International Productivity Differences, Infrastructure, and Comparative Advantage

Stephen Yeaple and Stephen S. Golub

November 2002

Yeaple
Department of Economics
University of Pennsylvania
Email: snyeapl2@ssc.upenn.edu
Tel: (215) 898-1875

Golub
Department of Economics
Swarthmore College
Swarthmore PA 19081
Email: sgolub1@swarthmore.edu
Tel: (610) 328-8103

Abstract
Recent studies have documented international disparities in total factor productivity (TFP) at the sectoral level, notably Harrigan (1997, 1999). Contrary to the standard Heckscher-Ohlin international trade model, there appear to be pervasive differences in "technology" between countries. We extend the existing literature in several directions. First, we compute sectoral TFP for a wide group of countries, including a number of developing countries. Second, as suggested by Clarida and Findlay's (1992) theoretical model, we quantify the extent to which public infrastructure explains these productivity differences. Third, as in Harrigan (1997), we use our measures of productivity and infrastructure to explain patterns of international specialization. We find that public infrastructure helps to explain patterns of both absolute and comparative advantage. Moreover, we show that an understanding of the role of factor endowments in comparative advantage also appears to hinge on the role of infrastructure.

I. Introduction

"Before we can place much faith in the hypothesis of systematic technological differences [between countries], we will need a lot more work to determine the source of these differences. Is it infrastructure? Is it organizational forms? Or what?" (Leamer and Levinsohn, 1995, p. 1360).

There is a substantial body of evidence that "productivity" differs between countries at the industry level. A number of studies have documented large and persistent sectoral differences in labor productivity between countries (McKinsey 1993, Van Ark and Pilat 1993, Dollar and Wolff 1993 for example). Labor productivity can be a misleading indicator of technological differences, particularly in comparing developed and less developed countries, as it could merely reflect differences in capital-labor ratios. Consequently total factor productivity (TFP) is a preferable measure of technological differences. More recently, several studies have shown that there are also large international disparities in TFP (e. g., Trefler 1995, Bernard and Jones 1996, Hall and Jones 1999, Harrigan 1999, and Acemoglu and Zilibotti 2001). Only Acemoglu and Zilibotti (2001), however, consider sectoral differences in TFP and include both developed and developing countries in their sample.

As we document below, there are large international differences in TFP at the industry level. These productivity differences are inconsistent with the standard neoclassical Heckscher-Ohlin model international trade, which assumes identical technologies across countries.[1] These international differences in sectoral TFP suggest that comparative advantage has a Ricardian character, reflecting technological differences between countries.[2]

[1] Recently, however, some authors have integrated technological differences in factor-endowments-based models Trefler 1995, Davis and Weinstein 1998).
[2] See Golub and Hsieh (2000) for further discussion and empirical analysis of the Ricardian model of trade.

But what explains these large disparities in sectoral TFP? The existing literature does not respond fully to the question posed by Leamer and Levinsohn above. Acemoglu and Zilibotti (2001) have tackled this question with a model based on differences in endowments of skilled labor between developed (North) and less developed countries (South) and the interaction of these endowments with technological change. New technologies will tend to be developed in the North, for skill-intensive goods, giving rise to productivity differences that differ by skill-intensity of industries. While the Acemoglu and Zilibotti hypothesis is plausible and finds some support, their model implies the "strong" proposition that "TFP in the South should be higher than TFP in the North in the less skill-intensive industries and lower than in the North in the more skill-intensive industries." (p. 585) But their findings and ours clearly show that TFP is much higher in the North in *all* industries. Acemoglu and Zilibotti explain this discrepancy in part by acknowledging that there must therefore be other reasons for TFP differences between countries.[3]

In this paper we focus on the role of government infrastructure in affecting the level and sectoral dispersion of TFP--i.e., absolute and comparative advantage. Theory and casual observation both suggest the importance of infrastructure. In a series of papers, Ronald Findlay and his co-authors have emphasized the importance of infrastructure for productivity and trade (Findlay and Wilson 1987, Clarida and Findlay 1992, Findlay 1996).

Casual observation in developing countries suggests that poor infrastructure contributes to low productivity. Power outages, weak telecommunications systems, lack of adequate roads are impediments to investment in developing countries. Weak infrastructure lowers the return to capital, thus explaining the Lucas (1990) paradox that capital fails to flow to developing countries characterized by low capital-labor ratios. Also, "competitiveness" rankings, such as

[3] They do find support for their weak hypothesis that TFP is relatively higher in the North in high skilled compared to low-skilled industries.

those of the World Economic Forum (2000), give a prominent place to assessments of infrastructure.

Findlay's papers also make the more subtle point that provision of public goods could affect comparative advantage in addition to the overall level of productivity. If the high tech sector is more sensitive to infrastructure than the low-tech sector, the provision of infrastructure will promote a comparative advantage in high tech goods. The asymmetric effects of comparative advantage on productivity, then, could help explain the observed international disparities of TFP, and these in turn affect international specialization. These are the key hypotheses that we investigate in this paper.

An additional complicating factor emphasized in Findlay's various papers is the endogeneity of the provision of infrastructure. A country with a "natural" comparative advantage in infrastructure-intensive high tech goods will tend to invest more in infrastructure, because the social rate of return to doing so is relatively high. But this will further reinforce both the absolute and comparative advantage of this country in high tech goods, both directly, and by inducing capital inflows. Thus, infrastructure cannot be regarded as exogenous.

In our empirical analysis, we control for the endogeneity of infrastructure provision using insights provided by Findlay's simple theoretical framework. We find that after controlling for unobserved heterogeneity across countries and the potential endogeneity of infrastructure that there remains a statistically significant positive relationship between productivity and infrastructure. We also show that this effect varies across sectors in a manner that suggests that infrastructure could play a role in comparative advantage. Finally, we relate infrastructure directly to international industrial specialization and show that after controlling for country fixed effects, factor endowments, and observed TFP levels across countries that infrastructure appears to be an important determinant of comparative advantage.

That infrastructure cannot be considered to be endogenous is an idea that has appeared in a recent literature. For example, Holtz-Eakin (1994) argues that the higher productivity observed in U.S. states with large stocks of public capital is due to unobserved heterogeneity across these states. He shows this apparent relationship between productivity and state-level stocks of government capital disappears when controlling for heterogeneity and potential endogeneity. Fernald (1999) considers an empirical framework that explicitly controls for the infrastructure response of government to productivity shocks and which allowed for infrastructure's effect to vary across industries. As in our study, Fernald's focus was on industry variation in productivity over time, but unlike our study Fernald considered only the United States. More recently, Roller and Waverman (2001) consider a simple, partial-equilibrium structural model relating telecommunications and the growth of GDP across OECD countries. They find that the expansion of telecommunications infrastructure is associated with significantly more rapid income growth. Canning (2001) studies the effects on real GDP of several measures of infrastructure on real GDP. Note, however, that none of these papers address the question of how infrastructure might affect productivity levels across both industries and countries.

The remainder of the paper is organized into four sections. Section II draws on the theoretical framework inspired by Findlay and uses the insights of this model to propose two empirical strategies for estimating the role of infrastructure in absolute and comparative advantage. Section III describes and presents our sectoral TFP calculations for a group of developed and less developed countries. Section IV relates our measures of infrastucture to TFP by sector, after controlling for the endogeneity of infrastructure. Section V follows Harrigan

(1997) in studying the effects of TFP and factor endowments, augmented by our measures of infrastructure, on the pattern of international specialization.   Section VI concludes.

II. An Empirical Strategy

In this section, we begin by considering the logic of Clarida and Findlay's (1992) model of the government provision of infrastructure. This model makes the important point that if governments' objective in providing infrastructure gives positive weight to social welfare conditional on a country's resources and if infrastructure raises productivity in a manner that varies across sectors, then the level of infrastructure provided by a country is likely to reflect that country's absolute and comparative advantages. The model makes clear that the provision of infrastructure is likely to be correlated with both a country's factor endowments and the state of its technology.

This is an important point because it highlights the difficulty of identifying infrastructure's addition to productivity. Highly productive countries may be likely to provide more infrastucture. However, governments choose infrastructure conditional not only on the state of technology but also on factor endowment and on the government's relative efficiency at providing infrastructure. Hence, if some subset of a country's factor endowment and some measures of governmental efficiency can be plausibly argued to be exogenous to the level of technology, then it may be possible to identify infrastructure's impact. We use this feature of a model in the second part of this section to formulate an estimation strategy. In the final part of this section we propose an exercise that allows us to explore directly the role of infrastructure in comparative advantage. This exercise draws heavily on the work of Harrigan (1997). The difference in our analysis is that we add the effect of infrastructure in a manner also suggested by the Clarida/Findlay model.

A. Governments’ Choice of Infrastructure

Governments provide infrastructure to influence the well-being of its constituents. Citizens consume public goods directly and public goods are also an input into goods and services. Clarida and Findlay (1992) focus on the role of infrastructure as an input into production. The underlying premise of their work is that infrastructure raises the productivity of industrial activities in a Hick’s neutral fashion. They assume further that the productivity effect of infrastructure varies across industries. To make these concepts concrete, consider the following specification of the production of an industry j:

$$X_j = \Phi_j\left(I, \theta_j\right) f_j\left(V_j\right), \tag{1}$$

where X_j is the level of output, $\Phi_j(.)$ is the productivity shifter, I is infrastructure available in the economy, θ_j is a measure of technological capability, and $f_j(.)$ is a function of privately employed factors, V_j. Holding the allocation of factors fixed, an increase in the level of infrastructure available can raise productivity simultaneously in all sectors j, but the level of this effect may vary across sectors with variation in the function $\Phi_j(.)$.

