TI-UP Report - A Short Synthesis of the Link between Infrastructure Provision / Adequacy and Economic Growth

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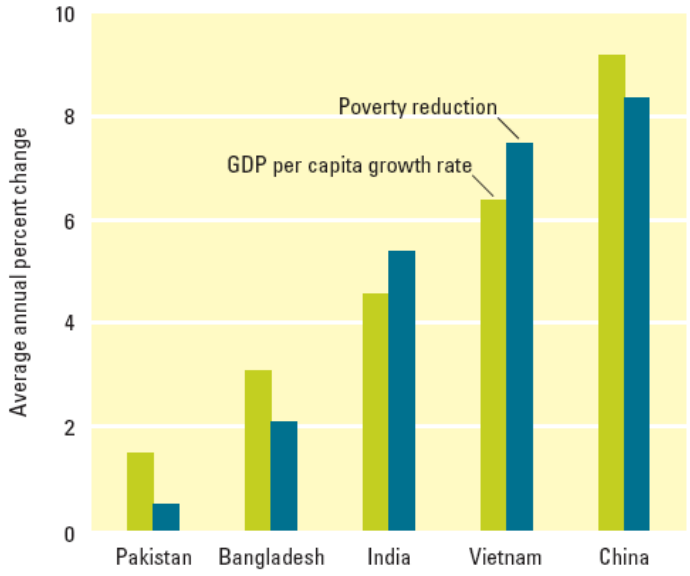
1. Economic Growth - An Overview

Economic growth is the most powerful means of reducing poverty and improving the quality of life in developing countries. Growth accounts for more than 80% of poverty reduction, and has lifted 500 million people above the poverty line since 1980, while less than 20% came as a result of changes in inequality (DFID 2008). A typical estimate from cross-country studies is that a 10 per cent increase in a country's average income will reduce the poverty rate by between 20 and 30 per cent (Adams et al 2002). Figure 1 illustrates this close association between growth and poverty reduction; it also clearly shows the dramatic efforts of China in bringing 400 million people out of poverty over a twenty year period (World Bank 2005).

Figure 1 - Growth is closely associated with poverty reduction. Source: World Bank World Development Report 2005



Note: All figures for 1992–98 except Bangladesh (1992–2000) and India (1993–99).
Source: World Bank (2002d).

The DFID White Paper 2009 supports this, citing that growth "*creates the livelihoods that support growing populations. Higher incomes lead to a reduction in infant deaths, increased school enrolment, and give us greater freedom to make our own decisions about our lives. Growth provides the tax revenue for states so they can fund public services, build accountable government and reduce reliance on external support. Growth provides countries and individuals with a ladder out of poverty*."

2. Economic Growth and Infrastructure

The role of infrastructure in promoting and supporting economic growth has been the subject of a great deal of research. Much of this work goes back to the World Bank's 1994 World Development Report which demonstrated in an international development

context that productivity growth is higher in countries with an adequate and efficient supply of and access to infrastructure services (World Bank 1994).

For the last couple of years it seemed the subject was losing much interest in the development economics community. Recently however, it seems to be returning again on the research agenda following an increased focus by donors and government on infrastructure investments (see Estache 2007 for a review of trends). Most research in the field, conclude an overall positive link between infrastructure investments and economic growth, usually defined by increased income (output).

The evidence base for this link is wide ranging and this short paper can only touch the surface – the arguments and relationships are complex. Recent work by Straub (2008) concludes that of a review of 140 specifications from 64 empirical papers that overall, 63% of the specifications find a positive and significant link between infrastructure and some development outcome, while 31% find no significant effect and only 6% find a negative and significant relationship.

Empirical models and growth studies identify benefits derived from the role of infrastructure in reducing transaction costs, increasing private investment and improving factor productivity (see for example Canning and Pedroni, 2004) and highlight the potential negative impacts caused by bottlenecks resulting from a lack of adequate infrastructure which in turn can harm prospects for investment and, therefore, growth.

The body of available evidence draws a strong correlation between the actual level of infrastructure stock in a country and the level of associated economic growth. In assessing the effects of infrastructure development on economic growth in Africa, Calderon (2009) found that across Africa, infrastructure contributed 99 basis points to per capita economic growth over the period 1990 to 2005, compared with only 68 basis points for other structural policies. The report concluded that levels of growth were affected by both the volume of infrastructure stocks and the quality of services; if all African countries were to catch up with the region's leader, Mauritius, it is estimated that their rate of economic growth would be enhanced by an average of 2.2%.

Esfahani and Ramirez (2003, cited in Bhattacharyay 2009) have found that if Africa had East Asia's growth rate in telephones per capita (10% vs 5%) and in electricity generation (6% vs 2%), its per capita growth rate would have been at least 0.9% higher.

