Trade and Sectoral Productivity

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Abstract

What do we know about cross country differences in sectoral productivity? Not much, even though they are at the heart of trade theory and many models of growth and development. In this paper we try to fill this gap by using a Hybrid-Ricardo-Heckscher-Ohlin trade model and bilateral sectoral trade data to overcome the data problem that has limited previous studies, which have used input and output data to back out productivities to the sample of OECD countries. We provide a comparable set of sectoral productivities for 24 manufacturing sectors and more than sixty countries at all stages of development. Our results show that TFP differences in manufacturing sectors between rich and poor countries are substantial and far more pronounced in skill intensive sectors. We also apply our productivity estimates to test trade models and theories on development that have implications for the patterns of sectoral productivities across countries.

1 Introduction

Differences in sectoral total factor productivity (TFP) across countries are at the heart both of trade theory and of many theories on growth and development. The Ricardian approach to international trade emphasizes those productivity differences as the main reason for cross country flows of goods, while the growth literature analyzes factors such as adequate technologies (Acemoglu and Zilibotti (2001)), external financial dependence (Rajan and Zingales (1998)),and institutions (Acemoglu et al. (2007)) that have clear predictions on the form of sectoral differences in total factor productivity. Nevertheless, due to data limitations, very little is known about the form of sectoral productivity differentials across countries outside the industrialized world, which makes it difficult to test those theories.

In this paper we try to overcome the data problem faced by the traditional approach of TFP measurement, which requires comparable data on outputs and inputs at the sectoral level by using trade theory and data to measure sectoral total factor productivities. To our knowledge we are the first to provide a comparable and - as we will argue - reliable set of sectoral TFPs for twenty four manufacturing sectors in more than sixty countries at all stages of development. To this aim we extend the Romalis (2004) model - that combines Heckscher-Ohlin trade with trade due to increasing returns and love for variety - to sectoral differences in total factor productivity and many asymmetric countries. In this way, we are able to back out sectoral productivity differences as observed trade that cannot be explained by differences in factor intensities and factor prices or by differences in trade barriers across countries. Our results give evidence that cross country TFP differences in manufacturing sectors are large, in general even larger than the substantial variation across countries at the aggregate economy level that has been found in the development accounting literature (see, for example, Hall and Jones (1999), Caselli (2005)). In addition, we show that productivity differences between rich and poor countries are systematically related to sectoral skill intensity but not to sectoral capital intensity of production. Productivity gaps are far more pronounced in high skill sectors such as Scientific Instruments, Electrical- and Non-electrical Machinery and Printing and Publishing, than in low skill sectors such as Apparel, Textiles or Furniture.

One application of our model is to predict trade flows. We show that Ricardian productivity differences substantially improve the ability of the model to predict bilateral sectoral trade compared to one that just allows for Heckscher-Ohlin trade and cross country variation in aggregate TFP. We also use our productivity estimates to test a number of theories on development that have implication for sectoral productivity differences and find that financial development, and the extent to which contracts are enforced are important determinants of sectoral TFP gaps.

1.1 Related Literature

There is a long line of papers which study sectoral productivity differences across countries by specifying a production possibility frontier and using data on sectoral inputs and outputs to calculate sectoral productivity differences. Some of the earlier contributions that use sectoral value value added as an output measure are Baumol et al. (1988), Dollar and Wolff (1993) and Maskus (1991). Those studies are limited to OECD countries and do not disentangle sectoral price indices, which are usually unavailable, from output quantities. As a consequence, variation in product prices across countries may wrongly be attributed to differences in TFP. Another line of research that tries to tackle this issue is the work within the International Comparison Project (ICOP) at the

University of Groningen. Researchers working in this project have constructed comparable sectoral price indices for a number of countries and years. They have computed sectoral productivity indices for up to 30 countries. However, also these studies include mainly OECD members and compare mostly labor productivities.

Acemoglu and Zilibotti (2001) calculate productivity indices for 27 3-digit manufacturing sectors in 22 developed and developing countries, using data from the United Nations. They realize that their indices are a mixture of output prices and TFP differences, but do not try to separate the two parts.

