum level of nutrition, to participate in the everyday life of society, and to ensure economic and social reproduction (World Bank 2000). Though a substantial proportion of the world's poor occupy rural areas, available evidence indicates that the proportion of the poor in urban areas has been increasing at a rapid rate due to urbanization (Ravallion 2007).

Nigeria is Africa's most populous country—its estimated population in 2005 was approximately 132 million—and has become an increasingly urbanized society. With the transformation from an agrarian to a petroleum-based economy in the 1970s, increased gravitation of people to towns and cities has been witnessed and the rate of urban population growth has exceeded overall population growth in Nigeria (DFID 2004a). Given this migration trend, development agencies have advocated increased urban infrastructure as a poverty reduction strategy. This policy measure differs substantially from conventional agricultural and rural development policies aimed at attenuating poverty in the rural areas.

Infrastructure is a broad concept that embraces public investment in physical assets and social services. The urge to increase public investments in urban areas stems from the view that they are key determinants of long-term sustainable growth and the capacity of the poor to benefit from the growth process. Theoretically, three schools of thought exist on the effectiveness of investment in infrastructure as a poverty reduction strategy. The first school argues that investment in social infrastructure, which embraces investment in education and health, is more relevant to the goal of poverty reduction than physical infrastructure (Jahan and McCleery 2005; Jerome and Ariyo 2004). The second school maintains that investments in both physical and social infrastructure reduce poverty. The last school holds that investment in infrastructure in general has no effect on poverty reduction. The main protagonists of the third view base their theoretical position on three arguments. First, there is the presumption that though investment in infrastructure is important for economic growth, it has little relevance to poverty reduction. Second, it has been argued that actual benefits from infrastructure have been significantly lower than anticipated. Third, there is a view that in developing countries characterized by weak governance and institutions, the tendency for government officials to be corrupt is very high, and in this scenario decisions to invest in infrastructure may be distorted, thereby lowering the contribution of infrastructure to growth and diverting benefits intended for the poor (Ali and Pernia 2003). However, despite the above views, there is now wider recognition that if governance and institutional frameworks are strengthened, the linkage between improved infrastructure and poverty reduction can also become stronger.

Though several studies have examined the impact of infrastructural development on growth and poverty reduction, little is known empirically about their linkage in Nigeria. This study therefore examines the impact of infrastructural development on poverty reduction in Nigeria. Specifically, the study examines the impact of physical and social

infrastructure on poverty in the country. The basic research questions addressed in the study include the following: What is the trend of poverty in Nigeria? Does infrastructural development reduce poverty? Which type of infrastructure, social or physical, exerts a greater effect as a poverty reduction strategy? What are the implications of increased urban infrastructure for urban poor? The main justification for this study stems from the fact that urban poverty requires the urgent attention of policymakers. Unless this issue is addressed, urbanization has the potential to lead to high levels of poverty and inequality, which could subsequently engender insecurity and conflict in society.

The rest of the paper is arranged as follows. The second section focuses on the macroeconomic profile of Nigeria and its current urbanization and poverty trends. In the third section a review of relevant literature is presented. This section also delves into the theoretical framework for the study. The fourth section considers the methodology used as well as the results obtained in the course of the study. In the fifth section we conclude the discussion and examine policy implications for the urban poor.

2 Macroeconomic profile, urbanization and poverty trends in Nigeria

2.1 Macroeconomic profile

In an attempt to examine poverty trends in Nigeria, this section begins by exploring the various macroeconomic indicators in the country. Table 1 shows that since 1970, oil has been the mainstay of the Nigerian economy. Oil revenue as a percentage of GDP, which stood at 1.9 per cent in 1970, rose to 24.6 per cent in 1980. Moreover in the years 1990, 2000 and 2005, the shares of oil revenue in the nominal GDP rose to 27.6 per cent, 32.0 per cent and 39.6 per cent respectively. The increasing share of oil in GDP indicates the rapid transformation of the Nigerian economy from an agriculture-based to an oil-dependent country. One of the consequences of the oil syndrome in Nigeria has been the rapid decline of the agricultural sector. This sector, which used to supply the bulk of foreign exchange receipts in the 1960s, gradually lost its international competitiveness as a result of the combined effects of the local overvaluation of the naira exchange rate, inadequate pricing policies and a general neglect of the rural economy (Ojo 1992).

Another effect of this transformation of the Nigerian economy was rural-urban migration, which has led to soaring populations in the cities. Given the oil boom in the early 1980s, there was a rapid growth of the public sector as attempts were made to provide infrastructure such as roads, water, electricity and telecommunications for the teeming urban population. Table 1 also indicates that most of the period between 1970 and 2005 was characterized by fiscal indiscipline, as government's expenditure continually exceeded its revenue. Furthermore, with the collapse of the international oil market due to an oil glut in the 1980s, and given the need to maintain the existing public infrastructure, the Nigerian government contracted huge external debt. External debt as a percentage of GDP, which stood at 2 per cent in 1970, rose to 23.7 per cent in 1985 and stood at 62.8 per cent in the year 2000.