A common way of reviewing infrastructure and economic growth is estimating the social economic rates of return of past and new investments. Research suggest economic returns on investment projects are averaging 30-40% for telecom, more than 40% for electricity generation and 80% for roads (when outliers are excluded) (see Estache, 2007, p.7). Another noteworthy and clear result is that the return tends to be higher in low-income than in middle-income counties (Canning and Bennathan 2000, Briceño, Estache, and Shafik 2004).

Similarly, across Latin America studies show that telecommunications, transport and power provision all have positive and significant impacts on economic output, with estimated marginal productivity of these assets significantly exceeding that of non-infrastructure capital (Calderón and Servén 2004).

Calderón and Servén (ibid) state that if Latin American countries' infrastructure stocks were to catch up with the regional leader (Costa Rica), they would get additional growth of between 1.1 and 4 percent per year and would reduce their GINI coefficient by between 0.02 and 0.10 (see Table 1 below)

Table 1 - Growth improvements in Latin American and Caribbean Countries (LAC) due to higher infrastructure development. Source: Calderón and Servén 2004

	Improvement to levels of LAC Leader			Improvement to levels of EAP Median		
Country	Stocks	Quality	Total	Stocks	Quality	Total
Argentina	1.3%	0.4%	1.7%	2.2%	0.9%	3.2%
Bolivia	3.8%	0.5%	4.3%	4.8%	1.0%	5.8%
Brazil	1.5%	1.4%	2.9%	2.4%	1.9%	4.4%
Chile	1.3%	0.0%	1.3%	2.3%	0.6%	2.8%
Colombia	1.9%	1.2%	3.1%	2.9%	1.7%	4.6%
Costa Rica	...	...	...	1.0%	0.5%	1.5%
Dominican Rep.	1.3%	0.1%	1.4%	2.3%	0.7%	2.9%
Ecuador	2.0%	1.0%	3.0%	3.0%	1.5%	4.5%
Guatemala	3.3%	0.4%	3.7%	4.2%	0.9%	5.2%
Honduras	3.1%	1.1%	4.2%	4.1%	1.6%	5.7%
Mexico	1.4%	0.2%	1.7%	2.4%	0.8%	3.2%
Nicaragua	3.4%	1.4%	4.8%	4.4%	1.9%	6.3%
Panama	1.4%	0.2%	1.5%	2.4%	0.7%	3.1%
Peru	3.0%	0.6%	3.5%	4.0%	1.1%	5.0%
El Salvador	1.6%	0.4%	2.1%	2.6%	1.0%	3.6%
Uruguay	0.7%	0.4%	1.1%	1.7%	0.9%	2.6%
Venezuela	1.1%	0.4%	1.4%	2.0%	0.9%	2.9%

Observations: The calculations of the potential growth effects are based on the coefficient estimates of column [6] of Table 3. Also, the median country of East Asia and the Pacific (EAP) in our analysis is the Republic of Korea.

Table 1 also demonstrates the impact of infrastructure catch up with Korea (the median of East Asia and the Pacific (PAC)). Costa Rica would see its growth rate rise by 1.5 percentage points (1 percent due to larger infrastructure stocks and 0.5 percent to better quality of infrastructure services) if its level of infrastructure development rose to match Korea's. In Bolivia, Guatemala, Honduras, Nicaragua, and Peru the impact would be huge - growth would speed up by at least 5 percentage points per year.

In a separate analysis Calderón and Servén (2003) take this relationship further, demonstrating that a major portion of the per-capita output gap that opened between Latin America and East Asia over the 1980s and 1990s can be traced to the slowdown in Latin America's infrastructure accumulation in those years.

Table 2 provides some support to these findings. It shows clearly that the accumulation of infrastructure stocks in East Asia, far outpacing infrastructure investment in other regions, has been matched by economic growth way in excess of the rest of the world. Between 1975 and 2005, East Asia's GDP increased ten-fold; South Asia's GDP increased five-fold and all other regions' economies grew by factors of between two and three.

For most policy makers this is no co-incidence (Straub, Vellutini and Warlters 2008), demonstrating for some that infrastructure investment is an essential determinant of growth (ADB, IBRD, WB, JICA 2005).

