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# Infrastructure and Economic Growth in East Asia

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## Abstract

This paper examines whether infrastructure investment has contributed to East Asia's economic growth using both a growth accounting framework and cross-country regressions. For most of the variables used, both the growth accounting exercise and cross-country regressions fail to find a significant link between infrastructure, productivity and growth. These conclusions contrast strongly with previous studies finding positive and

significant effect for all infrastructure variables in the context of a production function study. This leads us to conclude that results from studies using macro-level data should be considered with extreme caution. The Authors suggest that infrastructure investment may have had the primary function of relieving constraints and bottlenecks as they arose, as opposed to directly encouraging growth.

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This paper—a product of the Operations and Policy Unit, East Asia and Pacific Sustainable Department—is part of a larger effort in the department to examine the relationship between infrastructure and economic growth. Policy Research Working Papers are also posted on the Web at <http://econ.worldbank.org>. The authors may be contacted at [stephane.struab@ed.ac.uk](mailto:stephane.struab@ed.ac.uk), [charles.vellutini@ecopa.fr](mailto:charles.vellutini@ecopa.fr), or [mwarlters@worldbank.org](mailto:mwarlters@worldbank.org).

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## Infrastructure and Economic Growth in East Asia

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# 1. Introduction

Policy-makers in developing East Asia see infrastructure investment as an essential determinant of growth.<sup>1</sup> 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 to install major transport networks. Hopes for a significant contribution to growth in the Greater Mekong countries – Laos, Cambodia, Thailand, Vietnam, Myanmar, and China – are centered on plans for greater integration of transport and energy markets. 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.

The current emphasis on infrastructure draws its inspiration from East Asia's economic history, including the experience of countries such as Japan, South Korea, Malaysia and Taiwan, China, which also made large investments in infrastructure. East Asia's accumulation of infrastructure stocks has outpaced infrastructure investment in other regions (Table 1). And East Asia's economic growth has outpaced the growth of other world regions. 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.<sup>2</sup> For most policy-makers this is no coincidence.

**Table 1: Growth of GDP and Infrastructure Stocks**

	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)

<sup>1</sup> See ADB, IBRD, WB, JICA, (2005).

<sup>2</sup> Difference in GDP (PPP) in constant 2000 dollars between 1975 and 2005.

But academics aren't so sure. Perhaps it is East Asia's growth success that has driven the high rate of infrastructure investment, rather than the other way around. In the neoclassical growth model, exogenous shocks, such as new technology, increase the rate of return to capital, inducing investment. Investment increases the stock of capital, thereby reducing the rate of return to capital and restoring equilibrium at the initial capital-labor ratio and a higher level of output.<sup>3</sup> Within this framework, if infrastructure is merely another form of capital with decreasing returns, infrastructure investment does not "cause" long-term growth, it is an inevitable consequence of growth, but the sources of growth must be found elsewhere.

Decreasing returns to infrastructure investment can certainly be observed. For example, electricity supply capacity that exceeds demand growth provides a poor return on investment, as several countries found in the aftermath of the 1997 financial crisis when economies and electricity demand contracted. And most of East Asia's infrastructure investment has occurred as a reaction to emerging constraints. So there are certainly arguments that infrastructure has the same properties as assumed in the neoclassical framework for other forms of capital.

But the neoclassical growth model also assumes that investment responds automatically to changes in rates of return. In fact, most infrastructure services are not provided in freely functioning markets. Government regulation, market power and externalities mean that infrastructure services are rarely provided at prices that represent the cost of inputs or their marginal social value. And infrastructure investments are dominated by government decision-making (e.g. public investment) and regulatory constraints (e.g. spatial planning, environmental considerations, etc). If the link between high rates of return and investment is blocked, the economy will not grow in accordance with the neoclassical model's predictions.

Complete non-responsiveness of infrastructure investment could be a partial explanation for differences in observed long-run growth rates across countries.<sup>4</sup> Mere differences in the speed with which infrastructure investment responds to infrastructure constraints would only affect the speed with which economies return to the long-run equilibrium growth path following a shock, and would not determine countries' long-run growth rates. But for

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<sup>3</sup> See Barro and Sala-i-Martin (2005).

<sup>4</sup> It is assumed that infrastructure services are strongly complementary with modern technologies – that is other forms of capital investment cannot substitute for infrastructure services.

practical policy purposes, such “transitory” growth rates are just as important as long-run growth. In a developing economy with chronic under-supply of infrastructure, transitory growth could conceivably last for decades.

Following this line of argument, infrastructure policies might play a role in explaining East Asia’s relative growth success if East Asia is more effective than other regions in relieving infrastructure constraints as they emerge. A small piece of evidence to this effect may be seen in the results of enterprise surveys (Table 2), which indicate that new connections are provided to firms more quickly and that service interruptions are least costly in East Asia than in most developing regions.

**Table 2: Impact of Infrastructure Shortages on Firms**

Region	Electricity connection delay (days)	Value lost to power outages (% of sales)	Water connection delay (days)	Mainline telephone connection delay (days)
East Asia & Pacific	21	2.6	18	16
Europe & Central Asia	15	3.0	9	16
Latin America & Caribbean	34	4.1	35	36
Middle East & North Africa	62	4.3	44	49
South Asia	49	7.4	29	50
Sub-Saharan Africa	38	5.9	42	54
OECD	10	2.3	—	9

Source: The data are derived from World Bank Investment Climate Assessments, and reported at [www.enterprisesurveys.org](http://www.enterprisesurveys.org) (last visited January 10, 2008)

However, this could again reflect causality running the other way round, as economies with stronger growth have readily available resources to address such bottlenecks as they become apparent.

Beyond the neoclassical growth framework, endogenous growth theory envisages instances where an aggregate economy may exhibit increasing returns to scale, notwithstanding the presence of diminishing or constant returns to individual factors.<sup>5</sup> If infrastructure stocks play a role in the realization of these economies of scale, infrastructure policy has a role in determining long-run growth.

An important feature East Asia’s infrastructure history has been the construction of major transport links between cities. Korea’s Seoul-Pusan highway built in the 1960s, Malaysia’s road network built in the 1970s and 1980s, China’s rail network and more recent expressways

<sup>5</sup> See Aghion and Howitt (1998) and Barro and Sala-i-Martin (2005) for a review of endogenous growth models.

development, and Vietnam's Hanoi-Ho Chi Minh City and Hanoi-Haiphong highways have all enlarged and integrated domestic markets, as well as providing the logistical connections for access to ports and international markets. Further investment in these transport networks may not give the same boost to productivity, but it is possible that the larger markets they create facilitates the exploitation of economies of scale within firms, the production of more specialized goods and services, and better and more specialized skills matches between employers and workers. That is, notwithstanding the presence of diminishing returns to infrastructure investment, the creation of infrastructure networks could contribute to the rate of innovation and technological advance in the economy, and thereby lift the long-term growth rate.

An alternative possible source of ongoing growth may lie in knowledge externalities. Cities play an important role in facilitating the exchange of ideas and innovation, and hence advancing the technological frontier. To the extent that infrastructure services affect the efficiency of cities and the effectiveness with which knowledge is shared, infrastructure services may influence the rate of productivity growth.<sup>6</sup> Moreover, this raises the question of whether infrastructure investment should be directed in priority to large urban areas or to lagging regions. It has been hypothesized (Williamson, 1965), that poor countries would go first through a process of concentration, industrialization and regional divergence, in which infrastructure investment is if anything following development, but that, as congestion in cities becomes too important, a reversed process of deconcentration and regional convergence occurs, which could be sustained by regional infrastructure investment. If these linkages are important, understanding the dynamic of cities should play a particularly important role in analyzing the sources of East Asia's growth. Overall, however, the evidence on the link between urbanization, infrastructure and growth is still very limited. East Asia is one of the least urbanized regions in the world. But its rate of urbanization is one of the fastest and the East Asian mega-cities are comparably large and more densely populated. Average urban densities in East Asia range from 10,000 to around 15,000 persons per sq km – about double the urban densities of Latin America; triple those of Europe; and ten times those of US cities. On the Williamson's hypothesis, some corroborating evidence has been found for Korea (see Henderson, Shalizi and Venables, 2001), but more work is still due to guide policies.<sup>7</sup>

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<sup>6</sup> See Henderson (2005) on urbanization and growth.

<sup>7</sup> See Straub (2008) for a detailed discussion of economic geography and urbanization issues in the context of infrastructure policy.

While not a channel that has been greatly explored in modern growth theory, it is plausible that growth is enhanced in countries with lower poverty, all else equal. Poverty reduction could serve to increase market size (e.g. greater disposable income), enhance labor productivity (e.g. health improvements), and enhance innovation through improved human capital (e.g. less poor populations might invest more in education; there may be less scope for innovation in an agrarian society, etc.). If such linkages are important, ensuring that all sections of the population are provided with infrastructure could indirectly boost growth by reducing poverty. It is notable that East Asia has been more successful in providing rural access to all-weather roads than other developing regions. Access to roads has been shown in numerous studies to have a significant effect on rural poverty (Jacoby, 2000; Gibson and Rozelle, 2003).

**Table 3: Proportion of rural population living within two kilometers of an all-weather road**

Sub-Saharan Africa	30
Middle East & North Africa	34
Latin America & Caribbean	38
South Asia	58
Europe & Central Asia	75
East Asia	94

Source: Roberts et al (2006).

Theoretical speculation on the relationship between infrastructure and growth should be tested against empirical observations. Examining 80 econometric specifications from 30 studies using macro-level data, Straub (2007) reports a significant positive effect of infrastructure on output or growth in 56 percent of specifications, no significant effect in 38 percent, and a significant negative effect in 6 percent. Among the studies that do find positive effects there is wide variation in their estimated magnitude.