Overall, the major macroeconomic indicators in Table 1 indicate that the inflation rate was double-digit for most of the period between 1970 and 2005. Furthermore, the growth of the real GDP has not been impressive. Real GDP growth, which stood at 8.7

per cent in 1970, declined to 2.1 per cent in 1995 and later rose to 4.6 per cent in 2005. These data show that the Nigerian economy has been characterized by macroeconomic instability, particularly a fluctuation in growth patterns, which has important implications for the welfare of individuals in the country. Since aggregate growth has been postulated, theoretically, as the single most important factor affecting individual levels of income, the poor growth rate coupled with high population growth implies that the standard of living, measured in terms of per capita income, is very low in Nigeria. All these factors suggest the presence of a high incidence of poverty in the country.

Table 1
Major macroeconomic indicators, 1970–2005

Macroeconomic indicator (%)	1970	1975	1980	1985	1990	1995	2000	2005
Inflation rate	13.9	34.0	10.0	7.4	7.4	72.8	9.0	15.6
Real GDP growth	8.7	-14.8	7.7	7.4	8.3	2.1	3.9	4.6
Overall balance of payments/GDP	n.a.	n.a.	8.7	-1.7	0.4	-0.1	0.1	-2.4
Fiscal deficit/GDP	-5.1	-3.8	-3.7	-4.2	-8.5	0.1	-2.1	-1.3
Gross national saving/GDP	4.5	24.5	25.9	12.9	27.4	5.4	38.4	15.1
Export/GDP	10.6	23.2	28.5	16.7	43.2	34.3	58.9	50.7
Import/GDP	10.5	21.7	23.1	8.7	19.1	24.4	18.6	41.7
External debt/GDP	2.0	1.5	3.7	23.7	114.6	36.2	62.8	40.3
Oil revenue/GDP	1.9	18.6	24.6	15.1	27.6	16.4	32.0	39.6

Sources: IMF (2005); CBN (2005).

2.2 Urbanization and poverty trends in Nigeria

Given a population that exceeds that of any other country in Africa, urbanization is a common phenomenon in Nigeria. The main areas of attraction for migrants are the state capitals and major towns which are important administrative, commercial, educational and industrial centres. Rural migrants also shift towards the provincial administrative headquarters which serve as educational and commercial centres for the intermediate rural districts.

The dramatic shift in population from rural to urban areas can be attributed mainly to the increased emphasis placed on crude oil production in the country and the search for white-collar jobs in the cities. Prior to 1970, when agriculture was the mainstay of the economy, the rate of rural-urban drift was very low. Estimates of numbers of urban dwellers reveal that in 1952, 11 per cent of the total population was classified as urban; however by 1985 and 2002 the percentages of the population living in urban areas rose to 31 per cent and 46 per cent, respectively.

Table 2 indicates that a dramatic upward trend in urban population has been recorded since 1985, and the growth rate of the urban population has exceeded that of the country's population as a whole. Apart from this rapid urbanization, a spectacular geographical spread in urban population has also been witnessed in recent times in Nigeria. In 2002 it was estimated that some 18 cities had a population of more than 500,000. Moreover, the 1991 population census indicated that about 359 settlements had at least 20,000 people. These data suggest that unlike most African countries, where one or two cities dominate the urban network, almost all corners of the Nigerian territory have large centres of human agglomeration (DFID 2004b).

Table 2
National and urban population trends for Nigeria, 1985–2004

Year	National population growth rate (%)	Urban population growth rate(%)	Urban population as % of total
1985	2.8	5.7	31
1990	2.9	5.5	35
1995	3.0	5.4	40
2000	2.8	4.5	44
2002	2.7	4.0	46
2004	2.8	4.3	49

Source: World Bank (various years).

Table 3
Poverty trends in Nigeria, 1980–2004

		Poverty level (%)		
Year	Poverty level (%)	Urban	Rural	Population in poverty (millions)
1980	27.2	17.2	28.3	17.7
1985	46.3	37.8	51.4	34.7
1992	42.7	37.5	46.0	39.2
1996	65.6	58.2	69.3	67.1
2004	54.4	43.2	63.3	71.3

Source: National Bureau of Statistics (2006).

At this juncture it should be stressed that, although the urban population as a percentage of the total population has increased rapidly, its rate of increase has been declining. This implies that the volume of migration to cities has reduced, a trend that can be attributed to several factors. These include disillusion with urban conditions, declining business fortunes, loss of work as well as increasing returns to agricultural production brought about by the liberalization of agricultural prices in Nigeria.

One major consequence of rapid urbanization is the high incidence of poverty (a ravaging economic and social plague) in cities. Though the Nigerian economy is extremely rich in natural and human resources, a large proportion of its population is very poor. Table 3 shows that poverty levels have increased tremendously, from 27.2 per cent in 1980 to 65.6 per cent and 54.4 per cent in 1996 and 2004 respectively. Moreover, the estimated number of people living in poverty has also increased rapidly, from 17.7 million in 1980 to 67.1 million and 71.3 million in 1996 and 2004 respectively.

