Factor Returns, Institutions, and Geography: A View From Trade

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Abstract

We show that estimated productivities of labor and capital which rationalize trade flows across countries are related to total factor productivities which rationalize output differences across countries. We present evidence that these productivies from trade flows are related to the institutions and geography across countries. Protection of property rights is the dominant influence on both labor and capital productivity. We also address whether these institutions have a differential effect on those with relatively less education. We find little evidence that more property rights protection has a differential impact on skilled workers relative to unskilled workers. Evidence concerning democracy

is not compelling. Geography is only important in terms of distance to a large market.

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INTRODUCTION

Factor prices differ widely across countries. For example, the typical laborer in the United States is paid roughly twenty times the wage of the average laborer working in Mexico (Oostendorp 2005). What can account for this large discrepancy? No doubt the quality and quantity of other inputs as well as workers' skills affect workers' pay. Still, a few simple calculations indicate that differences in physical capital or the observed differences in educational attainment are unlikely to account for much of the observed differences in wages. For example, the typical U.S. worker has about three and a half more years of schooling than the typical Mexican worker in 1997. Suppose a relatively high return of 10 percent to years of schooling and that production in the U.S. and in Mexico is characterized by a Cobb-Douglas production function in capital and labor with labor's share equal to 0.6. Given these assumptions, the U.S. capital stock per worker would have to be 745 times larger to explain the twenty-fold difference in wages. Seven-hundred and forty-five times larger is very far from the actual five times larger capital per worker in the U.S. Thus, there must be other factors that account for the differences in the wages of laborers in these two countries. These observed differences in wages in the U.S. and Mexico are not particular to laborers alone. On average, for 59 job titles, Mexican wages on average are seven percent of the wages earned by a U.S. worker.[1]

Moreover, these large disparities in relative wages are not particular to the U.S. and Mexico example. For a set of 80 countries, the average manufacturing wage in the top five percent of countries is ten times greater than the median country's wage and 58 times greater than the average for the bottom five percent (World Bank 2003). For the small sample of countries with reliable estimates of capital's returns, these returns also differ widely across countries. For example, Trefler (1993) finds the rate of return on capital is roughly four times higher in the U.S. than in Sri Lanka. These differences in factor returns cannot even remotely be explained by the relative quantities of other measured factors of production.

Over the past decade, many economists have tried to quantify the variables that can account for cross-country differences in income per person. In all studies, differences other than physical and human capital loom large. Hall and Jones (1999) find that stocks of physical and human capital account for only 35 percent of the differences in income per worker between the richest and poorest countries; the remaining 65 percent is due to the residual, total factor productivity. Klenow and Rodriguez-Clare (1997) find that up to 80 percent of the cross-country variation in the level of output

[1] The only professions that earn as much as 10 percent of the comparable U.S. occupation are field crop farmers and cooks.

per worker is due to total factor productivity. Over longer horizons, Baier, Dwyer and Tamura (2006) find that variation in the growth of total factor productivity explains from 30 to over 80 percent of the cross-country differences in the growth of output per worker. This evidence clearly indicates that cross-country income differences are associated with productivity differences. Unfortunately, as Abramovitz (1956) puts it, total factor productivity is a measure of ignorance because little is known about it other than that total factor productivity makes income differences consistent with smaller factor endowment differences.

A substantial amount of research also has been devoted to understanding how income and total factor productivity are affected by institutions and geography. This research includes, among others, Knack and Keefer (1995), Sachs and Warner (1995), Barro (1996), Gallup and Sachs with Mellinger (1999), Hall and Jones (1999), Easterly and Levine (2003), Acemoglu, Johnson and Robinson (2005), and Rodrik, Subramanian and Trebbi (2004). This evidence clearly indicates the importance of the protection of private property rights, provides some support for the importance of democratic institutions, with mixed evidence concerning the importance of geography.

While it is important to quantify how institutions and geography can influence income per capita, it is also important to quantify how institutions and geography influence the returns to different factors of production; that is, how do institutions and geography influence the distribution of income between capital owners and workers, between skilled and unskilled labor? This point is stressed, but not quantified, in Acemoglu, Johnson and Robinson (2005). They state

> In other words, they (economic institutions) influence not only the size of the aggregate pie, but how the pie is divided among different groups and individuals in society.

In addition, knowing how institutions influence factors' returns and productivity is important partly because the effects on factor returns are likely to be helpful for understanding the development of institutions themselves.

In this paper we attempt to move beyond quantifying the extent to which institutions and geography influence the income of the average individual. Our goal is to quantify how institutions and geography influence 'how the pie is divided'. For much of the paper, we focus on the returns to capital and labor. Since productivity is highly correlated with factor returns, we compute capital and labor productivity and assess how the institutions and geography influence their productivity. We then classify workers in terms of skilled and unskilled, and calculate their productivities and assess how institutions and geography influence their returns. As in Trefler (1993), we use the measured factor content of trade to estimate the productivities of capital and labor across countries. Our model is similar to the standard Heckscher-Ohlin Vanek (HOV) model in that we calculate the 'measured' content of trade using the U.S.'s input-output tables. We do not, however, seek to answer whether the HOV model can account for the actual factor content of trade. Instead we use the minimal assumptions needed to compute relative productivity measures as in Trefler (1993). In the context of a trade model, Leontief (1953) first suggested that the productivities of factors of production may differ across countries and this may explain why the measured factor content of trade differs from the actual factor content of trade. Bowen, Leamer and Sveikauskas (1987) and Trefler (1993, 1995) follow Leontief's suggestion and allow for productivity differences in the HOV model. Trefler (1993) shows that factor-augmenting technology can exactly equate actual trade in factor services and the theoretically implied trade in factor services. In addition, factor-augmenting technological differences imply that factor prices can be equalized relative to productivity. Trefler presents evidence that there is a high correlation between factor payments and his estimates of factor productivity.

Allowing for differences in factor-augmenting technology may seem appealing, but these measures of productivity based on trade become a measure of ignorance. As Feenstra (2004, p. 61) notes,

> Even if we accept that the HOV equation can fit perfectly by allowing sufficient differences in technologies across countries, this begs the question, *where do the differences come from? ....* Such differences can hardly be accepted as exogenous, however, and must be explicable based on underlying causes. [Emphasis in original.]

This is precisely the same criticism that macroeconomics faced concerning total factor productivity.

In this paper, we explore the determinants of differences in relative factor productivities across countries. We examine the relationship of factor productivities to institutions and geography. For most of our results, we measure the extent to which institutions and geography influence productivity using two factors of production: physical capital and effective labor (or human capital). Because a differential effect on those with relatively less education is an important and interesting issue, we also examine the differential effects of institutions and geography on unskilled and skilled labor.

Our measures of institutions include measures of countries' protection of property rights and levels of democracy. With respect to geography, we consider two ways that geography influences factor productivity. First, geographic characteristics reduce productivity because they are associated with an unhealthy climate that is not conducive to production. Second, geography can limit the extent of the market due to the costs of trading across markets.

Government protection of property rights is highly correlated with factor productivity. Democracy generally is positively correlated with both labor and capital productivity, but this univariate relationship disappears once property rights are included in regressions. Geographic variables can account for some of the cross-country differences in productivity, but the only geography variable that is robustly correlated with productivity is minimum distance to a large market. These results continue to hold when we correct for potential endogeneity of the measures of property rights and democracy. We also find that the effect of property rights protection on the productivity of skilled and unskilled workers is similar.

This paper is organized as follows: Section two presents our construction of factor productivities and related analysis. We summarize HOV theory with and without differences in productivity, discuss the data used in this paper and compare the measures of capital and labor productivity to each other and to total factor productivity. In section three, the relationships of capital and labor productivities with institutions and geography are examined. We also examine the sensitivity of the results to institutions' possible endogeneity and present preliminary evidence on whether there are differential effects of institutions and geography on skilled and unskilled labor. Section four concludes.

MEASURED FACTOR CONTENT OF TRADE AND PRODUCTIVITY DIFFERENCES

In this section, we summarize how the standard measured factor content of trade can be used to estimate differences in relative factor productivities across countries. Let $j = 1, ..., H$ index countries, $m = 1, ..., M$ index factors of production and $n = 1, ..., N$ index industries. We define $y_i(n)$ as country i's production of good n. Each country has an $M \times 1$ vector of endowments $V_i = \left(v_i^1, v_i^3, v_i^2, ..., v_i^M, \right)'$.

We assume that countries have constant returns to scale production functions and we define the unit input requirement $d_j^m(n)$ as the amount of factor m required to produce one unit of good n in country j. Full employment of resources implies:

$$v_j^m = \sum_{n=1}^{N} d_j^m(n)\, y_j(n)$$

We define country i's total expenditures as E_i and country i's expenditure share on good n produced in country j as $s_{ij}(n)$. Goods market clearing implies $y_j(n) = \sum_{i=1}^{H} s_{ij}(n)E_i$. Factor market clearing for resource m in country j , therefore, can be expressed as:

$$v_j^m = \sum_{i=1}^{H}\sum_{n=1}^{N} d_i^m(n)\, s_{ij}(n)E_i \tag{1}$$

Exports of country $j's$ good n shipped to i equal $s_{ij}(n)E_i$. Total exports by country j to country i can be expressed $\sum_{n=1}^{N} s_{ij}(n)E_i$. Therefore, country $j's$ total exports to all countries can be expressed as:

$$exports_j = \sum_{i\neq j}^{H}\sum_{n=1}^{N} s_{ij}(n)E_i. \tag{2}$$

Similarly, way we can define country $j's$ imports as:

$$imports_j = \sum_{i\neq j}^{H}\sum_{n=1}^{N} s_{ji}(n)E_j. \tag{3}$$

Adding $\sum_{n=1}^{N} s_{jj}(n)E_j$ to (2) and (3) and subtracting equation (2) from (3) yields net exports for country j :

$$NX_j = \sum_{i=1}^{H}\sum_{n=1}^{N} \left[s_{ij}(n)E_i - s_{ji}(n)E_j\right]$$

In most empirical applications, the factor content of trade is computed using the U.S. input-output matrix. Therefore, the measured content of trade in factor m for country j is given by

$$F_j^m = \sum_{i=1}^{H}\sum_{n=1}^{N} d_{US}^m(n)\left[s_{ij}(n)E_i - s_{ji}(n)E_j\right] \tag{4}$$

In equation (4) the measured factor content of trade is calculated using the U.S.'s input-output matrix whereas in equation (1) labor market clearing is defined using country $j\prime s$ input-output matrix. The first economic assumption required to allow us to relate equations (1) and (4) into differences in productivity is

- Assumption 1: *Measured in effective units, the amount of input m required to produce one unit of good n is proportionate to the US's unit input requirement across all industries; that is,* $d_{US}^{m}(n) = d_{k}^{m}(n)\pi_{k}^{m}\ \forall\ n,$

  In this case the we can combine (1) and (2) to get

$$\begin{aligned} F_j^m &= \pi_j^m v_j^m - s_j \sum_{k=1}^{H} \pi_k^m v_k^m \\ &\quad - s_j \sum_{n=1}^{N} \left[\sum_{k\neq j}^{H} \sum_{i=1}^{H} d_j^m(n) \left(s_{ji}(n) - s_{ki}(n) \right) E_i \right] \end{aligned} \tag{5}$$

  where we can interpret π_j^m as the factor augmenting technology for input m in country j. Note we can interpret this assumption as follows: For a given amount of US production in all industries, if π_j^m is, say, one-half then country j needs to employ twice as much input m in all industries to produce the same amount of goods as the US. Since the $\pi' s$ are measured relative to the United States, it seems natural to interpret the π_j^m as the *relative factor augmenting productivity* of factor m in country j. Equation (5) is simplified further by the following assumption.