In choosing I, governments have at least two objectives. First, they may wish to maximize social welfare by providing infrastructure to the point at which the marginal social benefit of an additional unit of infrastructure is equal to its marginal social cost. The marginal social benefit of providing infrastructure can easily be computed by summing the additional output created by adding infrastructure, which in symbols is

$$MSB = \sum_j p_j X_j \left(\frac{1}{\Phi_j} \frac{\partial \Phi_j}{\partial I} \right), \qquad (2)$$

where p_j is the price of good j. Note that the marginal social benefit of providing infrastructure varies across countries with the scale and composition of output. Countries producing a large quantity of output will benefit more from infrastructure. Countries that produce relatively more in industries with large infrastructure sensitivities (the term in brackets) will benefit more from infrastructure. The second factor that a government might include in its objective function for infrastructure provision is political patronage. Government's might favor particular industries in its provision of infrastructure. Clarida and Findlay do not model this second factor and doing so is beyond the scope of this paper.[4] However, to the extent that governments place a positive weight on aggregate social welfare, the scale and composition of industrial production can be expected to play an important role.

The scale and composition of industrial production can be related to country characteristics, such as factor endowments, V, and technological capabilities across industries, θ. Hence, the level of government infrastructure provision should be indirectly a function of these country features, as summarized by the following equation:

$$I_c = I(q_c, V_c)\,, \qquad (3)$$

where c indexes countries and θ and V are vectors by industry and factor, respectively.

[4] Note, Findlay in other papers (1995) considers the possibility that governments vary in their objectives between infrastructure and income redistribution. He points out that governments that other government objectives can raise the cost of infrastructure provision and so affect the level of infrastructure provided.

Equations (1)-(3) have some important implications for thinking about the determinants of observed productivity differences across countries. Observed TFP differences across countries, Φ_c, are directly related to differences in actual technological capabilities across countries, θ_c, and to the level of infrastructure, I_c, provided. The level of infrastructure provided will in turn depend on a country's endowments and its technological capability. Finally, note that to the extent that cross-industry productivity differences affect the composition of industrial production, infrastructure will affect the composition of output.

B. Estimating Infrastructure's Contribution to Productivity

As noted in the introduction we use two empirical strategies to investigate the role of infrastructure in absolute and comparative advantage. Our first strategy is to calculate TFP for a sample of countries and industries (described below) and relate TFP to infrastructure measures. Our goal is to estimate the effect of infrastructure on the level of TFP (absolute advantage) and the extent to which this impact varies across industries (comparative advantage). We use the model presented above to guide the formulation of an empirical specification.

The first step in putting our simple theoretical model into practice is to choose a functional form for the relationship between infrastructure and observed TFP. We choose

$$\Phi_{jct} = \theta_{jct} I_{ct}^{\beta_j} \exp(\varepsilon_{jc} + \varepsilon_{jct}) , \qquad (4)$$

where j is an industry index, c is a country index country, and t is an index of time. According to this expression, observed TFP is a function of "Ricardian" productivity levels across countries (θ), the level of infrastructure (I), a time-invariant country-industry-specific measurement error (e), and idiosyncratic measurement error (ε). In moving from theory to empirics, we have chosen explicit functional form for the relationship between productivity and infrastructure, and we have added a stochastic unobservable. In keeping with the model, we allow the importance of infrastructure to vary across industries as indicated by the industry subscript on infrastructure's coefficient.

Taking logs and differing across time, we can rewrite this expression as

$$\hat{\Phi}_{jct} = b_j \hat{I}_{ct} + \hat{q}_{jct} + \hat{e}_{jct}, \tag{5}$$

where a "hat" denotes a percent change in a variable over time. Note that differencing has eliminated any time invariant country-industry measurement error.

The presence of $\hat{q}$ in (5) is at the root of the difficulty in estimating the effect of infrastructure on productivity levels across countries. We do not observe true technology-related productivity differences across countries or across time. To operationalize (5), we need to make further assumptions over the behavior of this variable. We assume that the growth rate in total factor productivity in industry j and in country c at time t can be approximated by

$$\hat{q}_{jct} = v_{jt} + n_{jct}. \tag{6}$$

According to (6), the growth in TFP in any country-industry is a function of a global fixed effect, v, and a country-specific idiosyncratic component, ν. This assumption is consistent with innovations in technological progress that have both a global and a local component. Substituting (6) into (5) yields

$$\hat{\Phi}_{jct} = b_j \hat{I}_{ct} + v_{jt} + n_{jct} + \hat{e}_{jct} \, . \tag{7}$$

Our ability to estimate the coefficient of interest, β_j, depends upon the relationship between the growth rate of infrastructure, $\hat{I}$, and the unobservables, n and $\hat{e}$, which are assumed to be innovations in a country's technology and in the quality of TFP measurement, respectively. There are strong reasons to suspect that the growth rate of infrastructure is unlikely to be orthogonal to either. A chief concern is that countries condition their choice of infrastructure on the level and the distribution of productivity across industries. If so, then it is highly likely that a countries provide more infrastructure as they become more productive. Another concern that arises is that a component of the change in TFP might be innovations in the quality of factors used in a country over time that are not captured in the calculation of observed TFP.[5] Finally, measures of TFP typically are pro-cyclical in part due to varying capacity utilization over the business cycle. Government provision of infrastructure might be correlated with the business cycle particularly in developing countries if the governments' budget constraints are affected.

We address these potential concerns in two ways. Our first method for reducing the impact of omitted variable bias is to proxy for innovations in the growth of technological ability, factor quality, and capacity utilization at the industry-country level with the growth rate and level of aggregate country TFP and the growth rate and level of skilled labor in total labor. This is strategy is closely related to that followed by Fernald (1999) who included a measure of aggregate productivity to control for endogenous government provision of infrastructure. By

[5] A further concern is that infrastructure is likely to be measured in the data with error, which could create an additional avenue through which infrastructure could be correlated with the residual.

including the level and growth rate of aggregate TFP we hope to alleviate concerns that our results reflect reverse causality or that rapidly growing countries choose to rapidly expand their infrastructure stock. By including the level and growth rate of skill in the population, we hope to control for any changes in observed TFP due to improving labor quality. Our estimating equation is thus

$$\hat{\Phi}_{jct} = b_j \hat{I}_{ct} + a_{1j}\hat{Y}_{ct} + a_{2j}Y_{ct-1} + a_{3j}\hat{H}_{ct} + a_{4j}H_{ct-1} + v_{jt} + e_{jct}, \tag{8}$$

where Y is the log of the level of aggregate TFP, H is the share of highly educated workers in the labor force, and all variables with a hat are percent growth rates. As a tradeoff between the benefit of longer differences in reducing the negative consequences of error-in-variables and the relatively short panel (18 years) we will use 3-year differences in estimating (8), which for most countries yields 6 observations.[6]

Our second strategy is to instrument for the growth rate in infrastructure using lagged factor endowments, being careful to include only those factor endowments that can plausibly be thought of as immobile across countries and are thus unable to move in response to productivity differences across countries.[7] Since the actual relationship between factor endowments and infrastructure provision can be highly nonlinear, we relate the growth in infrastructure in country c at time t to a translog function of lagged endowments, or

$$\hat{I}_{ct} = \sum_m \sum_l l_{ml} \ln V_{mct-k} \ln V_{lct-k} + h_{ct}. \tag{9}$$

[6] There are several countries that are missing data at either the beginning or end of the sample. Every country has at least three observations.
[7] These factor endowments include four labor categories defined by educational obtainment and arable land. We exclude physical capital because it is the least apt to be considered exogenous in a growing and open economy.

We use endowments lagged 6 and 9 years as our instruments in (9).[8] We also tried other variables notably, measures of "social" infrastructure as suggested by Hall and Jones (1999) but this had little effect on the results. We are also constrained by insufficient time series variation in the data on social infrastructure.

The final econometric issue that we will address is the possibility our panel data will exhibit both heteroskedascity and autocorrelation. To cope with potential heteroskedascity, we allow for the residuals to have different standard deviations across countries. To cope with autocorrelation induced by time differencing, we estimate an AR1 process.

C. Industrial Specialization and Infrastructure

The second part of our analysis is to relate infrastructure to a country's comparative advantage. Our estimating strategy here is to rely heavily on the methodology applied in Harrigan (1997). In that paper, Harrigan shows that a revenue function of the form given in equation (1) can be reasonably approximately by a translog function. Using the theoretical result that the first derivative of the revenue function with respect to prices are net outputs, Harrigan derived the following equation relating industry output shares to measures of prices, Hicks neutral productivity levels, and factor endowments:

$$S_j = a_{oj} + \sum_{z=1}^{J} a_{zj} \ln p_{zj} + \sum_{z=1}^{J} a_{zj} \ln f_{zj} + \sum_{m=1}^{M} c_{mj} \ln V_m , \qquad (10)$$

[8] By using only lagged endowments, we reduce the possibility that we our picking up evolutions in factor quality over our 3-year periods.

where S_j is the share of output in industry j in GDP, p are prices, ϕ are productivity levels, and V are factor endowments. Harrigan uses a variant of (10) to estimate the effect of productivity and factor endowments on the structure of output across a set of ten OECD countries over a period of twenty years. His adjustments to (10) take the form of adding country and industry fixed effects in lieu of prices, which are unobserved.