In the trade literature there is also a large number of contributions that compute productivity indices at various levels of aggregation. Harrigan (1997) and Harrigan (1999) constructs sectoral TFP indices for 8 (6) sectors, 2 (9) years, in 10 (8) OECD countries to test the fit of a generalized neoclassical trade model that allows for both Ricardian and Heckscher-Ohlin trade. He finds support for the existence of Rybzcinsky effects.

Golub and Hsieh (2000) compute labor productivities to test a Ricardian model of trade using data for OECD countries, while Eaton and Kortum (2002) develop a multi-country Ricardian model with a probabilistic technology specification that they calibrate to fit trade between OECD countries. Chor (2006) extends their model to differences in factor proportions and differences in other sectoral characteristics like financial dependence, volatility, and other variables. In principle, this class of models can be used to construct sectoral productivity indices from trade data. The main disadvantage is that the Eaton-Kortum model requires the specification of a statistical distribution for productivities, which makes it less general than our approach.

Trefler (1993), Trefler (1995) and Davis and Weinstein (2001) have shown convincingly that differences in total factor productivity at the country- or factor and country- level can help to substantially improve the fit of the Heckscher-Ohlin-Vanek prediction on cross country trade in factors but those studies do not investigate sector specific productivity differences.

Finally, Antweiler and Trefler (2002) provide some evidence for the importance of increasing returns to scale at the sectoral level using again the Heckscher-Ohlin-Vanek framework.

One advantage of our approach to computing sectoral TFP indices is the fact that we are able to construct a sectoral TFP index of the exporting country vis a vis every importing country, which enables us to compute standard errors of our estimates. Another important point is that trade theory enables us to disentangle cross country differences in value shipped that are due to differences in prices from disparities that are due to differences in quantities. In this way we can overcome the problem of mixing prices and quantities from which most previous studies have suffered. Moreover, we do not require information on sectoral inputs, such as capital stocks but just need aggregate factor prices.

The next section introduces the theoretical model and provides some intuition of the economic forces at work. Section 3 develops a methodology for computing sectoral productivity indices. We thoroughly discuss our dataset in section 4 and present the empirical results in section 5. This section also discusses implications on trade theory and several applications of the productivity estimates for growth theories. Section 6 provides a number of robustness checks, while the final section concludes.

2 A Simple Model

In order to use trade data to back out sectoral TFP differences we need model in which bilateral trade is determined. A convenient way to get this is to follow Krugman (1979) in assuming that consumers have love for variety and that production is monopolistic because of increasing returns.[1] We add three more ingredients to be able to talk about sectoral productivity differences. First, we assume that sectors use different factor proportions when faced with the same input prices, which gives rise to Heckscher-Ohlin stile trade between countries. Second, we add bilateral transport costs. As Romalis (2004) points out, this makes locally abundant factors relatively cheap and strengthens the link between factor abundance and trade. While without transport costs trade is undetermined in the Heckscher-Ohlin model as long as the number of factors is smaller than the number of goods and countries are not specialized, in this model there is a cost advantage to produce more in the sectors that use the abundant factors intensively which creates the prediction that countries export more in those sectors. Finally, we add sectoral differences in total factor productivity, which introduces a motive for Ricardian style trade. Countries that have a high productivity in a sector have a cost advantage relative to their foreign competitors and charge lower prices. Because the elasticity of substitution between varieties is larger than one, demand shifts towards the varieties of that country and leads to a larger world market share in that sector. Having explained the main features of the model, let us now develop the details.

[1] An alternative specification has been developed by Eaton and Kortum (2002). In their Ricardian style model there is perfect competition and every good is sourced from the lowest cost supplier that may differ across countries because of transport costs. We do not follow their approach because the probabilistic description of technology in their model, which requires assumption about the statistical distribution from which productivities are drawn.