Table 3 also indicates that both urban and rural poverty levels have increased since 1980. The urban areas in Nigeria are known to be the sites of concentration of poverty and wealth, as well as problems and solutions, and the high incidence of poverty in cities in Nigeria has led to growing urban crime, neglect of agriculture and unbalanced population concentration (Akinyemi, Olaopa, and Oloruntimehi 2005).

Though the transformation of the Nigerian economy from an agrarian to an oil-based economy has been offered as the main factor responsible for rural-urban drift and ultimately for the population problems in cities, other causal factors have also been identified; these include age and educational distribution of the population, gender factors and other socioeconomic variables (Greenwood 1975; Hugo 1998; Rempel

1970; Todaro 1989). Given the high incidence of urban poverty and its associated problems in developing countries, Nigeria included, there has been consensus on what policy measures should be initiated to reduce poverty. These include: (i) a market-oriented, growth-inducing approach that expands opportunities for production and remunerative employment among the poor; (ii) widespread access to social services such as health and education; and (iii) targeted transfer schemes such as food stamps, subsidized food distribution and nutrition programmes (Bardhan 1995; Fishlow 1995; Killick 1995; UNDP 1996, 1997; World Bank 1990).

Though this three-pronged policy approach is crucial, Gunatilaka (1999) argues that infrastructural development is a necessary condition for poverty reduction and a vital component of these policies. Given this view, this paper focuses on the impact of infrastructural development on poverty reduction in Nigeria.

3 Literature review and theoretical framework

3.1 Review of empirical studies

One of the earlier attempts to investigate the role of infrastructure in development processes is Aschauer (1989). In this seminal work based on research done in the United States, the author argues that non-military public investment is far more important in increasing aggregate productivity than military spending. This study concludes that core infrastructure such as street lights, highways, airports, etc., contributes more to productivity than other forms of infrastructure.

Following Aschauer's work, several studies have been carried out to unravel the link between infrastructure and poverty. Following this line of research, Fan, Hazell and Thorat (1999) estimate the effect of public expenditure on levels of rural poverty across Indian states. In this study the authors distinguish between expenditure on rural education, targeted rural development, public health, irrigation, power generation, agricultural research and development (R&D) and rural roads. They find that agricultural R&D, rural roads, rural education and targeted rural development all have negative and statistically significant effects on rural poverty. Of these, spending on agricultural R&D and rural roads has by far the largest impact on both growth and poverty.

Amis and Kumar (2000) investigate the relationship between urban economic growth, the provision of urban infrastructure and poverty reduction in Visakhapatnam, one of the largest port and industrial towns in India. In the study the authors identify many dimensions of poverty, including inadequate income, lack of assets ('no shelter, no property, no gold'), lack of support (especially for widows, deserted women and the handicapped), illness and debt. The results of this participatory study indicate that the city's growth was constrained by inadequate investment in infrastructure, especially for water and electricity. This study suggested that the provision of physical and social infrastructure is important for poverty reduction.

Canning and Bennathan (2000) compare the relative impact of infrastructure investment in electricity generation and paved roads in 52 and 41 countries, respectively. These authors find that (i) the return to investment on electricity generation is likely to be

higher in low-income countries; (ii) the return on investment from paved roads is likely to be higher in middle-income countries due to the low costs of road construction in these countries relative to low-/high-income countries; and (iii) both types of infrastructure generate less return on investment when not combined with human capital interventions. The study shows that the rate of return to infrastructure investment may vary depending on the income level of the country and the type of infrastructure. The study also suggests that infrastructure in isolation has limited impacts on economic growth, and that there should be a mixture of physical and human capital investment to maximize the return. Moreover, in a comparative study based in India and China, Pasha and Palanivel (2004) argue that for growth to contribute to poverty reduction, it must generate employment and income for the poor and stabilize the supply of goods and services on which the lives of the poor heavily depend.

Estache, Foster and Wodon (2002) explore the connections between infrastructure reforms (especially private sector participation) and poverty alleviation in Latin America. In the study, both macroeconomic and microeconomic linkages between infrastructure reforms and poverty reduction are examined. The authors conclude that service expansion made possible through privatization would lead to poverty reduction if such infrastructural developments were affordable to the poor.

In another study, Fan, Zhang and Zhang (2002) analyse the effects of different types of public expenditure on growth and rural poverty across Chinese provinces, distinguishing between expenditure on rural education, targeted poverty alleviation, telecommunications, irrigation, power generation, agricultural R&D and rural roads. These authors find that spending on rural roads has the largest impact on poverty. The estimated elasticities with respect to road density are 0.08 for agricultural GDP per worker, 0.10 for non-agricultural employment, and 0.15 for wages of non-agricultural workers in rural areas. Among government infrastructure projects, rural roads are found to have the largest impact on poverty incidence: for every 10,000 yuan invested in rural roads, 3.2 poor persons were estimated to be lifted out of poverty.