There are several possible reasons for the variation in empirical results. It seems quite likely that the effects of infrastructure investment do, indeed, vary from location to location, and across different stages of economic development. A further source of variation is the theoretical framework used. Straub (2007) observes that a positive effect of infrastructure on growth is more likely to be detected in studies based on a production function than studies using cross-country regressions. The empirical literature frequently fails to set out the theoretical issues that are being tested so that results may not be strictly comparable, a number of methodological problems are either not considered or cannot be addressed with macro-



level data, and above all, aggregate data are simply not adequate to address the important policy issues.

To illustrate this, our paper examines whether infrastructure investment has, indeed, contributed to East Asia's economic growth using both a growth accounting framework and cross-country regressions. Our results are then contrasted with the results of Seethepalli, Bramati, and Veredas (2007), who use a production function specification to examine the impact of infrastructure on East Asia's growth. With all three methodologies focused on the same region and the same time-frame, any significant findings that recur across methodologies would shed light on whether infrastructure investment has indeed been a cause of economic growth in East Asia.

Two main conclusions emerge. First of all, for most of the variables used both the growth accounting exercise and cross-country regressions fail to find a significant link between infrastructure, productivity and growth. When they do, they produce rather contradictory conclusions, as growth accounting indicates no contribution of infrastructure to productivity in the richer countries (South Korea and Singapore), and some contribution in the relatively poorest countries (of telecommunications in Indonesia and Philippines, and of roads in Thailand), while cross-country growth regressions tend to indicate that the effects are generally negative for low-income countries and positive only for the high-income ones.

Second, these conclusions contrast strongly with those of Seethepalli, Bramati and Veredas (2007), who find positive and significant effects for all infrastructure variables in the context of a production function study. This leads us to conclude that results from studies using macro-level data should be considered with extreme caution. Given that macroeconomic data give only limited support to the notion that infrastructure investment has driven growth in East Asia, we conclude by speculating on other aspects, in particular the idea that infrastructure investment may have had the primary function of relieving constraints and bottlenecks as they arose.

The structure of the paper is as follows. Section 2 presents the growth accounting exercise. Section 3 turns to cross-country growth regressions. Finally, Section 4 discusses the results, compares them to other related studies and concludes.

## 2. Growth accounting

### 2.1. Methodology

#### Standard growth accounting

The formal framework of growth accounting is the production function

$$(1) \quad Y = A.F(K, L),$$

where  $Y$  is aggregate GDP,  $A$  is the time-varying total factor productivity (TFP) and  $K$  and  $L$  are respectively (total) capital and labor. Taking logs and differentiating with respect to time yields

$$(2) \quad \frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + \frac{F_L \cdot L}{F} \frac{\dot{L}}{L} + \frac{F_K \cdot K}{F} \frac{\dot{K}}{K}.$$

Assuming that marginal factor productivities equal factor prices, we get the standard formula for growth accounting, where the growth of TFP is computed as the residual between the growth of GDP and the growth of factors:

$$(3) \quad \frac{\dot{A}}{A} = \frac{\dot{Y}}{Y} - S^L \frac{\dot{L}}{L} - S^K \frac{\dot{K}}{K}.$$

In this equation  $S^L$  and  $S^K$  are therefore the respective observed shares of income. Importantly, (3) is typically not implemented through econometric estimation but rather through direct calculation: all the variables on the right-hand side are observed. As reported in Barro and Sala-i-Martin, (3) has been used in many country-specific studies with the objective of calculating TFP growth.

## Growth accounting with infrastructure

Assume, as in Hulten et al. (2005) that infrastructure (denoted  $X$  in the following equations) influences output through two channels. First, it impacts TFP through

$$(4) \quad A = A(X) = \tilde{A} \cdot X^\eta$$

where  $\tilde{A}$  is the « true » TFP and  $\eta$  is the elasticity of  $A$  with respect to  $X$ . Here, infrastructure raises output without any payments by firms for infrastructure services. This channel captures the externality aspect of infrastructure.

Second, infrastructure can enter the production function as an additional production factor:

$$(5) \quad Y = \tilde{A} \cdot X^\eta \cdot F(\tilde{K}, L, X).$$

where  $\tilde{K}$  is the stock of non-infrastructure capital.

The presence of infrastructure as one more factor reflects its market-mediated impact, whereby firms pay for infrastructure services.

This leads to:

$$(6) \quad \frac{\dot{Y}}{Y} = \frac{\dot{\tilde{A}}}{\tilde{A}} + \eta \frac{\dot{X}}{X} + S^X \frac{\dot{X}}{X} + S^L \frac{\dot{L}}{L} + S^{\tilde{K}} \frac{\dot{\tilde{K}}}{\tilde{K}}$$

where  $S^X$  is the share of GDP that accrues to market-mediated infrastructure and  $S^{\tilde{K}}$  the share of revenue that accrues to non-infrastructure capital.

A few remarks are in order. First,  $\eta$ , the elasticity of TFP with respect to infrastructure, is not observable as it captures the externality dimension of infrastructure: there are no payments involved, and therefore no income and price data can be used. Second, (6) shows that should data on  $S^X$  be available, that relationship would enable us to disentangle the market-mediated influence of infrastructure from its externality incidence. However, even though in principle the market-mediated part of infrastructure could be tracked by the corresponding payments

and prices, in practice data on infrastructure prices are not available in a consistent way for the countries under analysis. In addition, available data on capital do not distinguish between different types of capital, including infrastructure. Instead of having data on  $\tilde{K}$ , we have data on  $K$ .

Because of this, it is clearer to rewrite to model so as to fit the available data, as:

$$(5') \quad Y = \tilde{A} \cdot X^\eta \cdot F(K, L)$$

which leads to

$$(6') \quad \frac{\dot{Y}}{Y} = \frac{\dot{\tilde{A}}}{\tilde{A}} + \eta \frac{\dot{X}}{X} + S^L \frac{\dot{L}}{L} + S^K \frac{\dot{K}}{K} + \varepsilon.$$

Finally, the trick is to substitute (3) into (6'), so that we get (appending an error term):

$$(7) \quad \frac{\dot{A}}{A} = \frac{\dot{\tilde{A}}}{\tilde{A}} + \eta \frac{\dot{X}}{X} + \varepsilon.$$

The left-hand side of (7) is TFP growth as computed (not estimated) in the standard growth accounting approach. An alternative route to a full estimation of (6') is thus to estimate the reduced form (7) using the (year by year) results of (3) in terms of TFP growth rates ( $\frac{\dot{A}}{A}$ ), which is convenient as these are available from standard growth accounting exercises for a number of countries.

Either (7) or (6') provide an estimation of  $\eta$ , the pure externality effect of infrastructure, as opposed to the full elasticity of output with respect to infrastructure. For example, if an estimation of (7) produces a value for  $\eta$  not significantly different from zero, it suggests that infrastructure has no externality role in that particular economy. However, because  $K$  includes  $X$ , it does not imply that infrastructure is not productive: it is just not more productive than other types of capital.

Finally note that (7) or (6') also provide a basis for estimating  $\frac{\dot{\tilde{A}}}{\tilde{A}}$ , the “true” TFP growth.

## 2.2. Data and estimation

There are two main options for estimating (7). One is based on regional panel data, while the other one is a country-per-country approach based on time series data.

The panel estimation technique rests on the assumption that a common production function exists for the Asian countries under analysis, with individual country effects to be controlled for. While this approach has been extensively used with state / provincial panel data for India (Hulten et al. (2005)), Italy (La Ferrara and Marcellino (2000)) and the US (Holtz-Eakin (1994)), the above assumption is dubious when applied to a set of countries as diverse as those in our sample. We report below tentative panel estimations that confirm such cross-country heterogeneity.

We therefore give priority to individual country estimations, which more realistically do not assume that there is a common underlying technology for all countries. This has been the approach used by most non-infrastructure growth accounting studies.<sup>8</sup>

Concerning any possible simultaneity in the estimations, note again that the left hand-side quantity in (8) – TFP growth – is computed directly from data, not estimated. In particular, we do not have to worry about the typical simultaneity problem in regression-based growth accounting studies, namely reverse causation from the growth rates of GDP to  $K$ . The only possible remaining source of simultaneity would be an influence of TFP growth on investment in infrastructure,  $\frac{\dot{X}}{X}$ . Possible causes of simultaneity include endogenous responses of infrastructure policies to TFP growth, making it necessary to test the presence of reverse causation in the data.

Country-specific estimations, as opposed to panel estimations, call for longer time series in order to produce efficient estimators. Two sets of long time series can be considered. First, physical indicators of infrastructure stocks have been used in the literature. Canning (1999) uses indicators of telephones lines availability, electricity generating power and length of

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<sup>8</sup> See for example Barro and Sala-i-Martin (2004).

paved roads and railways to estimate an aggregate production function. This dataset includes time series of usable length for key infrastructures (excluding water) for all countries included in our exercise. Second, it is in theory possible to build time series of infrastructure stocks based on investment data together with the perpetual inventory method – just as time series of  $K$  are normally constructed. Unfortunately, in practice financial data on infrastructure (in monetary terms or as percentage of GDP) are scarce for the sample countries. Also, some authors (see Pritchett, 1996) have warned against the poor quality of financial indicators of public investment. For these reasons, we concentrate on physical indicators of infrastructure.

With respect to explanatory variables, we have used data from the Canning database in five countries: Indonesia, Philippines, Thailand, South Korea and Singapore. The following series of physical infrastructure indicators from the Canning (1998) database, as extended with the World Bank's infrastructure database, have been used:

- Number of telephones and telephone main lines;
- Electricity generating capacity;
- Total roads (railways and paved roads).

Finally, the TFP growth rates calculated by the Asian Productivity Organization (APO, 2004) for the five countries under analysis have been used as the dependent variable, as in (7). The APO has calculated (not estimated) TFP growth rates following the standard methodology that is, following equation (3) and, in addition, taking into account changes in labor quality.