2.1 Demand

Out model generalizes the setup of Romalis (2004). We assume that consumers in all country have identical, homothetic preferences. They are described by a two tiered utility function. The first level is assumed to be a Cobb-Douglas aggregator over K sectoral sub-utility functions. This implies that consumers spend a constant fraction of their income, σ_{ik}, which we allow to differ across countries, on each sector.[2]

$$U_i = \prod_{k=0}^{K} u_{ik}^{\sigma_{ik}} \tag{1}$$

Sectoral sub-utility is a symmetric CES function over sectoral varieties, which implies that consumers value each of the available varieties of goods in a sector in the same way.

$$u_{ik} = \left[\sum_{b \in B_{ik}} x_{bk}^{\frac{\epsilon_k - 1}{\epsilon_k}} \right]^{\frac{\epsilon_k}{\epsilon_k - 1}} \tag{2}$$

Note also that utility is strictly increasing in the number of sectoral varieties available in a country. $\epsilon_k > 1$ denotes the sector specific elasticity of substitution between varieties and B_{ik} is the set of varieties in sector k available to consumers in country i.

Goods can be traded across countries at a cost that is specific to the sector and country-pair. In order for one unit of good that has been produced by sector k of country j to arrive in destination i, τ_{ijk} units need to be shipped.

The form of the utility function implies that the demand function of country i consumers for a sector k variety produced in country j has a constant price elasticity, ϵ_k, and is given by the

[2]We could easily generalize preferences to two-tiered CES.

following expression.

$$x_{ijk} = \frac{\hat{p}_{ijk}^{-\epsilon_k} \sigma_{ik} Y_i}{P_{ik}^{1-\epsilon_k}}, \tag{3}$$

where $\hat{p}_{ijk} = \tau_{ijk} p_{jk}$ is the market price of a sector k good produced by country j in the importing country i[3] and P_{ik} is the optimal sector k price index in country i, defined as

$$P_{ik} = \left[\sum_{b \in B_{ik}} \hat{p}_b^{1-\epsilon_k} \right]^{\frac{1}{1-\epsilon_k}} \tag{4}$$

2.2 Supply

In each country, firms may be active in one of $k = 0, ..., K$ different sectors. Production technology differs across sectors due differences in factor intensities and differences in sectoral total factor productivity. In each sector firms can freely invent varieties and have to pay a fixed cost to operate. Because of the demand structure and the existence of increasing returns production is monopolistic, since it is always more profitable to invent a new variety than to compete in prices with another firm that produces the same variety.

Firms in country j combine physical capital, $K_j(n)$, with price r_j, unskilled labor, $L_j(n)$, with price w_j^u and skilled labor $S_j(n)$ with price w_j^s to produce.[4] In addition, there is a country and sector specific total factor productivity term, A_{jk}. Firms' production possibilities in sector k of country j are described by the following total cost function

[3] This implies that exporting firms charge the same factory gate price in all markets, so there is no pricing to the market behavior.

[4] The fact that within every country every factor has a single price reflects the assumption that factors can freely move across sectors within a country. For the empirical model we need not make any assumptions on factor mobility across countries.

$$TC(q_{jk}) = (f_{jk} + q_{jk})\frac{1}{A_{jk}}\left(\frac{w_j}{\alpha_{u,k}}\right)^{\alpha_{u,k}}\left(\frac{w_j}{\alpha_{s,k}}\right)^{\alpha_{s,k}}\left(\frac{r_j}{\alpha_{cap,k}}\right)^{\alpha_{cap,k}}. \tag{5}$$

The form of the cost function implies that the underlying sectoral production function of each firm is Cobb-Douglas with sectoral factor intensities $(\alpha_{u,k}, \alpha_{s,k}, \alpha_{cap,k})$. To produce firms need to pay a sector and country specific fixed cost, f_{jk} that uses the same combination of capital, skilled and unskilled labor as the constant variable cost.