Gomanee et al. (2003) investigate the effects of government expenditure in different sectors on US$1/day poverty headcount, holding the level of GDP per capita constant. Using cross-country data, the regression estimates indicate that higher government expenditure on education, agriculture and housing and amenities (i.e., water, sanitation and social securities) all have a positive and statistically significant impact on poverty when one shifts the distribution of income in a pro-poor direction by holding aggregate income constant.

Given the controversy surrounding both the theoretical and empirical literature on the determinants of poverty, Jalilian and Weiss (2004) explore the nexus between infrastructure, growth and poverty using samples of countries from Africa, Asia and Latin America. Applying different theoretical and empirical techniques, they obtain results from the estimation of the ‘ad hoc model’ showing that on average, a 1 per cent increase in infrastructure stock per capita, holding human capital constant, is associated with a 0.35 per cent reduction in the poverty ratio, when poverty is measured by US$1/day poverty headcount, or 0.52 per cent when it is measured by US$2/day poverty headcount. This study suggests that while infrastructure investment in general has a role to play in poverty reduction, physical infrastructure investment needs to be very substantial and must be supported by factors such as improvement in social infrastructure so as to promote rapid reductions in poverty.

To provide more insights into the link between infrastructure and poverty reduction, Fan and Chan-Kang (2004) further examine the impact of public infrastructure on growth and poverty reduction in China. In the study, particular attention is paid to the contribution of roads. This study indicates that low quality (mostly rural) roads have benefit-cost ratios for GDP that are about four times larger than the benefit-cost ratios for high quality roads. The study suggests that in terms of poverty reduction, low quality roads raise far more rural and urban poor above the poverty line per yuan invested than do high quality roads.

Jerome and Ariyo (2004) explore the impact of infrastructural reforms (that is, implementation of privatization and liberalization in telecommunications and private investment in infrastructure) on poverty reduction. The study notes that infrastructure reforms and privatization in Africa have been carried out without considering the needs of the poor and without meeting the policy preconditions that are indispensable for their effectiveness. The consequence of this is that infrastructure privatization, rather than having a positive impact, has negatively affected the poor in Africa. The authors argue that the goals of infrastructure reforms can only be achieved if such reforms are undertaken in the context of appropriate market and regulatory frameworks.

Akinbobola and Saibu (2004) investigate the nexus between income inequality, unemployment and poverty in Nigeria using a vector autoregressive (VAR) approach. In this study, quarterly data on real per capita income, government capital expenditure, unemployment rate and the human development index were sourced for the period 1986–2000 and used for the analysis. The results from the four-variable VAR model show that reduction in unemployment rate improves human development and consequently reduces poverty. Moreover, growth in public expenditure reduces unemployment and improves the human development index. The study suggests that infrastructure-based policies, which initially reduce unemployment, would also improve the living conditions of Nigerians.

The review of empirical literature presented here has indicated that while several studies have been carried out to investigate the link between infrastructure and poverty in Asian and Latin American countries, little or no research, to our knowledge, has been done to explore this issue in Nigeria. Given the dearth of empirical studies on this issue in Nigeria, the present study becomes justifiable since it will provide necessary insight into the role of infrastructure in poverty reduction, and also shed light on the question of which type of infrastructural investment is more effective in poverty reduction in Nigeria.

3.2 Theoretical framework of the study

One of the first systematic attempts to link infrastructure indirectly to poverty reduction was made by John Maynard Keynes in 1936. In *The General Theory of Employment Interest and Money*, Keynes argues that in an economy characterized by depression and market failure, high public expenditure is necessary to adjust the economy back to high levels of employment. This implies that high public investment in infrastructure would increase national income, employment and the welfare of people.

This theory could be of practical importance in developing countries where the bulk of investment in infrastructure is owned and financed by government, and market mechanisms do not function properly. In these countries almost 70 per cent of

infrastructure investments are financed by governments or public utilities from their own resources or from non-concessional borrowing, 3 per cent from aid, and the balance from the private sector (DFID 2002).

Anderson, Renzio and Levy (2006) maintain that public infrastructure produces two main effects which are microeconomic and macroeconomic in nature. According to these authors, the microeconomic effects of public investment produce two main impacts, quantity effect and price effect. A public infrastructure investment increases the quantity and/or quality of public goods and services. Since public goods are exclusively produced by the government, the quantity of these goods is initially rationed by firms and households. However, with additional public infrastructure investment, there is an increase in the quantity and/or quality of this rationed good, therefore benefiting both firms and households in the process. In this case, much public infrastructure provides direct welfare benefits in the form of increased quantity and/or quality of final goods and services.

The price effect, being a crucial component of the microeconomic impacts of infrastructural investment, changes the prices of various market goods and services produced or used by firms and households. This situation occurs when the public good produced is either a substitute for or complement to other market goods and services used by households or by firms. Price change can also occur when the good or service produced by the government is not a pure public good but merely contributes to existing private sector production.

