

## The macro-economic significance of infrastructure

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### Infrastructure defined

The term “infrastructure” is a relatively modern concept and is hardly encountered in classical economic readings. Prior to the development of modern free enterprise democracies, facilities that would today be regarded as infrastructure (such as roads and dams) were commonly referred to as public works or public utilities. It is regarded as necessary for a report of this nature to avoid any ambiguity in the discussion of the concept of infrastructure. A thorough definition is therefore required, which will also serve to facilitate the discussion in the ensuing sub-section on the characteristics of infrastructure.

In the *World Development Report 1994*, the World Bank provides a very concise definition of infrastructure as such, but elaborates on the economic component thereof via the use of examples. Its definition is provided in box 3.1.

#### Box 1: World Bank’s definition of infrastructure

*Infrastructure is an umbrella term for many activities referred to as “social overhead capital”...that share technical features (such as economies of scale) and economic features (such as spillovers from users to non-users).*

*Economic infrastructure can be classified into three categories:*

- *Public utilities – power, telecommunications, piped water supply, sanitation and sewerage, solid waste collection and disposal, and piped gas*
- *Public works – roads and major dam and canal works for irrigation and drainage*
- *Other transport sectors – urban and inter-urban railways, urban transport, ports and waterways, and airports*

The *Cambridge Encyclopedia* provides a useful, though also concise definition of infrastructure that captures one of its essential characteristics, namely the link between infrastructure and value added in the economy. This definition also implicitly recognises the distinction between the physical components of infrastructure and investment in human capital (see box 3.2).

#### Box 2: Cambridge Encyclopedia’s definition of infrastructure

*The network of factors which enables a country’s economy or an industrial operation to function effectively. They include such matters as transport, power, communication systems, housing and education.*

Conventional economic theory, as expounded by most leading economists, regards infrastructure as “social overhead capital”. When discussing the economic term “capital”, most authoritative economics textbooks distinguish between the concept of “social overhead capital” and “directly productive investment” (Herrick & Kindleberger: 1983).

Due to the occurrence of so-called “natural monopolies”, extraordinary large financial capital requirements and the absence of so-called “rivalness in consumption”, the former concept has always been the domain of the public sector (in modern free enterprise economies). The latter concept is traditionally associated with private sector ownership and operation and includes plant, equipment and inventories.

Interestingly, Herrick & Kindleberger provide a useful distinction between “economic infrastructure” and “social infrastructure”, as stated in box 3.3.

<p><b>Box 3: Herrick and Kindleberger’s definition of infrastructure</b></p>
<p><i>(Infrastructure is)...social overhead capital... (which)...includes both economic investment needed to enable other production for the market to take place and purely social capital, which improves well-being directly.</i></p>
<p><i>Examples of this division are:</i></p>
<ul style="list-style-type: none"><li>• <i>Economic infrastructure – public utilities such as ports, roads, railroads, airfields, electricity and gas production &amp; transmission capacity, communications networks, etc. One can also include the buildings and equipment needed for government activities, fire and police protection, the courts and other state services.</i></li><li>• <i>Social infrastructure – the structures and equipment required for shelter, education, public health, and recreation.</i></li></ul>

It is clear from the above definition that infrastructure is one component of “capital formation”, a term that enjoys universal application through systems of national accounts. Capital formation occurs when some portion of a country’s national income is invested in facilities that serve to augment value added in future. The latter occurs through private sector investments in physical capital stock (also called “production structure”) and public sector investments in the services that facilitate and integrate economic activities – infrastructure.

The economics profession does not however, seem to have reached consensus over the distinction between economic and social infrastructure, as clearly illustrated by Todaro’s definition (2000), which refers to economic infrastructure as encompassing both public utilities and facilities such as schools and hospitals. Todaro nevertheless makes a valuable contribution to the knowledge base on infrastructure by explicit

reference (in the formal definition) to the causalities between the level and quality of infrastructure and the pace and diversity of economic development.

More importantly, Todaro emphasises the crucially important role of infrastructure in raising productivity, and, by inference, a nation's international competitive advantage. Essentially, this takes place through lowering the costs of production, an issue that is also acknowledged by the Development Bank of Southern Africa (DBSA) in its explanation of the nature of infrastructure. The DBSA's formal definition of economic infrastructure (1998) is aligned to that of the World Bank, as depicted in box 3.4.