- Assumption 2: *Preferences are homothetic and countries spend equal shares on each good; that is,* $s_{ji}(n) = s_{ki}(n)$ *for all* n.[2]

We can then rewrite equation (5) as:

[2] Clearly this condition is satisfied when preferences are homothetic and there are no transport costs, which is typically assumed in the HOV studies.

$$F_j^m = \pi_j^m v_j^m - s_j \sum_{k=1}^{H} \pi_k^m v_k^m \quad (6)$$

Since this is a linear system of equations in the unknowns $\pi' s$, we can use simple linear algebra techniques to search for the existence of factor augmenting productivities that satisfy this system of equations. With stronger assumptions than those used here, Trefler (1993) refers to these differences, as we do here as well, as international differences in factor productivity. He defines π_i^m as the factor augmenting technology for factor m in country i. The measured factor content of trade for factor m by country i adjusted for differences in productivity is $F_j^m = \pi_j v_j^m - s_j \sum_{i=1}^{H} \pi_i v_i^m$ in which the π_i^m's are unknowns. As Trefler shows, the estimates of productivity for a factor are independent of mis-measurement of the quantities of other factors and their productivities. It is important to note that Assumption 1 does not require factor payments to be identical across industries within a country. Indeed wages may differ across industries within a country as long as they are proportional across countries.[3] This is consistent with the work of Krueger and Summers (1989). Also note that the assumption of homothetic preferences assumes no trade costs so we might expect the role of geography to be limited in this context. If trade costs are significant then *second-order geography* may influence factor payments in the way described by Redding and Venables and Overman, Redding, and Venables.

Data

As is standard in most empirical trade research, the data used in this study are drawn from a variety of sources. Unless otherwise noted, all data are for 84 countries in 1997 based on 32 industries of traded goods. Appendix Tables 1 and 2 list the

[3] We thank Daron Acemoglu for pointing this out to us.

countries and industries.[4] The data on trade flows are from Feenstra (2000.)

Our initial estimates use data for just two factors of production: the capital stock and the labor force measured in effective labor units. The capital stock measures are constructed using the perpetual inventory method with an annual depreciation rate of 13.3 percent, as in Leamer 1984, using real investment data from Baier, Dwyer, and Tamura (2006). Aggregate labor force data are converted into effective labor force units by multiplying the labor force by $\exp(\varphi(educ_i, exper_i))$ where $educ_i$ is the number of years of schooling for the average worker in country i, $exper_i$ is the average level of experience in country i and $\exp(\varphi(educ_i, exper_i))$ reflects returns to education and experience.[5] Data on the labor force are from the World Bank (2002) and data on education are from Baier, Dwyer, and Tamura (2006).

For some of our analysis, labor is divided into skill categories based on education. Data on educational enrollments are used to estimate the number of workers with some should be no more than primary education – called "unskilled workers" and those with at least some education beyond the primary level – called "skilled workers". Because we do not know the average education of workers who attended only primary school, calculating these fractions of the labor force comes at the expense of not being able to measure labor in effective labor force.

Construction of the direct and indirect input requirement matrix is standard (Bowen,

[4] Data are available to estimate trade productivities for 91 countries, but the institutional information used in the later regressions is not available for seven of them, which leaves the 84 countries listed in Appendix Table 1.

[5] The derivatives of φ(educ$_i$,exper$_i$) are the returns to an additional year of schooling or experience that can be estimated from Mincerian wage regressions. As in Hall and Jones (1999), Debaere and Demiroglu (2003) and Baier, Dwyer and Tamura (2006), we assume that the return to education for the first four years of schooling is 13.4 percent, 10.1 percent for the second four years and 6.8 percent for all years of education above the 8th year. As in Bils and Klenow (2000), we assume the return to experience is quadratic.

Leamer and Sveikauskas 1987). Input requirements are based on the 1997 input-output tables for the United States. The stocks of capital by industry in the U.S. are from the U.S. series "fixed reproducible tangible wealth." To equate the total of these capital stocks and our computed U.S. perpetual-inventory aggregate capital stock, the capital stock in each industry is multiplied by the ratio of the U.S. perpetual-inventory aggregate capital stock to the total of the U.S. capital stocks from fixed reproducible tangible wealth. This results in a sum of the capital stocks by industry in the U.S. equal to our estimate of the aggregate U.S. capital stock. Data for the U.S. labor force employed in each sector are from the National Income and Product Accounts of the United States and the Bartelsman, Becker, and Gray (2002) productivity database for 1997. The total labor force is adjusted to equal the World Bank's estimate of the U.S. labor force (World Bank 2002). Data on workers' average education by industry for the U.S. are from the 1990 Census (Ruggles, Sobek *et al.* 2003). Income per capita and population are from the World Bank (2002). Each country's share of world consumption is its share of absorption of goods and services in all countries.

Productivity Estimates

Baseline Assumptions and Results for Trade.—

We succinctly summarize the model outlined above

Assumption 1. Within each country, factors are mobile across sectors and factor markets clear.

Assumption 2. Tastes can be represented by homothetic preferences that are the same across countries and expenditure shares are constant across countries.

Assumption 3. The unit-input requirement for factor m in producing good n in country i is $d_i^m(n)$ and the input requirement are proportional across countries; that is, we assume $d_i^m(n)\pi_i = d_{US}^m(n)$

We focus on the following implication of the model, namely

1. **Proposition 2**

   Factor prices are equalized in terms of effective labor, i.e., $w_i^m = \pi_i^m w_{US}^m$.

Trefler (1993) examined the plausibility of this framework by comparing relative factor returns, $w_{m,i}/w_{m,US}$, to the relative productivities, $\pi_{m,i}$. He found a good fit between these relative factor returns and the relative productivities.[6]

Gabaix (1997) argues that Trefler methodology can be misleading. He shows this by calculating the productivity by factor types assuming the *measured factor content of trade is zero* and shows there is 'little' difference between these productivities and the productivities that are calculated the factor content of trade is allowed to be different from zero. However, the purpose **of** this paper is to understand how we can use trade data to infer productivities by factor type. We can use algebra similar to what Gabaix used and show how the relative productivities are determined. If we normalize the U.S.'s productivity to unity, the productivity of factor m in country i relative to U.S. productivity can be written as a function of factor m's average product and trade by or

$$\pi_{m,i} = \frac{TE_i/v_i^m}{TE_{US}/v_{US}^m} + \frac{F_i^m}{v_i^m} - \frac{TE_i}{TE_{US}}\left(\frac{F_{US}^m}{v_{US}^m}\right) \tag{7}$$

where TE_i is total domestic expenditure on final goods and services in country i, v_i^m is country $i's$ endowment of resource m, and F_i^m is the factor content of trade in resource m for country i. Total domestic expenditure is approximately equal to Gross Domestic Product, in which case the first term on the right-hand side indicates that

[6] Using a different methodology, Repetto and Ventura (1997) find that, while factor prices do reflect differences in factor-augmenting productivity, disparities exist in relative factor prices even after taking into account differences in productivity. Because of the data requirements for their tests, they have a relatively small sample size and their estimates are imprecise.

relative productivities are related to the *relative average product.* Because of diminishing returns, it would be hard to imagine a world in which factor returns (marginal products) are orthogonal to average products. Trade can weaken this relationship, but average products are likely to be of first-order importance in determining productivities. Holding constant average product, a country's relative productivity is higher if the country is an exporter of that factor's services.[7] The larger the factor content of trade relative to the endowment (F_i^m/v_i^m), the higher is measured relative productivity. It is also easy to see why the factor content of trade is scaled by the endowment. If a country is a net exporter of a factor's service and its endowment of that factor is small, that factor must be relatively productive. The third term enters with a minus sign because, everything else the same, a country's relative productivity compared to the US is lower if the US is a net exporter of that factor's service. The intuition for this is straightforward as well. If the U.S. is a net exporter of a factor's services and its endowment of that factor is relatively small that factor must be relatively productive in the U.S. and, as a result, country $i's$ relative productivity must be relatively lower. The third term also is scaled by country i's size relative to the U.S.

Figure 1 shows estimates of aggregate labor and capital productivities by country. The vertical axis is the country's capital productivity and the horizontal axis is the country's labor productivity. The line in the figure is the line indicating equality of capital and labor productivity. The figure shows that countries with high measured labor productivity tend to have high measured capital productivity, but the relationship between these two measures is far from perfect. The correlation between the two measures is modestly high (0.58), but far from one, which leads to the question: What influences the productivities of capital and labor?

[7] In our data, the average estimates of the productivities are ten percent different with trade than without trade, indicating that the trade data are adding information to the technology matrix.

Also we find that the mean level of capital productivity is higher than the mean level of labor productivity, and there is less dispersion of capital productivity than labor productivity. This is not too surprising to us. If capital is more mobile than labor, then returns to capital will be more similar across countries. There are a few countries that have high capital productivities relative to their labor productivity and to their GDP, for example Angola. This high capital productivity may be due to the endowments of natural resources – e.g., diamonds and oil in Angola. Thus the first two points that are important to note from the data are

- There is a modestly high correlation between labor productivity and capital productivity.
- On average, countries' relative capital productivity is higher than relative labor productivity.

In the next section, we compare these productivity measures to the macroeconomist's measure of TFP.

HOV Productivity and Total Factor Productivity

What is the correlation of these measures of factor productivity based on trade with other measures of aggregate productivity? We compare the factor-augmenting productivity from Trefler's approach to the estimate of productivity from development accounting.

In the growth literature, factor endowments account for little of the cross-country differences in income per worker. Klenow and Rodriguez-Claire (1997) and Hall and Jones (1999) emphasize this, finding that much of cross-country differences in output per worker are due to differences in total factor productivity. They calculate total factor productivity from an aggregate production function. Let y_i be output per worker in country i. With Cobb-Douglas production, output per worker, y_i, is

$$y_i = A_i k_i^{\alpha} h_i^{1-\alpha} \tag{8}$$

where A_i, k_i, and h_i, are total factor productivity, capital per worker and human capital per worker in country i. Total factor productivity in country i relative to total factor productivity in the U.S. is

$$\frac{A_i}{A_{US}} = \frac{y_i / k_i^{\alpha} h_i^{1-\alpha}}{y_{US} / k_{US}^{\alpha} h_{US}^{1-\alpha}} \tag{9}$$

This relative total factor productivity can be compared to productivity estimated from the factor content of trade. A simple way to aggregate the capital and labor productivities from trade theory is to take a geometric average of the capital and labor productivities, $\pi_i = \pi_{k,i}^{\eta} \pi_{\ell,i}^{1-\eta}$, with the weight on capital's productivity equal to its share of income. We set capital's share of income η to 0.33, a value consistent with Gollin's (2002) careful cross-country study of income shares. Figure 2 shows that there is a substantial positive relationship between the geometric average of the trade productivities and relative total factor productivity. Total factor productivity and the weighted average of trade productivities do not lie along the line in the figure showing equality, but the correlation between the measure of relative productivity from the factor content of trade and relative total factor productivity is 0.876.[8] This indicates that the two measures of productivity derived from largely independent data are quite similar.[9]

[8] If productivity differences are assumed to be only labor augmenting as in Hall and Jones (1999), the correlation of relative total factor productivity and the total relative trade productivity is 0.89. We also performed a grid search allowing capital's share to vary between 0.01 and 0.99. The highest correlation between the aggregated trade productivities and total factor productivity is 0.876 to three digits, which is the value with capital's share ranging from 0.31 to 0.40.