The macroeconomic effects of public investment focus on the impact of public infrastructure on macroeconomic aggregates and its ultimate effect on economic growth. Anderson, Renzio and Levy (2006) argue that the macroeconomic effects of public infrastructure investment transmit through five basic channels to affect economic growth. These authors maintain that public investment complements private capital, crowds-in private investment, increases market integration, and raises aggregate demand and national savings. Given the increase in aggregate demand, and assuming that national savings translate into investment, economic growth occurs.

Jahan and Mcleery (2005) emphasize that infrastructure development can lead to poverty reduction through direct or indirect channels. Through the direct channel it reduces poverty as people's access to health and educational services improves, there is cleaner energy available and the government provides for protection against national disasters. The indirect effect of infrastructure provision on poverty occurs when the productivity of workers increases, transport costs are reduced and more employment is generated, thereby leading to economic growth. This implies that infrastructure provision can have economic and social impacts on the lives of people.

Jahan and Mcleery (2005) also argue that the impact of infrastructure on economic growth and poverty reduction takes the form of first-round effects, followed by subsequent impacts. In the first round, infrastructure development produces two initial effects that could lead to poverty reduction through economic growth. These two initial impacts are the supply side and demand side impacts. The development of infrastructure improves the supply side of the economy by reducing cost, enhances the business climate, makes room for better access to market opportunities and opens up new opportunities. These supply side effects attract domestic and foreign investment, increasing employment and national output. The demand side effect of infrastructural

development occurs when projects are implemented. In this case, the new project, say road construction, creates new jobs through which incomes are generated. The social dimension of better infrastructure is that it increases access to basic social services, thus improving the living conditions of the poor. The subsequent effect of infrastructure development arises from fiscal revenue generated from it. As fiscal revenue increases through growth, additional budget can be generated for programmes that improve the living conditions of the poor.

The theoretical exposition presented above has indicated that the link between infrastructure and poverty is not simple, but is rather a complex one. Infrastructure development can directly or indirectly lead to poverty reduction. It has also been emphasized that the extent to which infrastructure leads to poverty reduction through economic growth depends on the quality of governance and the institutional setting.

4 Empirical methodology and results of the study

4.1 The model

In an attempt to examine the nexus between infrastructure investment and poverty reduction in Nigeria, this study adopts the structural vector autoregressive (SVAR) technique. The SVAR is a more refined use of VARs and has become a popular tool for evaluating economic models, particularly in the macroeconomic literature (Sarte 1997). The wide adoption of the SVAR technique also arises from the fact that it takes into consideration the structure and dynamics of the economy being studied.[1] The SVAR econometric framework tests the relative importance and dynamic effect of various shocks on variables of interest (Sims 1980a, 1980b). Given that the dynamics of the Nigerian economy could be typically approximated by a system of linear equations containing *k*-variables, an SVAR model (assuming ρ lags but no exogenous variables) is specified as

$$A_0 y_t = A_1 y_{t-1} + ... + A_k y_{t-k} + CD_t + Be_t \quad (1)$$

where $y_t = (y_{1t}, y_{2t}, \ldots . y_{nt})$ is an nx1 vector of non-policy and policy variables and A_i and C are parameter matrices of order n x n. D_t contains all deterministic variables which may consist of a constant, a linear trend, seasonal dummy variables as well as other specified dummy variables. Moreover, e_t, which is an nx1 vector of structural shock or innovations in policy and non-policy variables, is assumed to be a white noise process with $(0,1_n)$.

Drawing on the theoretical and empirical literature, the model for this study is represented by a four-component vector (y_t) of endogenous variables defined as

$$y_t = (pov_t, rpsf_t, gov_t, gro_t)' \quad (2)$$

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1 For a fuller exposition of SVAR one can consult Sims (1980a, 1980b), Amisano and Giannini (1997) and Breitung, Bruggemann, and Lutkepohl (2004).

where *pov* is the variable that measures poverty, *rpsf* denotes real physical and social infrastructure investments, *gov* is the quality of governance while *gro* is growth of real GDP. To assess the relative effects of physical and social infrastructure on poverty reduction, the variable $rpsf_t$ is broken into its physical (*rpif*) and social (*rsif*) components and separate SVARs for these components are estimated.

In Equation (2) above, all variables are in logarithmic form. Moreover, to achieve identification of the SVAR, this study draws from the theoretical and empirical literature as well as the 'trickle down model' adopted from Jalilian and Weiss (2004). Given that matrix **B** is diagonal and of order 4 x 4, matrix **A** now has the following non-recursive structure:

$$\begin{array}{cccc} gro_t & rpsf_t & gov_t & pov_t \end{array}$$

$$\begin{bmatrix} 1 & * & * & 0 \\ 0 & 1 & * & 0 \\ 0 & 0 & 1 & 0 \\ * & * & * & 1 \end{bmatrix}$$

The non-recursive identification scheme above is just-identified with four restrictions and the asterisks (*) symbolize freely estimated parameters.[2] The first line is the equation for growth and it shows that this variable is a function of the level of infrastructure and the quality of governance. This draws from the 'trickle down model' which argues that growth depends on the level of infrastructure in the economy. The second line indicates that the level of infrastructure in an economy depends on the quality of governance. This means that in a country characterized by bad and corrupt governance, growth can occur without any feedback on the welfare of people. The third line shows that the quality of governance depends on factors which are not explicitly included in our model, while the fourth line indicates that the level of poverty depends on growth, infrastructure and governance.