**Box 4: DBSA's definition of infrastructure**

*Economic infrastructure is that part of an economy's capital stock that produces services to facilitate economic production or serves as inputs to production (e.g. electricity, roads and ports) or is consumed by households (e.g. water, sanitation and electricity)*

*Economic infrastructure can be divided into three categories:*

- *Public utilities (electricity, gas, water, telecommunications, sanitation, sewerage and solid waste disposal)*
- *Public works (water catchment in dams, irrigation and roads)*
- *Other transport sub-sectors (railways, roads, seaports, airports and urban transport systems)*

*Social infrastructure provides services such as health, education and recreation and has both a direct and an indirect impact on the quality of life.*

In the DBSA's *Infrastructure Barometer (2006)*, it is pointed out that infrastructure categories such as transport, energy, water, and information & communications technology (ICT) are all imperative to improving macro-economic efficiency through, for example, reducing the cost of doing business. The DBSA also points out that each of these categories is important for broader development goals, by delivering outcomes which improve the quality of life and increase workforce productivity.

Widespread recognition exists over the absence of adequate modes and levels of infrastructure as a contributing factor in the state of underdevelopment in that exists in the Third World. Despite potentially high rates of return offered by developing countries that exhibit relatively low capital/labour ratios, foreign direct investment flows to most of the world's underdeveloped countries remains paltry. This is to a large extent explained by the relatively low levels of investment in human capital, infrastructure and research & development encountered in most underdeveloped economies (Lucas 1988).

## **Economic relevance of infrastructure**

### **Introductory remarks**

Whereas a study of the physical and technical attributes of various types of infrastructure falls within the domain of the different specialist engineering professions, a concise overview of key economic characteristics underpinning infrastructure is regarded as prudent for a study that will serve to inform executive decision-making at regional government level.

The essential characteristics of infrastructure have been identified in the preceding discussion of the formal definitions of the concept. Closer scrutiny, however, reveals the existence of a number of dynamic features of infrastructure that exert strong interrelationships with key economic and development indicators.

The development of civilization is directly linked to the development of transportation and other infrastructure. In the absence of transport, most markets would cease to exist, employees would not be able to commute, medicine would not be available in clinics and the world would regress back to the pattern of a subsistence economy. In the absence of adequate supplies of water, food production would falter and societies would be faced with the prospect of famine and the rapid spread of diseases.

Furthermore, an infrastructure network forms an integral part of a country's ability to conduct socio-economic activity. It is no surprise that the expression *via vita* ("the road is life") was a common slogan during the era of the Roman Empire. The total length of the road network that enabled the Romans to control their huge empire measured more than 100,000 kilometres.

Like most things in life, however, infrastructure is not free. Due to the absence of the principle of "rivalness in consumption", infrastructure facilities mostly exhibit the classic characteristics of public goods, which require fiscal intervention. Taxation revenues and government bond issues are most often utilised to finance the establishment of new infrastructure. In free enterprise democracies, public sector expenditures form part of a budgetary process that involves political debate, political decision-making and, ultimately, statutory regulation. Against this background, it is useful to provide an overview that attempts to seek consensus on non-emotional issues and emphasises the economics and societal importance of infrastructure.

Infrastructure represents capital expenditure, which, by its very nature, is expensive. It can be argued that a country's infrastructure is of strategic importance, due to its role in facilitating the range of economic activities that, collectively, represent the taxation base of the state. Without fiscal revenues, a government would, in fact, be powerless. It is therefore imperative that such strategic assets be adequately maintained, as any systematic erosion thereof would translate into a relative decline in the tax base.

## **Economic benefits of infrastructure investment**

The logic behind adequate investment in infrastructure is not difficult to comprehend when one considers a socio-economic environment where it is absent. The vast positive externalities that arise from public expenditure on services such as education, health, roads, electricity, sanitation and water would not be present and a society's standard of living would approximate that of primitive times. Without the physical facilities underpinning law enforcement and jurisprudence, social unrest would escalate to a dimension similar to that of a civil war.

On the level of technical analysis, the most obvious proof of the advantages of investment in infrastructure may be found in input/output table analysis (of the national accounts). The supply and use tables derived from such analysis provide emphatic empirical proof relating to the positive effects on value added in the economy of increased expenditure on infrastructure.

These and other potential benefits of economic activity relating to investment in new infrastructure will be briefly discussed. Some of the benefits will pertain to infrastructure in general, whilst others will be discussed with reference to a particular type of infrastructure.

### **1 Unlocking of factor and product markets**

Roger Bacon, the celebrated British Scientist, recognised the crucial role of transport systems as early as the 13<sup>th</sup> Century when he wrote that: "There are three things contributing to the greatness of mankind. Fertile soil, a hard-working nation and the possibility of an easy transport of persons and commodities from one place to another" (as quoted in Tuma, 1979). The existence of roads in the development of markets, particularly in rural areas, has traditionally enjoyed particular prevalence in establishing infrastructure priorities. Research by Gilles, *et. al.* (1992), confirms that the absence of good roads can increase the cost of producing surplus crops by as much as 100%. Irrigation provides a further example of the powerful effect that infrastructure investment can exert on the productivity of factor markets, whilst a modern, industrialised economy simply cannot function properly in the absence of a reliable supply of electricity.