## **2.3. Results**

The main results from individual growth accounting regressions are reported in Table 4. First, in South Korea and Singapore, which are the two most developed economies in our sample (Figure 1), we cannot reject the hypothesis that the coefficients on the three infrastructure variables are zero. Again, recall that the interpretation for this result is not that infrastructure is not productive but rather that there is no evidence from this exercise that it is more productive than other types of capital.

Second, in Indonesia, Thailand and Philippines we report preliminary evidence that some infrastructure variables are significantly more – or less – productive than other types of capital.

In Indonesia, the number of telephones has a positive coefficient of 0.12, significant at the 90% level. This suggests a productivity level above that of the rest of capital, specifically an externality effect expressed as an output elasticity of 0.12. However, in the same country electricity generating capacity appears to be *less* productive, at the 95% level of significance. With a  $R^2$  of 0.59, it is interesting to note that the growth of the two significant infrastructure indicators seem to explain a large share of the standard TFP growth. Since the electricity generating capacity variable carries a negative coefficient, it implies that the bulk of TFP growth has rested on the increase in the number of telephones. The estimate of the “true” TFP growth (after accounting for infrastructure growth) is only 0.0430% per year.

In the Philippines, the telephone variable also has a positive coefficient, significant at the 90% level, again supporting externalities from this variable.

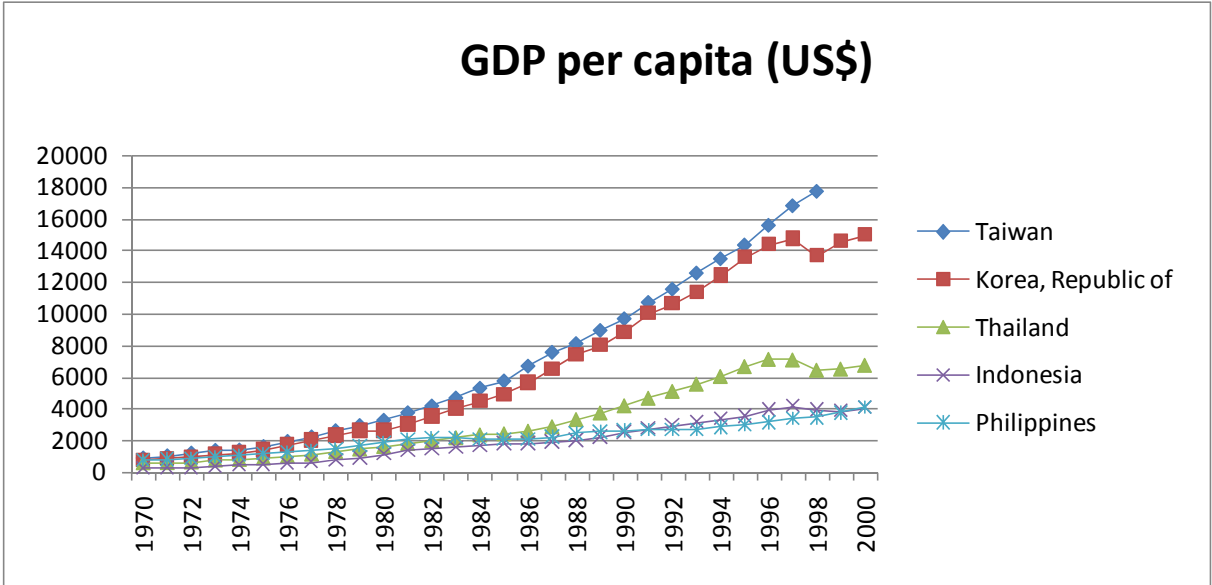
The road variable is significant in only one country, Thailand, at the 95% level. But with a  $R^2$  of 0.49, this variable alone explains a lot of the standard TFP growth. The estimate of the true TFP growth is a negative -0.3964% per year – suggesting that roads have been a primary driving force of productivity growth. With 11 observations only in Thailand, however, caution is warranted in interpreting this result.

One possible interpretation for the presence of two groups, with the most developed countries (South Korea and Taiwan, China) exhibiting no specific impact of infrastructure, is that infrastructure is not a binding constraint in these countries because it has been tailored to the needs of the economy, whereas it is in developing countries such as Philippines, Thailand and Indonesia, infrastructure has yet to catch up with the economy’s needs and could still be a bottleneck. The negative impact of electricity generating capacity in Indonesia could possibly be interpreted in this context as the result of the instability of infrastructure needs in a rapidly changing economy.

However, this interpretation, which is impossible to test with a sample of 5 countries, is clearly not consistent with the results reported in the next section on growth regressions,

which are based on a broader sample of countries. Tables 9 to 12 show that the interaction terms between the Low-Income dummy and infrastructure variables often carry a significantly *negative* coefficient. This suggests that the explanation for the mixed outcome from our growth accounting regressions could be related to factors which are orthogonal to GDP, for example if the productivity impact of the infrastructure stock is conditional on complementary factors such as the quality of regulation and governance in the sector.

Figure 1



The simple OLS specification based on equation (7) has been tested in several directions. First, the regressions have been tested for the presence of endogeneity. For each country, Hausman tests using various lags of the explanatory variables as instruments have been performed, all rejecting endogeneity. However, for several countries autocorrelation for some of the exogenous variables is rejected, making the latter invalid instruments for Hausman tests. In those specific cases, we follow the literature<sup>9</sup> in using population and population density (both contemporary and lagged) as instruments for Hausman test, which also leads to the rejection of endogeneity.

Second, time dummies were tentatively introduced as explanatory variables in each of the regressions above. The objective of this introduction was to test for possible time-varying effects on TFP growth, for example the role of the 1997 crisis in Asia. We do not report the

<sup>9</sup> See Straub (2007).



results of these estimations as the time variable is never a significant determinant of TFP growth.

Thirdly, the individual country regressions used above have the obvious shortcoming that they cannot account for cross-country variations. Could not pooled data reveal cross-country regularities masked by individual estimations? With the important caveat noted above – a common technology in all five country is a strong assumption – pooled/panel estimations were performed under various specifications. Table 5 reports the outcome of these estimations, with none of the infrastructure significantly different from zero and very low  $R^2$ .

Next, we turn to the results from cross-country regressions.

### 3. Growth regression

This section applies growth regression techniques to the study of the link between infrastructure and growth in the case of East Asian countries.

#### 3.1 Standard framework

Standard cross-country regressions in general start from a specification that intends to explain real per capita GDP growth by the initial level of real per capita GDP and explanatory factors such as physical investment, human capital (for example proxied by enrollment in different education levels) and additional factors that vary across studies. Indeed, approximately 60 different variables have been used in this abundant literature (Romp and de Haan, 2005), of which varying subsets have been deemed “robust” by different authors.<sup>10</sup>

Adding infrastructure capital to this framework yields the following reduced form equation to be estimated:

$$(9) \quad g_i = \alpha y_{i0} + \beta K_i^I + Z_i \gamma + v_i$$

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<sup>10</sup> See Levine and Renelt (1992), Sala-i-Martin (1997), and Temple (2000) for a discussion.

where  $g_i$  is the growth rate of real per capita GDP for country  $i$ ,  $y_{i0}$  is initial income (possibly in log form),  $K_i^I$  is a measure of infrastructure capital, and  $Z_i$  is a vector of covariates as mentioned above.

## 3.2. Data

We opt for physical infrastructure indicators. Three specific reasons support this choice.<sup>11</sup>

1. As mentioned above, public investment data are subject to a lot of problems, which make them unlikely to capture infrastructure stock or availability properly.
2. Physical indicators allow for a longer time frame and a higher number of countries.
3. They will allow for direct comparisons with the results from the growth accounting exercise.

Physical indicators for three different sectors (telecom, energy and transport) are taken from Canning's database, covering the 1971-1995 period. Specifically, we use the following series:

- Main telephone lines per 1,000 people. This series is extended up to 2002/2003 using Estache and Goicoechea (2005).
- Electricity generating capacity in million kilowatt per 1,000 people.
- Rail route length in km per 1,000 people.
- Paved road length in km per 1,000 people.

Additionally, we perform some tests with alternative variables: Telephone mainlines (per 1,000 people) from the World Bank World Development Indicator (WDI), fixed line and mobile phone subscribers (per 1,000 people) also from WDI, to capture the rise in mobile connections in the second half of the 1990s, roads total network and percentage of paved roads from WDI, which is used here as a quality proxy. We introduce additional proxies for

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<sup>11</sup> See Straub (2007) for a more general discussion of public investment versus physical infrastructure indicators.

the quality of the other services under study, namely telephone faults (per 100 mainlines) and electric power transmission and distribution losses in % of output, both from WDI. Other general data include (from WDI, unless mentioned otherwise) measures of GDP per capita, gross fixed capital formation, primary and secondary school enrollment (from Barro and Lee, 2000), primary and secondary schooling expenditures, government stability and Corruption (from Political Risk Service, International Country Risk Guide), life expectancy, M2/GDP (as a measure of financial development), imports/GDP and inflation.

### **3.3. Sample**

We rely on a sample of 93 developing or emerging countries. Of these 40 are classified by the World Bank as low income, 25 as lower middle income, 19 as upper middle income and 9 as high income. Note that this last category includes Hong Kong, Korea, Singapore and a number of oil producing countries. Overall, 16 East Asian and Pacific countries are included: China, Fiji, Hong Kong, Indonesia, Korea, Lao PDR, Malaysia, Mongolia, Myanmar, Papua New Guinea, Philippines, Singapore, Thailand, Tonga, Vanuatu, Vietnam.

### **3.4. Techniques**

In what follows we present two types of estimations. First, we perform simple cross country estimations based on the collapsed data set for 1971-1995 or 1984-1995 alternatively, using the rate of growth of GDP per capita as dependent variable and standard controls (initial level of GDP, investment, proxies for human capital). In each case, we instrument potentially endogenous infrastructure indicators and perform related tests. We also test specifications with different set of regional dummies (specific East Asian dummy, income groups), and the alternative infrastructure indicators mentioned above.