[9] However, one might not be too surprised at the high correlation. Following Gabaix's suggestion that the relative factor productivities are simply the average product, a little algebra shows that if

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What country-specific factors are related to these measures of relative productivity? We focus on the correlations of factors' productivities with geography, property rights protection and democratic government. We separate the potential influence of geography on productivity into "productive geography," which affects productivity through geographic characteristics, and "market geography," which affects productivity through access to large markets and the ability to specialize and exploit economies of scale. Then we describe the measures of property rights and democracy.

Initially, we report the R^2 from separate regressions of the productivity measures on productive geography, market geography, property rights protection, and democracy. These are followed by regressions that include different subsets of these four possible influences on productivity. Causality and correlation, of course, are not the same thing. It is likely, though, that a country's geographic characteristics are exogenous relative to factor productivity in the country. Property rights and democracy, on the other hand, could be as much a result as a cause of factor productivity. In the last part of this section, we present some instrumental-variables estimates of the relationship of productivity with property rights and democracy.

The data on geography are from Gallup and Sachs with Mellinger (1999). The measure of protection of property rights is from Hall and Jones (1998, 1999). The data on democracy are based on the Polity IV data (Marshall and Jaggers 2004) that

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$\pi_i = (\pi_i^K)^\eta(\pi_i^L)^{1-\eta} = \left(\frac{Y_i/K_i}{Y_{US}/K_{US}}\right)^\eta \left(\frac{Y_i/L_i}{Y_{US}/L_{US}}\right)^{1-\eta}$ which, if $\alpha = \eta$, implies that

$$\pi_i = \left(\frac{Y_i/(K_i^\eta L_i^{1-\eta})}{Y_i/(K_i^\eta L_i^{1-\eta})}\right) = \left(\frac{A_i}{A_{US}}\right)$$

Thus, the geometric average of the relative productivities would be equal to relative TFP with a correlation of one. Since the correlation is high, but not perfect, we presume that trade conveys additional information regarding productivities.

update the Polity III data (Jaggers and Gurr 1995). The data on legal origin are from La Porta, Lopez-de-Silanes, Shleifer and Vishny (1998).

Geography

Geography can affect productivity directly by limiting the productivity of resources due to characteristics associated with its geographic location or indirectly by limiting the extent of the market and the ability of factors to specialize and achieve economies of scale.

The tropics seem like paradise with an abundance of sun, vegetation and food, but the reality can be quite different. Diet often includes limited variety and the seemingly desirable characteristics of the tropics can foster diseases that reduces the production of goods and services (Gallup and Sachs with Mellinger 1999). With abundant rainfall and no frost, the tropics are breeding grounds for diseases and the diseases' carriers.[10] To lessen illness and death, resources can be allocated to prevent and treat diseases, but this implies that smaller quantities of other goods and services are produced. Such use of resources acts effectively as a tax on non-disease-preventing production in the area. We use latitude and the fraction of the population with malaria to measure these adverse effects of tropical diseases.

More obviously than the tropics, deserts are inhospitable environments that can be associated with lower output. Deserts have little precipitation, high winds, poor soil and extreme temperatures. All of these characteristics make capital and labor less productive by making the production of many goods more costly. To estimate the effect of desert climate on productivity, we use desert area in tropical latitudes relative to total land in each country and desert area in temperate latitudes relative

[10] The most notable pests are the Anopheles mosquito which spreads malaria and the tsetse fly which spreads sleeping sickness (African trypanosomiasis).

to total land in each country, as do Gallup and Sachs with Mellinger (1999).[11] In sum, the productive geography hypothesis suggests that countries located in less temperate zones (lower latitudes) with a higher prevalence of malaria and countries with a higher fraction of land covered by desert have less productive capital and labor.

Figure 3 shows the relationships between productive geography and labor and capital productivity. The "productive geography" shown in the two panels of the figure are the results of separate regressions of labor and capital productivity on the productive geographic variables: latitude, desert, and fraction of the population with malaria. By itself, productive geography explains 42 percent of the variation in labor productivity and six percent of the variation in capital productivity. For labor productivity, latitude and the fraction of the population afflicted by malaria are statistically significant at the five percent level but neither desert variable is statistically significant.[12] For capital productivity, only the fraction of land that is tropical desert is statistically significant at the five percent level.

A country's location can affect the size of the economic market and the economy's ability to specialize and achieve economies of scale. Countries with small local markets that are far away from large markets and have no access to water transport may not be able to specialize and exploit economies of scale as much as others. We test this market geography hypothesis by four variables: 1. the logarithm of land area; 2. the logarithm of the minimum great-circle distance to Tokyo, Rotterdam, or New York

[11]Extremely cold environments also have undesirable characteristics, but few people live in such areas, e.g. above the Artic Circle. Perhaps this explains why there are no estimated effects of very cold climates in the published literature.

[12]Because malaria can be a result as well as a cause of low income or low productivity, we use the incidence of malaria in 1966 to lessen any endogeneity of the incidence of malaria relative to the 1997 estimates of productivity.

We also examined whether absolute distance from the equator affects growth and found empirical results qualitatively similar to those presented.

which measures the proximity to large markets; 3. a dummy variable equal to one if the country is landlocked which represents the cost of moving goods into and out of a country; and 4. the fraction of land that is within 100 kilometers of the coast.

Figure 4 shows the relationships between market geography and labor and capital productivity. By itself, market geography explains 43 percent of the variation in labor productivity and eleven percent of the variation in capital productivity. Distance from large markets is the only variable that is statistically significant at the five percent level, with the productivity of both labor and capital falling as the distance to a large market increases.

Property Rights and Democracy

In addition to geographic factors, the productivity of factors of production is likely to be affected by the institutions in a country. The two institutions that we investigate in this paper are protection of private property rights and the democratic selection of government officials.

Why would protection of property rights affect labor and capital productivity? In the absence of protection of property rights, individuals face two types of risks. First, if individuals fear government expropriation, they will try to hide their assets to decrease the probability of government expropriation, which can decrease the efficiency of production. For example, the possibility of expropriation can be reduced by building smaller-than-optimal production facilities that are not as readily obvious or fixed in place (de Soto 2000). Second, as suggested by Tullock (1967) and elaborated by Murphy, Shleifer, and Vishny (1991), Acemoglu (1995), and Grossman and Kim (1995), some individuals may choose to attempt to steal from those who produce goods and services, and those who produce goods will use resources to protect themselves from the predators. Effective protection of private property rights that decreases theft will result in resources being allocated to more productive uses.

We quantify the government's protection of property rights by the same measure used by Knack and Keefer (1995) and Hall and Jones (1999), which is based on five components from the International Country Risk Guide and available from Hall and Jones (1998). The first two components measure the role of government in protecting against predatory private behavior through the rule of law and bureaucratic quality. The other three components measure the government as a possible diverter of resources by measures of government corruption, risk of expropriation, and the government's repudiation of contracts. We use a somewhat arbitrary equally weighted average of these five measures. The relationships between these measures of the protection of property rights and labor and capital productivity are shown in Figure 5. The government's protection of property rights explains 69 percent of the cross-country variation in labor productivity and 22 percent of the cross-country variation in capital productivity.

The effect of democratic government on productivity is not obvious. More democratic societies can winnow out bad laws and inefficient leaders, effects which would tend to raise productivity. In this case, political and economic freedom are mutually reinforcing, a point emphasized by Friedman (1962, Ch. 1). On the other hand, people may vote for income redistribution and make the economy less efficient, with the relationship between redistribution and the wealth distribution not necessarily obvious (Peltzman 1980).

To measure democracy, we follow a procedure similar to Rodrik (1999), classifying Jaggers and Gurr's (1995) updated Polity IV measures (Marshall and Jaggers 2004) into two equally weighted groups, Categories A and B, and then using an equally weighted average of these groups.

Category A is an equally weighted average of six measures of institutionalized democracy, four of which reflect the selection and the accountability of the executive and two of which reflect the expression of political opinions. Category A's measures of institutional democracy include 1. the existence of institutionalized procedures for the transfer of executive power; 2. the extent to which subordinates have equal opportunity to become superordinates; 3. the choice of the executive by election, a dual process in which one office is elected and the other is hereditary, or by hereditary alone; 4. the extent to which decisions made by the executive are accountable to other authorities; 5. whether, when and how policy preferences can be expressed; and 6. whether alternative preferences for policy leadership can be expressed. Category A is an equally weighted ten-year average in which all components are normalized from zero to one, with higher values indicating more democracy. Category B measures the extent to which the political process is open to the general population. The two components contained in Category B are 1. the extent to which political expression is suppressed or curtailed and 2. the extent to which citizens can express political preferences, civil liberties are guaranteed, and people can participate in the political process. Both scores are normalized from zero to one with a higher score indicating a more democratic regime. Category B is a ten-year equally weighted average of these components.

The overall measure of democracy is an equally weighted average of the Category A and Category B measures of democracy. Different weighting schemes yield quantitatively similar results for the measure of democracy.

There is a positive and statistically significant relationship of both labor and capital productivity with this measure of democracy, which explains 39 percent of the cross-country variation in labor productivity and nine percent of the cross-country variation in capital productivity. Figure 6 shows the relationship of this measure of democracy with labor and capital productivities.

Productivity, Geography and Institutions – OLS Estimates

In this section, we allow the measures of geography and institutions to enter into a regression specification simultaneously to identify which variables appear to be robustly correlated with productivity.[13]

Table 1 shows the estimated coefficients in OLS regressions for labor and capital productivity.[14] Property rights are statistically significant and highly correlated with labor productivity in all specifications in Table 1. On the other hand, democracy is not statistically significant in any regression that includes property rights. The only geographic variable that is robustly related to labor productivity is the logarithm of the minimum distance to a large market.[15]

The regression results are very similar for capital productivity. Property rights are significantly related to capital productivity. Democracy, on the other hand, is not statistically significant at the ten percent level in any of the six regressions that includes property rights as a right-hand side variable. There is some evidence that the logarithm of the minimum distance to a major market is related to capital productivity.

The apparent insignificance of democracy could be due to using a rather arbitrarily equally weighted index of aspects of democracy, some of which are important and some of which are not. To examine this issue, we test whether the equally weighted index is consistent with the data. The Category B components are so collinear that

[13] The results are similar for log-linear estimates and fractional logit (Papke and Wooldridge 1996) specifications. Since it is not obvious which is the correct functional form, a simple functional form test of the log-linear specification compared to the levels specification revealed that the levels specification explains a higher fraction of the variation for capital, labor, and skilled and unskilled productivities.

[14] The reported standard errors are White heteroskedasticity-consistent standard errors.