Our only adjustment to Harrigan's approach is to allow infrastructure to play a role in the structure of output. Using our decomposition of productivity levels into "Ricardian" and infrastructure-related components, we obtain the following analog to Harrigan's estimating equation:

$$S_{jt}^{k} = h_{jc} + d_{jt} + \left(\sum_{z=1}^{J} a_{zj} b_{z}\right) \ln I_{t}^{k} + \sum_{z=1}^{J} a_{zj} \ln q_{zt}^{k} + \sum_{m=1}^{M} c_{mj} \ln V_{mt}^{k} + e_{jkt}, \qquad (11)$$

where η and δ are country and time fixed effects. Notice how infrastructure enters (11). The coefficients, a_{zj} represent general equilibrium effects that relate prices and productivity in industry z to output in industry j. The coefficients, β_z, relate infrastructure to productivity levels in industry z. The effect of infrastructure is then a function of how it changes productivity in each sector and how productivity in each sector affects output in sector j. Note that while our first empirical exercise is designed to obtain estimates of the contribution of infrastructure to industry level productivity β_j, our second method cannot identify β_j independently of the general equilibrium parameters, a_{zj}. Nevertheless, estimation of (11) can shed light on the net impact of infrastructure on industrial specialization.

One possible outcome from estimating (11) is that one might find that infrastructure plays no role in comparative advantage. Indeed, were infrastructure provided by governments that conditioned their level of provision only on V and θ then we might reasonably expect that it would play no role in determining international specialization in a specification that properly controls for factor endowments and technological capabilities. As Findlay (1995) points out, however, governments differ in their ability to raise funds to finance infrastructure development as well as in their priorities. To the extent that these country characteristics are not systematically related to country endowments and productivity levels, infrastructure can be expected to play its own role. The magnitude of this role is, of course, an empirical matter.

Before we can estimate (11) we must address the problem, encountered in the previous section, that we do not have measures of "Ricardian" technology differences, θ, across industries and countries. Estimating (11) without measures of technological abilities is likely to create an omitted variable problem in which the coefficients on infrastructure contain some component more appropriately attributed to pure technological differences across countries. While we do not have measures of actual technological abilities, we do have our measures Φ that should be highly correlated with θ. We use our observed TFP measures to proxy for actual technological differences across countries.

In estimating (11), we diverge slightly from Harrigan (1997). Harrigan imposes two sets of restrictions on the coefficient estimates. The first is the restriction that the coefficients c_{mj} should sum to zero. The motivation for this restriction is the fact that the revenue function is homogenous of degree zero in factor endowments so that a proportional increase in all endowments should have no impact on industry shares in output. The second restriction imposed by Harrigan is that the coefficients $a_{zj} = a_{jz}$ (the relative price effect) should be symmetric across industries. In our analyses that follow, we choose not to impose either restriction. There are several motives for this deviation.[9] First, like Harrigan, the number of factors in our dataset is clearly less than the number of goods. Homogeneity restrictions only make sense if all factors are included and theory requires that the number of factors be at least as large as the number of goods. Second, like Harrigan, we find that the data reject the hypothesis that the symmetry conditions hold. Since our primary goal is not to "estimate" the neoclassical model but is instead to estimate the impact of infrastructure, we choose not to take a purist view of these restrictions. Finally, we choose not to restrict the coefficients because we wish to observe the difference between the "long" regression in which Infrastructure is directly included in the specification and the "short" regression in which factor endowments and TFP measures, "pick up" the impact of infrastructure. Finally, we do follow Harrigan in instrumenting all TFP variables with the average level in the remaining countries in the sample in order to cope with problems of mismeasurement.

III. Data and Measurement

In this section, we describe the data sources that form the basis of our analyses. These data fall into two general categories, measures of output and total factor productivity, and measures of factor endowments and infrastructure.

A. Total Factor Productivity Comparisons

As in Harrigan (1999) we calculate international differences of sectoral TFP for manufacturing subsectors. We go beyond Harrigan, however, by examining a larger group of countries and sectors. Harrigan limited his analysis to 8 developed countries and to sub-sectors

[9] We have experimented with different specifications imposing these restrictions in different mixtures. We found that the magnitudes of the coefficient estimates vary moderately across specifications but the qualitative results are robust.

of machinery and equipment, based on data from the OECD STAN database. We use instead the United Nations Industrial Development Organization (UNIDO) INSTAT database, which covers a much larger group of countries, and provides data for value added, employment, and capital formation by three digit manufacturing ISIC category. We are able to calculate TFP for 19 countries listed in Table 1A over the period 1979-1997 for ten industries between the two and three digit level ISIC categories. These countries were selected according to data availability and geographic and economic diversity. The industry classifications are shown in Appendix One and the UNIDO database is described in more detail in Appendix Two. In calculating aggregate TFP, we used the same method described below, but different data sources. Aggregate real output and employment were taken from the World Bank's Development Indicators, while aggregate capital stock data were taken from the Penn World Tables and updated using real gross fixed investment, also from the World Bank's Development Indicators.

Following much of the literature on productivity comparisons, we use the TFP index proposed by Caves et al (1982), which is defined as

$$\ln \Phi_{jct} = \left(\ln X_{jct} - \overline{\ln X_{jt}}\right) - s_{jct}\left(\ln L_{jct} - \overline{\ln L_{jt}}\right) - \left(1 - s_{jct}\right)\left(\ln K_{jct} - \overline{\ln K_{jt}}\right) \qquad (12)$$

where c indexes countries, j indexes industry, and t indexes time. The variables X are value-added, L is total hours of labor, and K is capital stock. In each of the parentheses, there are individual country variables relative to the mean value of this variable across countries in the sample. Finally, $s_{jct} = \left(s_{jct} + \overline{s_{jt}}\right)/2$ is an average of the labor cost share as measured in country c and the cross-country average. This index is popular within the literature because it is superlative in the sense that it is exact for a translog functional form, and it is transitive so that the choice of the base country is unimportant. Our choice of base country is the geometric average of the countries in the sample.

In calculating (12), we adjust each country's number of workers by industry and year as reported in UNIDO by the average number of hours per worker by country and year for total manufacturing as reported by the International Labor Organization. Our industry-country-year capital stock data are constructed via perpetual inventory method using real dollar gross fixed capital formation as reported by UNIDO. The resulting data is then adjusted for year-to-year variations in capacity utilization. Finally, labor cost share data were computed as the ratio of payments to labor in total value-added. Following Harrigan (1997, 1999), we smooth the relatively volatile labor cost coefficients using the fitted values from the following regression:

$$s_{jct} = h_{cj} + p_{j} \ln\left(\frac{K_{jct}}{L_{jct}}\right) + e_{jct}\,. \qquad (13)$$

Additional information concerning the construction of the TFP measures can be found in the appendix.

C. Data Summary

We begin by considering the level of TFP by country and industry for the year 1989, which is close to the mid-point of our 1979-1997 sample, in Table 1A. For the most part, the overall levels of calculated TFP accord well with intuition. India's TFP is of the order of 10 percent of the U.S. level, and the other developing countries in Table 1A such are generally at 10-40% of the U.S. level. Japan's TFP is the closest to the United States and even exceeds the latter in two sectors, while Canada's TFP approaches the level of the United States in a number of sectors. Note that the levels of TFP vary considerably within countries as well. For instance, Singapore's TFP is very low in Food Processing and Textiles but relatively high in Electronics and Machinery while TFP in the UK is relatively low in Chemicals and high in Machinery.

While the data as a whole accord well with intuition, there are a number of countries where the levels appear to implausible. For instance, Austrian TFP appears to be lower than one might expect while Chilean TFP appears unreasonably high in many industries. Such outliers might well be explained by systematic differences in country accounting techniques, and it is exactly this concern that prompts our focus on the time series, or within, variance by country. To the extent that these measurement issues are country specific and time invariant, time differencing will remove this source of mismeasurement.

Table 1B show the average annual growth rates of TFP relative to the United States over our sample period. It is this variance that will be key to our econometric analyses below. A perhaps surprising feature of the data is that many the TFP growth rates of many countries fall well below those in the United States. There are, however, many countries whose productivity performance has been consistently better than the United States, including the rapidly growing Asian countries of Korea, Indonesia, and Hong Kong. In Europe, Finland and Turkey have also shown relatively strong productivity growth over the sample period. The real laggards in the sample are several of the most developed, including Canada, the Netherlands, and the UK, plus several of the least developed, including India, Singapore, and Chile.

We now consider the distribution and growth rates of endowments and infrastructure measures. We begin by considering the levels of infrastructure and endowments in 1989 as shown in Table 2A, shown relative to the United States levels. The infrastructure structure measures confirm intuition that the wealthier countries have the largest relative stock of infrastructure with the least developed countries, such as India, Indonesia, Chile and Colombia having a fraction of the infrastructure in the developed world.

Given that our estimation strategy will focus on differences across time, we show the average annual growth rates of infrastructure and endowments in Table 2B. These data reveal that it is indeed the least developed countries that increased the size of their infrastructure stock most substantially over the sample period. In particular, Indonesia, one of the countries with the most rapid productivity growth, led all other countries in expanding telecommunications and electrical generating capacity. Korea and Turkey, two other countries enjoying rapid productivity growth, also accumulated infrastructure at a particularly rapid pace. Infrastructure growth apparently did not guarantee productivity growth, however, with India being a particularly stark example. Further, Finland, which enjoyed rapid productivity growth in the sample period did not accumulate infrastructure at a particularly rapid pace.

To get a sense of the connection between a country's provision of infrastructure and its characteristics, we regressed our three infrastructure measures on five factor endowment measures, aggregate TFP and a set of time and country dummies. These results are shown in Table 3.[10] Several interesting patterns emerge. First, all three measures of infrastructure are increasing in aggregate TFP, in the stock of physical capital, and in the availability of arable land. There is a strong correlation between TFP and infrastructure, but the causality cannot be established. Second, there appear to be large differences in the way infrastructure provision responds to changes in size and composition of the labor force. Roads are negatively associated with low and moderately skilled workers while Telecoms and Power are positively correlated with these labor categories. The signs on the High Skill variable also differ across infrastructure

[10] This set of regressors differs from our set of instruments used in the analysis below where we consider a translog function, which excludes capital and aggregate TFP, and we use several lags. The results here are intended to show that infrastructure provision is related to country characteristics.

measures. An increase in skilled workers is associated with an increase in the stock of roads but appears to have no impact on the provision of telecommunications or electrical capacity. In summary, infrastructure is correlated with factor endowments and TFP, but the nature of the relationship between infrastructure provision and labor force composition differs across infrastructure types.