Then, we present panel regressions on 5-year subperiod averages with the same dependent variable. This frequency should result in enough variations in infrastructure indicators to allow the use of fixed effects. Following best practice in this type of exercise, we compare fixed vs. random effects and perform instrumental estimations. Finally, we use Arellano-Bond dynamic panel techniques.

### 3.5. Interpretation

Table 6 presents the results from cross country regressions with the 1971-1995 averages. Overall, only the number of telephone lines per hab. is significant, with a positive sign of 0.022. This implies that an increase in 100 lines per hab., from the average level over the period of Venezuela (63) to that of Korea (163) would add 2.2 points to the average growth rate of per capita GDP. All other infrastructure variables are insignificant and the paved roads length one is of the wrong sign. In columns 5 and 6, we add measures of quality of infrastructure, namely the number of telephone faults and electricity losses. These measures are not significant and the main indicators' coefficients are unchanged.

When considering instead the 1984-1995 period, in Table 7, which in particular enables us to introduce indices of government stability and corruption as additional control variables, we get even less conclusive results. The number of phone lines is now only significant when quality is controlled for and its coefficient is about half of the 1971-1995 one, while the paved roads variable is now negative and significant.

In Tables 8 and 9, we address the fact that infrastructure stocks may be determined simultaneously with output. Following previous contributions in the literature, we use beginning of the period (1971) values of the indicators themselves, as well as 1971 values of the level of population, population density and the share of agriculture in GDP. Overall, the results from IV estimations are similar to simple OLS. The coefficient for the number of phone lines is now larger, between 2.8 (1971-1995) and 4.7 (1984-1995). Note however that a Wu-Hausman test does not reject exogeneity in all but one of the 12 estimations.

Next, we test regional effects by interacting the infrastructure indicators with regional dummies. Tables 9 to 13 present the results for telecom, energy, railroad and roads respectively. In each case, we first use an East Asian dummy, then dummies for low and middle income countries respectively.

As for telecom, the group of East Asian countries does not display any significantly different behavior (the coefficient is negative but not significant), while income classification indicates that telecom impact is significantly lower in low income countries, a result that may appeal to

Röller and Waverman's (1999) conclusions on network externalities in telecom kicking in at near universal coverage level.

In Table 10, we observe that the impact of energy is positive and significant for the subgroup of East Asian countries, suggesting that the development of the electric network may have been an important contributor to growth of per capita output during the period. To compare again the same countries as before, the difference between the period average electricity generating capacity of Korea (0.667 million kw per 1,000 hab.) and that of Venezuela (0.376) implies an additional 1.1% per capita GDP growth. As for the level of development, the impact of electricity generation appears lower in low and middle income countries.

In Table 10, the impact of the railroad network is positive and weakly significant for East Asian countries, and it is again lower for low and middle income countries (actually slightly negative for low income ones). Finally, a similar pattern is repeated in Table 13 with respect to paved roads. Note finally, that in all cases instrumental estimations fail to yield significant results, and that the Wu-Hausman test fails to reject exogeneity in all but one of the 8 specifications tested.

Overall, this exercise seems to provide two main insights. First, East Asian countries display positive and significant returns from infrastructure across most dimensions. Second, a pattern emerges that indicates low or possibly negative returns for low income countries, slightly higher returns for middle income ones and strongly positive returns for the richer countries in the sample. The type of data we use does not allow for a very detailed analysis of this result. One possibility is simply a network effect type of explanation, although it is not clear how this applies to roads for example. Alternatively, it may be the case that richer countries also display more favorable conditions along other dimensions (better incentive structure, more efficient political interactions) that provide the required conditions for a favorable effect of infrastructure investment.

Finally, we use alternative infrastructure indicators in Table 14. Using the number of fixed and mobile phone lines, we inquire whether the very quick surge in mobile telephony in the 1990s had a special effect on growth above the effect of traditional main lines, as suggested by Waverman, Meschi and Fuss (2005). In column 1, we use 1984-2003 averages, and introduce both the number of fixed line 1984-1995 and the number of fixed plus mobile lines

1996-2003. Mobile lines appear to have a significant and positive effect on GDP per capita growth and render the effect of fixed lines negative. This result loses significance when instruments are used, but again exogeneity is not rejected at usual levels.

In column 3, we combine the total length of the road network and the percentage of paved roads, which results in only the second indicator being significant. This indicates that it is the quality of the road network that mostly provides growth dividends. In column 4, an indicator of the number of vehicles per kilometer of road is added to the specification. This variable now shows up positive and significant at the 5% level, while road length and proportion of paved road fail to be significant. If anything, this seems to indicate that, because it is usage of infrastructure that ultimately drives aggregate growth benefit, a proxy for the average use of roads capture the benefits from the extension and the quality of the network. Again, IV estimations yield no clear results and endogeneity is rejected.

Next, we perform panel estimations using 5 year averages of the different indicators. The results from fixed effects vs. random effects estimations are shown in Table 15, and a Hausman test is performed to decide which estimation technique is more suited. In all cases, a full set of time dummies is included. The main conclusions are that none of the infrastructure indicators introduced individually is significant, except negative and significant signs for electricity in the random effect specification and for paved roads in the fixed effects one respectively. Fixed effect estimations are supported by the test in 2 out of 4 cases (telecom and roads).

In columns 9 and 10, we introduce all four indicators together. The number of phone lines is positive and significant, while electricity and roads remain negative and significant. In this case, the Hausman test favors fixed effect estimation. Again, the interpretation of the signs of the coefficients, and especially the negative ones, is made difficult by the nature of the data. Several lines may be relevant, among which an “optimal stock” type of argument (returns may become negative in case of over accumulation), or arguments about investment decisions being politically driven and therefore departing significantly from efficiency.

In Table 16, we address the issue of endogeneity. Instruments are now the lagged value of infrastructure indicators, as well as the ones used previously (1971 values of the share of agriculture in GDP, population, and population density). Following the outcome of the test in

column 9 and 10 of Table 15, we chose a fixed effect specification and introduce a full set of time period dummies. Overall, few results are again significant, with only electricity generating capacity being positive and significant. This holds true when all indicators are introduced together. Note that exogeneity is now rejected for the individual estimations with the number of phone lines and the electricity generating capacity.<sup>12</sup>

## 4. Conclusion

Our results on growth accounting are mixed: in Indonesia and the Philippines telecommunications investment has generated externalities and has contributed to growth more than other types of capital. Roads have positively influenced TFP growth in only one country, Thailand. In South Korea and Singapore, however, two countries which have markedly higher GDP than the other countries in the sample, no significant effect of infrastructure on TFP growth has been detected.

Our cross country growth regressions provide relatively fragile results on the impact of infrastructure in per capita GDP growth, a conclusion that contrasts with previous studies that found robust results (Easterly and Servén, 1993; Calderón and Servén, 2004 among others). The number of phone lines appears positively related to growth in the cross country exercise, and some regional patterns emerge, showing above average effects for East Asia and high income countries. However, most results appear not to be robust when using panel techniques or when controlling for an endogenous response of infrastructure to growth.

Our growth accounting estimates indicate that infrastructure has contributed to TFP growth in poorer countries, while having no significant effect in other, richer economies. A possible explanation would be that poor countries have less developed infrastructure networks, and experience a one-off productivity dividend as they develop those networks. But in our cross-country growth regressions, which draw on data extending beyond East Asia, the interaction terms between the Low-Income dummy and infrastructure variables (Table 10 to Table 13) carry significantly *negative* coefficients. This suggests that the explanation for the mixed

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<sup>12</sup> Finally, we perform Arellano-Bond IV estimations similar to the one implemented in Calderón and Servén (2004). Two types of instruments are used: internal ones, constituted by the lagged values of the differenced explanatory variables including infrastructure indicators, and the external ones used above, namely 1971 values of the share of agriculture in GDP, population, and population density. Only electricity generating capacity is significant, and its coefficient is negative. Results are not shown here to save space.

outcome from our growth accounting regressions could be related to factors which are orthogonal to GDP, such as government policies and the quality of regulation and governance. The two results could be reconciled with a growth story in which infrastructure constraints, if left unaddressed by governments, can slow the transition towards the long-run growth path, but do not ultimately affect the long-run rate of growth. Governments of poor countries in East Asia may do a better job of addressing these constraints than governments of poor countries elsewhere.

It is interesting to compare our results with those of Seethepalli et al (2007). As in Estache et al. (2005), these authors compare a “benchmark” (without infrastructure) production function estimated at the steady state with the same specification including infrastructure variables (these include physical indicators for telecom, electricity, roads, sanitation and water).<sup>13</sup> Using data for East Asian countries<sup>14</sup>, they find that virtually all dimensions of infrastructure positively influence GDP per capita when controlling for education and investment. The cross-country regressions have similar controls, while our growth accounting estimations both investment and changes in the quality of labor are captured in the APO calculations of TFP growth rates, making comparison meaningful. Our growth accounting results in the Philippines, Indonesia and Thailand tends to support their result that telecom and road infrastructure enhances productivity conditional on investment and education, but not so for electricity. But our results from South Korea and Singapore, where no infrastructure impact has been found, suggest that individual countries could be at variance with the cross-country results of Seethepalli et al (2007). And our growth regressions provide much weaker results than those obtained by Seethepalli et al. One of the reasons might be the fact that they do not control for the potential endogeneity of infrastructure stocks. While they argue that the use of stocks rather than flows mitigates the problem of reverse causation, countries may have unobserved characteristics that lead them both to have higher infrastructure stocks and higher growth. The fact that fixed effects estimations are not carried out reinforces the concern that this may bias the results (Holtz-Eakin, 1994).

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<sup>13</sup> This approach parallels our interpretation of our results in terms of infrastructure productivity greater than or less than that of other types of capital.

<sup>14</sup> Australia, Cambodia, China, Fiji, Indonesia, South Korea, Laos, Mongolia, Papua New Guinea, Philippines, Singapore, Thailand, Tonga, Vanuatu, Vietnam.