[15] Latitude is statistically significant only if the logarithm of the minimum distance to a major market is not included in the regressions.

separate estimation is not feasible, and we examine only the Category A components separately. In the specification including all variables, an F-test for equating the six coefficients of the Category A components has a p-value of 93 percent and the R^2 increases only from 0.75 to 0.77 when the components are entered in separately. For the same regression for capital productivity, however, the p-value is 4 percent and the R^2 increases from 0.33 to 0.40 when the components are entered separately. The restriction imposed on the coefficients is marginally statistically significant but none of the individual estimated coefficients is statistically significant, quite possibly indicative of multicollinearity. Somewhat surprisingly, these tests suggest that the individual components of democracy are unimportant for labor productivity but are important for capital productivity. They also indicate that teasing any such possible relations from the data is likely to be complicated by correlations among the components. We do not pursue this line of research in this paper but discuss its implications in the conclusion.

Even though not statistically significant, the point estimates still could indicate that geography is economically important compared to institutions. We estimate the economic importance of geography and institutions by calculating whether a country would have higher productivity with the United Kingdom's geographic position or with its institutions.[16] The United Kingdom has attractive geographic features: direct access to the ocean, relatively short distances to large markets, low incidence of malaria, almost no desert, and a location in a relatively temperate zone. The United Kingdom also has relatively high scores on property rights and democracy. The property rights index is 0.933 compared to a mean of 0.624 and a median of 0.571

[16] Here, we are assuming the costs of switching geographic positions and institutions are zero and that institutions are independent of geography. Obviously, the costs of changing geography and institutions are far from zero. Institutions may well depend partly on geography (Acemoglu, Johnson and Robinson, 2001; Engerman and Sokoloff 2003).

and the democracy index is 0.902 compared to a mean of 0.614 and a median of 0.657.[17]

We compare the Philippines to the United Kingdom using the regressions for labor and capital productivity in Table 1 that include all variables. If the Philippines kept its institutions but had the United Kingdom's geography, the Philippines' labor productivity would increase from seven percent to 28 percent of the U.S.'s and capital productivity would increase from 25 percent to 26 percent of the U.S.'s. On the other hand, if the Philippines were to keep its physical position and adopted the same institutions as the United Kingdom, labor productivity would increase from seven percent to 75 percent and capital productivity would increase from 25 percent to 58 percent. In short, the Philippines' geography which, practically speaking is almost entirely exogenous to the Philippines, has far less effect on the Philippines' labor and capital productivities than does its protection of property rights and governance. The Philippines is hardly unique.

Consider Ethiopia, a country at roughly the same latitude as the Philippines but with other geographic characteristics that are worse than those of the Philippines – a much higher incidence of malaria, no port, and a location farther from large markets. A move to the United Kingdom's geographic position would increase Ethiopia's labor productivity from two percent to 33 percent and capital productivity from 25 percent to 35 percent. If Ethiopia adopted the United Kingdom's institutions, labor productivity would increase from two percent to 74 percent and capital productivity would increase from 25 percent to 61 percent.

Table 2 presents the results of this analysis by quintiles based on the countries' labor and capital productivities, with the numbers in the table being the mean of the values in each quintile. This table shows that adopting the United Kingdom's institutions

[17] For comparison, the property rights index for the United States is 0.947 and the democracy index is 0.902.

uniformly has a bigger impact on productivity than does adopting its geography. If all countries could move to the United Kingdom's geographic position, average labor productivity in the middle quintile would increase from 17 percent of the U.S.'s level to 36 percent. On the other hand, if the world were to adopt the United Kingdom's institutions, labor productivity in the middle quintile would increase to 66 percent of the U.S.'s level. The U.K.'s geography would increase the middle quintile's capital productivity by a trivial amount, but the U.K.'s institutions would increase it by 25 percentage points to 73 percent.

While better geography would help people in the Philippines and in much of the rest of the world, better institutions would help them quite a bit more. These results are similar to those in Rodrik, Subramanian and Trebbi (2004).[18] Our results also indicate that protection of property rights is more important than democracy.[19]

[18] This conclusion is not sensitive to the specification of the regressions. An ad hoc specification search is not particularly informative, although it can provide an indication of the sensitivity of results to specification. To this end, we ran all possible regressions of labor and capital productivity on any five of the ten variables. Property rights were statistically significant at the five percent level in all 126 regressions for labor productivity including property rights and in 56 of the 126 regressions for capital productivity including property rights. With property rights included, democracy was not statistically significant in any of the 56 regressions for each productivity. With property rights included, the only geography variables that are statistically significant in more than four regressions for either labor or capital productivity are distance to a major market for labor productivity and latitude for capital productivity; distance to a major market is statistically significant in 32 of the 56 regressions for labor productivity that include property rights and distance, and latitude is statistically significant in 18 of the 56 regressions for capital productivity that include property rights and latitude.

[19] As another measure of government efficiency, there are 2002 data on government regulation from the World Bank (2004). If the cross-sectional variation of this variable has changed little with time, these variable for 2002 are additional measures of government efficiency and may be related to 1997 productivity differences. As with democracy, these variables have little or no explanatory power once property rights are included in the regressions.

Institutions clearly can increase the relative well being of both workers and owners of physical capital, even given a disadvantageous location. Our estimates indicate that the Philippines still would not be as wealthy as the United Kingdom or the United States if the Philippines had better protection of property rights, but better protection of property rights would make their wealth dramatically higher than it is. The policy implications of these observations are far from immediate (Rodrik, Subramanian and Trebbi 2004, pp. 157-58), but they indicate a direction for further analysis.

Robustness to Endogeneity and Measurement Error

There are several reasons why the coefficients on the above estimates might be biased or inconsistent and, therefore, inaccurately reflect how institutions affect productivity and factor returns. The results may be sensitive to the specification of individual regressions. Causality may run from productivity to institutions; if more productive countries choose better institutions, the importance of institutions may be overstated. On the other hand, the indexes are noisy measures of institutions and these coefficients may suffer from the classic errors in variables bias toward zero.

To examine the importance of reverse causality and measurement error, we use instrumental variables for the institutional variables. The instruments are 1. the legal origin of a country, a set of dummy variables divided into alternatives of English, French, German and Scandinavian, Spanish and Socialist legal systems, 2. a dummy variable equal to one if a country ever had a Communist government, 3. a measure of ethnolinguistic fractionalization that measures the likelihood that two randomly matched people in a country speak the same language, and 4. the productive and market geography variables.

Table 3 reports the results from the instrumental variables (IV) estimation.[20] Prop-

[20]In all specification, the instrumenting variables pass the overidentification tests. These tests are

erty rights remain robustly related to labor productivity and the coefficient estimates are higher than in OLS regressions. The evidence for the importance of property rights for capital productivity is weaker than in the OLS regressions. Even so, the measure of property rights is statistically significant at the ten percent level in all but one of the IV specifications, and the democracy index never is statistically significant. As before, the distance to a large market is the only geographic variable that is robustly related to labor productivity. There also is some evidence that distance to a large market is related to capital productivity.

Productivity of Skilled and Unskilled Workers

The evidence above indicates that protection of property rights benefits both workers and owners of capital, but the evidence could be consistent with unskilled workers losing out. In that analysis we measure labor in terms of effective labor units and examine how institutions affect a worker with the average years of schooling and experience in that country. How do geography and institutions affect the productivity of workers with different skill levels?

To provide an initial answer to this question, we divide the labor force into workers with at most primary education and those who have completed some secondary or higher education. A practical problem arises because the Baier, Dwyer and Tamura (2006) data include no information on the years of schooling completed by workers who complete only primary school. As a result, these measures of productivity for unskilled and skilled workers are not for effective labor based on average education. Instead, they are the productivity of workers who have completed at most primary school and the productivity of workers who have completed more schooling.

Table 4 presents the regressions for the workers with no more than primary education and those with more education. This table shows that property rights are

available upon request.

more closely related to the productivity of both sets of workers than is geography. As before, the only geographic variable consistently associated with productivity is the logarithm of the minimum distance to a major market. The coefficient estimates suggest that better protection of property rights raises the productivity of skilled workers more than the productivity of workers with less education. At least without controlling for endogeneity, it seems to be the case that more property rights protection benefits skilled workers more than unskilled workers.

The differential effect for skilled and unskilled workers disappears when instrumental variables are used for property rights protection and for democracy. Table 5 shows the estimated equations using instrumental variables.[21] The coefficient on property rights is statistically different for skilled workers compared to unskilled workers only in the first equation with property rights and the market geography variables.

The apparent difference between the OLS and IV estimates may be explicable, perhaps being consistent with an exogenous effect of property rights and endogenous feedback that increases workers' education. Suppose that an exogenous increase in property rights protection occurs. By hypothesis, this will lead to an increase in the returns to both skilled and unskilled labor. This increases the accumulation of human capital, because returns to it have increased. Consequently, average education increases and there is an increase in the actual education of those who have completed more than primary school. While the average education of those with primary education also would increase, the low upper bound for primary education is consistent with a smaller effect on their average education. As a result, OLS using the number of workers with at most primary education and those with more indicates a greater effect of property rights on skilled workers' productivity because the OLS estimate includes this endogenous increase in years of schooling completed.

[21] In all specification, the instrumenting variables pass the overidentification tests. These tests are also available upon request.

We conclude that these results provide no support for concerns that protecting property rights favors one class of workers over another class of workers. In fact, the correlation between low skill productivity and income per worker is positive, 0.80.[22]

CONCLUSION

In the trade literature, there has been little work done to explain cross-country differences in productivities from Trefler's modification of the HOV model. We show that the measures of productivity based on the HOV model are highly correlated with productivity estimated by development accounting. Hence, our research ties the productivities based on trade into the literature on total factor productivity, which has substantial evidence on the effects of institutions and geography on economic growth.

We find little evidence that geography is reliably associated with productivity, especially in terms of climate and related factors. We do find that distance from a large market has a consistent effect on productivity, but this effect is of secondary importance compared to institutions.

We find that more protection of private property rights is correlated with higher productivity of capital and labor and that the higher productivity of labor reflects higher productivity of both skilled and unskilled workers. Once property rights are included in the estimated equations, the overall democracy index plays little direct role in influencing factor productivity. This conclusion is the same as that reached by many others, as the summary by Gerring, Bond and Barndt (2004) indicates. On

[22] Caselli and Coleman (2004) find a negative relationship between the productivity of unskilled workers and output per worker. In their framework, countries choose "appropriate technology"; that is, they can adopt and employ technologies that make one type of workers more productive, but this comes at the expense of making the other type less productive. In our framework, there is no trade-off between the productivity of worker types and the correlation can be positive or negative.

the other hand, we find that the restriction of the democracy index to an equally weighted average is inconsistent with the data for capital productivity. If all of the coefficients on the individual components were zero, an equally weighted average of unimportant factors would be as good as any other weighted average of the components. For capital productivity, the restriction to an equally weighted average has a p-value of 4 percent, statistically significant and therefore marginally inconsistent with no effect of any component. Unfortunately, there is substantial correlation of the various components. Sorting out whether the statistical significance is happenstance or indicative of an interesting relationship is not trivial. Gerring, Bond and Barndt (2004) and Acemoglu and Johnson (2005) present interesting evidence on possible links of political organization and economic growth. We currently are pursuing this issue with more data over a longer period. In the meantime, it can be said that private property rights are important, and it is uncertain whether democratic institutions affect productivity independently of property rights.

Beyond this important issue, there are numerous directions that can be pursued to clarify the effect of institutions on productivity. Important questions are how quickly institutional change translates into changes in measured productivity and quantifying whether institutions have an effect on factor returns independent of the effect on productivity, as Rodrik (1999) suggests. Embedding trade into a model in which there is corruption as in Anderson and Marcouiller (2002) or Anderson and Bandiera (2003) or where countries face a trade-off among different levels of efficiency as in Caselli and Coleman (2004) would go a long way in aiding our understanding of how institutions influence productivity and efficiency.