IV. Results

In this section we present the results to the two separate exercises outlined in Sections II.B and II.C above. We begin with our efforts to estimate the relationship between the growth of infrastructure by country and the concurrent growth in total factor productivity. We will show that indeed a strong relationship exists and that this relationship varies considerably across industries. We then relate changes in the level of infrastructure by country and the evolution of industrial structure. We again find evidence that infrastructure is associated with industrial specialization in a manner that is highly suggestive of an effect of infrastructure on comparative advantage.

A. Observed TFP as a Function of Infrastructure

Here, we present our estimates of the role of infrastructure on observed productivity differences across countries, industries, and time as specified in equation (8). Our core results are presented in Table 4 where we report two sets of coefficient estimates for each industry. Each row corresponds to a different specification. The first set correspond to a specification in which no effort has been made to account for the endogeneity of infrastructure, while the second set corresponds to the specification in which controls have been included and infrastructure has been instrumented with lagged factor endowments.[11] The second column indicates the type of specification. The next seven columns report the parameter estimates and their T-statistics, and the final column reports the Chi-squared statistic and its P-value for a Wald Test on the three infrastructure variables. The coefficients on year dummies have been suppressed to improve clarity of exposition.

We begin by highlighting general features of the results across specifications. The first observation is that the coefficients on infrastructure are generally positive with none of the coefficients being both negative and statistically significant. Second, the Chi-Squared statistic indicates that the infrastructure variables are always jointly statistically significant. Growth in a country's stock of infrastructure is associated with at least some component of the differences in observed productivity growth across countries and time. Third, the coefficient on the aggregate growth rate of TFP is positive and statistically significant in seven of the ten industries and is negative and statistically significant in none. These results suggest that our controls are apt to be picking up improving technological capabilities across industries as intended. Fourth, none of the coefficients on lagged aggregate TFP are statistically significant, suggesting that technological "catch-up" does not appear to play an important role in our dataset. Fifth, the coefficients on the change in human capital are generally not statistically significant, but, when they are, they tend to negative rather than positive. This result suggests that the growth rate of industry TFP is not easily explained by improving labor quality after controlling for movements in aggregate TFP. Finally, the coefficients on lagged human capital are generally not statistically significant, but when they are, they tend to be positive. We interpret this result as suggesting that

[11] We do not report the first stage regressions of infrastructure on lagged endowments. These endowments include all of those shown in Table 2 with the exception of capital, which we believe might reasonably be thought of as internationally mobile and hence endogenous. The fit of these regressions was quite good with R-squares that exceed 0.5 in each.

there is a moderate tendency for high human capital countries to improve their technological capacity over time.

We now turn to the individual coefficients on the infrastructure variables. There is a remarkable degree of consistency between the coefficients estimated in the "naïve" specification and the specification that seeks to control for simultaneity. Beginning with Roads, we see that in the "naïve" specification, the coeffi cient on Roads is positive and statistically significant in seven of the ten manufacturing industries with only Chemicals, Electronics, and Instruments apparently insensitive to the availability of a developed road network. Adjusting for simultaneity by adding controls and instrumenting has the effect of making Food and Paper no longer statistically significant. Turning to Telecoms, only Metal and Electronics fail to achieve positive and statistically significant coefficients in the "naïve" specification, while in the IV/controls specification, Paper, Machinery, Transport Equipment and Instruments also appear to be insensitive to the availability of a developed telecommunications network. Hence, in Roads and Telecoms, taking simultaneity into account has the anticipated effect of reducing the apparent importance of infrastructure. Turning to Power, we find that only two industries, Electronics and Instruments, obtained a positive and statistically significant coefficient in the "naïve" specification. In the IV specification, we find again that only in these two industries are the coefficients on Power both positive and statistically significant, although both obtain slightly larger coefficients in the IV specification. We conclude that electrical generating capacity plays a strong role in only these two industries, but that this effect does not appear sensitive to the possible simultaneity of infrastructure. In summary, a "naïve" approach to estimating the impact of infrastructure on observed TFP appears to overstate moderately the impact of infrastructure, but the extent and direction of bias varies in magnitude and direction across industries.

We now wish to gauge the importance of infrastructure in explaining TFP. In the interest of exposition, we focus now on the coefficients obtained from the instrumented specification, which we have strong reasons to prefer over the least squares estimates. To do this we compute the Beta coefficients for the instrumented specification by multiplying each coefficient by the sample standard deviation of the infrastructure variable and divide by the standard deviation of observed TFP. These coefficients are shown in Table 5. Those figures printed in boldface are those that are statistically significant at the 10% level in the instrumented infrastructure specification. The last column in Table 5 are the “beta” coefficients obtained from a third specification in which our measure of infrastructure is the first principle component of roads, telecoms, and power. In this specification, the same set of controls and instruments are used. This information allows us to compare the relative “infrastructure sensitivity” across industries.

Table 5 reveals that there are stark differences in the effect of infrastructure provision on TFP across industries. Different types of infrastructure appear to matter for different types of industries. Roads appear to be relatively most important for Transportation Equipment, Machinery, and Fabricated Metals; Telecommunications infrastructure appears to matter most for Textiles, Wood, Chemicals, and Food, while electrical generating capacity (Power) appears to matter most for Electronics and Instruments. Note that while the results presented in the first three columns are particularly stark, the high correlation among infrastructure types, particularly telecoms and power, suggest care in assessing the extent to which “infrastructure-intensity” varies across industries.

Turning to the final column of Table 5, we see that there are considerable differences across industries in the relative importance of overall infrastructure provision as measured by the first principle component of our three infrastructure measures. Infrastructure matters most in

Electronics, Transport Equipment, Textiles, Instruments, and Fabricated Metals, and least in Food, Wood, Paper and Chemicals. These results are consistent with the logic of the Findlay model: industries vary with respect to their infrastructure intensity so that in providing infrastructure, governments influence the comparative advantage of their countries. They are also consistent with an important role for the provision of infrastructure in determining absolute advantage. In all industries, an increase in the bundle of infrastructure available raises productivity substantially.

Our final exercise of our exercise of relating TFP levels across countries to infrastructure is to assess the predictive ability of the model. We do this in two ways. First, we compare the actual level of TFP across countries by industry in 1989 to the predicted level of TFP using only the infrastructure measures and their estimated coefficients. Second, we compare the actual level of TFP across industries within each country in 1989 to the predicted level of TFP, again using only the infrastructure measures and their estimated coefficients. Both of these comparisons push hard the predictive ability of the model in that the coefficient estimates were obtained in time differenced specifications, removing any country effect from both TFP levels and infrastructure. The within-country, cross-industry comparisons are even more exacting in that the estimated coefficients for each industry were obtained by running each industry separately. These results are shown in Table 6.

On the left-hand side of Table 6 are the correlations by industry between actual and predicted relative TFP levels across countries. These correlations range from a high of 0.90 in Textiles and 0.71 in Transport Equipment with the average correlation at about 0.83. We conclude that the model does a good job of predicting the level of TFP across countries, which suggests that infrastructure alone can explain a substantial portion of absolute advantage across countries.

Turning to the right-hand side of Table 6, we see the correlations across actual and predicted relative TFP levels across industries by country. The largest correlation, 0.65, occurs for Austria, and the average correlation is about 0.26. Of the 19 countries, 16 have nonnegative correlations, while 3 are negative with Singapore particularly so. Note that for the cross-industry correlation to be positive, a country with above average infrastructure stocks must be relatively more productive than average in infrastructure intensive industries while the opposite must be so for a country with below average infrastructure stocks. This pattern is apparent for the majority of the countries in the sample. Note that two of the countries with negative correlations, Hong Kong and Singapore, are fairly unique within our sample being small island nation states. One possible explanation for their relatively poor performance of infrastructure in these countries is that our measure Roads might be a particularly poor measure of transport infrastructure in this setting.[12] The other country for which the correlation is negative is India, which could well stem from the particularly poor quality of this data. We conclude that the infrastructure does a reasonably good job predicting the pattern of TFP across industries within a country, particularly given the fact that each industry was run in time differences and no restrictions were made across industries. To the extent that TFP differences across industries and countries are associated with comparative advantage, these results provide indirect evidence that infrastructure provision may alter a country's comparative advantage.

[12] Note that in each industry specification, the country-industry fixed effect has been time differenced out. For HK and Singapore, this country-industry fixed effect appears to dominate.

B. Infrastructure and International Industrial Specialization

Until now, we have explored the role of infrastructure in comparative advantage by accessing the degree to which infrastructure affects relative TFP differently across sectors. Since relative productivities can act as a source of comparative advantage, our approach has had an indirect flavor. In this section, we directly access the degree to which infrastructure stocks across countries influence a country's degree of specialization in production. To do this, we estimate (11), which relates output shares across industries, countries, and time to factor endowments, relative TFP, and infrastructure.

We report two sets of results. In the first, we report the results of estimating the full equation, including infrastructure. We find that a country's level of infrastructure is associated with its industrial specialization even after controlling for both observed TFP levels and factor endowments. In the second, we compare the coefficients obtained with and without infrastructure and show that the coefficients on factor endowments change when infrastructure measures are included in the system. This latter result suggests that measures of infrastructure may be an important omitted variable in empirical neoclassical models of comparative advantage.