To analyse the model represented by Equation (2) above, both the impulse response functions (IRFs) and forecast error variance decomposition (FEVD) are used. The IRFs trace out the response of current and future values of each variable to a one-unit increase in the current value of one of the VAR errors, assuming that the errors are equal to zero. The FEVD, on the other hand, is the percentage of the variance of the error made in forecasting a variable due to a specific shock at a given horizon.

4.2 Data sources and measurement of variables

To achieve the objective of the study, quarterly data for the period 1970:1–2005:4 were employed. This period comprises the period of economic regulation (1970–85) and the period of economic deregulation (1986–2005) in Nigeria. The two main justifications for the use of quarterly data are, first, that the estimation using the SVAR technique

2 The adoption of a non-recursive identification scheme is justified because the impulse response function derived from it does not depend on the ordering of variables in the SVAR system.

requires a large database; and second, that there is a desire to minimize any problems with temporal aggregation (Christiano and Eichenbaum 1987).

Following Okojie (2002), poverty is measured by real consumption expenditure per capita. Though an alternative to this measure is per capita income, this study employed real consumption expenditure per capita on the basis of the consensus of opinion that an expenditure measure of poverty is superior to income measures. Moreover, aggregate infrastructure is proxied by expenditure on physical infrastructure proxied by real capital expenditure on economic services (such as transport and communication, roads, etc.) and social infrastructure proxied by real capital expenditure on social and community services. In the absence of quarterly GDP data in Nigeria, Gandolfo's (1981) algorithm for the interpolation of annual GDP series into quarterly series was used.[3] This interpolation technique is justified on the grounds that it is quite robust and is based on order statistical theory which is not confined to any variable type, whether stock or flow.

With respect to the quality of governance which is included as a variable in the model, this is proxied by fiscal discipline captured by the level of fiscal deficit. It is expected that in an economy characterized by good governance, the level of fiscal discipline will be high and fiscal deficit will be very low.

In the study, data are obtained from the Central Bank of Nigeria's Statistical Bulletin (2005), the National Bureau of Statistics (various years) and the International Monetary Fund's International Financial Statistics (various years).

4.3 Results

Preliminary analysis

To investigate the link between infrastructure and poverty reduction in Nigeria, a preliminary step was carried out which entailed testing for the order of integration of variables (also known as a unit root test), determination of the lag length of the SVAR, as well as a cointegration test. In testing for unit root, the augmented-Dickey-Fuller (ADF) and Philips-Perron (PP) tests were adopted. Moreover, to determine the order of the reduced-form VAR, the Akaike information criterion (AIC), Schwarz Bayesian criterion (SBC) and Hannan-Quinn criterion were used. With respect to the cointegration test, the multivariate approach proposed by Johansen (1988) and Johansen and Juselius (1990) was employed. These results, though not presented here, indicate that the variables employed in the study are of unit root in levels and the order of the reduced-form of the SVAR is two. Moreover, the cointegration test using the multivariate also indicates that there are two cointegrating relationships among the variables *gov*, *gro*, *pov*, *rpsf*, *rsif* and *rpif*.

Given the existence of two cointegrating vectors as obtained from the likelihood ratio test, the conventional approach is to estimate a structural vector error correction model (SVECM). However, to avoid the problem of misspecification which could arise due to incorrect imposition of long-run identification restriction, a different procedure was pursued in this study. Following Benkwitz, Lutkepohl and Wolters (2001), the reduced-