We leave many other unanswered questions. Most glaringly, why do some countries fail to protect property rights given that both owners of physical and human capital gain from better institutions? We do not doubt that the answer is that some people in these countries would lose if property rights were protected. While it may seem plausible to say “The ruling elite would lose and therefore prevents change”, it is an uninformative truism. This merely puts a name on the answer without providing any way of identifying these people or how they would be affected.

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Table 1

Relationship of Factor Productivities with Institutions and Geography

OLS Estimates

(Labor Productivity)

Right-hand-side Variable	Regressions								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Property Rights	1.414[a]		1.304[a]	1.434[a]		1.406[a]	1.292[a]		1.263[a]
	(0.180)		(0.233)	(0.178)		(0.210)	(0.200)		(0.223)
Democracy		0.664[a]	0.152		0.610[b]	0.069		0.502[b]	0.074
		(0.140)	(0.138)		(0.249)	(0.189)		(0.238)	(0.179)
Proximity to Large Markets	-0.062[c]	-0.180[a]	-0.060[c]				-0.124[a]	-0.247[a]	-0.124[a]
	(0.033)	(0.033)	(0.033)				(0.043)	(0.050)	(0.044)
Fraction of Land Near Coast	0.124	0.008	0.089				0.034	-0.070	0.026
	(0.096)	(0.140)	(0.102)				(0.109)	(0.147)	(0.109)
Landlocked Dummy Variable	0.080	0.072	0.078				0.041	0.031	0.043
	(0.081)	(0.095)	(0.079)				(0.082)	(0.108)	(0.084)
Logarithm of Land Area	-0.008	-0.016	-0.011				-0.026	-0.037	-0.027
	(0.027)	(0.044)	(0.028)				(0.029)	(0.046)	(0.029)
Latitude				0.000	0.004[b]	0.000	-0.003[c]	-0.004	-0.003
				(0.001)	(0.002)	(0.001)	(0.002)	(0.003)	(0.002)
Fraction of Land in Tropical Desert				-0.107	-0.144	-0.085	0.008	0.037	0.031
				(0.081)	(0.156)	(0.103)	(0.101)	(0.150)	(0.113)
Fraction of Land in Temperate Desert				-0.058	0.318	-0.030	0.092	0.261	0.128
				(0.424)	(0.544)	(0.446)	(0.421)	(0.464)	(0.427)
Fraction of Population with Malaria				-0.144[b]	-0.206	-0.121	-0.097	-0.137	-0.074
				(0.060)	(0.151)	(0.095)	(0.065)	(0.134)	(0.092)
Constant	0.027	1.586[b]	0.042	-0.472[a]	0.006	-0.507[a]	0.939	2.615[a]	0.920
	(0.412)	(0.667)	(0.406)	(0.118)	(0.225)	(0.149)	(0.632)	(0.988)	(0.647)
R-squared	0.73	0.55	0.73	0.71	0.48	0.71	0.75	0.58	0.75

Heteroskedasticity-consistent standard errors in parentheses

Statistically significant at 1 percent is denoted by “a”, 5 percent by “b”, 10 percent by “c”.

Table 1 (Cont'd)

Relationship of Factor Productivities with Institutions and Geography

OLS Estimates

(Capital Productivity)

Right-hand-side Variable	Regressions								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Property Rights	0.571[a]		0.599[a]	0.772[a]		0.743[a]	0.639[a]		0.623[a]
	(-0.124)		(-0.147)	(-0.145)		(-0.155)	(-0.165)		(-0.175)
Democracy		0.196	-0.039		0.355[b]	0.069		0.253	0.042
		(0.119)	(0.132)		(0.167)	(0.149)		(0.175)	(0.162)
Proximity to Large Markets	-0.004	-0.059[b]	-0.005				-0.113[b]	-0.173[a]	-0.112[b]
	(0.027)	(0.026)	(0.028)				(0.048)	(0.047)	(0.048)
Fraction of Land Near Coast	-0.029	-0.057	-0.020				-0.069	-0.121	-0.074
	(0.108)	(0.118)	(0.110)				(0.120)	(0.127)	(0.121)
Landlocked Dummy Variable	-0.073	-0.076	-0.073				-0.128	-0.133[c]	-0.126
	(0.077)	(0.077)	(0.077)				(0.081)	(0.079)	(0.082)
Logarithm of Land Area	-0.015	-0.016	-0.014				-0.028	-0.033	-0.028
	(0.017)	(0.019)	(0.017)				(0.018)	(0.021)	(0.019)
Latitude				-0.001	0.001	-0.001	-0.005[b]	-0.005[b]	-0.005[b]
				(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Fraction of Land in Tropical Desert				-0.097	-0.107	-0.076	-0.018	-0.002	-0.004
				(0.067)	(0.107)	(0.086)	(0.082)	(0.121)	(0.103)
Fraction of Land in Temperate Desert				-0.201	0.011	-0.173	-0.238	-0.152	-0.217
				(0.365)	(0.372)	(0.367)	(0.332)	(0.326)	(0.350)
Fraction of Population with Malaria				0.098	0.077	0.122	0.126	0.108	0.139
				(0.085)	(0.111)	(0.096)	(0.085)	(0.113)	(0.102)
Constant	0.428	1.133[a]	0.425	0.062	0.298[b]	0.027	1.476[b]	2.301[a]	1.465[b]
	(0.364)	(0.369)	(0.367)	(0.111)	(0.144)	(0.135)	(0.622)	(0.578)	(0.626)
R-squared	0.23	0.14	0.23	0.27	0.11	0.27	0.33	0.23	0.33

Heteroskedasticity-consistent standard errors in parentheses

Statistically significant at 1 percent is denoted by "a", 5 percent by "b", 10 percent by "c".

Table 2
Effect of the United Kingdom's Geography and Institutions on Productivities
Estimates by Quintile Based on OLS Estimates

	Bottom Quintile (Percent)	Fourth Quintile (Percent)	Middle Quintile (Percent)	Second Quintile (Percent)	Top Quintile (Percent)
Labor Productivity					
Productivity with UK's Institutions	69.37	71.37	79.54	78.76	91.70
Productivity with UK's Geography	33.77	34.17	49.58	67.12	95.96
Actual Labor Productivity	2.98	6.44	17.35	47.84	108.00
Capital Productivity					
Productivity with UK's Institutions	71.85	71.75	76.19	76.00	78.77
Productivity with UK's Geography	46.38	52.71	51.67	63.14	65.84
Actual Capital Productivity	22.79	35.37	47.78	67.56	95.13

Table 3

Relationship of Factor Productivities with Institutions and Geography

IV Estimates

(Labor Productivity)

Right-hand-side Variable	Regressions								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Property Rights	1.834[a]		1.319[c]	2.143[a]		1.781[a]	1.915[a]		1.529[a]
	(0.361)		(0.725)	(0.375)		(0.475)	(0.382)		(0.504)
Democracy		2.397[b]	0.871		1.985[a]	0.725		2.013[a]	0.751
		(1.033)	(1.014)		(0.671)	(0.565)		(0.755)	(0.638)
Proximity to Large Markets	-0.006	0.002	0.017				-0.053	-0.173[b]	-0.06
	(0.054)	(0.120)	(0.067)				(0.066)	(0.086)	(0.067)
Fraction of Land Near Coast	0.107	-0.442	-0.099				0.062	-0.210	-0.025
	(0.108)	(0.347)	(0.269)				(0.120)	(0.198)	(0.141)
Landlocked Dummy Variable	0.080	0.047	0.068				0.055	0.086	0.074
	(0.087)	(0.179)	(0.100)				(0.094)	(0.148)	(0.095)
Logarithm of Land Area	-0.011	-0.057	-0.028				-0.025	-0.067[c]	-0.041
	(0.020)	(0.048)	(0.031)				(0.023)	(0.039)	(0.027)
Latitude				-0.002	0.003[c]	-0.001	-0.003	-0.002	-0.002
				(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
Fraction of Land in Tropical Desert				0.028	0.389	0.240	0.081	0.582[c]	0.307
				(0.152)	(0.329)	(0.226)	(0.142)	(0.345)	(0.239)
Fraction of Land in Temperate Desert				-0.136	0.808	0.162	0.136	1.044	0.498
				(0.582)	(0.904)	(0.636)	(0.567)	(0.968)	(0.647)
Fraction of Population with Malaria				0.014	0.379	0.241	0.015	0.439	0.232
				(0.112)	(0.306)	(0.211)	(0.103)	(0.312)	(0.211)
Constant	-0.643	-0.233	-0.735	-0.945[a]	-1.077[b]	-1.274[a]	-0.089	1.245	-0.133
	(0.680)	(1.311)	(0.774)	(0.256)	(0.534)	(0.365)	(0.871)	(1.163)	(0.874)
R-squared	0.70			0.64	0.19		0.70	0.27	

Heteroskedasticity-consistent standard errors in parentheses

Statistically significant at 1 percent is denoted by “a”, 5 percent by “b”, 10 percent by “c”.

Table 3 (Cont'd)
Relationship of Factor Productivities with Institutions and Geography
IV Estimates
(Capital Productivity)

Right-hand-side Variable	Regressions (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Property Rights	0.847^{b}		1.163^{c}	1.053^{a}		1.022^{b}	0.921^{b}		1.045^{b}
	(0.381)		(0.693)	(0.352)		(0.421)	(0.374)		(0.472)
Democracy		0.811	-0.534		0.786^{c}	0.063		0.621	-0.241
		-0.626	-0.970		-0.470	-0.501		-0.513	-0.598
Proximity to Large Markets	0.032	0.005	0.018				-0.080	-0.155^{a}	-0.078
	(0.057)	(0.073)	(0.064)				(0.065)	(0.058)	(0.062)
Fraction of Land Near Coast	-0.041	-0.217	0.085				-0.056	-0.155	-0.029
	(0.114)	(0.210)	(0.257)				(0.118)	(0.134)	(0.132)
Landlocked Dummy Variable	-0.074	-0.084	-0.066				-0.121	-0.119	-0.127
	(0.092)	(0.109)	(0.095)				(0.092)	(0.101)	(0.089)
Logarithm of Land Area	-0.016	-0.030	-0.005				-0.027	-0.041	-0.023
	(0.021)	(0.029)	(0.029)				(0.023)	(0.027)	(0.025)
Latitude				-0.002	0.000	-0.002	-0.005	-0.005^{b}	-0.005^{b}
				(0.002)	(0.001)	(0.002)	(0.002)**	(0.002)	(0.002)
Fraction of Land in Tropical Desert				-0.044	0.060	-0.025	0.016	0.132	-0.057
				(0.143)	(0.231)	(0.201)	(0.139)	(0.234)	(0.224)
Fraction of Land in Temperate Desert				-0.233	0.164	-0.206	-0.218	0.039	-0.334
				(0.546)	(0.634)	(0.565)	(0.557)	(0.657)	(0.606)
Fraction of Population with Malaria				0.161	0.260	0.181	0.177	0.248	0.107
				(0.105)	(0.215)	(0.187)	(0.101)*	(0.212)	(0.198)
Constant	-0.012	0.487	0.044	-0.126	-0.041	-0.154	1.011	1.967^{b}	1.025
	(0.716)	(0.795)	(0.740)	(0.240)	(0.374)	(0.324)	(0.855)	(0.790)	(0.819)

Heteroskedasticity-consistent standard errors in parentheses
Statistically significant at 1 percent is denoted by "a", 5 percent by "b", 10 percent by "c".