The results of estimating (11) are shown in Table 7.[13] The dependent variable is the share of the respective industry's output in total GDP. As in Harrigan (1997), all of the results are obtained using only the within country variance in output shares, factor endowments, TFP, and infrastructure. Note that for purpose of comparison, we include results for agricultural and services. Since we do not have TFP data for these sectors, the results are not strictly comparable.

[13] Note that like Harrigan, we obtain extremely high R-squared (not shown) that vary between 0.95 and 0.99. There were a total of 308 observations. Time and country dummy coefficients have been suppressed for expositional clarity.

Nevertheless, by reporting these results we will be able to better interpret the coefficients obtained for our ten manufacturing industries.

The infrastructure variables are shown in the first three rows of Table 7. We first note that in every manufacturing industry at least one of the infrastructure variables is statistically significant and of the thirty coefficients estimated all but eight are statistically significant. For instance, the increased provision of Roads is associated with a statistically significant increase in all manufacturing industry output shares except Food, Wood and Paper. An increase in the penetration of telephones is associated with an increase in the output share of all industries with the exception of Food, Paper and Machinery with the latter associated with a decrease in output. Finally, an increase in a country's electrical generating capacity is associated with an increase in the output of Food and Paper and a decrease in the output shares most of the other manufacturing sectors.

The overall impression created by these results is that manufacturing industries are on average road and telecommunications intensive relative to nonmanufacturing while manufacturing is relatively less intensive in the use of electrical generating capacity. Turning to the final two columns of Table 7, we see that this interpretation is broadly consistent with this hypothesis. For agriculture and services, an increase in either roads or telecoms is associated with a reduction in the size of these sectors while electrical capacity appears to have no strong impact on either.

Note also that the strong statistical significance across industries suggests that infrastructure provision by governments is not entirely a passive mapping of factor endowments and technological capabilities into infrastructure. Governments do "choose" infrastructure conditional on information not contained in our other regressors and this choice of infrastructure is never innocuous in its effects across industries.[14]

The results reported in Table 8 are also interesting in their similarities to the results reported in Harrigan (1997). An important similarity is that observed TFP appears to play a significant role in the pattern of industrial specialization. With the exception the own-TFP coefficient for Wood, which is not statistically significant, an increase in own sector relative TFP is generally associated with an increase in that sector's relative importance in GDP. Note also that our results concerning TFP are also consistent with those of Harrigan (1997) in that the many of the off diagonal coefficients are negative, which indicates that high relative TFP in one industry tends to lead to a movement of factors out of other industries. This result is important confirmation of Harrigan's findings because our sample covers a much wider set of countries as well as larger set of industries.

To gauge the magnitude of our coefficients and the importance of including measures of infrastructure as a determinant of industrial specialization, we now report the Beta coefficients obtained by estimating (11) both with and without measures of infrastructure. These coefficients are shown in Table 8 where W in each row indicates the specification with infrastructure measures and WO indicates the specification without these measures. Coefficients that are statistically significant at the 10 percent level are presented in bold.

We begin by discussing the magnitudes of the Beta coefficients on the Infrastructure variables shown in the first three rows of Table 8. The coefficients are generally very large in absolute value, frequently exceeding one by a substantial margin. For instance, a one standard deviation increase in a country's quantity of roads leads to a 2.12 standard deviation increase in a

[14] These results also strongly suggest that infrastructure provision should directly affect relative factor prices. By providing infrastructure, governments might inadvertently change the distribution of income across factors.

country's output share of Fabricated Metals and an increase in Power is associated with a 0.6 standard deviation decrease in a country's output share of Fabricated Metals. Similarly, a one standard deviation increase in Electrical Power generating capacity is associated with very large decreases in a country's output share of Textiles, Chemicals, and Instruments. We conclude from the magnitude of these coefficients that the role of infrastructure provision in determining a country's comparative advantage appears to be of first order importance.

We now turn our attention to the Beta coefficients on the five factor endowments. We initially focus our attention on the specifications that include the three infrastructure measures, or those rows that begin with W. Several interesting patterns emerge from Table 8. First, consider the coefficients on the labor endowments by skill category. The coefficients on Unskilled and Moderately Skilled labor are positive and statistically significant for many of the manufacturing sectors, such as Textiles, Chemicals, Metals, Machinery, Instruments, and to a lesser extent Wood Products. The coefficients on High Skilled Labor are negative and statistically significant for many of the manufacturing sectors for these same industries. These results suggest that with the exception of Food Processing, Paper, and Transport Equipment, manufacturing appears to be disproportionately attracted to low and moderately skill abundant countries. Note that this coefficient pattern is reversed in the Services sector, where an increase in unskilled labor is associated with a decrease in its share while the opposite is true of an increase in highly skilled labor. Second, an increase in a country's capital stock tends to be associated with a decrease in most manufacturing sectors with the exception of machinery, and an increase in the size of the service and agricultural sectors.

We now consider the impact of including infrastructure by comparing the coefficients in the W and WO rows. Again, an interesting pattern emerges. Including infrastructure appears to have the effect of strengthening the relationship between factor endowments and industrial specification in a large number of sectors. For instance, with the exception of the Food and Paper sectors, all of the coefficients on Unskilled labor in the ten manufacturing sectors rise when the three infrastructure measures are included while the coefficient on Services becomes even more negative. This pattern occurs again in the coefficients on high skilled labor and physical capital. With the exception of Food and Paper, all the coefficients on high skilled labor in the manufacturing industries become smaller with the inclusion of infrastructure, while the coefficient on services becomes larger.

These results are interesting for several reasons. First, the dramatic differences in the coefficients between the "short" specifications, which exclude infrastructure, and "long" specifications, which include infrastructure, reinforce the earlier observation that countries choose infrastructure conditional on their factor endowments. In the "short" specifications, the factor endowment coefficients reflect both the direct impact of changes in endowments on industrial specialization and the indirect effect of these changes through their effect on changes in government provision of infrastructure. Second, by comparing the coefficients from the "short" and "long" specifications, we find that the "indirect" effect of infrastructure appears to run in the opposite direction of the direct effect.

This second observation cries out for explanation. An interesting possibility is that as countries accumulate capital and skill, they have a larger volume of output and so choose to provide a greater volume of infrastructure (the scale effect). Adding more infrastructure favors manufacturing industries. So while the accumulation of skilled workers and physical capital might have the direct effect of expanding the relative size of the service sector and decreasing the relative size of the manufacturing sector, the indirect effect is to boost the relative productivity of manufacturing industries brought about by the increased availability of infrastructure. This indirect effect tends to offset the direct effect. Unfortunately, TFP data for agriculture and services are not available, preventing a direct test of this hypothesis. Nevertheless, the results clearly show that (1) infrastructure has important consequences for industrial specialization, and (2) controlling for infrastructure appears to lead to a clearer picture of the role of factor endowments.

V. Conclusion

In this paper we have pursued two complementary empirical strategies to investigate the role of infrastructure in comparative advantage. Our hypotheses were that infrastructure raises productivity and does so in a manner that varies across industries. Our first approach focused on the relationship between infrastructure and productivity across both countries and industries. This approach strongly suggests that infrastructure affects both absolute and comparative advantage, i.e., the international pattern of aggregate and sectoral TFP. Our second approach related infrastructure directly to the pattern of international industrial specialization in manufacturing. The results of our investigation suggested that infrastructure affects the composition of output. Moreover, including infrastructure measures appeared to be important in understanding the role of factor endowments more generally. In particular, the effect of infrastructure is to dampen the effect of factor endowments.

Given the strong results obtained in our study, we believe that the link between provision of infrastructure and observed TFP differences across countries is deserving of greater attention. The causes and consequences of productivity differences across countries are at the center of controversies in international and development economics. Indeed the size, pervasiveness, and persistence of these productivity differences are one of the most striking features of the contemporary world economy. The sources of these differences have large implications for the manner in which economists perceive the workings of the international economy, as suggested by the opening quote from Leamer and Levinsohn (1995). The results of our study suggest that a large component of these productivity differences across country are due to infrastructure.

Appendix One: Industry Definitions

Industry Name	ISIC Industries Included
Food	311, 313
Textiles	321,322,323,324
Wood	331,332
Paper	341,342
Chemicals	351, 352, 355,356
Metals	381
Machinery	382
Electronics	383
Transport Eqp.	384
Instruments	385

Appendix Two: Data For Calculating TFP

Real Value Added. Our primary source of data is the United Nations Industrial Development Organization (UNIDO) Industrial Statistics Database (INSTAT) at the 3-digit SIC level. This database contains information on production, value added, labor compensation and employment for a large group of countries. The advantage of this database is the comprehensive country coverage. The main deficiencies of the data are that UNIDO does relatively little to ensure international consistency and there are gaps in the data. Also, the UNIDO data is based on census rather than national accounts concepts of value added and labor compensation, which tend to overstate value added and understate labor's share. To fill the missing data and to provide a consistency check we also made extensive use of the OECD's Structural Analysis Industrial Database (STAN). The OECD strives for greater consistency and completeness than UNIDO but only covers OECD countries, which now includes Korea and Mexico. Due to our goal of including countries with very wide divergences in productivity, we chose to work with UNIDO. Where there was overlap between the two data sets, however, we used STAN in some cases to adjust the levels of the results obtained with the UNIDO data.

We used the aggregate manufacturing value added deflator to deflate each industry. These manufacturing value added deflators were calculated from nominal and real manufacturing value added obtained from the World Development Indicators (WDI). It is possible to obtain sector-specific output deflators from the UNIDO database by dividing nominal output by an index of industrial production, but the resulting deflators proved to be very erratic and we chose to use the aggregate manufacturing deflators instead.