A first conclusion is therefore that the results from studies using aggregate data lack robustness. Indeed, as shown above, different techniques (production function, growth regressions, growth accounting) produce very different results, even when looking at similar set of countries. Moreover, similar techniques, when applied to slightly different samples, also fail to produce consistent results. For example, we were unable to reproduce the results from Calderón and Servén (2004) in our sample of 93 developing countries.

Keeping these caveats in mind, what are the potential lessons for East Asian economies? Overall, our results give only limited support to the notion that infrastructure investment has driven growth in East Asia. Our results do not seem to be inconsistent with a story in which infrastructure can constrain growth, when that growth potential is generated exogenously, and that East Asian countries have been relatively successful in addressing infrastructure constraints as they arise. But the weakness of our data and results do not permit any definitive conclusions about the theoretical channels by which infrastructure may have influenced growth in East Asia.

If indeed East Asia is more effective than other regions at responding to infrastructure constraints it would be useful to understand why. Various arguments could be mounted. For example, East Asia has high levels of savings, and the availability of financing may facilitate more rapid responses. East Asian countries have typically relied on powerful planning agencies, such as Japan's MITI, etc. And to the extent that private investment in infrastructure has played a role in total investment, it is notable that the modalities employed in East Asia have differed from those employed elsewhere: for example, while East Asia focused on attracting investment at the wholesale level and greenfield sites (eg independent power producers), Latin America placed greater emphasis on the concessioning of existing retail systems. Testing such hypotheses is a subject for separate enquiry.

**Table 4. Results from growth accounting (single-country OLS estimations)**

Dependent variable : TFP growth rate	<b>Indonesia</b>	<b>Thailand</b>	<b>Philippines</b>	<b>South Korea</b>	<b>Singapore</b>
Constant	0.000430 (0.012378)	-0.003964 (0.013298)	-0.032361 (0.016032)	-0.011897 (0.049837)	0.013270 (0.019744)
Number of telephones	0.122859* (0.055356)	-0.082006 (0.048992)	0.282970* (0.152046)	-0.071994 (0.123365)	-0.090847 (0.107652)
Total roads (railways and paved roads)	-0.119878 (0.129726)	0.470495** (0.196164)	-0.017326 (0.221852)	0.539977 (0.534860)	-0.191091 (0.300689)
Electricity generating capacity	-0.047187** (0.015937)	0.027691 (0.052692)	0.062823 (0.123118)	-0.026010 (0.083775)	-0.003853 (0.076603)
R <sup>2</sup>	0.590285	0.486470	0.153937	0.069669	0.092980
Number of observations	14	11	28	21	18

Standard errors in parentheses. \*\* significant at the 5% level; \* significant at the 10% level.

**Table 5. Results from growth accounting (panel estimations)**

Dependent variable : TFP growth rate	Pooled regression, unbalanced sample	Pooled regression, balanced sample	Fixed effects, unbalanced sample	Fixed effects, balanced sample	Random effects, unbalanced sample	Random effects, balanced sample
Constant	-0.008737 (0.007908)	-0.012026 (0.010743)			-0.003989 (0.010032)	-0.013044 (0.010060)
Number of telephones	0.043324 (0.048094)	0.057099 (0.079778)	0.027650 (0.050246)	0.030315 (0.084314)	0.035615 (0.048686)	0.059584 (0.079787)
Total roads (railways and paved roads)	0.154079 (0.107193)	0.207674 (0.193470)	0.029425 (0.125109)	-0.042937 (0.276359)	0.085562 (0.115693)	0.226184 (0.187275)
Electricity generating capacity	-0.015537 (0.027578)	-0.031110 (0.034907)	-0.017844 (0.027756)	-0.027643 (0.037000)	-0.016328 (0.027313)	-0.032020 (0.034794)
R <sup>2</sup>	0.046681	0.091113	0.112922	0.167258	0.086519	0.080648
Number of observations	92	40	92	40	92	40

Standard errors in parentheses. \*\* significant at the 5% level; \* significant at the 10% level.

**Table 6. Cross section 1971-1995, OLS.**

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	OLS	OLS	OLS	OLS
	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth
Constant	-2.528 (0.970)**	-3.061 (1.161)**	-3.657 (1.239)***	-3.528 (0.996)***	-2.665 (1.265)**	-2.486 (2.058)
GDPpc71	-0.001 (0.000)***	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.001 (0.000)***	-0.001 (0.000)***
prim_expen_70	-0.053 (0.034)	-0.028 (0.039)	-0.058 (0.065)	-0.041 (0.036)	-0.060 (0.037)	-0.025 (0.058)
second_expen_70	0.002 (0.001)	0.001 (0.001)	-0.000 (0.004)	0.001 (0.002)	0.002 (0.002)	-0.013 (0.009)
Invt_GDP7195	0.227 (0.042)***	0.223 (0.054)***	0.289 (0.054)***	0.270 (0.042)***	0.234 (0.053)***	0.220 (0.074)***
main7195	0.022 (0.003)***				0.022 (0.004)***	
egc7195		2.871 (2.084)				4.108 (2.577)
rail7195			0.127 (1.687)			
pavroads7195				-0.172 (0.362)		
tel_faults7195					0.001 (0.003)	
elec_loss7195						0.030 (0.071)
Observations	51	48	41	51	47	33
R-squared	0.68	0.53	0.50	0.56	0.69	0.50

Robust standard errors in parentheses. Significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

**Table 7. Cross section 1984-1995, OLS.**

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	OLS	OLS	OLS	OLS
	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth
Constant	-5.691 (1.813)***	-6.385 (1.744)***	-6.289 (1.919)***	-8.614 (1.483)***	-4.570 (2.326)*	-4.183 (3.437)
GDPpc71	-0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)	0.000 (0.000)**	-0.000 (0.000)	0.000 (0.000)
prim_enrol8495	0.007 (0.013)	0.014 (0.013)	0.013 (0.013)	0.020 (0.011)*	-0.010 (0.014)	0.018 (0.033)
Invt_GDP8495	0.261 (0.066)***	0.272 (0.063)***	0.297 (0.065)***	0.281 (0.054)***	0.238 (0.075)***	0.290 (0.086)***
Govstab8495	0.070 (0.305)	0.045 (0.317)	-0.002 (0.320)	0.533 (0.293)*	0.344 (0.321)	-0.113 (0.417)
Corrup8495	0.110 (0.356)	0.202 (0.326)	0.151 (0.417)	0.140 (0.337)	-0.478 (0.459)	0.107 (0.463)
main8495	0.005 (0.004)				0.012 (0.005)**	
egc8495		-0.411 (1.343)				-1.629 (1.777)
rail8495			1.262 (1.720)			
roads8495				-1.414 (0.631)**		
tel_faults8495					0.006 (0.005)	
elec_loss8495						-0.104 (0.095)
Observations	55	54	47	49	48	42
R-squared	0.51	0.48	0.48	0.60	0.55	0.43

Robust standard errors in parentheses. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

**Table 8. Cross section 1971-1995, 2SLS.**

	(1)	(2)	(3)	(4)	(5)	(6)
	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth
Constant	-2.537 (1.109)**	-1.983 (1.245)	-2.839 (1.341)**	-3.184 (1.322)**	-4.132 (3.062)	27.406 (93.724)
GDPpc71	-0.001 (0.000)***	0.000 (0.000)	-0.001 (0.000)**	-0.000 (0.000)**	-0.001 (0.001)	0.003 (0.012)
prim_expen_70	-0.063 (0.047)	-0.075 (0.055)	-0.047 (0.072)	-0.047 (0.050)	-0.068 (0.051)	0.107 (0.614)
second_expen_70	0.002 (0.003)	0.001 (0.003)	-0.003 (0.006)	0.002 (0.003)	0.004 (0.004)	-0.073 (0.203)
Invt_GDP7195	0.230 (0.042)***	0.230 (0.053)***	0.248 (0.055)***	0.250 (0.051)***	0.253 (0.048)***	0.245 (0.416)
main7195	0.028 (0.013)**				0.028 (0.014)**	
egc7195		-6.453 (5.223)				-48.742 (164.983)
rail7195			1.892 (1.522)			
pavroads7195				0.464 (0.429)		
tel_faults7195					0.012 (0.022)	
elec_loss7195						-1.881 (6.248)
Observations	44	44	36	41	41	30
Wu-Hausman F test, p-value	0.70	0.13	0.11	0.18	0.83	0.28

Standard errors in parentheses. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. Instruments: 1971 Infrastructure physical stock, 1971 share of agriculture in GDP, 1971 population density.

**Table 9. Cross section 1984-1995, 2SLS.**

	(1)	(2)	(3)	(4)	(5)	(6)
	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth
Constant	-3.785 (2.091)*	-6.569 (3.047)**	-6.276 (1.999)***	-10.275 (2.832)***	-3.602 (2.562)	3.534 (17.124)
GDPpc71	-0.000 (0.000)	0.000 (0.001)	-0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)	0.003 (0.004)
prim_enrol8495	-0.011 (0.022)	0.030 (0.045)	0.017 (0.023)	0.023 (0.020)	-0.052 (0.032)	0.222 (0.285)
Invt_GDP8495	0.245 (0.070)***	0.180 (0.083)**	0.248 (0.083)***	0.264 (0.078)***	0.286 (0.087)***	0.122 (0.307)
Govstab8495	0.019 (0.395)	0.511 (0.924)	0.190 (0.417)	0.935 (0.527)*	0.387 (0.497)	1.065 (2.511)
Corrup8495	-0.130 (0.368)	-0.303 (1.085)	0.003 (0.407)	0.065 (0.359)	-1.030 (0.591)*	-1.900 (3.664)
main8495	0.024 (0.017)				0.047 (0.021)**	
egc8495		-5.502 (14.823)				-38.323 (51.504)
rail8495			1.393 (1.892)			
roads8495				-1.789 (1.217)		
tel_faults8495					0.028 (0.022)	
elec_loss8495						-1.380 (1.764)
Observations	48	47	44	40	43	37
Wu-Hausman F test, p-value	0.29	0.77	0.14	0.29	0.33	0.05

Standard errors in parentheses. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. Instruments: 1971 Infrastructure physical stock, 1971 share of agriculture in GDP, 1971 population density.