Table 2 - Growth of GDP and Infrastructure Stocks. Source: Straub, Vellutini and Warlters 2008

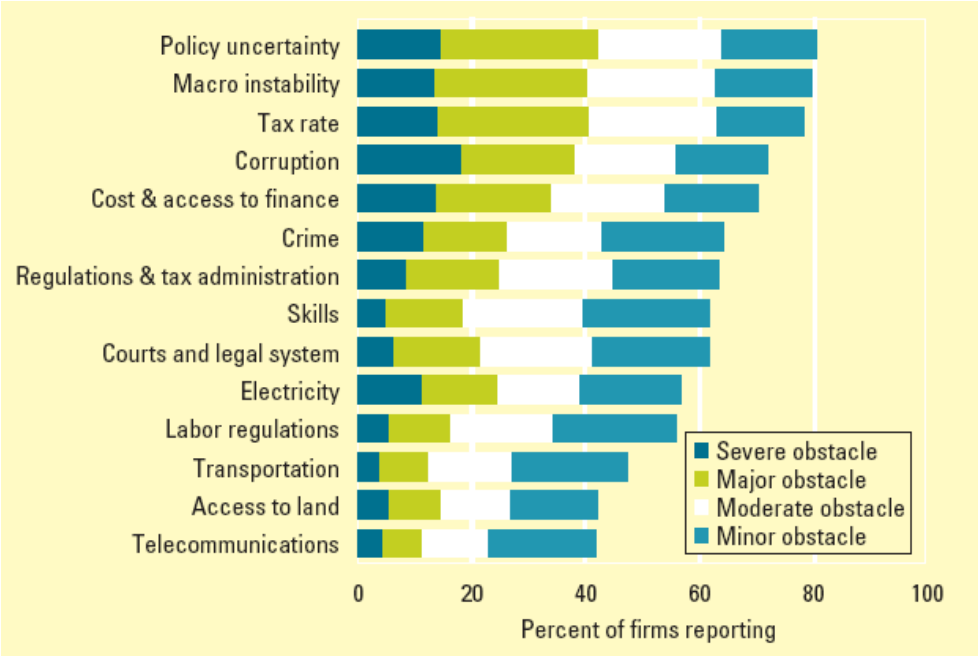
1995 levels as multiples of 1975 levels				
	GDP	Electricity	Roads	Telecoms
East Asia	4.8	5.9	2.9	15.5
South Asia	2.6	4.4	2.5	8.2
Middle East & North Africa	1.8	6.1	2.1	7.2
Latin America & Caribbean	1.8	3.0	1.9	5.1
OECD	1.8	1.6	1.4	2.2
Pacific	1.7	2.0		4.3
Sub-Saharan Africa	1.4	2.6	1.7	3.9
Eastern Europe	1.0	1.6	1.2	6.9

GDP – PPP constant 2000 international $; Electricity - MW of generating capacity; Roads – km of paved road; Telecoms – number of main lines. See Annex 1 for construction. Sources: World Development Indicators and Canning (1998)

Governments in East Asia and ASEAN region continue to build development policy around growth in stocks of infrastructure. The two fastest-growing economies in the region, China and Vietnam, are investing around 10 percent of GDP in infrastructure, and even at that rate they are struggling to keep pace with demand for electricity and telephones and transport infrastructure (Straub, Vellutini and Warlters 2008), while in Indonesia, since its election in late 2004, the new Indonesian government has made infrastructure a national priority, seeking to restore investment to its pre-crisis level of 5-6 percent of GDP (ibid). In the Greater Mekong countries, Laos, Cambodia, Thailand, Vietnam and Myanmar, there are hopes for a significant growth contribution from plans for greater integration of transport and energy markets (Battacharyay 2009).

The evidence suggests that Infrastructure can be a catalyst for growth at a number of levels. However, only as long as it is supported by a wider stable institutional and regulatory environment. This is clearly shown in Figure 2 below, which charts the outputs of a World Bank programme of investment climate surveys (World Bank 2005).

Figure 2 - Investment Climate Constraints in Developing Countries. Source: World Bank World Development Report 2005



This aspect is often neglected in the body of available evidence, which does not generally take into account the nature of the prevailing regulatory framework, the identity of operators and the nature of the political economy process that drives investments. The disparity in the growth rates between Asia, Africa and Latin America and the effectiveness of infrastructure in the development process correlates strongly with associated levels of political and socio-economic stability for example (Author observation).

In addition, meta-analysis of the subject shows that the impact of infrastructure on a country is often higher in developing countries compared to high income countries (Romp and de Haan 2005; Calderon and Serven 2004; Briceño et al. 2004).

Despite all positive research outcomes on the link between infrastructure and growth, it remains difficult to establish causality for specific interventions in the field, and much more empirical study on the subject is needed to pinpoint detailed effects under specific situations, for different groups, sectors, or for specific countries and regions.

3. Infrastructure and Pro-Poor Growth

To widen the view on the link between infrastructure and growth, much research recently has centred on pro-poor growth specifically. Being more specific than general economic growth in a country due to infrastructure investments, DFID defines pro-poor growth as the rise in average income of poor people.