Monopolistic producers maximize profits given (3) and (5). Their optimal decision is to set prices as a fixed mark up over their marginal costs.

$$p_k = \frac{\epsilon_k}{\epsilon_k - 1}\frac{1}{A_{jk}}\left(\frac{w_j}{\alpha_{u,k}}\right)^{\alpha_{u,k}}\left(\frac{w_j}{\alpha_{s,k}}\right)^{\alpha_{s,k}}\left(\frac{r_j}{\alpha_{cap,k}}\right)^{\alpha_{cap,k}} \tag{6}$$

The combination of sectors with different factor intensities, and country-sector specific TFP differences gives the model Heckscher-Ohlin as well as Ricardian features. Since the elasticity of substitution across varieties, ϵ_k is larger than one, consumers spend more on cheaper varieties. This together with the pricing structure implies that lower production costs translate into larger market shares. Low production costs may be either due to the fact that a sector is intensive in locally cheap factors, or due to high productivity in this sector. In the Appendix we develop a general equilibrium version of the model and discuss in more detail how comparative advantage is determined.

3 Estimation of the Sectoral Productivities

In this section we derive a method to estimate sectoral productivity differences across countries based on our model of international trade. To make progress, we write the sectoral volume of bilateral trade (measured at destination prices), which is defined as imports of country i from country j in sector k as

$$M_{ijk} = \hat{p}_{ijk} x_{ijk} N_{jk} = p_{jk} \tau_{ijk} x_{ijk} N_{jk}. \tag{7}$$

The measured CIF value of bilateral sectoral trade is the factory gate price charged by country j exporters in sector k multiplied by the transport cost, the quantity demanded for each variety by country i consumers and by the number of varieties produced in sector k in the exporting country.

Substituting the demand function x_{ijk} from (3), we obtain

$$M_{ijk} = \frac{(p_{jk}\tau_{ijk})^{1-\epsilon_k} \sigma_{ik} Y_i}{P_{ik}^{1-\epsilon_k}} N_{jk}. \tag{8}$$

Finally, using the fact that exporting firms choose a factory gate price which is a constant markup over their marginal cost and substituting the marginal cost function (5), we can the write bilateral sectoral trade volume as

$$M_{ijk} = \left[\frac{\frac{\epsilon_k}{\epsilon_k - 1} \left(\frac{w_j^u}{\alpha_{k,u}} \right)^{\alpha_{k,u}} \left(\frac{w_j^s}{\alpha_{k,s}} \right)^{\alpha_{k,s}} \left(\frac{r_j}{\alpha_{k,cap}} \right)^{\alpha_{k,cap}} \tau_{ijk}}{A_{jk} P_{ik}} \right]^{1-\epsilon_k} \sigma_{ik} Y_i N_{jk}. \tag{9}$$

Equation (9) makes clear that bilateral trade in sector k measured in dollars depends positively on importing countries' consumers' expenditure share on sector k goods, σ_{ik}, and their total income,

Y_i. On the other hand, because the elasticity of substitution between varieties is larger than one, the value of trade is falling in the price charged by exporting firms, p_{jk}. This and the pricing rule (6) implies that trade is decreasing in the production cost of the exporters. If a factor is relatively cheap in a country, this leads to a cost advantage for exporting firms in sectors where this factor is used intensively. The same holds true for sectoral productivities A_{jk}. If a country has a high productivity in a sector relative to other exporters, it can charge lower prices and has a larger value of exports.

All of the previous statements hold conditional on the number of firms in sector k in the exporting country. Since we do not have reliable data on the number of firms active the in exporting countries but we observe the value of sectoral production, we can use the model to solve for the number of firms given total production. The monetary value of total production of sector k in country j, $Output_{jk}$, equals the monetary value of production of each firm times the number of firms.

$$p_{jk} q_{jk} N_{jk} = Output_{jk} \tag{10}$$

Assuming that new firms can enter freely, in equilibrium firms make zero profits and price at their average cost. Combining this with (6), it is easy to solve for equilibrium firm size, which depends positively on the fixed cost and the elasticity of substitution.