### **2 Contribution to GDP**

Public sector capital formation represents an indispensable element of economic activity. The productive investments by the private sector to augment new output capacity through factories and equipment will not yield adequate returns unless they are supplemented by social and economic infrastructure. The latter serves to integrate the economic activities of private businesses. For example, increased agricultural output for export purposes

will simply rot in the absence of sufficient transport, storage and harbour facilities.

Research has been conducted by Botha and Lockwood (2005) into the contribution to South Africa's gross domestic product (GDP) of road construction activity. The results were derived from a calculation of the weighted contributions to GDP by each of the key sectors involving road building activity, based on the particular sector's GDP multiplier (utilizing input/output table analysis). The multipliers for the different sectors involved with road building activity were based on the 2004 national accounts. The total impact on GDP of every rand spent on road building involves a multiplier effect of almost 1.27 times the initial outlay.

The DBSA makes the point that, if the efficiency of infrastructure is increased, there should be a concomitant improvement in growth performance. In its *2006 Infrastructure Barometer*, the DBSA quotes World Bank research findings, based on cross-country analyses that indicate the existence of a direct correlation between infrastructure accumulation and growth, as measured by improvements in GDP per worker and growth in infrastructure stocks per worker. Infrastructure is, clearly, both essential for the maintenance of a certain level of economic output and a positive rate of growth of output.

### 3 Economic multiplier effects

A narrow view of the substantial financial capital requirements of infrastructure creation often leads to reluctance on the side of public sector authorities to commit the necessary budgetary funds. The negative effect that taxes exert on personal disposable income (when earmarked for infrastructure investments) should be assessed against the background of strong macroeconomic multiplier effects that are generated by capital expenditure projects.

Research conducted by Lockwood (2006) to determine an objective estimate of the social and economic impact of a development finance fund similar in nature to the Risk Capital Facility administered by the Industrial Development Corporation (IDC) confirms the existence of strong capital formation multiplier effects in South Africa. Under the assumption that the facility would have an initial capital base of R250 million – matched, on a project-by-project basis by the IDC, it was concluded that, in total, additional output of *up to* R2.1 billion could be directly supported over a three-year period. When account is taken of the indirect and induced effects of the leveraged investment, the cumulative impact could rise to potential additional business turnover of around R7.5 billion for all of the direct, induced and indirect multiplier effects (based on the 2005 input/output tables of the national accounts for South Africa).

#### 4 Positive rates of return on investment

Consensus exists that infrastructure investments produce relatively high rates of return. Research by Easterly and Rebelo (1993), covering a large sample of developing countries, confirmed the existence of a rate of return of 63% on transportation and communication projects. Research by Bregman and Marom (1993) found that projects relating to transportation, power, water and sanitation in Israel resulted in output increases of between 31% and 44% for every monetary unit of increase in the level of infrastructure.

In the areas of investments in human capital and research & development, returns are usually of a long-term nature, but can also be substantial. Tables 4.1 and 4.2 illustrate rates of return in education, based on research by Psacharopoulos (1993). These rates are calculated as the rate of interest that reduces to zero the net present value of the discounted difference between the costs and benefits of different stages of education. Benefits are determined as the difference between post-tax earnings of university graduates and secondary school graduates. The latter simultaneously serves as the opportunity cost for each year of higher education and is supplemented by the costs of education. It stands to reason that any increase in the level of subsidisation of higher education will tend to increase the private rate of return and *vice versa*.

<b>Table 1: Social rates of return to investment in education (%)</b>			
	<b>Primary</b>	<b>Secondary</b>	<b>Higher</b>
Developing regions			
Sub-Saharan Africa	24	18	11
Asia	20	13	12
Latin America	18	13	12
High income countries			
	14	10	9

<b>Table 2: Private rates of return to investment in education (%)</b>			
	<b>Primary</b>	<b>Secondary</b>	<b>Higher</b>
Developing regions			
Sub-Saharan Africa	41	27	28
Asia	39	19	20
Latin America	26	17	20
High income countries			
	22	12	12

## 5 Positive effect on earnings potential

A further consideration is the impetus that adequate investment in education infrastructure (particularly higher education) provides to earnings levels. Higher education's attractiveness from the perspective of individual income earning capacity is quite profound and can also be objectively verified: education and income are highly correlated at both the individual and the societal level.

This fact has been empirically proven for developed and developing countries, particularly through the research of Carnoy (1967) and Balug (*et. al.* -1969), who analysed statistics for Mexico and India, respectively. For Mexico, graduates at age 30 were found to be earning 105% more than matriculants of the same age. For India, the graduate premium at age 30 was found to be 60%. According to research conducted by Botha (2006), this ratio was 45% for South Africa in 1995 (average for all age levels).