Available evidence suggests that there is a distributional aspect in many cases, documenting that higher rates of growth not only lead to more poverty reduction but also to reduced levels of inequality. (Lopez 2004, Calderón and Servén 2004).

A study by UNESCAP (2006) on infrastructure in developing Asian countries has shown that road transport and electricity, in particular, play a key role in poverty reduction.

Larson et al. (2004) use Vietnam as a case in point and seek to quantify the poverty reduction benefit. Studying the growth and poverty effects of Vietnam's Public Investment Programme (PIP) between 1996 and 2000 (summing up more than 200 large scale investment projects with a value of more than 300,000 billion VND) Larson concludes that an additional 1 percent of GDP in public investment led to a corresponding proportionate reduction in poverty in the order of 0.5% over the period.

Calderón and Servén (2004), find that not only is growth positively affected by the stock of infrastructure assets, but that income inequality declines with higher infrastructure quantity and quality, suggesting that infrastructure development can be highly effective to combat poverty. Using telephone density as the infrastructure indicator, Lopez (2004), using a panel framework and controlling for reverse causation, finds that infrastructure raises both growth and reduced income inequality.

Among the most detailed studies of the link between infrastructure and pro-poor growth are those that have been undertaken by the International Food Policy Research Institute (IFPRI) (Fan et al, 1999, 2000, 2003 & 2004). These have looked at the effectiveness of government expenditure in reducing rural poverty in India and China (and more recently Vietnam and Uganda). Collectively they indicate the critical role of infrastructure development in a rural context, identifying large differences between different dimensions of infrastructure in their poverty and productivity effects. Willoughby (2004) has converted the findings of the studies in India and China into a common currency (US dollars 2003) to illustrate these differentials. He shows the estimated potential income and poverty reduction effects of an additional $1,000 equivalent spending in each of the

two countries. As Table 3 below indicates, although the greater productivity increase was estimated to result from increasing expenditure on agricultural research and development, a greater impact on poverty reduction in India could have been achieved by devoting funds to road improvements.

Table 3 - Estimated GDP and Poverty Reduction Benefits accruing from $1000 sector expenditure. Source: Willoughby 2004

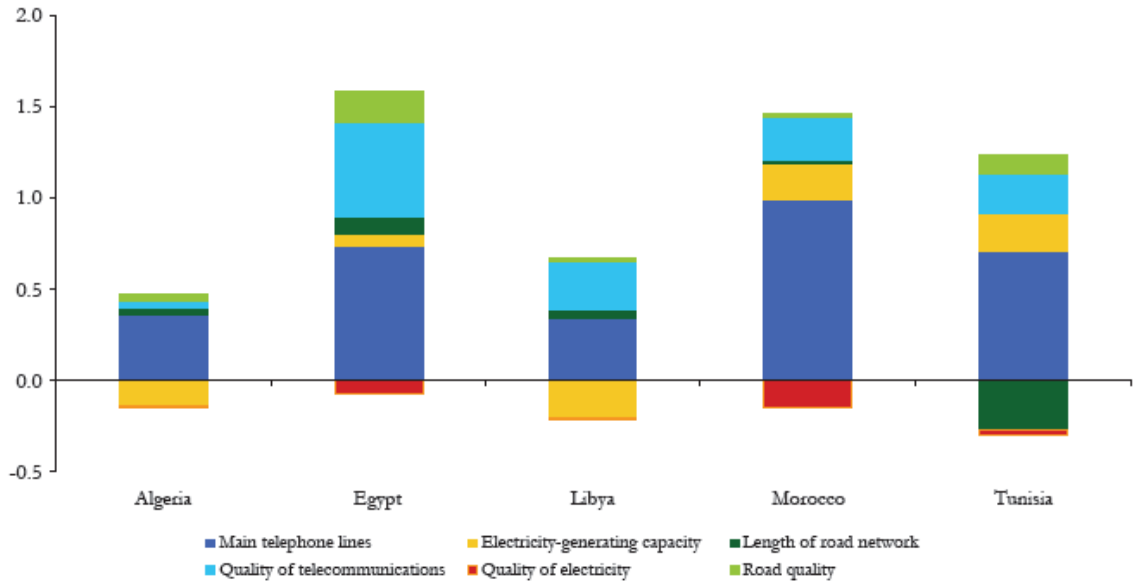
	---------INDIA--------		----------CHINA----------		
	Agric. - GDP -	Poor reduced	Agric. - GDP -	- Rural -- - GDP -	Poor reduced
	(£)	(No.)	(£)	(£)	(No.)
Ag. R&D	13,450	2.7	9,590	9,590	8.0
Irrigation	1,360	0.3	1,880	1,880	1.6
Roads	5,310	4.0	2,120	8,830	3.9
Education	1,390	1.3	3,710	8,680	10.4
Electricity	260	0.2	540	1,260	2.7
Conserv'n	960	0.7	n.a.	n.a.	n.a.
Anti-pov.	1,090	0.6	n.a.	n.a.	1.3
Health	840	0.9	n.a.	n.a.	n.a.
Telecom.	n.a.	n.a.	1,910	6,980	2.6