PPP exchange rate. To compare levels of real outputs they must be converted to a common currency. Productivity is calculated as manufacturing value added per employee, deflated by the manufacturing value-added deflator and converted to $U.S. at an equilibrium or purchasing power parity exchange (PPP) rate. In principle, it would be desirable to have PPPs at a disaggregated level, as in Golub and Hsieh (2000). Unfortunately, there are no available estimates of absolute PPP exchange rates for manufacturing for a number of countries. As an alternative, we used the average real exchange rate over the sample period, using manufacturing value added deflators, as a rough indicator of the equilibrium real exchange rate. More precisely, we calculated the PPP exchange rate as $PPP_t = \left(e_0^* \frac{P_0^\$}{P_0^d} \right) \frac{P_t^d}{P_t^\$}$ where $\left(e_0^* \frac{P_0^\$}{P_0^d} \right)$ is the equilibrium real exchange rate and P_t^d and $P_t^\$$ are domestic and U.S. manufacturing value added deflators at time *t*. The equilibrium real exchange rate is proxied by the average real exchange rate over the sample period. Given the imperfect nature of this PPP calculation, as well as international differences in data construction for value added, level comparisons must be made with great caution and this is one of the reasons that we focus on first differences.

Capital Stock In order to compute TFP, we need data on capital stocks in addition to real value added and labor input. Due to the unavailability of internationally comparable capital stock data, we used a perpetual inventory method, as is common. INSTAT contains gross investment data. Letting I_{it} be gross real investment of sector *i* in period *t*, converted to a common currency, and the depreciation rate be δ, the capital stock is obtained as:

$$K_{it} = \sum_{n=1}^{T} I_{i,t-n} (1-d)^{n-1}$$

We followed Harrigan's (1999) well known study of international productivity differences in assuming a useful life of capital goods of ten years (T = 10) and a depreciation rate of 15 per cent (δ = 0.15). This high rate of depreciation and low life of capital goods is convenient in that it obviates the need for an assumption about the initial stock of capital and permits computation of a longer time series. As it is, with T = 10, the computed capital stock series begins in 1979 with data on investment beginning in 1970. Also, while these assumptions probably bias the estimated capital stock downwards, they do so equally for all countries and should not much affect relative capital stocks and hence TFP.

To obtain real investment, nominal investment was deflated by an aggregate business fixed investment deflator from the World Bank World Development Indicators, and converted to a common currency using the producer durables PPP from the International Comparison Project (ICP) database. Finally, following Keller (2001) we have adjusted for varying capital utilization over time by estimating a trend for output by country and industry and adjusting the capital stock figures for deviations from this trend.

References

Bernard, Andrew B., and Charles J. Jones, "Comparing Apples to Oranges: Productivity Convergence and Measurement Across Industries and Countries," American Economic Review, December 1996.

Acemoglu, Daron and Fabrizio Zilibotti, "Productivity Differences," Quarterly Journal of Economics, May 2001.

Canning, David, "The Contribution of Infrastructure to Aggregate Output," mimeo, World Bank, 2001.

Clarida, Richard and Ronald Findlay, "Government, Trade and Comparative Advantage" American Economic Review, 1992.

Davis, Donald and Weinstein, Donald, 2001." An Account of Global Factor Trade," American Economic Review 91: 1423-1453.

Dollar, David and Wolff, Edward N. "Convergence of Industry Labor Productivity Among Advanced Countries, 1963-1982," Review of Economics and Statistics, 1993.

Golub, Stephen S.. and Hsieh, Chang-Tai. 2000. Classical Ricardian theory of comparative advantage revisited. Review of International Economics, 8(2), 221-234.

Findlay, Ronald, and Ronald Jones, "Input Trade and the Location of Production," American Economic Review, May 2001

Findlay, Ronald and John D. Wilson, " The Political Economy of Leviathan," in A. Razin and E Sadka eds, Economic Policy in Theory and Practice, (London: MacMillan), 1987.

Findlay, Ronald, "Government, Trade and International Capital Mobility," in New Directions in Development Economics, ed. By Mats Lindahl and Benno J. Ndulu, (Routledge) 1996.

Hall, Robert and Charles I. Jones, "Why Do Some Countries Produce So much More Output than Others?" Quarterly Journal of Economics, 1999.

Holtz-Eakin, Douglas, “Public-Sector Capital and the Productivity Puzzle,” Review of Economics and Statistics, February 1994.

Harrigan, James, “Technology, Factor Supplies, and International Specialization: Estimating the Neoclassical Model,” American Economic Review, September 1997.

Harrigan, James, “Estimation of Cross-Country Differences in Industry Production Functions,” Journal of International Economics, 1999.

Jones, Ronald, “Comparative and Absolute Advantage,” Swiss Journal of Economics, 1980.

Leamer, Edward and James Levinsohn, “Testing Trade Theories and Predicting Trade Flows,” in Handbook of International Economics, vol III, ed. By Gene Grossman and Kenneth Rogoff, North Holland, 1995.

Lucas, Robert E., “Why Doesn’t Capital Flow from Rich to Poor Countries,” American Economic Review, May 1990. (verify)

McKinsey Global Institute, Manufacturing Productivity (McKinsey, Washington) 1993.

Roller, Lars-Hendrik and Leonard Waverman, “Telecommunications Infrastructure and Economic Development: A Simultaneous Approach,” American Economic Review, September 2001.

Trefler, Daniel., 1993. The case of missing trade and other mysteries. American economic review, 85: 1029-46.

Van Ark, Bart (1993), and Dirk Pilat, "Productivity Levels in Germany, Japan and the United States: Differences and Causes," Brookings Papers on Economic Activity Microeconomics 2, 1993, pp 1-48 .

World Economic Forum, World Competitiveness Report 2000.

Table 1A: TFP Level Relative to the US, 1989

	Food	Textile	Wood	Paper	Chem.	Metal	Mach-inery	Electric	Trans. Eq.	Instru-ments
Austria	46	68	66	62	48	69	64	61	57	47
Canada	75	90	87	69	69	80	76	87	75	59
Chile	56	51	54	87	78	53	31	67	52	39
Colombia	48	32	25	38	42	29	24	42	42	32
Finland	47	63	65	59	42	67	64	69	44	59
France	53	80	69	65	56	75	73	64	59	68
Hong Kong	32	33	36	27	19	28	23	23	27	18
India	6	7	6	6	9	9	9	13	5	5
Indonesia	9	11	12	10	10	23	18	18	16	3
Italy	54	80	78	76	56	70	68	67	53	55
Japan	70	87	122	97	89	103	95	73	86	63
Korea	29	30	35	33	24	33	29	28	27	20
Netherlands	54	84	72	64	58	66	62	56	51	53
Singapore	16	21	25	29	22	32	41	30	29	15
South Africa	28	25	30	35	44	31	42	27	37	24
Spain	50	63	65	66	55	59	55	63	56	44
Turkey	27	24	31	29	29	29	24	30	24	20
UK	49	58	77	69	52	66	64	55	53	43
USA	100	100	100	100	100	100	100	100	100	100

Table 1B: TFP Growth Relative to the US, Average Annual

	Food	Textile	Wood	Paper	Chem.	Metal	Mach-inery	Electric	Trans. Eq.	Instru-ments
Austria	-0.2	0.9	-0.7	0.5	0.0	1.1	-0.4	-0.7	0.9	0.3
Canada	-0.9	-1.4	-1.0	-2.7	0.4	-0.1	-2.2	-2.0	-1.3	0.4
Chile	-1.4	-0.3	-1.3	-2.1	-1.8	-2.1	-1.2	-3.3	-1.2	0.7
Colombia	-0.2	-1.3	0.1	0.6	0.9	1.8	-2.1	-0.2	1.8	4.5
Finland	0.5	1.5	1.5	0.6	1.4	1.9	2.0	1.8	0.9	2.9
France	-1.3	0.3	0.6	-0.3	-0.5	1.4	-0.8	0.3	0.3	0.7
Hong Kong	0.8	1.5	1.6	0.8	2.9	3.3	3.0	2.5	1.6	2.2
India	1.3	0.3	-0.1	-0.7	0.9	-1.2	-0.6	-2.3	0.1	-0.7
Indonesia	0.3	5.0	3.3	2.7	1.2	4.9	1.1	2.9	8.1	-0.4
Italy	-1.3	0.1	0.0	-1.1	0.9	0.3	-1.2	-1.4	-0.3	0.5
Japan	0.3	0.0	0.3	0.5	0.6	1.2	-0.6	-1.5	1.0	1.4
Korea	3.3	5.8	4.3	4.2	3.6	7.1	5.7	4.6	6.4	5.0
Netherlands	-0.3	-0.3	-1.8	-0.4	-0.5	-0.9	-0.1	-2.0	-1.0	-2.2
Singapore	-1.3	-1.6	-0.5	-0.8	-0.8	0.6	-4.0	-3.9	0.0	-1.3
South Africa	-0.2	1.8	0.2	1.9	-1.0	0.7	1.6	-0.2	0.0	4.7
Spain	-0.2	-1.6	-2.0	0.1	-0.1	1.0	-0.4	-1.1	-2.6	-0.4
Turkey	1.7	0.1	1.6	1.9	1.8	1.6	2.0	1.1	3.2	3.4
UK	-1.4	-0.7	-1.5	-1.5	-1.6	-0.8	-1.8	-2.5	-0.2	-0.3
USA	0	0	0	0	0	0	0	0	0	0

Table 2A: Factor Endowments and Infrastructure in Levels, 1989
in relation to USA = 100