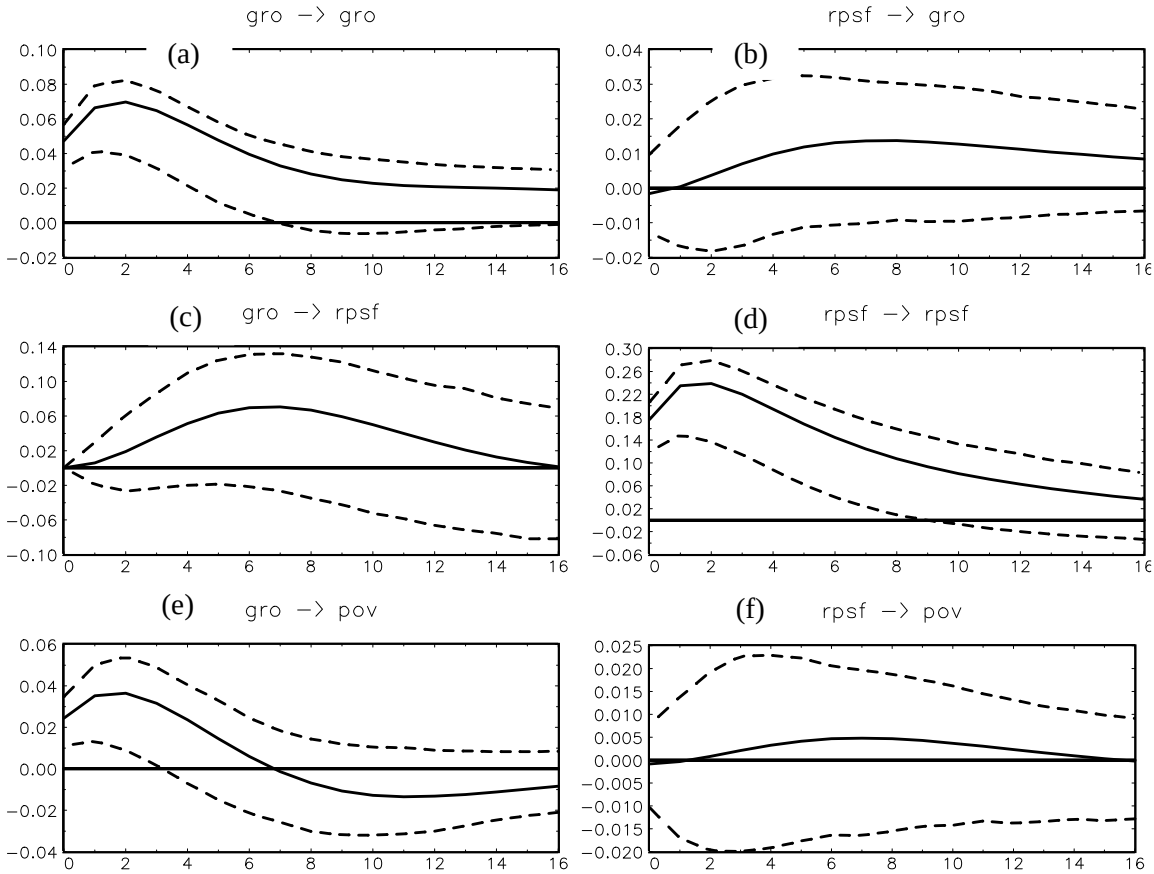
3 Asogu (1996) examines the various non-parametric methods of interpolating annual statistical series into quarterly time series.

form VAR in levels could be consistently estimated and appropriate confidence intervals for the impulse responses obtained using the bootstrap procedure. Having estimated the reduced-form VAR, the estimated coefficients and the fitted residuals were saved. The residuals were reshuffled with replacement, and an artificial dataset was created using the estimated VAR model as the true data generating process. A series of 1 000 such simulations were undertaken in this study.

Impulse response analysis

For the purpose of examining the impact of infrastructural development on poverty reduction, the IRFs estimated from the SVAR models were used as analytical tools. In recovering the SVAR parameters from their reduced form, a non-recursive identification scheme was employed. Figure 1 shows the estimated IRFs when non-recursive identification is used. The IRFs indicate the direction and size of the effect of a one standard deviation shock to one variable on other system variables over time. Panel (d) shows that a one standard deviation in infrastructure can be approximated as a 0.18 per cent increase in infrastructure. With the increase in infrastructure, panel (a) indicates that economic growth measured as increase in real GDP occurs immediately; this could be attributed to the demand side effect of infrastructure which leads to creation of new employment and generation of incomes to those initially experiencing deprivation.

Figure 1
Impulse response function of SVAR model (recursive identification scheme)



Note: Solid lines indicate SVAR impulse responses while broken lines indicate 95 per cent Efron percentile confidence intervals calculated with 1,000 bootstrap procedures.

Source: Author's calculations

Panel (f) shows that real consumption expenditure per capita, a proxy for poverty, increases only after the second quarter and declines as the level of real infrastructure falls. The increase in real consumption expenditure per capita indicates that infrastructure reduces poverty. Moreover, as the level of real infrastructure declines (see Figure 1, panels (d) and (f)) real consumption expenditure per capita declines. The decline in real infrastructure may be attributed to the high inflation in Nigeria in the 1980s, which lasted until the mid-2000s. With high inflation, the budgetary allocation to infrastructure declined in real terms and less infrastructure was provided with a given level of government expenditure. Panel (a) also indicates that a one standard deviation in growth is approximately a 0.05 per cent increase in real GDP. This increase in growth leads to an immediate increase in infrastructure (panel (b)) and an increase in real consumption expenditure per capita occurs after the second quarter (panel (f)). This result indicates that infrastructure development causes growth but does not immediately lead to poverty reduction. The result also suggests that a bi-directional causal link exists between infrastructure and growth. This means that infrastructure development causes growth and growth itself can lead to infrastructure development.