4. Infrastructure and Growth: A Sectoral Overview

Much of the discussion and analysis of the link between growth and infrastructure has focused on the direct productivity enhancing and factor accumulation aspects of infrastructure. In the examination of the contribution of infrastructure at a sectoral level, the evidence is very much related to the facilitating role that infrastructure plays in terms of **human development** – better infrastructure inducing improvements in health and education which increases labour productivity in the short term by making the existing stock of human capital more effective and in the medium and long term by inducing additional investment in education (Straub 2008). This is particularly evident in the water and sanitation sectors (SIWI 2005).

There has been some attempt to analyse the specific contribution of different types of infrastructure to growth (see Calderon 2009). As an example, Figure 3 shows the contribution of different infrastructure assets to growth in North African countries (ibid). In general, telephone penetration, quality of telecommunication services, and road quality explain the largest bulk of the contribution of infrastructure development to growth in these countries.

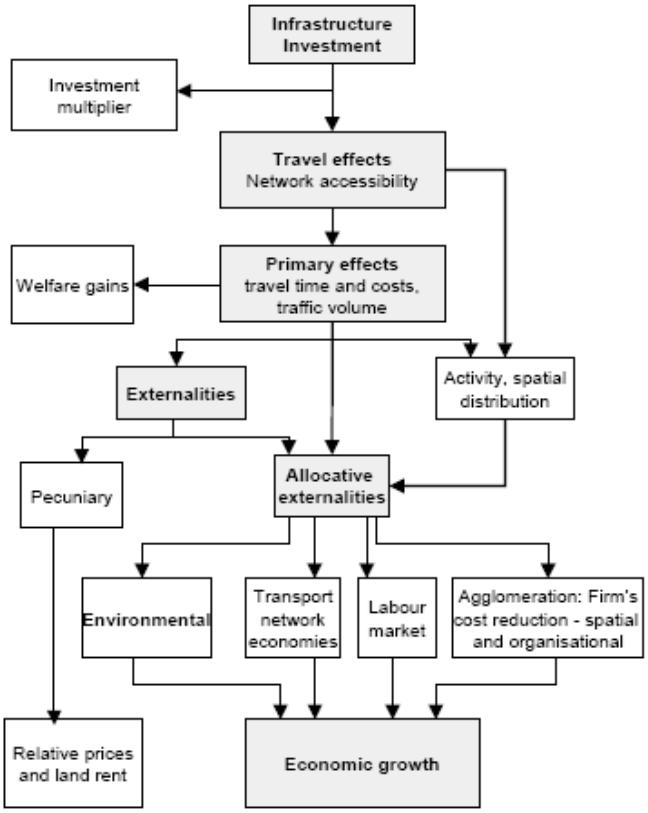
Figure 3 - Changes in per capita growth in North Africa as a consequence of infrastructure –2001 to 2005 compared with 1991 – 1995. Source: Calderon 2009



4.1 Transport

The transport sector and in particular the road transport sector, is often cited as being critical to international development efforts, in the effect it can have on the pace and pattern of economic growth (African Union, WB, EU 2005)). Improved transport infrastructure reduces transaction costs and bottle necks and works for economic growth at two levels (See Figure 4). The first in terms of market expansion and improved access to social infrastructure at the local level, leading to increased productivity; the second, in terms of improved trunk links between major centres, stimulating economic activity and reducing regional disparities (Willoughby 2004).

Figure 4 - Links between transport sector infrastructure investment and economic growth. Source: Y. Berechman, 2001, cited in OECD 2003



In the first case, rural road impact studies carried out by the Guinea Ministry of Transport published in 2005, showed that, over a five-year period, the area of land sown with crops doubled and output sold almost quadrupled in places where roads had been improved, while the same indicators stagnated in nearby areas chosen as controls because no road improvements had been undertaken. Travel time had halved, and freight transport costs had fallen 25% in the areas improved, but remained largely unchanged in the control areas (Guinea MoT 2005, Cited in World Bank 2005). In Vietnam, analysis of household budget survey results showed that in communes with an upgraded road running through then, income gains were 16% higher than in communes without roads and that this was the most significant income-increasing factor other than increases in rice yields (Glewwe, Gragnolati and Zaman (2000)) while well documented studies of Morocco (Khandker et al 1994 and Levy and Voyadzis 1996) have found that the existence of a paved road in a community increased girls probability of attending primary school by 40% and that paving of a rural road typically increased the enrolment rate for boys by 25% while more than doubling it for girls.