$$q_{jk} = f_{jk}(\epsilon_k - 1) \tag{11}$$

Using this result and plugging it into the definition of sectoral output, we get[5]

$$N_{jk} = \frac{Output_{jk}}{p_{jk}(\epsilon_k - 1)f_{jk}}. \tag{12}$$

Substituting for N_{jk} in the import equation, we obtain

$$M_{ijk} = \left[\frac{\frac{\epsilon_k}{\epsilon_k - 1} \left(\frac{w_j^u}{\alpha_{k,u}}\right)^{\alpha_{k,u}} \left(\frac{w_j^s}{\alpha_{k,s}}\right)^{\alpha_{k,s}} \left(\frac{r_j}{\alpha_{k,cap}}\right)^{\alpha_{k,cap}}}{A_{jk}} \right]^{-\epsilon_k} \left[\frac{\tau_{ijk}}{P_{ik}}\right]^{1-\epsilon_k} \sigma_{ik} Y_i \frac{Output_{jk}}{(\epsilon_k - 1)f_{jk}}. \tag{13}$$

This equation can be rearranged to solve for the sector productivity A_{jk}. Because a productivity index needs to be defined relative to some benchmark, we measure productivity relative to a reference country. We choose the US as a benchmark because they export to the greatest number of destinations in most sectors.[6] Another advantage of choosing a reference country is that all the terms that are not indexed to the exporting country j (i.e. σ_{ik}, Y_i, P_{ik}) drop from the equation. For each importer i we can express the "raw" productivity of country j in sector k relative to the US measured using imports of country i.

$$\begin{aligned} \frac{\tilde{A}_{ijk}}{\tilde{A}_{iUSk}} &\equiv \frac{A_{jk}}{A_{USk}} \left(\frac{f_{jk}}{f_{USk}}\right)^{-1/\epsilon_k} \left(\frac{\tau_{ijk}}{\tau_{iUSk}}\right)^{\frac{1-\epsilon_k}{\epsilon_k}} = \\ &= \left(\frac{M_{ijk}}{M_{iUSk}} \frac{Output_{USk}}{Output_{jk}}\right)^{1/\epsilon_k} \left(\frac{w_j^u}{w_{US}^u}\right)^{\alpha_{k,u}} \left(\frac{w_j^s}{w_{US}^s}\right)^{\alpha_{k,s}} \left(\frac{r_j}{r_{US}}\right)^{\alpha_{k,cap}} \end{aligned} \tag{14}$$

Our "raw" productivity measure, $\frac{\tilde{A}_{ijk}}{\tilde{A}_{iUSk}}$, is a combination of relative productivities, relative fixed costs and relative transport costs. Intuitively, country j is measured to be more productive

[5]Here we assume, consistently with our model, that firms do not use intermediate goods to produce.

[6]We have also tried other benchmark countries like Germany or Japan and our results are robust to these alternative specifications.

than the US in sector k if, controlling for the relative cost of factors, j exports a greater fraction of its production in sector k to country i than the US. Note that we can compute this measure vis a vis every importing country using only data on relative imports and on exporters' relative production and factor prices.

This "raw" measure of relative productivities contains also relative sectoral transport costs and fixed costs of production. While relative transport costs vary by importing country, exporters' relative productivities and fixed costs are invariant to the importing country. Consequently, it is easy to separate the two parts using regression techniques.

Taking logarithms, and assuming for the moment that sectoral fixed costs are equal across countries, ie $f_{jk} = f_k$, [7], we get

$$\log\left(\frac{\tilde{A}_{ijk}}{\tilde{A}_{i,US,k}}\right) = \log\left(\frac{A_{jk}}{A_{US,k}}\right) + \frac{1-\epsilon_k}{\epsilon_k}\log\left(\frac{\tau_{ijk}}{\tau_{iUSk}}\right). \tag{15}$$

We assume that bilateral transport costs, τ_{ijk}, are a log-linear function of a vector of bilateral variables (i.e. distance, common language, common border, free trade arrangements, tariffs, etc.) plus a random error term. Hence, $\tau_{ijk}^{\frac{1-\epsilon_k}{\epsilon_k}} = X_{ijk}^{\beta_k} e^{u_{ijk}}$, where X_{ijk} is a vector of bilateral variables and u_{ijk} is noise. Consequently, we obtain a three dimensional panel with observations that vary by industry, exporter and importer.