Table 4

Relationship of Skilled and Unstilled Workers' Productivity with Institutions and Geography

OLS Estimates

(Primary Education)

Right-hand-side Variable	Regressions								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Property Rights	0.643[a]		0.638[a]	0.841[a]		0.807[a]	0.657[a]		0.648[a]
	(0.164)		(0.153)	(0.132)		(0.126)	(0.180)		(0.174)
Democracy		0.257[b]	0.006		0.392[a]	0.082		0.241[c]	0.021
		(0.104)	(0.061)		(0.139)	(0.087)		(0.136)	(0.083)
Proximity to Large Markets	-0.096[a]	-0.154[a]	-0.096[a]				-0.118	-0.181[b]	-0.118
	(0.032)	(0.028)	(0.032)				(0.084)	(0.074)	(0.085)
Fraction of Land Near Coast	0.1	0.059	0.098				0.093	0.042	0.091
	(0.083)	(0.106)	(0.091)				(0.067)	(0.084)	(0.069)
Landlocked Dummy Variable	0.038	0.035	0.038				0.026	0.02	0.027
	(0.053)	(0.058)	(0.053)				(0.042)	(0.047)	(0.042)
Logarithm of Land Area	0.023[c]	0.021	0.023				0.022[c]	0.017	0.022[c]
	(0.014)	(0.018)	(0.014)				(0.012)	(0.017)	(0.012)
Latitude				0.002[b]	0.004[a]	0.002[b]	-0.001	-0.001	-0.001
				(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.003)
Fraction of Land in Tropical Desert				-0.087[b]	-0.095	-0.062	-0.048	-0.038	-0.041
				(0.042)	(0.082)	(0.049)	(0.078)	(0.094)	(0.076)
Fraction of Land in Temperate Desert				0.176	0.408	0.209	-0.016	0.063	-0.006
				(0.280)	(0.358)	(0.273)	(0.221)	(0.252)	(0.227)
Fraction of Population with Malaria				0.004	-0.017	0.032	0.035	0.009	0.041
				(0.034)	(0.070)	(0.050)	(0.035)	(0.061)	(0.044)
Constant	0.176	0.932[a]	0.176	-0.401[a]	-0.148	-0.443[a]	0.371	1.235	0.365
	(0.226)	(0.293)	(0.226)	(0.082)	(0.108)	(0.104)	(0.838)	(0.745)	(0.851)
R-squared	0.63	0.53	0.63	0.57	0.39	0.57	0.64	0.54	0.64

Heteroskedasticity-consistent standard errors in parentheses

Statistically significant at 1 percent is denoted by “a”, 5 percent by “b”, 10 percent by “c”.

Table 4 (Cont'd)

Relationship of Skilled and Unstilled Workers' Productivity with Institutions and Geography

OLS Estimates

(Secondary Education)

Right-hand-side Variable	Regressions								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Property Rights	1.311[a]		1.182[a]	1.331[a]		1.299[a]	1.177[a]		1.139[a]
	(0.164)		(0.213)	(0.169)		(0.196)	(0.182)		(0.201)
Democracy		0.643[a]	0.179		0.578[b]	0.078		0.481[b]	0.095
		-0.131	-0.100		-0.223	-0.200		-0.216	-0.200
Proximity to Large Markets	-0.053[c]	-0.160[a]	-0.051[c]				-0.129[a]	-0.240[a]	-0.129[a]
	(0.029)	(0.030)	(0.029)				(0.036)	(0.044)	(0.036)
Fraction of Land Near Coast	0.110	-0.004	0.068				0.007	-0.091	-0.004
	(0.093)	(0.134)	(0.099)				(0.107)	(0.141)	(0.107)
Landlocked Dummy Variable	0.094	0.086	0.091				0.046	0.038	0.049
	(0.080)	(0.094)	(0.078)				(0.080)	(0.103)	(0.082)
Logarithm of Land Area	-0.005	-0.013	-0.009				-0.025	-0.035	-0.027
	(0.026)	(0.041)	(0.027)				(0.027)	(0.043)	(0.028)
Latitude				0.000	0.003[b]	0.000	-0.004[b]	-0.004[c]	-0.004[b]
				(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)
Fraction of Land in Tropical Desert				-0.116	-0.146	-0.092	-0.008	0.027	0.022
				(0.073)	(0.138)	(0.092)	(0.089)	(0.134)	(0.103)
Fraction of Land in Temperate Desert				-0.040	0.313	-0.008	0.078	0.244	0.124
				(0.410)	(0.518)	(0.423)	(0.409)	(0.442)	(0.407)
Fraction of Population with Malaria				-0.139[b]	-0.191	-0.113	-0.101	-0.128	-0.071
				(0.059)	-0.135	-0.086	-0.062	-0.121	-0.085
Constant	-0.029	1.387[b]	-0.012	-0.417[a]	0.017	-0.457[a]	1.048[c]	2.553[a]	1.024[c]
	(0.385)	(0.630)	(0.376)	(0.114)	(0.202)	(0.137)	(0.568)	(0.899)	(0.581)
R-squared	0.71	0.55	0.72	0.70	0.46	0.70	0.74	0.58	0.74

Heteroskedasticity-consistent standard errors in parentheses

Statistically significant at 1 percent is denoted by "a", 5 percent by "b", 10 percent by "c".

Table 5

Relationship of Skilled and Unstilled Workers' Productivity with Institutions and Geography

IV Estimates

(Primary Education)

Right-hand-side Variable	Regressions								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Property Rights	1.446[a]		1.441[b]	1.560		1.457[a]	1.475[a]		1.459[a]
	(0.455)		(0.574)	(0.397)		(0.382)	(0.437)		(0.419)
Democracy		1.675[b]	0.008		1.237[a]	0.206		1.234[a]	0.030
		(0.803)	(0.803)		(0.310)	(0.455)		(0.461)	(0.531)
Proximity to Large Markets	0.011	-0.006	0.011				-0.024	-0.132	-0.024
	(0.059)	(0.081)	(0.053)				(0.094)	(0.085)	(0.055)
Fraction of Land Near Coast	0.067	-0.310	0.065				0.130	-0.050	0.127
	(0.111)	(0.274)	(0.213)				(0.097)	(0.160)	(0.117)
Landlocked Dummy Variable	0.038	0.015	0.038				0.044	0.056	0.045
	(0.068)	(0.137)	(0.079)				(0.064)	(0.083)	(0.079)
Logarithm of Land Area	0.019	-0.012	0.019				0.023	-0.003	0.022
	(0.019)	(0.041)	(0.024)				(0.016)	(0.037)	(0.022)
Latitude				0.000	0.004[a]	0.000	0.000	0.000	0.000
				(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.002)
Fraction of Land in Tropical Desert				0.050	0.232[c]	0.110	0.049	0.321[b]	0.058
				(0.083)	(0.121)	(0.182)	(0.086)	(0.157)	(0.199)
Fraction of Land in Temperate Desert				0.096	0.709[c]	0.181	0.042	0.578	0.056
				(0.308)	(0.391)	(0.512)	(0.314)	(0.458)	(0.538)
Fraction of Population with Malaria				0.165[c]	0.342[b]	0.230	0.181[b]	0.387[b]	0.190
				(0.095)	(0.144)	(0.169)	(0.091)	(0.167)	(0.176)
Constant	-1.105	-0.558	-1.106[c]	-0.881[a]	-0.813[a]	-0.974[a]	-0.979	0.334	-0.980
	(0.728)	(0.876)	(0.612)	(0.261)	(0.239)	(0.294)	(1.067)	(0.998)	(0.727)

Heteroskedasticity-consistent standard errors in parentheses

Statistically significant at 1 percent is denoted by "a", 5 percent by "b", 10 percent by "c".

Table 5 (Cont'd)

Relationship of Skilled and Unstilled Workers' Productivity with Institutions and Geography

IV Estimates

(Secondary Education)

Right-hand-side Variable	Regressions								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Property Rights	1.505[a]		0.942	1.843[a]		1.426[a]	1.603[a]		1.102[b]
	(-0.329)		-0.689	(-0.363)		(-0.446)	(-0.362)		(-0.491)
Democracy		2.041[a]	0.951		1.845[a]	0.836		1.885[a]	0.976
		(0.759)	(0.964)		(0.399)	(0.531)		(0.553)	(0.622)
Proximity to Large Markets	-0.027	-0.013	-0.002				-0.080	-0.171[a]	-0.090
	(0.044)	(0.082)	(0.063)				(0.050)	(0.053)	(0.065)
Fraction of Land Near Coast	0.102	-0.368	-0.123				0.026	-0.220	-0.087
	(0.096)	(0.273)	(0.255)				(0.109)	(0.239)	(0.137)
Landlocked Dummy Variable	0.094	0.066	0.081				0.056	0.089	0.080
	(0.080)	(0.155)	(0.095)				(0.081)	(0.142)	(0.093)
Logarithm of Land Area	-0.007	-0.046	-0.026				-0.025	-0.064	-0.045[c]
	-0.024	-0.057	-0.029				-0.024	-0.071	(-0.026)
Latitude				-0.002	0.003	-0.001	-0.003[b]	-0.003	-0.003
				-0.002	-0.002	-0.002	(-0.002)	-0.003	-0.002
Fraction of Land in Tropical Desert				-0.018	0.345[b]	0.226	0.042	0.534[b]	0.336
				(0.102)	(0.172)	(0.213)	(0.097)	(0.249)	(0.233)
Fraction of Land in Temperate Desert				-0.096	0.765	0.247	0.108	0.972	0.579
				(0.420)	(0.523)	(0.598)	(0.420)	(0.612)	(0.630)
Fraction of Population with Malaria				-0.025	0.347[c]	0.237	-0.024	0.407[c]	0.258
				(0.098)	(0.184)	(0.198)	(0.090)	(0.231)	(0.206)
Constant	-0.338	-0.080	-0.439	-0.759[a]	-0.980[a]	-1.138[a]	0.345	1.279	0.287
	(0.605)	(1.008)	(0.735)	(0.242)	(0.293)	(0.343)	(0.745)	(1.105)	(0.852)

Heteroskedasticity-consistent standard errors in parentheses

Statistically significant at 1 percent is denoted by "a", 5 percent by "b", 10 percent by "c".