Citied earlier in this paper, studies by IFPRI have been particularly useful in their analysis of economic and poverty reduction benefits associated with infrastructure spend in rural areas. In their study of Uganda (Fan et al 2004) it was found that the expenditures with the highest marginal returns were in rural roads and agriculture. The study concluded that “roads should receive particular attention among all types of infrastructure, and among all types of road, low grade roads such as feeder roads should have higher priority than tarmac or murram (earth) roads”(p49).

Analysing the contribution of transport to the wider economy, Willoughby (2004) again uses the example of Uganda. Both Uganda and Ethiopia undertook major economic policy reforms in the 1980s. The benefits were substantial, and significant reductions in poverty resulted, but in Uganda the results were geographically quite concentrated. Many areas were excluded from significant impact, demonstrating a spatial relationship with the availability and quality of transport infrastructure.

Macro level studies attempting to assess the actual contribution of transport infrastructure to GDP produce mixed result, with some disagreement on the causal link. To what extent does GDP growth increase demand for transport services (OECD 2003) and to what extent does an increase in quality and quantity of transport stock increase GDP? Two principle mechanisms have adopted to measure this link – the earliest evidence and measure of the link adopted the use of output elasticities; this approach is based on the assumption that investments in transport infrastructure have the economic effect of both increasing the level of economic activity and the productivity of private capital. Although seen as an overestimate by many commentators (see Calderon 2009; and Gramlich 1994, for an overview of the critique), the seminal work of Aschauer (1989) showed a strong correlation between high growth rates and increases in transport investment. The estimated elasticity of output with respect to the public capital was calculated as 0.39, meaning that a 1 percent increase in the capital stock would increase output in the private sector by 0.39%. Even so, subsequent research also produced wide-ranging positive impacts on growth, but also with big differences in for instance rural vs. urban interventions.

More recently time travel savings and the associated productivity gain has been used by economists as an alternative measure for growth (OECD 2003). In the study of the impact of the developing Trans European Highway Network (TEN), the EU adopted an aggregate relationship to generate the link between a given level of transport expenditure and the implied productivity gain and then between this productivity gain and the growth of output or employment. The estimates made are of potentially very substantial output/employment gains. EU GDP is estimated to be 0.25% higher and employment 0.11% higher by 2025 from the priority TEN projects and even greater employment gains (800,000 jobs or a 0.49% increase) are obtained from the full network (European Commission 2003, cited in OECD 2003).

Using either approach, the economic benefits of developing strategic transport infrastructure in landlocked countries are particularly acute. Three independent sets of data on developing countries international trade flows and shipping costs were gathered and analyzed in a recent study (Faye, McArthur, Sachs and Snow 2004, cited in AU, ADB, WB and EU 2005). The elasticity of trade volumes with respect to transport costs was found to be high, at around –3.0. The median landlocked country faced transport costs about 50% higher than the median coastal economy and hence had a trade volume 60% less. The same study found that transport costs for intra-African trade are well over twice what they would be for trade within other main regions of the developing world, and that nearly half of this cost premium was due to weaker infrastructure. Using distance as a proxy for transport costs it has been reported that doubling costs reduced trade volumes by 80% (cited in Straub 2008).

The significance of transport costs for production and trade is highlighted most recently in the 2009 World Development Report (WDR) (p171). Here, the World Bank state "*transport and trade costs influence trade volumes*". A 10-percent increase in trade costs is estimated to reduce trade volumes by 20 percent. Trade in intermediate goods is

especially sensitive to transport costs. If the share of imported intermediate inputs in final demand is large, small changes in transport costs can have large effects on the volume of trade flows—the "trade friction" increases. For instance, a 5-percent increase in transport costs can produce trade friction equivalent to an ad valorem tax of almost 50 percent, when the share of intermediate inputs in value added is 70 percent. As transport costs fall, then, trade in intermediates would also increase rapidly. See for instance Jacoby (2000) for the relation between market access and rural roads.