[7]Later we will relax this assumption. An alternative interpretation is to consider productivity as a measure that also contains the fixed cost of production. After all, why should only the variable cost of production be taken into account?

$$
\begin{aligned}
\log\left(\frac{\tilde{A}_{ijk}}{\tilde{A}_{i,US,k}}\right) &= \log\left(\frac{A_{jk}}{A_{US,k}}\right) + \beta_{1k}(\log Dist_{ij} - \log Dist_{i,US}) + \\
&+\beta_{2k}(\log Tariff_{ijk} - \log Tariff_{i,US,k}) + \\
&+\beta_{3k} CommonLang_{ij} + \beta_{4k} English_i + \\
&+\beta_{5k} CommonBorder_{ij} + \beta_{6k} CommonColony_{ij} + \epsilon_{ijk} \qquad (16)
\end{aligned}
$$

Relative TFP of country j in sector k is captured by a country-sector dummy. The coefficients measure the impact of the log difference in bilateral variables on the sectoral trade cost multiplied by the negative sector specific factor $\frac{1-\epsilon_k}{\epsilon_k}$.

The sector-country dummies are computed as

$$
\frac{A_{jk}}{A_{US,k}} = exp\left[\log\left(\frac{\bar{\tilde{A}}_{ijk}}{A_{i,US,k}}\right) - \beta^k_{FE}\bar{X}_{ijk}\right] \qquad (17)
$$

where the means are calculated across our (at most) 36 importing countries i and β_{kFE} is the fixed effect panel estimator for the vector β_k. Consequently, the estimated productivity of country j in sector k relative to the US is the mean of $\left(\frac{\tilde{A}_{ijk}}{\tilde{A}_{iUSk}}\right)$ across importing countries controlling for the average effect of relative transport costs. This is a consistent estimator for relative productivities as long as there are no omitted variables with a nonzero mean across importers.

Our measure of relative TFP is transitive. This implies that productivities are comparable across countries *within* sectors in the sense that $\frac{A_{jk}}{A_{j'k}} = \frac{A_{jk}}{A_{USk}}\left(\frac{A_{j'k}}{A_{USk}}\right)^{-1}$. However, one cannot compare TFP in any country *between* sectors k and k' because this would mean to compare productivities across different goods.

Our productivity indices could alternatively be interpreted as differences in sectoral product quality across countries. In this case there would not be any cost differences arising from TFP differentials across countries but consumers would be willing to spend more on goods of higher quality. Differences in M_{ijk} across countries would not arise because of differences in quantities shipped due to cost differentials but because of differences in quality. Since we look only at expenditure and not at prices, we cannot distinguish between the two interpretations.[8]

4 The Data

In this section we describe all the inputs needed to construct our measures of sectoral productivity. We compute sectoral productivities for 24 manufacturing sectors in 64 countries at all stages of development for three time periods, the mid-eighties, the mid-nineties and the beginning of the

[8] A completely isomorphic model to the one presented in the main text is the following one: Replace sectoral subutility with the following expression:

$$u_{ik} = \left[\sum_{b \in B_{ik}} (\lambda_{bk} x_{bk})^{\frac{\epsilon_k - 1}{\epsilon_k}} \right]^{\frac{\epsilon_k}{\epsilon_k - 1}},$$

where $\lambda_{bk} > 0$ is a utility shifter that measures product quality and let the cost functions be identical across countries for a given sector,

$$TC(q_{jk}) = (f_{jk} + q_{jk}) \left(\frac{w_j}{\alpha_{u,k}} \right)^{\alpha_{u,k}} \left(\frac{w_j}{\alpha_{s,k}} \right)^{\alpha_{s,k}} \left(\frac{r_j}{\alpha_{cap,k}} \right)^{\alpha_{cap,k}}.$$