**Table 10. Cross section, Telecom, regional dummies interactions.**

	(1)	(2)	(3)	(4)
	OLS	OLS	2SLS	2SLS
	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth
Constant	-2.577	-1.769	-0.034	2.113
	(0.980)**	(0.913)*	(3.507)	(5.107)
GDPpc71	-0.001	-0.001	-0.001	-0.001
	(0.000)***	(0.000)***	(0.001)	(0.001)*
prim_expen_70	-0.055	-0.063	-0.083	-0.084
	(0.034)	(0.034)*	(0.097)	(0.090)
second_expen_70	0.002	0.003	0.004	0.002
	(0.001)	(0.001)*	(0.006)	(0.005)
Invt_GDP7195	0.229	0.220	0.065	0.148
	(0.043)***	(0.040)***	(0.197)	(0.113)
main7195	0.029	0.022	0.027	0.000
	(0.007)***	(0.003)***	(0.025)	(0.000)
EA*main	-0.006		0.313	
	(0.005)		(0.339)	
LI*main		-0.222		-1.188
		(0.066)***		(1.224)
MI*main		0.004		0.009
		(0.003)		(0.030)
Observations	51	51	44	44
R-squared	0.68	0.75		
Wu-Hausman F test, p-value			0.22	0.47

Robust standard errors in parentheses. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. Regional dummies: EA (East Asia), LI (low income countries), MI (middle income countries). Instruments: see Table 3 and 4.



**Table 11. Cross section, Energy, regional dummies interactions.**

	(1)	(2)	(3)	(4)
	OLS	OLS	2SLS	2SLS
	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth
Constant	-2.058	-1.085	-0.784	-0.646
	(1.159)*	(1.150)	(1.752)	(1.542)
GDPpc71	-0.000	-0.000	0.000	-0.000
	(0.000)	(0.000)**	(0.000)	(0.001)
prim_expen_70	-0.048	-0.079	-0.053	-0.093
	(0.038)	(0.037)**	(0.064)	(0.048)*
second_expen_70	0.000	0.002	0.001	0.002
	(0.002)	(0.001)	(0.003)	(0.003)
Invt_GDP7195	0.197	0.188	0.106	0.182
	(0.049)***	(0.047)***	(0.128)	(0.060)***
egc7195	-0.899	4.450	-3.038	-0.057
	(2.244)	(1.454)***	(6.514)	(6.997)
EA*egc	4.625		32.843	
	(1.361)***		(30.305)	
LI*egc		-18.451		-19.050
		(3.343)***		(16.486)
MI*egc		-3.719		0.000
		(1.186)***		(0.000)
Observations	48	48	44	44
R-squared	0.60	0.70		
Wu-Hausman F test, p-value			0.25	0.87

Robust standard errors in parentheses. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. Regional dummies: EA (East Asia), LI (low income countries), MI (middle income countries). Instruments: see Table 3 and 4.

**Table 12. Cross section, Rail, regional dummies interactions.**

	(1)	(2)	(3)	(4)
	OLS	OLS	2SLS	2SLS
	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth
Constant	-3.245	-2.387	-0.320	-0.489
	(1.257)**	(1.138)**	(2.900)	(1.867)
GDPpc71	-0.000	-0.000	-0.000	-0.001
	(0.000)	(0.000)	(0.000)	(0.000)***
prim_expen_70	-0.043	-0.046	0.001	-0.049
	(0.061)	(0.061)	(0.121)	(0.081)
second_expen_70	0.001	0.004	0.000	0.012
	(0.004)	(0.004)	(0.010)	(0.010)
Invt_GDP7195	0.241	0.224	0.024	0.172
	(0.058)***	(0.049)***	(0.194)	(0.071)**
rail7195	0.661	52.269	4.073	-19.234
	(1.771)	(16.292)***	(2.968)	(9.942)*
EA.rail	22.630		101.633	
	(11.833)*		(78.180)	
LI.rail		-57.714		0.000
		(16.315)***		(0.000)
MI.rail		-50.803		23.624
		(16.076)***		(10.950)**
Observations	41	41	36	36
R-squared	0.55	0.61		
Wu-Hausman F test, p-value			0.04	0.12

Robust standard errors in parentheses. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. Regional dummies: EA (East Asia), LI (low income countries), MI (middle income countries). Instruments: see Table 3 and 4.

**Table 13. Cross section, Roads, regional dummies interactions.**

	(1)	(2)	(3)	(4)
	OLS	OLS	2SLS	2SLS
	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth
Constant	-3.045 (1.043)***	-1.686 (1.011)	-2.085 (2.169)	2.604 (7.157)
GDPpc71	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.001 (0.001)
prim_expen_70	-0.043 (0.036)	-0.062 (0.034)*	-0.062 (0.058)	-0.087 (0.084)
second_expen_70	0.002 (0.002)	0.002 (0.001)	0.002 (0.003)	0.001 (0.004)
Invnt_GDP7195	0.236 (0.048)***	0.209 (0.043)***	0.187 (0.109)*	0.097 (0.196)
pavroads7195	-0.101 (0.350)	4.250 (1.621)**	0.353 (0.480)	-8.633 (10.902)
EA* pavroads7195	1.746 (0.891)*		2.914 (4.421)	
LI* pavroads7195		-6.112 (1.736)***		0.000 (0.000)
MI* pavroads7195		-4.037 (1.461)***		9.525 (11.397)
Observations	51	51	41	41
R-squared	0.59	0.65		
Wu-Hausman F test, p-value			0.29	0.32

Robust standard errors in parentheses. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. Regional dummies: EA (East Asia), LI (low income countries), MI (middle income countries). Instruments: see Table 3 and 4.

**Table 14. Cross section, Alternative infrastructure indicators.**

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	2SLS	OLS	OLS	2SLS	2SLS
	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth
Constant	-3.083 (1.624)*	-1.456 (4.275)	-3.770 (1.549)**	-3.544 (1.627)**	-2.077 (6.697)	-9.343 (11.441)
GDPpc71	-0.000 (0.000)***	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)*	-0.000 (0.000)	-0.000 (0.000)
prim_enrol8403	-0.018 (0.016)	-0.026 (0.033)				
second_enrol8403	0.021 (0.011)*	-0.012 (0.050)				
Invt_GDP8403	0.073 (0.377)	-0.015 (0.554)				
Invt_GDP8495			0.204 (0.054)***	0.202 (0.072)***	0.154 (0.143)	0.321 (0.339)
prim_enrol8495			0.007 (0.012)	0.007 (0.013)	-0.010 (0.058)	0.061 (0.109)
Govstab8495	(0.052)	(0.157)	-0.114 (0.270)	0.086 (0.304)	-0.041 (0.700)	0.351 (1.133)
Corrup8495	0.412 (0.252)	0.488 (0.573)	-0.066 (0.289)	-0.370 (0.347)	-0.489 (0.853)	0.196 (1.389)
telman_8495	-0.102 (0.008)*	-0.155 (0.092)				
fix+mob_9603	0.008 (0.003)**	0.038 (0.039)				
roads_tot_8495			0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)
pavroads%_8495			0.028 (0.016)*	0.007 (0.021)	0.057 (0.087)	-0.076 (0.175)
vehicles8495				0.018 (0.009)**		0.063 (0.095)
Observations	46	41	53	52	41	40
R-squared	0.64		0.48	0.52		
Wu-Hausman F test, p-value		0.34			0.82	0.42

Robust standard errors in parentheses. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.  
Instruments: see Table 3 and 4.

**Table 15. Panel 5 years average, Fixed and random effects.**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	pcGDPgrowt h	pcGDPgrowt h	pcGDPgrowt h	pcGDPgrowt h	pcGDPgrowt h	pcGDPgrowt h	pcGDPgrowt h	pcGDPgrowt h	pcGDPgrowt h	pcGDPgrowt h
	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects
Constant	-3.624 (2.595)	-3.580 (1.093)***	-4.288 (6.055)	-5.847 (1.477)***	-2.489 (6.391)	-2.503 (1.833)	-4.853 (6.059)	-8.293 (1.475)***	3.691 (6.833)	-3.969 (1.707)**
GDPpc	-0.000 (0.000)***	-0.000 (0.000)**	-0.000 (0.000)***	-0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)***	-0.000 (0.000)	0.000 (0.000)
Invt/gdp	0.111 (0.030)***	0.145 (0.023)***	0.093 (0.061)	0.109 (0.036)***	0.147 (0.069)**	0.196 (0.043)***	0.087 (0.053)	0.134 (0.034)***	0.113 (0.075)	0.186 (0.040)***
lifeexpect	0.091 (0.042)**	0.045 (0.020)**	0.102 (0.105)	0.099 (0.029)***	0.062 (0.120)	0.041 (0.036)	0.120 (0.103)	0.091 (0.029)***	-0.006 (0.129)	0.079 (0.032)**
m2/gdp	-0.054 (0.014)***	-0.006 (0.008)	-0.032 (0.028)	0.015 (0.014)	-0.049 (0.030)	-0.002 (0.016)	-0.020 (0.030)	-0.000 (0.014)	-0.006 (0.032)	0.014 (0.015)
imports/gdp	0.030 (0.019)	0.007 (0.009)	0.029 (0.042)	0.003 (0.013)	0.040 (0.040)	-0.012 (0.015)	-0.003 (0.035)	0.014 (0.012)	0.063 (0.047)	-0.028 (0.017)*
inflation	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)***
main	-0.003 (0.003)	0.001 (0.003)							0.023 (0.011)**	0.012 (0.006)*
egc			-2.427 (1.516)	-1.325 (0.709)*					-6.563 (2.014)***	-4.407 (1.258)***
rail					-3.314 (5.158)	-1.242 (1.093)			-4.596 (5.445)	-0.642 (1.083)
pav							-2.823 (1.084)***	0.116 (0.188)	-4.053 (1.776)**	-0.851 (0.448)*
Obs	497	497	313	313	237	237	276	276	202	202
R-squared	0.23		0.20		0.27		0.24		0.35	
Haus test FE vs RE	51.06***		12.43		11.48		18.41**		19.79*	

Standard errors in parentheses. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. Full set of period dummies included.