The implication of these findings, therefore, is that government fiscal policy that gives priority attention to infrastructural development by creating physical and social infrastructure will go a long way in reducing the poverty level in the country.

Variance decomposition

The above results indicate that infrastructure investment causes growth and leads to poverty reduction. To provide further empirical evidence on the question of which type

Table 4
SVAR forecast error variance decomposition

	Proportion of forecast error variance in 'POV' accounted for by:			
Forecast horizon (quarters)	*gro*	*rsif*	*gov*	*Pov*
1	0.21	0.12	0.18	0.47
4	0.17	0.09	0.19	0.55
8	0.12	0.08	0.25	0.55
12	0.13	0.07	0.29	0.51
16	0.14	0.07	0.30	0.49
	Proportion of forecast error variance in 'GRO' accounted for by:			
Forecast horizon (quarters)	*gro*	*rsif*	*gov*	*pov*
1	0.78	0.03	0.19	0.00
4	0.79	0.02	0.19	0.00
8	0.76	0.01	0.17	0.05
12	0.73	0.01	0.15	0.12
16	0.69	0.01	0.13	0.16
	Proportion of forecast error variance in 'POV' accounted for by:			
Forecast horizon (quarters)	*gro*	*rpif*	*gov*	*pov*
1	0.26	0.01	0.17	0.55
4	0.21	0.00	0.17	0.61
8	0.16	0.00	0.23	0.61
12	0.16	0.01	0.27	0.57
16	0.17	0.01	0.28	0.55
	Proportion of forecast error variance in 'GRO' accounted for by:			
Forecast horizon (quarters)	*gro*	*rpif*	*gov*	*pov*
1	0.81	0.01	0.18	0.00
4	0.82	0.00	0.17	0.00
8	0.78	0.03	0.14	0.05
12	0.72	0.05	0.12	0.11
16	0.70	0.05	0.11	0.13

of infrastructure, social or physical, exerts a greater effect as a poverty reduction strategy, we analyse the contributions of each of these components of total infrastructure to growth and poverty reduction, using the SVAR FEVD. In analysing the FEVD, results are reported for forecast horizons 1, 4, 8, 12 and 16 quarters.

Table 4 shows the FEVD, which gives an idea of the share of fluctuation in growth (*gro*) and poverty indicator (*pov*) that are caused by different shocks. The results indicates that after the 1st, 4th and 8th quarters, social infrastructure (*rsif*) contributes 12 per cent, 9 per cent and 8 per cent respectively to the forecast error variance of real consumption expenditure per capital (*pov*) which is the poverty indicator. The FEVD also indicates that shock to physical infrastructure only contributed 1 per cent to the poverty indicator in the first quarter and nothing in the 4th and 8th quarters, and another 1 per cent in the 12th and 16th quarters. The decline in the contributions of these components of infrastructure to growth and poverty indicators could also be attributed to high inflation. These results, therefore, indicate that investment in social infrastructure has greater potential to reduce poverty than investment in physical infrastructure in Nigeria.

5 Conclusions and policy implications for urban poor

Major cities in Nigeria are characterized by ‘slums’ and ‘ghettos’ where substantial proportions of the population are living in highly impoverished conditions. Until recently, policy thrusts in Nigeria have focused on reduction of poverty in the rural areas. However, with the high rate of rural-urban migration, policies which directly and indirectly reduce urban poverty are needed if the welfare of the population is to be enhanced. Using aggregate data, the results of this study reveal that there is a negative relationship between infrastructural investment and poverty. The study also suggests that though investment in infrastructure in general reduces poverty, investment in social infrastructure exerts a greater effect as a poverty reduction strategy relative to physical infrastructure investment. At this juncture, it becomes pertinent to ask: what are the policy implications of this study for the urban poor?

First, in developing countries characterized by market failure, government has an active role to play in the development of infrastructure in urban areas. In this respect, fiscal policy aimed at massive investment in infrastructure in urban areas is crucial to poverty reduction. The situation in Nigeria is such that, though expenditure on infrastructure has increased in absolute terms, real expenditure on infrastructure has declined over the years. Therefore attention has to be focused on the quantity of infrastructure in urban areas (that is, how many kilometres of roads are built, and how many megawatts of electricity are generated per hour) rather than on nominal expenditure on infrastructure. Another policy implication of this study is that the Nigerian government needs to devote a substantial proportion of its budgetary allocations and spending to the development of social infrastructure, which comprises investment in education and health. Since investment in education and health contributes greatly to the development of human capital, increasing social infrastructure can help to improve the welfare of people in the urban areas. On a last note, given that the development of essential and adequate infrastructure depends on governance, development agencies have a crucial role to play in the reorientation of people and the strengthening of legal institutions to minimize the levels of corruption. In a highly corrupt country like Nigeria, it is not unusual for people

in government to embezzle funds meant for infrastructural projects. This tendency could be minimized if legal frameworks were strengthened.

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