However, as cited earlier, transport infrastructure is not a panacea. A key aspect at both the micro and macro scale in terms of sustained long term economic growth lie not just in new infrastructure, but in management and maintenance. In addition, the external operating environment is critical. Service operators have to be stimulated by appropriate combinations of competition and regulation to respond effectively to market demand and opportunities opened by advances in technology (authors note). As a final note, the World Bank 2009 WDR states *"Developing countries should pay more attention to transport and communications regulations to reduce transport and trade costs…the most critical policy related aspects the naturally monopolistic nature of transport—have been assumed away. Developing countries should do more to address the negative effects of market structure in the transport sector. And for some aspects of the agenda, they will need international support".*

4.2 Electricity

The direct contribution of electricity and power output to GDP is a moot point – in the available time – this short synthesis of two World Bank reports citing the case of Bangladesh provides some indication of the key issues:

Over the period 2002 to 2008 Bangladesh has consistently posted robust economic growth, averaging over 6 percent. However, the World Bank (2008) report that poor infrastructure and in particular, unreliable power supply remains a significant constraint on growth. The Bank reports that that poor quality power supply costs the country as much as 2 percent in GDP growth each year (ibid). Manufacturers, surveyed in the World Bank's most recent Investment Climate Assessment (2003), estimate that power shortages cost them around 12 percent in lost sales on an annual basis. This loss is particularly acute in rural areas where only 32 percent of enterprises have access to electricity compared to 60 percent in urban areas. A 2007 report from the Bank, believes that if this infrastructure gap is closed, that Bangladesh could raise GDP towards the 7.5 percent it must sustain to join the ranks of middle income countries.

4.3 Telecoms

The impact of telecommunications on growth was first reported by Andrew Hardy (Hardy 1980, cited in Sridha 2007) based on data from 45 countries; he noted the largest effect of telecommunication investment on GDP found in the least developed economies and the smallest effect, in the most-developed economies. Work by Sridha (2007) finds that a 1 percent increase in tele-density (total telephones per 100 population) increases national output by 0.15 percent without fixed effects and by 0.10 percent with fixed effects.

Table 4 below, summarizes the compounded growth impacts (CAGR) of cell phone penetration in developing countries – the data suggests that mobile communications contribute an average of 2.48 percent to national output.

A number of studies support this finding: Easterly (2001 cited in Calderón and Servén 2004) reports that a measure of telephone density contributes significantly to explain the growth performance of developing countries over the last two decades and Lopez (2003), cited previously found that investment in telecommunication infrastructure both raised growth and income distribution.

Table 4 - Compounded Annual Growth Rate (CAGR) of GDP Per Capita for Developing Countries and the Contribution of Cell Phone to GDP. Source: Sridha, 2007

				Contribution of cell CAGR over relevant time period		
Country	**Time period**	**CAGR,GDP per capita**	**CAGR, cell penetration**	**a_3 =0.08**	**a_3=-0.006**	**a_3=0.007**
Armenia	1998-2001	4.63%	33.65%	4.12%	-0.33%	0.38%
Benin	1998-2000	1.71%	102.25%	16.52%	-1.48%	1.67%
Bangladesh	1998-2001	2.98%	60.69%	9.80%	-0.86%	0.98%
Cote d'Ivoire	1998-2001	-3.25%	62.48%	10.25%	-0.91%	1.03%
Indonesia	1996-2001	-0.97%	49.45%	10.41%	-1.04%	1.15%
India	1998-2001	2.95%	51.37%	7.59%	-0.64%	0.74%
Kenya	1995-2001	1.07%	111.93%	48.97%	-175.97%	12.89%
Madagascar	1998-2000	1.11%	67.11%	8.95%	-0.74%	0.85%
Mozambique	1998-2001	3.06%	115.33%	27.47%	-3.23%	3.41%
Pakistan	1998-2001	2.06%	53.83%	8.15%	-0.70%	0.80%
Senegal	1998-2001	2.27%	78.11%	14.61%	-1.39%	1.55%
Tanzania	1996-2001	2.09%	86.69%	27.55%	-4.64%	4.33%
Average		**1.64%**	**72.74%**	**16.20%**	**-15.99%**	**2.48%**

a_3 =0.08 (cell phone model, without fixed effects, Table 8-2)
a_3= -0.006 (cell phone model, with fixed effects, Table 8-1)
a_3=0.007 (cell phone model, after removing outliers, with fixed effects, Table 9)

4.4 Water and Sanitation

Research commissioned by the Governments of Norway and Sweden (SIWI 2005) concludes that "improved water supply and sanitation and water resources management boosts countries' economic growth and contributes greatly to poverty eradication". Although difficult to draw a firm causal link, both this work and the findings of Sachs (for the WHO 2001) suggest that rates of economic growth in low income countries with improved access to safe water and sanitation grew on average at 3.7%, compared against rates of only 0.1% for countries with limited access. The work of SIWI and the WHO form the basis of additional analysis provided by Klop (2009) on behalf of OECD DAC (2009), which attempt to rationalise this growth figure.