**Table 16. Panel 5 years average, 2SLS estimations.**

	(1)	(2)	(3)	(4)	(5)
	Fixed Effects, 2SLS	Fixed Effects, 2SLS	Fixed Effects, 2SLS	Fixed Effects, 2SLS	Fixed Effects, 2SLS
	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth	pcGDPgrowth
Constant	-5.587 (2.496)**	-17.221 (6.732)**	-7.866 (7.535)	-20.282 (6.758)***	-8.576 (11.968)
GDPpc	-0.000 (0.000)**	0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	0.004 (0.002)*
Invt/gdp	0.143 (0.031)***	0.267 (0.070)***	0.216 (0.065)***	0.043 (0.054)	0.205 (0.104)**
lifeexpect	0.106 (0.042)**	0.239 (0.109)**	0.094 (0.124)	0.340 (0.106)***	0.071 (0.192)
m2/gdp	-0.057 (0.017)***	-0.040 (0.033)	-0.043 (0.031)	-0.030 (0.033)	-0.081 (0.053)
imports/gdp	0.038 (0.021)*	-0.070 (0.050)	0.023 (0.039)	0.045 (0.039)	-0.025 (0.076)
inflation	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)**
main	-0.002 (0.005)				-0.082 (0.052)
egc		6.211 (2.714)**			38.411 (20.499)*
rail			2.650 (7.567)		-11.985 (14.405)
pav				-0.459 (1.889)	-6.015 (5.749)
Observations	362	218	177	202	148
Haus test endog p-value	60.17***	38.84***	0.15	13.12	7.28

Standard errors in parentheses. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. Instruments: Lagged infrastructure, agri/gdp71, population density 71, population 71. Full set of period dummies included.

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## Data Used to Construct Table 1

## GDP, PPP (constant 2000 international \$millions)

	1975	1995		1975	1995
Benin	2764	5405	Fiji	2287	3644
Botswana	1610	9813	Kiribati	639	312
Burkina Faso	4541	9027	Papua New Guinea	6516	11732
Burundi	2716	4527	Solomon Islands	219	902
Cameroon	12873	22120	<b>Pacific</b>	<b>9661</b>	<b>16590</b>
Central African Republic	3391	4070	China	553368	3289651
Chad	4068	5764	Hong Kong, China	34260	147174
Congo, Dem. Rep.	52934	36764	Indonesia	145836	578545
Congo, Rep.	1541	3214	Korea, Rep.	130306	612756
Cote d'Ivoire	16038	22699	Malaysia	36847	155960
Gabon	5605	7232	Philippines	142576	251787
Gambia, The	879	1722	Singapore	14853	69738
Ghana	19302	30880	Thailand	80327	379609
Guinea-Bissau	663	1190	<b>East Asia</b>	<b>1138373</b>	<b>5485220</b>
Kenya	13012	28492	Australia	220530	405317
Lesotho	1346	4022	Austria	121243	198386
Madagascar	10203	11314	Belgium	158164	244173
Malawi	3038	5542	Canada	403919	690682
Mali	4607	7099	Denmark	90191	132958
Mauritania	2795	4417	Finland	71506	106834
Niger	5246	6942	France	825783	1330942
Nigeria	56673	86360	Germany	1146873	1886329
Rwanda	3706	4689	Greece	112493	157198
Senegal	7724	11896	Iceland	3512	6318
Sierra Leone	2754	2549	Ireland	30949	69229
South Africa	238007	336107	Italy	780564	1311128
Sudan	19806	36507	Japan	1604460	3154122
Togo	4179	5889	Luxembourg	7021	15457
Zambia	6958	7322	Netherlands	240912	378810
Zimbabwe	17294	30394	New Zealand	49479	67479
<b>Africa</b>	<b>526273</b>	<b>753968</b>	Norway	67021	128940
Bangladesh	70353	154277	Portugal	79042	151892
India	686903	1812285	Spain	463198	734659
Nepal	11141	25576	Sweden	145256	199406
Pakistan	71015	221173	Switzerland	149436	202905
Seychelles	439	1002	United Kingdom	877471	1353078
Sri Lanka	20570	52119	United States	4276900	7972800
<b>South Asia</b>	<b>860421</b>	<b>2266432</b>	<b>OECD</b>	<b>11925923</b>	<b>20899042</b>
Georgia	19101	7102	Algeria	77437	139093
Hungary	90088	106685	Egypt, Arab Rep.	57323	183865
Latvia	16076	14353	Iran, Islamic Rep.	241211	303055
<b>Eastern Europe</b>	<b>125265</b>	<b>128140</b>	Israel	49149	115993

	1975	1995		1975	1995
Jordan	4775	17044	Ecuador	20981	37910
Kuwait	29998	39060	El Salvador	19155	24836
Morocco	41924	83587	Guatemala	20962	37241
Oman	6398	26067	Guyana	2634	2550
Saudi Arabia	164947	246567	Haiti	11586	11407
Syrian Arab Republic	18863	47456	Honduras	7433	15887
Tunisia	19582	45666	Jamaica	6964	9322
Turkey	164329	359470	Mexico	379924	690902
United Arab Emirates	22440	54161	Nicaragua	15676	12071
<b>MENA</b>	<b>898376</b>	<b>1661084</b>	Panama	7971	14222
			Paraguay	8450	22475
Bahamas, The	1818	4168	Peru	80292	108373
Argentina	289859	392783	St. Vincent and the Grenadines	206	525
Belize	347	1066	Suriname	2297	2228
Bolivia	12241	16759	Swaziland	1496	3700
Brazil	595873	1119487	Trinidad and Tobago	7342	9159
Chile	36824	114771	Uruguay	17484	26419
Colombia	105789	239245	Venezuela, RB	92975	134806
Costa Rica	11651	25234	<b>LAC</b>	<b>1777094</b>	<b>3115287</b>
Dominican Republic	18864	37741			

### Electricity Generating Capacity ('000 MW)

	1975	1995		1975	1995
ANGOLA	523	617	NIGER	20	63
BENIN	15	15	NIGERIA	860	5881
BURUNDI	6	43	REUNION	74	299
CAMEROON	225	627	RWANDA	35	34
CAPE VERDE IS.	6	7	SENEGAL	130	231
CENTRAL AFR.R.	17	43	SEYCHELLES	11	28
CHAD	22	29	SIERRA LEONE	95	126
COMOROS	1	5	SOMALIA	18	70
CONGO	32	118	SUDAN	205	500
DJIBOUTI	24	85	TANZANIA	160	543
ETHIOPIA	320	464	TOGO	24	34
GABON	58	310	UGANDA	163	162
GAMBIA	10	29	ZAIRE	1217	3193
GHANA	896	1187	ZAMBIA	1031	2436
GUINEA	175	176	ZIMBABWE	1192	2148
GUINEA-BISS	8	11	<b>AFRICA</b>	<b>9699</b>	<b>25172</b>
IVORY COAST	360	1173			
KENYA	283	809	BAHAMAS	255	401
LIBERIA	300	332	BARBADOS	67	140
MADAGASCAR	95	220	BELIZE	11	25
MALAWI	87	185	COSTA RICA	404	1165
MALI	37	87	DOMINICA	6	8
MAURITANIA	39	105	DOMINICAN REP.	732	1450
MAURITIUS	132	364	EL SALVADOR	314	751
MOZAMBIQUE	793	2383			

	1975	1995		1975	1995
GRENADA	7	9	BANGLADESH	933	3284
GUATEMALA	327	766	INDIA	22249	93755
HAITI	89	153	NEPAL	62	292
HONDURAS	159	305	PAKISTAN	2236	14025
JAMAICA	687	1182	SRI LANKA	381	1555
MEXICO	11559	44257	<b>South Asia</b>	<b>25861</b>	<b>112911</b>
NICARAGUA	252	457			
PANAMA	346	957	BULGARIA	7060	12087
PUERTO RICO	3453	4575	ROMANIA	11577	22276
ST.KITTS&NEVIS	13	16	POLAND	20057	29465
ST.LUCIA	14	22	<b>Eastern Europe</b>	<b>38694</b>	<b>63828</b>
ST.VINCENT&GRE	9	14			
TRINIDAD&TOBAGO	404	1150	AUSTRALIA	21509	39693
ARGENTINA	9260	19610	AUSTRIA	10016	17440
BOLIVIA	376	805	BELGIUM	9809	14916
BRAZIL	19569	59036	CANADA	61352	113340
CHILE	2620	5854	DENMARK	5958	11144
COLOMBIA	3504	10758	FINLAND	7395	14427
ECUADOR	525	2539	FRANCE	46289	107611
GUYANA	170	114	GREECE	4664	8942
PARAGUAY	191	6533	HUNGARY	4291	7012
PERU	2400	3831	ICELAND	514	1081
SURINAME	301	425	IRELAND	2051	4399
URUGUAY	796	2052	ITALY	39163	65821
VENEZUELA	4570	19975	JAPAN	112285	226966
<b>LAC</b>	<b>63390</b>	<b>189335</b>	LUXEMBOURG	1157	1257
			MALTA	110	250
ALGERIA	1107	6007	NETHERLANDS	14931	19012
BAHRAIN	187	1080	NEW ZEALAND	4901	7520
EGYPT	3955	16015	NORWAY	16928	27674
IRAN	4850	26257	PORTUGAL	3227	9378
IRAQ	840	9500	SPAIN	25756	45764
ISRAEL	2251	4480	SWEDEN	23135	33623
JORDAN	92	1126	SWITZERLAND	11846	16657
KUWAIT	1474	6988	U.K.	73923	70213
MOROCCO	958	3795	U.S.A.	527346	764876
OMAN	91	1744	<b>OECD</b>	<b>1028556</b>	<b>1629016</b>
QATAR	204	1365			
SAUDI ARABIA	425	20934	FIJI	83	200
SYRIA	684	4330	PAPUA N.GUINEA	255	490
TUNISIA	426	1736	SOLOMON IS.	8	12
TURKEY	4165	20953	TONGA	3	7
UNITED ARAB E.	175	5390	<b>Pacific Islands</b>	<b>349</b>	<b>709</b>
YEMEN	14	810			
<b>MENA</b>	<b>21898</b>	<b>132510</b>	CHINA	35000	204100
			HONG KONG	2274	10096
			INDONESIA	1259	20296
			KOREA, REP.	5135	35355
			LAOS	55	256