	Road Density	Phone/ Pop.	Electrical Capacity	Labor Force	Share Low Skill	Mod. Skill	High Skill	Capital per Worker	Arable Land/ Pop
Austria	103	77	79	3	340	123	19	140	25
Canada	66	102	113	11	180	72	98	76	213
Chile	7	9	13	4	560	70	26	14	25
Colombia	3	13	10	11	750	40	16	12	13
Finland	62	98	82	2	400	96	35	148	63
France	114	90	67	20	520	79	26	131	38
Hong Kong	3	81	43	2	480	89	23	95	0
India	10	1	3	286	820	30	9	2	25
Indonesia	7	1	2	61	800	32	5	5	13
Italy	45	70	39	19	600	66	21	98	25
Japan	41	80	48	52	360	94	47	219	13
Korea	7	52	20	15	350	111	30	45	13
Netherlands	55	85	43	6	390	96	37	131	13
Singapore	7	64	38	1	660	62	12	24	0
South Africa	14	56	33	10	730	51	7	117	50
Spain	34	56	46	13	700	51	19	79	50
Turkey	7	20	11	19	830	26	12	5	63
U.K.	45	81	41	23	490	81	33	69	13
U.S.A.	100	100	100	100	100	100	100	100	100

Table 2B: Average Annual Growth Rates of Factor Endowments and Infrastructure

	Road Density	Phone/ Pop.	Electrical Capacity	Labor Force	Share Low Skill	Mod. Skill	High Skill	Capital per Worker	Arable Land/ Pop
Austria	0.5	3.4	1.2	0.6	-1.0	-0.3	7.9	2.7	-0.9
Canada	-0.3	2.5	0.6	1.7	-1.3	-1.5	1.9	2.0	-1.1
Chile	-1.2	9.7	2.3	2.5	-1.7	1.6	4.4	4.7	-5.3
Colombia	-2.2	7.3	1.6	3.4	-0.7	1.1	4.4	1.1	-5.5
Finland	1.4	2.6	2.0	0.5	-3.1	1.7	3.7	-0.1	-1.0
France	-0.5	4.4	3.1	0.6	-1.4	0.7	4.2	1.3	-0.2
Hong Kong	0.5	4.7	4.9	1.9	-2.9	2.6	4.8	5.4	-4.1
India	1.7	10.3	4.7	2.0	-0.4	2.0	4.0	4.0	-2.1
Indonesia	3.0	14.0	10.0	2.8	-1.0	4.7	8.6	7.1	-1.8
Italy	-0.2	4.1	1.7	0.7	-1.1	1.0	6.1	0.6	-0.9
Japan	2.2	2.5	2.1	0.9	-2.6	1.0	3.3	2.7	-0.8
Korea	6.1	11.0	6.5	2.3	-4.3	2.0	5.6	7.5	-2.1
Nether-lands	0.0	3.0	-0.7	1.5	-1.7	0.2	3.5	0.5	0.2
Singa-Pore	-0.7	4.5	3.2	3.1	-3.7	6.2	5.4	5.0	-6.3
South Africa	-0.9	4.3	1.5	2.5	-3.3	3.5	10	-2.2	-1.3
Spain	4.8	6.7	1.1	0.3	1.9	-2.7	1.9	8.6	0.0
Turkey	-0.3	12.8	6.3	2.5	-0.7	3.0	4.7	0.5	-1.8
U.K.	0.0	3.1	-0.6	0.5	-1.4	1.1	2.2	1.7	-0.7
U.S.A.	-0.3	2.6	0.0	1.4	-0.1	-1.8	2.9	1.9	-1.4

Table 3: Who Builds Infrastructure?

	Roads	Telecoms	Power
Low Skill	-0.27	0.69	0.33
	(2.35)	(1.97)	(1.80)
Moderate Skill	-0.18	0.42	0.30
	(-2.79)	(1.62)	(2.05)
High Skill	0.11	0.06	0.01
	(2.79)	(0.41)	(0.18)
Arable Land	0.43	0.46	0.51
	(3.70)	(1.54)	(2.52)
Capital	0.58	0.72	0.50
	(6.44)	(4.80)	(4.68)
Aggregate TFP	0.67	0.72	1.17
	(2.74)	(1.77)	(7.78)
N	359	359	359
R-Squared	0.99	0.99	0.13

All variables are in logs. T-statistics computed using heteroskedascity-consistent standard errors adjusted for clustering by country are shown in parentheses. Year and country dummies are suppressed.

Table 4: TFP Growth As a Function of Infrastructure Growth

	IV	Roads	Tele-com	Power	Δ Agg. TFP	Lag Agg. TFP	Δ HC	Lag HC	Chi-Sq (p-val.)
Food	N	0.22 (2.28)	0.13 (1.98)	-0.02 (-0.27)					12.25 (0.01)
	Y	0.11 (0.88)	0.28 (2.55)	-0.01 (-0.07)	0.14 (0.69)	0.01 (0.45)	0.05 (0.21)	0.06 (1.81)	15.51 (0.00)
Textiles	N	0.26 (2.12)	0.17 (1.96)	0.13 (1.48)					21.81 (0.00)
	Y	0.28 (1.84)	0.45 (3.59)	-0.01 (-0.10)	0.44 (2.10)	0.01 (0.85)	-0.30 (-1.06)	0.07 (1.99)	38.01 (0.00)
Wood	N	0.18 (1.86)	0.13 (1.90)	0.03 (0.37)					17.31 (0.00)
	Y	0.22 (1.87)	0.32 (3.78)	-0.06 (-0.54)	0.62 (2.77)	0.00 (0.01)	-0.52 (-2.2)	0.05 (1.43)	27.59 (0.00)
Paper	N	0.33 (3.05)	0.16 (1.92)	0.02 (0.19)					21.42 (0.00)
	Y	0.20 (1.41)	0.12 (0.98)	0.14 (0.85)	0.78 (3.41)	-0.01 (-0.80)	-0.30 (-1.01)	0.03 (0.58)	11.88 (0.01)
Chem-icals	N	0.08 (0.69)	0.13 (1.62)	0.05 (0.46)					6.53 (0.08)
	Y	0.08 (0.53)	0.26 (1.98)	0.04 (0.28)	0.77 (3.65)	0.01 (0.47)	-0.21 (-0.83)	0.07 (1.84)	9.27 (0.03)
Metal	N	0.36 (2.85)	0.07 (0.76)	0.09 (0.09)					14.82 (0.00)
	Y	0.30 (1.82)	0.23 (1.57)	0.13 (0.77)	0.49 (2.17)	0.02 (1.00)	-0.18 (0.27)	0.04 (0.80)	18.82 (0.00)
Mach-inery	N	0.43 (4.00)	0.21 (2.79)	0.06 (0.57)					32.81 (0.00)
	Y	0.45 (2.78)	0.12 (0.89)	0.03 (0.18)	1.10 (4.18)	-0.01 (-0.92)	-0.20 (-0.57)	0.02 (0.05)	15.69 (0.00)
Elect-ronics	N	0.17 (1.14)	0.05 (0.47)	0.21 (1.91)					10.50 (0.01)
	Y	-0.02 (-0.11)	0.05 (0.39)	0.56 (3.40)	0.35 (1.35)	0.00 (0.18)	-0.51 (-1.45)	0.11 (2.15)	21.69 (0.00)
Trans-port	N	0.39 (2.75)	0.29 (3.07)	0.02 (0.18)					28.55 (0.00)
	Y	0.69 (4.07)	0.13 (0.77)	-0.04 (-0.20)	0.90 (3.13)	-0.01 (-0.69)	-1.22 (-2.95)	0.00 (0.03)	22.73 (0.00)
Instru-ments	N	0.20 (1.17)	0.27 (2.24)	0.22 (1.61)					19.78 (0.00)
	Y	0.28 (1.18)	0.21 (1.10)	0.42 (1.79)	-0.06 (-0.18)	0.01 (0.29)	-0.45 (-1.22)	0.04 (0.76)	16.97 (0.00)

Time dummy coefficients suppressed. Chi-sq. refers to Wald Test on Infrastructure Only.

Table 5: Observed TFP as a Function of Infrastructure, Beta Coefficients

	Roads	Telecoms	Power	First PC Of the 3 Measures
Food	0.22	**0.59**	-0.02	**0.78**
Textiles	**0.49**	**0.83**	-0.01	**1.25**
Wood	**0.40**	**0.62**	-0.09	**0.74**
Paper	0.37	0.24	0.22	**0.81**
Chemicals	0.17	**0.58**	0.07	**0.81**
Metal	**0.60**	0.49	0.21	**1.20**
Machinery	**0.91**	0.26	0.05	**0.93**
Electronics	-0.05	0.12	**1.06**	**1.46**
Transport Eq.	**1.41**	0.28	-0.07	**1.36**
Instruments	0.40	0.33	**0.51**	**1.21**

Coefficients in bold are statistically significant at 10% level. Final column is beta coefficient obtained from using the first principle component of roads, telecoms, and power as our measure of infrastructure stock and repeating the analysis.