## 6 Alleviation of poverty

Public sector expenditure in the area of capital formation is particularly relevant for a country at South Africa's stage of development. In most developing countries, the record of success in the adequate and cost-efficient provision of infrastructure is closely related to government's capacity to establish, finance and operate infrastructure projects such as roads, telecommunications and water schemes.

As emphasised by the DBSA (2006), developmental infrastructure concerns more than merely economic growth and diversification. The contribution that infrastructure can make to reducing poverty is vast and includes reducing the vulnerability of poor people through health facilities, an improved work and study environment, access to information through the media, and more time for productive activities.

Examples abound in underdeveloped countries, particularly in urban areas, of worsening poverty as a direct result of infrastructure expansion lagging behind population growth. Although public sector capacity constraints in the area of infrastructure provision may be countered by public/private partnerships, the responsibility for the facilitation and fiscal provision of socio-economic infrastructure remains in government's hands.

## 7 Safety of the public

Roads are notorious for the dangers posed to drivers and pedestrians alike, particularly as a result of inadequate technical specifications (such as being too narrow) and deterioration (such as potholes). In South Africa, a high prevalence exists of vehicle accidents that are accompanied by serious injury

or deaths. It stands to reason that any significant improvement in the quality of roads will be accompanied by a lower prevalence of accidents, injuries and fatalities.

## 8 Contribution to employment creation

Beyond a certain level of output growth (depending on the multiplier effects of the different sectors of economic activity), both formal and informal sector employment will be created. According to the World Bank (1994), as long as quality and cost-effectiveness are not compromised, labour-based approaches to infrastructure development can also be an important instrument for employment-intensive economic growth.

Macro-economic impact studies conducted by Botha & Lockwood (2005) and Lockwood (2006), based on input/output analysis confirmed the existence of significant employment creation effects emanating from a given level of new capital formation in a variety of economic sectors.

## 9 Contribution to taxation revenues

A further important macroeconomic effect that was calculated in studies by Botha and Lockwood (2005 & 2007) relates to government revenues (the so-called fiscal backflow effect). In essence, this effect is created as a result of the fact that most of the processes involved with the generation of value added (GDP) in the economy are subject to some form of tax. More than 50% of gross value added in the economy (at factor cost) is attributable to the remuneration of employees, the majority of whom are liable for personal income taxes. A second key taxation effect is related to the variety of indirect taxes, most notably valued added tax and the fuel tax. The third separate taxation effect that is measured by I/O analysis is company taxation.

In the case of the study on the socio-economic impact of a proposed Risk Capital Fund (Botha & Lockwood, 2007), it was found that almost R700 million of additional personal, company and indirect taxes could be supported/generated for the government (over a three-year period) as a consequence of the economic activity induced by an initial capital outlay of R500 million by the proposed Fund.

## 10 International competitiveness

International agencies exist that are continuously producing surveys and reports on the perceived investment risk and competitiveness of advanced economies and developing countries alike. Several authoritative surveys publish data on the perceived quality and scope of basic economic infrastructure, including the annual World Competitiveness Report, published by the Swiss-based Institute for Management Development (IMD). In the

event of South Africa embarking on an effective strategy to improve the reach and quality of its infrastructure, the country will almost certainly experience an upgrading of its global competitiveness, which may eventually become manifested in tangible benefits relating to lower public sector debt service costs.

The imperative of sufficient and modern infrastructure in enhancing a country's attractiveness as a destination for foreign direct investment is underscored by the World Bank (1994). Surveys by prospective international investors invariably include detailed reference to the range and quality of infrastructure, which is a key factor in ranking potential destinations for foreign investment.

## **Summary**

The pervasive nature of the way that infrastructure stimulates economic activity is manifested in various causal effects that flow from an increased level of public sector capital expenditures. The most important ones relate to poverty alleviation (due to the enhanced provision of access to markets), facilitation of future growth in key industries (especially tourism), increased employment, a direct and indirect contribution to GDP, and the generation of fiscal revenue for government.

It is recommended, therefore, that an agenda be prepared by all the stakeholders in the infrastructure sectors to resolve any maintenance and construction backlogs, and to identify new projects that possess the potential to provide basic services, whilst simultaneously enhancing the country's taxation base. The latter issue cannot be over-emphasized. Macro-economic impact assessments of any particular infrastructure project will clearly reveal the presence or absence of sustained economic benefits that may outweigh the associated costs to the fiscus.

In the event of projects being funded through a combination of fiscal resources, grant funding and concessional loans, these benefits will tend to be far greater than the costs. Any new infrastructure project should ideally involve cost-benefit analyses and a concerted public-private sector partnership approach to local economic development.

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