Figure 1: Labor and Capital Productivity

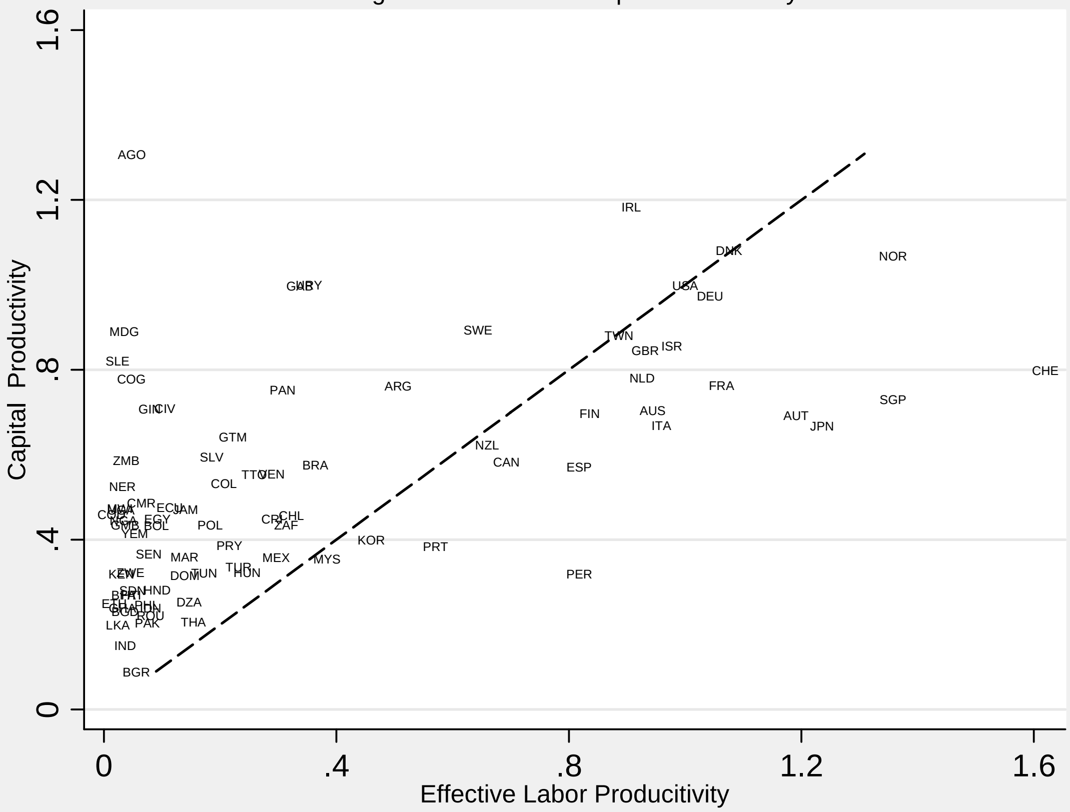


Figure 2: Total Factor Productivity and Trade Productivity

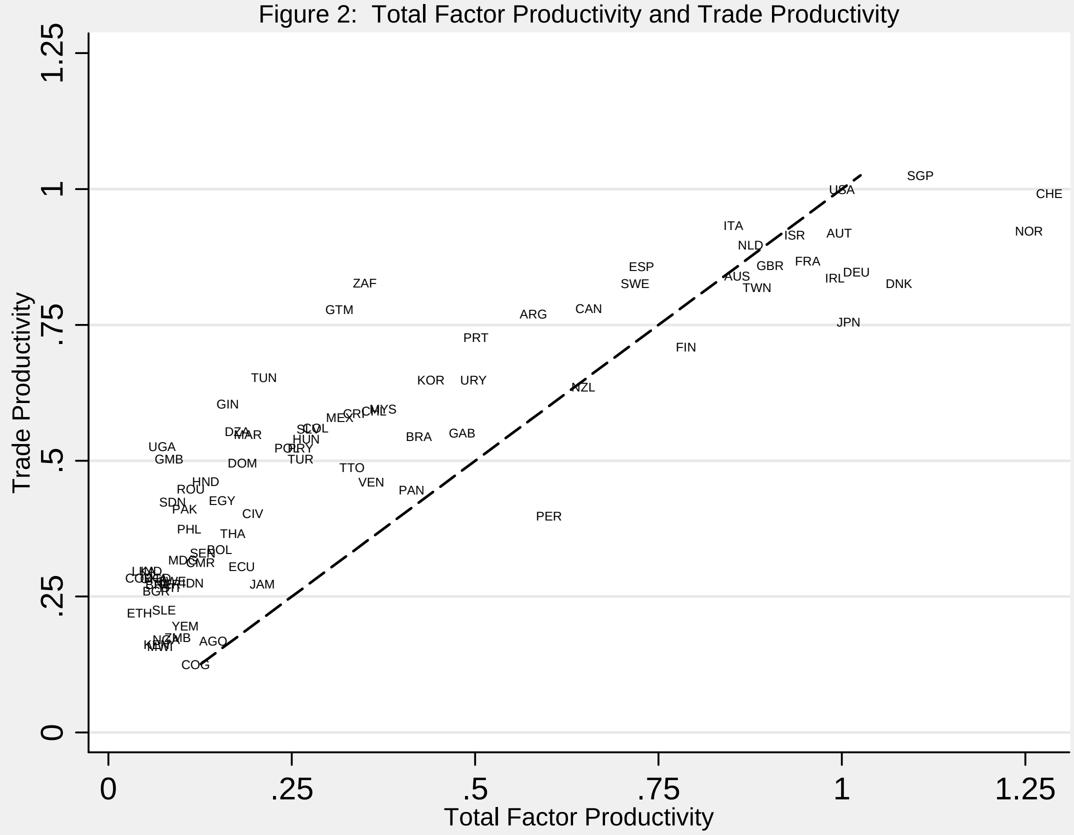


Figure 3: Productive Geography, Labor, and Capital Productivity

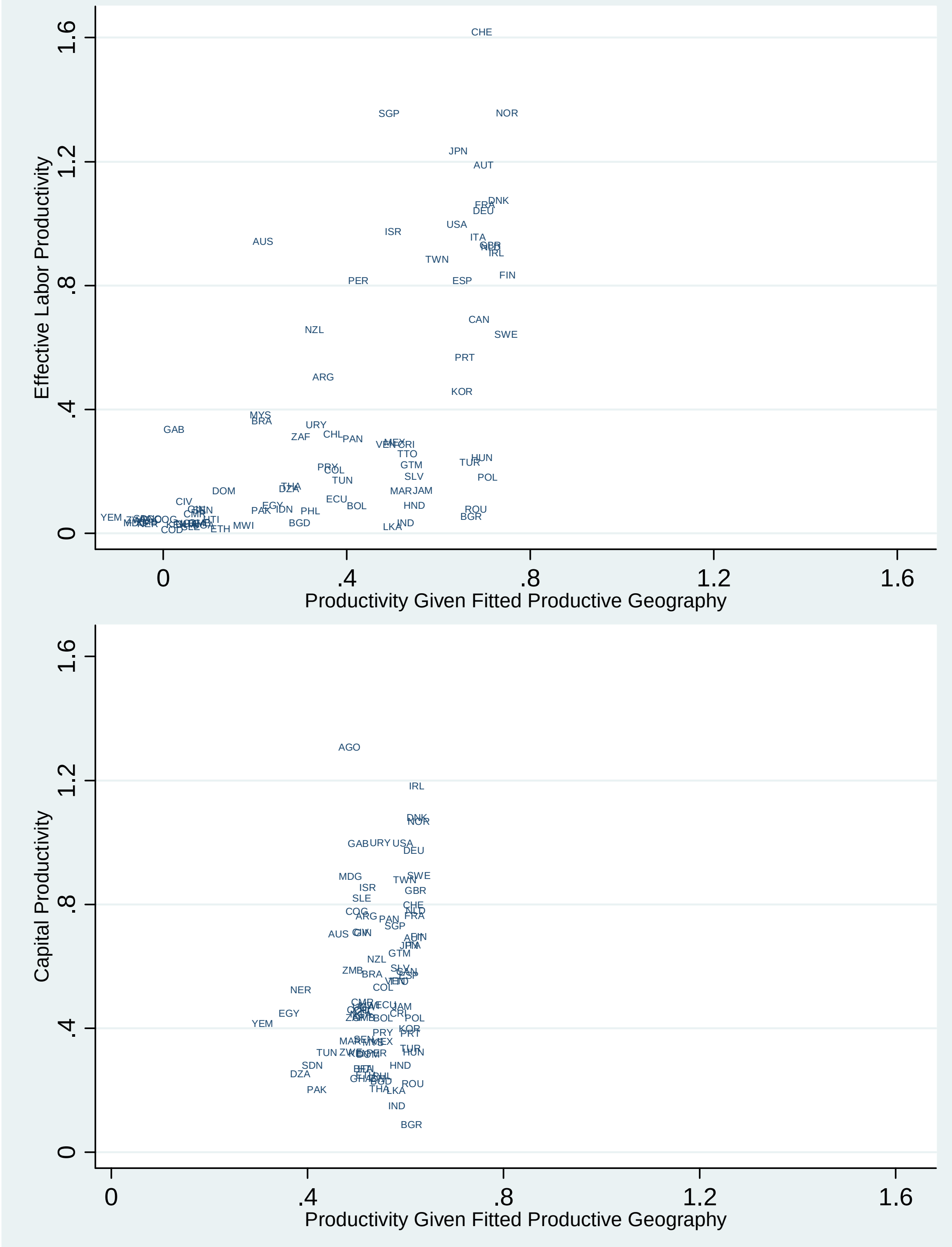


Figure 4: Market Geography, Labor, and Capital Productivity

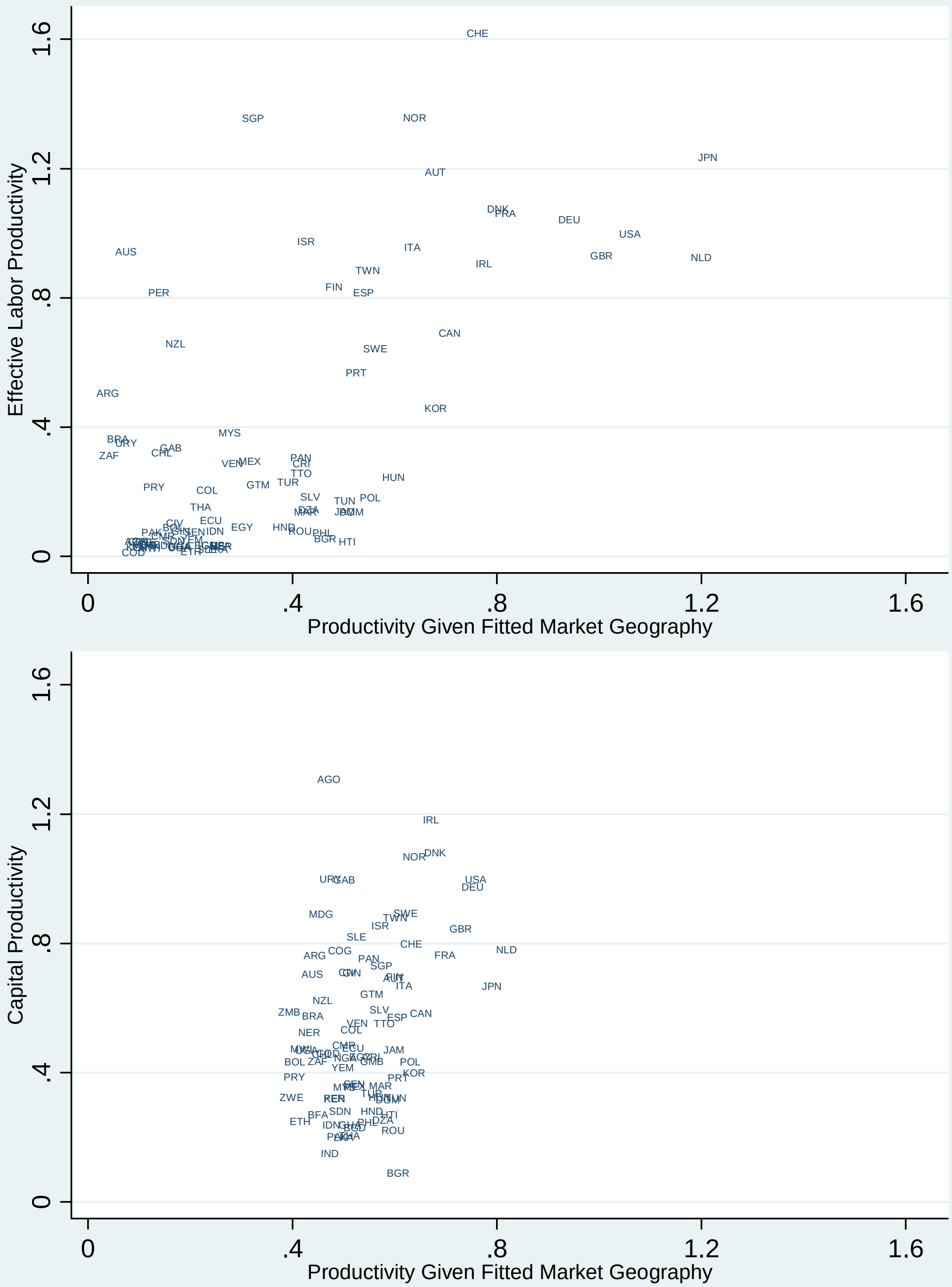


Figure 5: Property Rights, Labor, and Capital Productivity

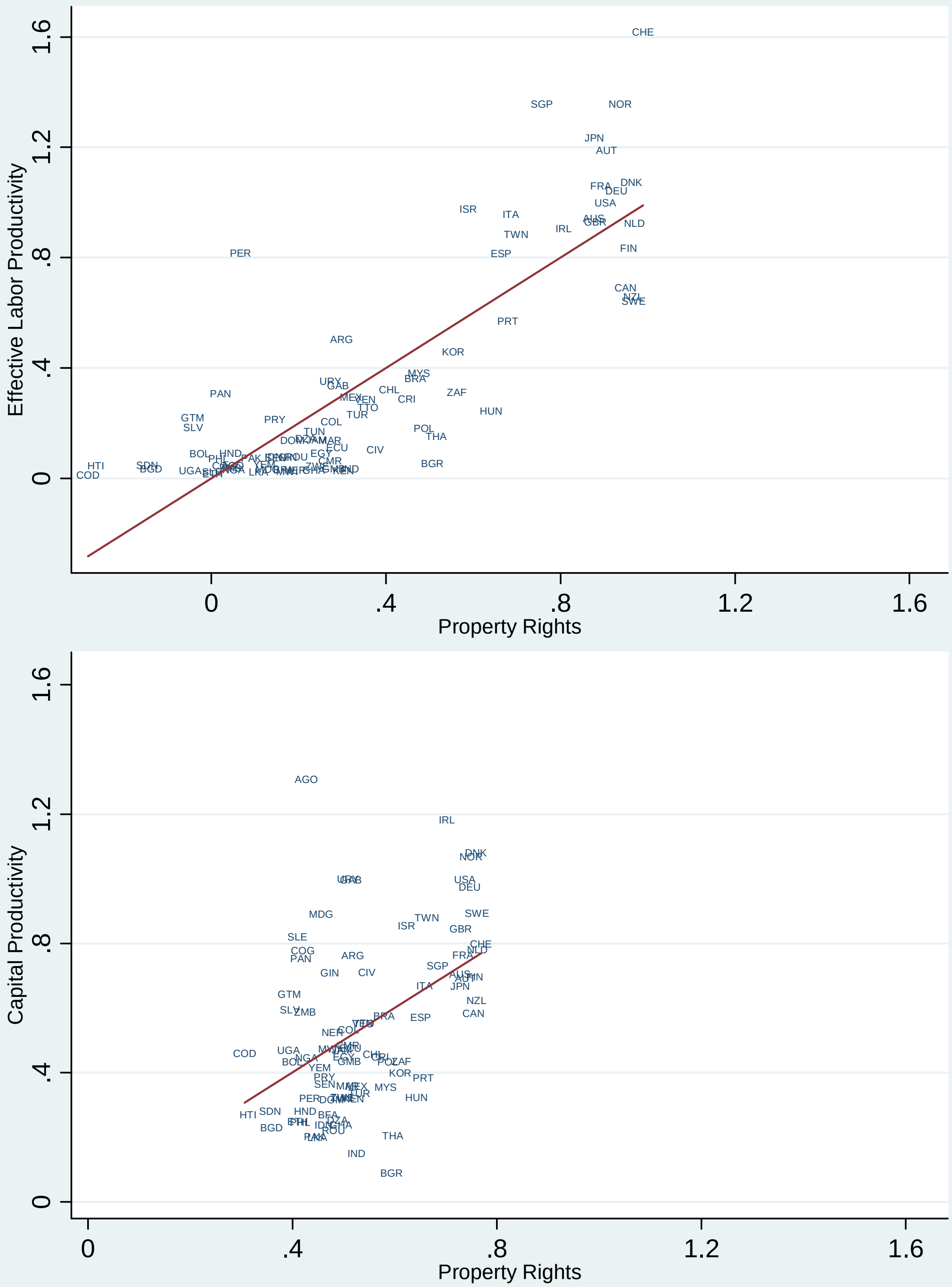
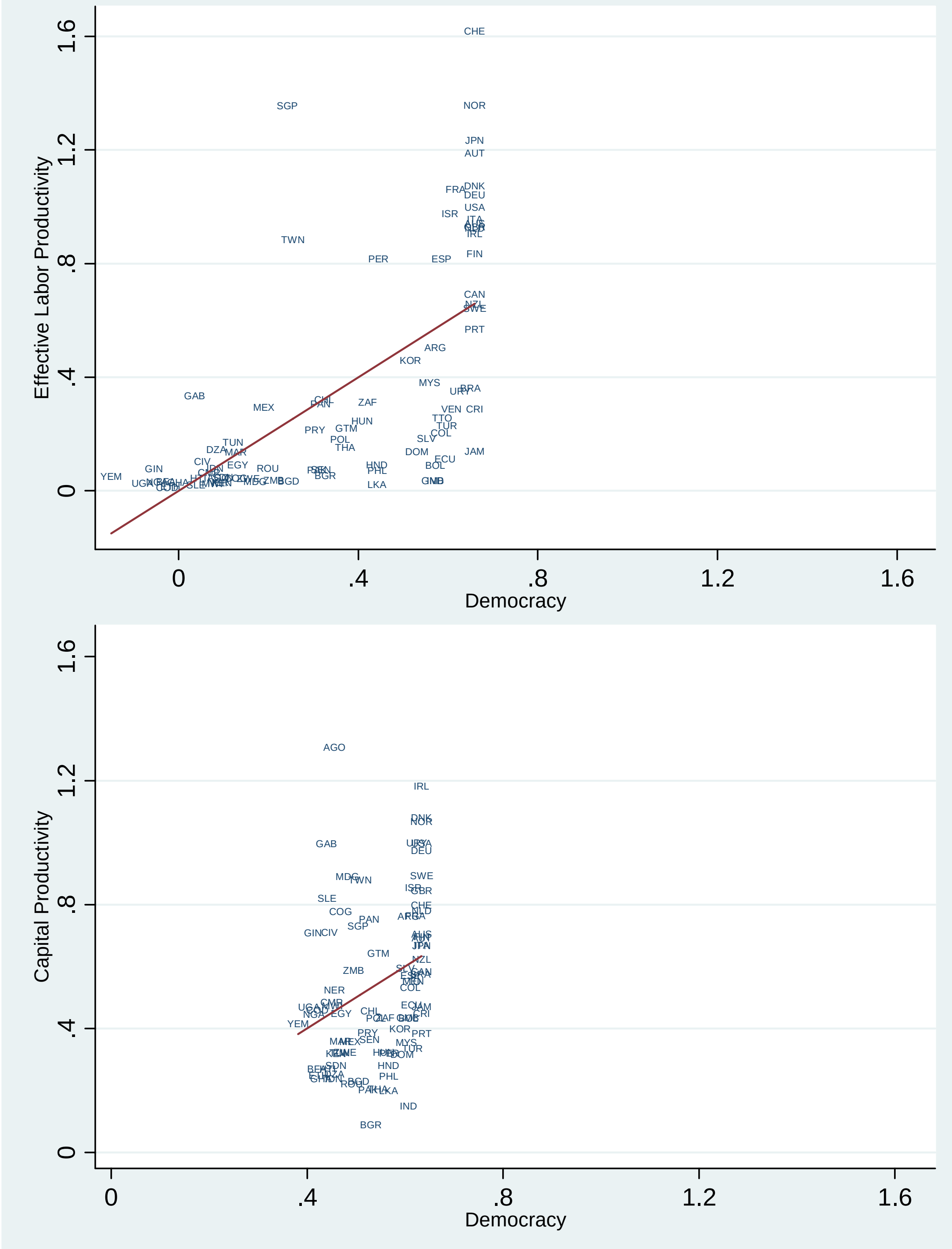


Figure 6: Democracy, Labor, and Capital Productivity



Appendix Table 1
Countries (84) Included in Empirical Analysis

Algeria	Haiti	Senegal
Angola	Honduras	Sierra Leone
Argentina	Hungary	Singapore
Australia	India	South Africa
Austria	Indonesia	Spain
Bangladesh	Ireland	Sri Lanka
Bolivia	Israel	Sudan
Brazil	Italy	Sweden
Bulgaria	Ivory Coast	Switzerland
Burkina Faso	Jamaica	Tawain
Cameroon	Japan	Thailand
Canada	Kenya	Trinidad and Tobago
Chile	Korea, Rep.	Tunisia
Colombia	Madagascar	Turkey
Congo	Malawi	Uganda
Congo, Democratic Republic	Malaysia	United Kingdom
Costa Rica	Mexico	United States
Denmark	Morocco	Uruguay