SIWI argue that that improved water and sanitation towards meeting the MDG targets will result in time savings estimated at US$ 64 billion. This gain is accrued through increased productivity and production within both households and wider economies as a result of improved water collection and access arrangements for sanitation.

Both SIWI and the WHO estimate significant benefits as a result of the reduced cost of disease and health. SIWI (2005) predict that annual global value of adult working days

gained as a result of less water related illness would amount to almost US$750 million. Sachs (2001) goes further; he uses techniques to value lost life years, estimating that policies aimed at improved water and sanitation provision could save 330 million disability adjusted life years (DALYs[1]) by the year 2015. Valuing a DALY at US$563, Klop (2009) calculates that this could amount to a single years benefits of US$186 billion.

Table 5 - Cost Benefit Ratios and Economic Benefits accruing from meeting the MDG target for water and sanitation. Source: SIWI 2005

Region	Cost-benefit ratios and , Total economic benefits by intervention											
	Halving the proportion of people without access to both improved water supply and improved sanitation. Meeting the MDG Target.			Access for all to improved water and improved sanitation services			Access for all to improved water and sanitation services plus household water treatment at point of use			Access for all to regulated in-house piped water an sewerage connection		
Select countries within:	Cost/Benefit	Annual Costs in USD millions	Annual Benefits in USD millions	Cost/Benefit	Annual Costs in USD millions	Annual Benefits in USD millions	Cost/Benefit	Annual Costs in USD millions	Annual Benefits in USD millions	Cost/Benefit	Annual Costs in USD millions	Annual Benefits in USD millions
Africa	11.33	2021	22908	10.89	4043	44036	14.269	4360	62214	4.39	24729	108441
America	10.21	157	1607	10.59	315	3334	13.77	368	5074	3.88	2320	9007
Europe	3.40	71	242	6.55	143	934	5.82	266	1551	1.27	4206	5337
E. Mediterranean	34.95	100	3505	42.50	201	8523	61.47	250	15355	14.49	3275	47431
South East Asia	3.16	3628	11457	7.88	7257	57155	9.41	7704	72478	2.90	35074	101643
Western Pacific	3.36	3282	11013	6.63	6563	43487	7.89	6957	54885	1.93	28129	54426
Rest of the world		2046	33668		4087	105410		4744	132549		38782	229616
Total	7.50	11305	84400	11.63	22609	262879	13.96	24649	344106	4.07	136515	555901

The table above presents the total annual economic value for selected sub-regions of the world and compares four levels of intervention. The data suggests that the economic benefits of improved water supply and in particular sanitation far outweigh investment costs. Economic benefits range from US$3 to US$34 per US$1 invested (depending on the region and technologies applied) would be gained in health, individual and household, agricultural and industrial sectors if the water and sanitation MDG targets are achieved with total annual benefits accruing to US$ 84 billion. The table also shows that investment in water and sanitation infrastructure in Africa brings the greatest level of benefit, with a cost benefit ratio of 11.3.

[1] A DALY represents one year of healthy life lost. A DALY is used to estimate the gap between current health status of a population and the ideal situation where everyone in that population would live to old age in full health (WHO 2002, cited in SIWI 2005)

5. Policy Issues

The case for infrastructure investments for overall development and growth is clearly justified by empirical studies. The majority of research concludes that low-income countries benefit significantly from better infrastructure, income increases, and in most cases this also affect the poorest populations positively. However, the difficulty is in designing specific (sub) national policies to lift the poorest populations out of poverty and for instance in achieving the MDGs on the basis of clear empirical evidence. Much more research and solid, reliable data are needed to establish specific causality between infrastructure interventions and impact.

There are no easy solutions for development practitioners in how to design policy and allocate resources in the sector, and tailored approaches will be needed in specific countries or regions; rural versus urban priorities, tradable or non-tradable infrastructure resources, focus on increasing access or affordability, introduce service fees or (cross-) subsidies, etc. Still, there is overarching and clear evidence that would justify infrastructure investments as a clear policy target to assist developing countries in their economic development and pro-poor growth.

Current Debates on Infrastructure Policy have not changed that much over the last 25 years or so and they centre around two core questions (Estache and Fay, 2007):

- who should be in charge of the sector: the government or the private sector; the central government or the subnational governments; and finally, independent regulators or politicians?
- who should pay for the services: the users, the taxpayers or in some case the donors.

One of the main reasons for this lack of clear cut answers to these core questions is the lack of objective data on the sector, but with the recent refocus on the issue of infrastructure amongst development economists, much more data and probably evidence is being generated.

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