MALAYSIA	1227	10600	SINGAPORE	1150	4513
MONGOLIA	266	901	THAILAND	2754	17544
MYANMAR	437	1344	<b>East Asia</b>	<b>52788</b>	<b>312727</b>
PHILIPPINES	3231	7722			

**Paved road length (average of five years to 1975 and 1995), kilometers**

	<b>1975</b>	<b>1995</b>		<b>1975</b>	<b>1995</b>
ANGOLA	7292	8995	MEXICO	51278	86988
BENIN	798	1210	NICARAGUA	1422	1605
BOTSWANA	165	3635	PANAMA	2146	3004
BURKINA FASO	473	1768	ARGENTINA	36904	61400
BURUNDI	116	1028	BOLIVIA	1128	1954
CAMEROON	1125	3750	BRAZIL	54418	142919
CENTRAL AFR.R.	193	510	CHILE	8724	11974
CHAD	267	430	COLOMBIA	6664	12778
CONGO	402	1030	ECUADOR	3161	5663
DJIBOUTI	269	363	PARAGUAY	872	2785
GABON	209	680	PERU	5074	7571
GAMBIA	296	590	VENEZUELA	19643	31379
GHANA	6958	8523	<b>LAC</b>	<b>199470</b>	<b>384367</b>
IVORY COAST	1549	4500			
KENYA	5767	13078	CHINA	92000	207000
LESOTHO	215	802	HONG KONG	1031	1594
LIBERIA	296	574	INDONESIA	28356	153046
MADAGASCAR	3782	5352	KOREA, REP.	7803	51530
MALAWI	1299	2480	MALAYSIA	15977	42910
MALI	1734	2297	PHILIPPINES	15990	25827
MAURITANIA	613	870	SINGAPORE	1605	2893
MAURITIUS	1613	1730	TAIWAN, CHINA	9415	16987
MOZAMBIQUE	3458	5309	THAILAND	14058	43659
NIGER	1014	4405	<b>East Asia</b>	<b>186235</b>	<b>545444</b>
NIGERIA	16713	31667			
RWANDA	84	790	EGYPT	9216	17902
SENEGAL	2439	4300	MOROCCO	21937	29813
SEYCHELLES	85	210	OMAN	332	5598
SIERRA LEONE	1099	1743	SAUDI ARABIA	9950	33820
SOUTH AFRICA	38141	57511	SYRIA	11222	24308
SWAZILAND	192	787	TUNISIA	10087	15310
TANZANIA	3418	3800	TURKEY	22480	49180
TOGO	710	2037	<b>MENA</b>	<b>85224</b>	<b>175931</b>
ZAIRE	2020	2550			
ZAMBIA	4062	6575	AUSTRALIA	209978	296532
<b>Africa</b>	<b>108865</b>	<b>185876</b>	AUSTRIA	98919	109500
			DENMARK	61086	71059
BARBADOS	1216	1365	FINLAND	28525	47167
COSTA RICA	1688	5604	GREECE	21699	35748
EL SALVADOR	1342	1740	ICELAND	113	2595
GUATEMALA	2554	3237	IRELAND	81761	86787
HONDURAS	1238	2401	ITALY	268500	305443

	1975	1995		1975	1995
JAPAN	265350	798521	BULGARIA	24133	33900
LUXEMBOURG	4460	5057	CZECHOSLOVAKIA	67794	73496
NETHERLANDS	82501	108142	HUNGARY	40514	53389
NEW ZEALAND	44280	54672	POLAND	163541	207264
SPAIN	132400	157666	<b>Eastern Europe</b>	<b>295982</b>	<b>368048</b>
SWEDEN	50690	120484			
U.K.	329469	363707	BANGLADESH	3752	8278
U.S.A.	2854706	3716867	INDIA	411898	1001000
<b>OECD</b>	<b>4534436</b>	<b>6279946</b>	NEPAL	1307	3242
			PAKISTAN	19769	58267
			<b>South Asia</b>	<b>436727</b>	<b>1070787</b>

### Telephone Main Lines

	1975	1995		1975	1995
ALGERIA	128900	1176316	TOGO	4596	21715
BENIN	5313	28206	UGANDA	20100	43245
BOTSWANA	5000	59673	ZAIRE	26900	36000
BURKINA FASO	2400	30043	ZAMBIA	28400	76769
BURUNDI	2700	17169	ZIMBABWE	81672	154621
CAPE VERDE IS CENTRAL	1490	21513	<b>Africa</b>	<b>1830771</b>	<b>7082217</b>
AFR.R.	2336	7769	BARBADOS	27000	90132
CHAD	2400	5334	COSTA RICA	81000	557226
COMOROS	450	4510	DOMINICA	2180	17800
CONGO	5600	21410	EL SALVADOR	48100	284777
DJIBOUTI	1551	7556	GRENADA	3050	23200
ETHIOPIA	45250	142452	GUATEMALA	47583	289531
GAMBIA	1470	19202	HONDURAS	17003	160819
GHANA	31259	59978	JAMAICA	49700	291780
GUINEA	6448	10855	MEXICO	1644499	8801030
IVORY COAST	24022	115790	NICARAGUA	21947	96611
KENYA	53000	239639	PUERTO RICO	242900	1195921
LESOTHO	1917	17792	ST.LUCIA	3600	30576
MADAGASCAR	14643	32581	ST.VINCENT & GRE	3170	18236
MALAWI	8700	34338	TRINIDAD & TOBAGO	40800	209310
MALI	3567	17164	ARGENTINA	1651000	5531700
MAURITANIA	1329	9249	BRAZIL	1800000	12082563
MAURITIUS	15434	148185	CHILE	297000	1884762
MOZAMBIQUE	31100	59819	COLOMBIA	837600	3872847
NIGER	3400	13342	ECUADOR	165000	748167
REUNION	14900	218723	GUYANA	14200	44615
RWANDA	2300	15000	PARAGUAY	29977	166895
SENEGAL	14432	81988	PERU	239000	1109232
SEYCHELLES	1480	13527	SURINAME	10494	53158
SIERRA LEONE	7598	16627	URUGUAY	187000	621996
SOUTH AFRICA	1156000	3919085	VENEZUELA	501000	2463166
SUDAN	42300	75000	<b>LAC</b>	<b>7964803</b>	<b>40646050</b>
SWAZILAND	3358	19762			
TANZANIA	27056	90270			

	<b>1975</b>	<b>1995</b>		<b>1975</b>	<b>1995</b>
BANGLADESH	54000	286600	NETHERLANDS	3335500	8119999
BHUTAN	570	5243	NEW ZEALAND	987000	1719000
PAKISTAN	208000	2127000	NORWAY	913900	2431272
SRI LANKA	42500	204350	PORTUGAL	778000	3586002
INDIA	1465415	11977999	SPAIN	4697998	15095385
<b>South Asia</b>	<b>1770485</b>	<b>14601192</b>	SWEDEN	4209002	6012999
BAHRAIN	14000	140850	SWITZERLAND	2470000	4318496
EGYPT	345000	2716212	U.K.	13229992	29408730
IRAN	685000	5090363	U.S.A.	80515048	164624240
ISRAEL	597000	2342618	<b>OECD</b>	<b>180703559</b>	<b>401578885</b>
KUWAIT	89000	382287	FIJI	16174	64772
MOROCCO	110000	1158000	TONGA	590	6610
OMAN	3701	169939	VANUATU	1010	4215
QATAR	12300	122701	<b>Pacific Islands</b>	<b>17774</b>	<b>75597</b>
SAUDI ARABIA	138000	1719413	CHINA	1692001	40706032
SYRIA	128000	930000	HONG KONG	837023	3278287
TUNISIA	65000	521742	INDONESIA	207500	3290854
UNITED ARAB E.	25808	672330	KOREA, REP.	1058075	18600216
<b>MENA</b>	<b>2212809</b>	<b>15966455</b>	LAOS	5400	20410
AUSTRALIA	3538998	9199997	MALAYSIA	169000	3332447
AUSTRIA	1505000	3749087	MYANMAR	25400	146670
BELGIUM	1849960	4632093	PHILIPPINES	284000	1409639
CANADA	8277996	17457262	SINGAPORE	210390	1429000
DENMARK	1706660	3202525	TAIWAN, CHINA	774233	9174816
FINLAND	1353000	2809999	THAILAND	219000	3481996
FRANCE	7098997	32399992	<b>East Asia</b>	<b>5482022</b>	<b>84870367</b>
GREECE	1687001	5162774	HUNGARY	508000	1892892
ICELAND	75500	148675	POLAND	1386000	5728497
IRELAND	330000	1310000	ROMANIA	857000	2967957
ITALY	9659995	24854022	TURKEY	680585	13227696
JAPAN	32377012	61105824	<b>Eastern Europe</b>	<b>3431585</b>	<b>23817042</b>
LUXEMBOURG	107000	230512			

For each value reported in Table 1, the region's aggregate stock in 1995 is calculated as a multiple of the aggregate stock in 1975.