Dominican Republic	Netherlands	Venezuela, RB
Ecuador	New Zealand	Yemen, Rep.
Egypt, Arab Rep.	Niger	Zambia
El Salvador	Nigeria	Zimbabwe
Ethiopia	Norway	
Finland	Pakistan	
France	Panama	
Gabon	Paraguay	
Gambia	Peru	
Germany	Philippines	
Ghana	Poland	
Guatemala	Portugal	
Guinea	Romania	

Appendix Table 2
Industries (32) Included in Empirical Analysis

Industry	BEA Code
Food and Kindred Products	14
Tobacco	15
Apparel	16, 17 18, 19
Pulp, Paper and Allied Products	24, 25
Printing and Publishing	26A, 26B
Drugs	29A
Soaps, Cleaners and Toilet Goods	29B
Agricultural Chemicals	27B
Industrial Chemicals and Synthetics	27A
Rubber and Plastic Products	32
Primary Metals	37
Non-Ferrous Metals	38
Fabricated Metals	38, 40,41,42
Farm Machines	44,45
Construction, Mining Equipment	46
Computers	51
Other Non-Electrical Equipment	43, 47,48,49,50,52
Household Appliances	54
Household Video	56
Electrical Components	57
Other Electrical	53,55,58
Motor Vehicle	59A, 59b
Other Transport	60, 61
Lumber, Wood, Furniture	20, 21, 22, 23
Stone and Clay	36
Glass	35
Instruments	62, 63
Other Manufactures	64
Agriculture	01, 02, 03, 04
Mining	05, 06, 07, 09, 10
Gas/Oil	08
Construction	11, 12