Table 6: Correlations Between Actual and Predicted By Industry and Country

By Industry		By Country	
Food	0.80	Austria	0.65
Textiles	0.90	Canada	0.27
Wood	0.89	Chile	0.41
Paper	0.81	Colombia	0.36
Chemicals	0.73	Finland	0.48
Metal	0.88	France	0.59
Machinery	0.89	Hong Kong	-0.17
Electronics	0.76	India	-0.15
Transport Eq.	0.71	Indonesia	0.42
Instruments	0.89	Italy	0.17
Average	0.83	Japan	0.40
		Korea	0.02
		Netherlands	0.37
		Singapore	-0.61
		S. Africa	0.10
		Spain	0.33
		Turkey	0.47
		UK	0.39
		USA	0.47
		Average	0.26

Table 7: Production Specialization, Infrastructure, Factor Endowments, and TFP

	Food	Textiles	Wood	Paper	Chem.	Fab. Metals	Mach-inery	Electric	Trans. Eqp.	Instru-Ments
Roads	-0.4	2.8	0.1	-0.1	1.9	0.9	1.2	2.6	1.0	0.3
	(-1.4)	(6.2)	(0.8)	(-0.8)	(5.5)	(6.7)	(2.9)	(5.1)	(3.9)	(3.0)
Telecoms	-0.0	1.0	0.3	0.1	0.4	0.4	-0.9	1.1	0.7	0.1
	(-0.1)	(4.6)	(3.9)	(0.6)	(2.4)	(6.1)	(-4.1)	(4.3)	(4.8)	(1.9)
Power	0.68	-0.9	0.1	0.4	-0.5	-0.3	0.3	-1.0	0.1	-0.2
	(3.8)	(-3.0)	(1.2)	(3.1)	(-2.1)	(-3.5)	(1.1)	(-3.0)	(0.7)	(-3.6)
Land	0.3	1.4	0.1	0.1	-0.0	0.2	-2.4	1.0	0.6	0.0
	(2.0)	(5.5)	(1.8)	(1.2)	(-0.1)	(1.9)	(-10.1)	(3.3)	(4.1)	(0.7)
Capital	-0.1	-2.9	-0.3	0.0	-1.2	-0.4	0.6	-0.6	-0.2	-0.2
	(-0.9)	(-12.6)	(-4.3)	(0.5)	(-6.9)	(-5.0)	(3.0)	(-2.2)	(-1.7)	(-5.1)
Unskilled Labor	0.1	2.9	0.6	-0.1	1.7	0.4	0.6	-0.0	0.1	0.3
	(0.6)	(7.9)	(5.1)	(-0.4)	(6.4)	(3.5)	(1.9)	(-0.1)	(0.3)	(3.8)
Moderate Skill	-0.1	1.8	-0.1	-0.2	1.5	0.4	2.0	0.1	-0.5	0.2
	(-0.7)	(6.4)	(-1.0)	(-1.5)	(7.4)	(4.8)	(7.8)	(0.4)	(-3.2)	(4.1)
High Skill	0.3	-0.8	-0.0	0.3	-1.0	-0.3	-0.7	0.1	0.5	-0.2
	(2.0)	(-3.6)	(-0.4)	(3.1)	(-5.8)	(-4.2)	(-3.3)	(0.2)	(3.7)	(-4.1)
TFP										
Food	**1.7**	-1.2	-0.5	-0.2	-0.2	-0.1	-1.3	2.0	-0.5	-0.1
	(5.1)	(-0.6)	(-2.8)	(-1.0)	(-0.5)	(-0.6)	(-2.7)	(3.3)	(-1.6)	(-1.1)
Textile	0.6	**3.6**	1.0	0.2	1.0	0.5	-0.5	-0.6	-0.1	0.3
	(1.9)	**(7.4)**	(6.7)	(1.2)	(2.9)	(3.2)	(-1.1)	(-1.2)	(-0.4)	(3.2)
Wood	-0.1	0.6	**-0.3**	-0.2	0.8	0.0	-0.6	1.8	0.1	0.1
	(-0.4)	(1.4)	**(-2.2)**	(-0.8)	(2.6)	(0.3)	(-1.6)	(3.7)	(0.4)	(1.7)
Paper	-0.9	-1.0	0.0	**0.6**	-1.2	-0.2	-0.2	-0.9	-0.4	-0.1
	(-3.2)	(-2.3)	(0.2)	**(3.2)**	(-3.5)	(-1.6)	(-0.4)	(-1.7)	(-1.7)	(-1.0)
Chem.	-0.4	-1.9	-0.2	0.2	**0.5**	-0.6	1.9	-1.2	0.7	-0.2
	(-1.3)	(-4.2)	(-1.4)	(1.3)	**(1.5)**	(-3.9)	(4.6)	(-2.4)	(2.7)	(-2.5)
Metal	-0.8	-1.5	0.5	-0.2	-0.7	**0.5**	1.0	-0.0	-0.0	-0.1
	(-2.5)	(-3.0)	(3.2)	(-1.1)	(-1.8)	**(3.3)**	(2.3)	(-0.1)	(-0.1)	(-1.0)
Mach	1.1	-0.4	-0.1	0.2	0.2	-0.2	**2.6**	-1.9	0.4	-0.1
	(4.6)	(-1.1)	(-0.6)	(1.0)	(0.6)	(-1.2)	**(7.1)**	(-4.3)	(2.0)	(-0.8)
Electric	-0.7	-2.6	-0.4	-0.6	-1.1	-0.4	-1.4	**0.6**	-0.7	-0.1
	(-2.8)	(-6.1)	(-3.2)	(-3.6)	(-3.5)	(-3.2)	(-3.7)	**(1.2)**	(-2.9)	(-1.5)
Trans-port	-0.3	1.1	-0.3	-0.0	-0.1	-0.1	-0.1	0.3	**1.0**	0.0
	(-1.8)	(3.6)	(-2.9)	(-0.1)	(-0.4)	(-0.9)	(-0.2)	(0.9)	**(5.6)**	(0.1)
Instu-Ments	0.2	1.1	0.3	0.0	0.3	0.1	-1.0	0.3	-0.1	**0.2**
	(1.1)	(3.6)	(3.2)	(0.2)	(1.6)	(1.5)	(-3.8)	(0.9)	(-0.4)	**(2.6)**

T-statistics reported in parentheses.

Table 7 Continued

	Agri-culture	Services
Roads	-4.8 (-5.4)	-4.5 (-2.4)
Telecoms	-2.9 (-6.6)	-3.5 (-3.7)
Power	-0.8 (-1.4)	0.7 (0.6)
Land	-1.6 (-3.2)	1.9 (1.8)
Capital	1.9 (4.3)	2.9 (3.1)
Unskilled Labor	-0.9 (-1.2)	-3.7 (-2.5)
Moderate Skill	-0.9 (-1.6)	-1.0 (-0.9)
High Skill	-0.2 (-0.5)	2.8 (1.0)
Food	0.3 (0.3)	-1.0 (-0.4)
Textile	5.2 (5.6)	5.2 (2.6)
Wood	-1.4 (-1.6)	2.5 (1.4)
Paper	-0.8 (-0.9)	1.1 (0.6)
Chem.	-1.1 (-1.2)	4.7 (2.5)
Metal	-3.3 (-3.5)	-2.0 (-1.0)
Mach	3.1 (4.0)	-5.5 (-3.4)
Electric	-2.3 (-2.8)	8.0 (4.6)
Trans-port	-1.4 (-2.4)	-2.5 (-2.0)
Instu-Ments	0.3 (0.6)	-5.0 (-4.2)

T-statistics reported in parentheses.

Table 8: Beta Coefficients with and without Infrastructure

	Food	Textiles	Wood	Paper	Chem.	Metals	Mach-inery	Electric	Trans. Eqp.	Instru-ments
Infrastructure										
Roads	-0.42	**2.38**	0.26	-0.19	**2.50**	**2.12**	**1.29**	**2.37**	**1.43**	**1.43**
Telecoms	-0.02	**1.03**	**0.74**	0.09	**0.64**	**1.13**	**-1.08**	**1.16**	**1.03**	**0.53**
Power	**0.68**	**-0.66**	0.23	**0.46**	**-0.55**	**-0.64**	0.28	**-0.81**	0.14	**-1.01**
Labor										
Unskilled										
W	0.17	**2.61**	**1.45**	-0.10	**2.54**	**0.96**	**0.73**	-0.03	0.09	**1.61**
WO	**0.35**	**1.53**	**1.43**	-0.01	**1.28**	0.04	-0.25	**-1.07**	**-0.52**	**0.99**
Mod. Skill										
W	-0.14	**1.52**	-0.20	-0.25	**2.09**	**0.95**	**2.17**	0.11	**-0.73**	**1.25**
WO	0.16	**0.85**	-0.06	-0.05	**1.32**	**0.38**	**1.61**	**-0.57**	**-0.91**	**0.66**
High Skill										
W	**0.39**	**-0.88**	-0.08	**0.51**	**-1.70**	**-0.86**	**-0.95**	0.06	**0.88**	**-1.28**
WO	0.26	**-0.45**	-0.05	**0.44**	**-1.27**	**-0.46**	**-0.80**	0.51	**1.09**	**-0.96**
Other Factors										
Capital										
W	-0.20	**-3.69**	**-1.08**	0.09	**-2.40**	**-1.21**	**1.02**	**-0.79**	**-0.46**	**-1.88**
WO	**-0.45**	**-2.19**	**-0.72**	0.00	**-0.98**	0.19	**1.26**	**0.75**	**0.54**	**-0.98**
Land										
W	**0.73**	**2.50**	**0.70**	0.36	-1.02	**0.74**	**-5.43**	**1.83**	**1.78**	0.37
WO	0.10	**1.63**	-0.39	-0.21	-1.85	-0.20	**-4.83**	**0.99**	0.23	-0.61

	Agri-culture	Services
Infrastructure		
Roads	**-0.61**	**-0.58**
Telecoms	**-0.37**	**-0.46**
Power	-0.10	0.09
Labor		
Unskilled		
W	-0.12	**-0.52**
WO	0.15	**-0.31**
Mod. Skill		
W	**-0.11**	-0.14
WO	-0.04	-0.05
High Skill		
W	-0.03	**0.46**
WO	-0.12	**0.36**
Other Endowments		
Capital		
W	**0.37**	**0.58**
WO	-0.05	0.13
Land		
W	**-0.43**	**0.53**
WO	0.26	**1.14**

W: Indicates the presences of the infrastructure measure. WO: Indicates the absence.
Bold figures are those that are statistically significant at the 10% level or better.