Assuming that all firms within a sector of the exporting country produce varieties of the same quality, demand of country i consumers for sector k varieties produced in j is

$$x_{ijk} = \frac{\hat{p}_{ijk}^{-\epsilon_k} \lambda_{jk}^{\epsilon_k - 1} \sigma_{ik} Y_i}{\tilde{P}_{ik}^{1-\epsilon_k}},$$

where $\tilde{P}_{ik} = \left[\sum_{b \in B_{ik}} (\frac{\hat{p}_b}{\lambda_{jk}})^{1-\epsilon_k} \right]^{\frac{1}{1-\epsilon_k}}$ is the optimal quality adjusted price index. In this case the value of bilateral trade is

$$M_{ijk} = \frac{(p_{jk}\tau_{ijk})^{1-\epsilon_k} \lambda_{jk}^{\epsilon_k - 1} \sigma_{ik} Y_i}{\tilde{P}_{ik}^{1-\epsilon_k}} N_{jk}. \tag{18}$$

Comparing this expression with the one in the main text, (8), it becomes clear that productivity differences are indistinguishable from differences in product quality, because bilateral trade is identical in both cases.

21st century. In order to do so, we require data on bilateral trade at the sector level, information on sectoral production, factor prices, sectoral factor intensities and on elasticities of substitution.

Bilateral sectoral trade data, M_{ijk}, and sectoral production, $Output_{jk}$, are obtained from the from the World Bank's Trade, Production and Protection database. This dataset merges trade flows and production data from different sources into a common classification: the International Standard Industrial Classification (ISIC), Revision 2. The database potentially covers 100 developing and developed countries over the period 1976-2004. We use trade and production data for years 1984-1996, 1994-1996 and 2002-2004, considering 36 importing countries and 64 exporting countries. The 36 importers represent more than $\frac{2}{3}$ of world imports[9]. To mitigate problems of data availability and to smooth the business cycle, we average the data over three years. We exclude, tobacco (314), petroleum refineries (353), miscellaneous petroleum and coal products (354) and other manufactured products not classified elsewhere (390) from the 28 sectors in the ISIC classification because trade data do not properly reflect productivity in those sectors.

For the monetary value of production, $Output_{jk}$, we use information on Gross Output from the Trade, Production and Protection database [10]. The original source of this variable is the United Nations Industrial Development Organization's (UNIDO) Industrial Statistics. For the years 1994-1996 some data have been updated by Mayer and Zignago (2005) [11]. The production data published by UNIDO is by no means complete and that is the main limitation in computing productivities[12].

[9] We have to exclude US as an importer country because we use them as our benchmark country. The countries represent more than 80% of the remaining imports.

[10] Gross Output represents the value of goods produced in a year, whether sold or stocked. It is reported in current dollars. Our results are robust to using Value Added instead.

[11] They have updated a previous version of the Trade and Production Database. As in the latest version of the Trade, Production and Protection Database, data from years 94-96 remain the same, the Mayer & Zignago database of 2005 is more complete than the Nicita & Olarreaga database of 2006.

[12] Besides this, we require exporting countries to export at least to 5 importing countries in any given sector during the relevant period.

UNIDO also collects data on establishments that we could have used directly, instead using Gross Output data. However, these data are less reliable than production data because different countries use different threshold firm sizes when reporting data to the UNIDO[13].

Sectoral elasticities of substitution, ϵ_k, are obtained from Broda and Weinstein (2006). They construct elasticities of substitution across imported goods for the United States at the Standard International Trade Classification (SITC) 5 digit level of disaggregation for the period 1990-2001. We transform those elasticities to our 3 digit ISIC rev.2 level of disaggregation by weighting elasticities by US import shares.

Factor intensities, $(\alpha_{ku}, \alpha_{ks}, \alpha_{kcap})$, are assumed to be fixed across countries. This assumption allows us to use factor income share data for just one country, namely the US.[14] To proxy for skill intensity, we follow Romalis (2004), in using the ratio of non-production workers to total employ-

[13]While the fact that some countries do not consider micro-firms, whereas others do does not change aggregate output numbers much, the number of establishments is indeed severely affected by this inconsistency. For a description of UNIDO's data issues see Yamada (2005).

[14]This assumption is innocuous as long as there are no systematic differences in sectoral factor income shares. To see this, suppose $\alpha_{kjs} = \alpha_{kUSs} + \nu_{jk}$. Then it follows from (14), that productivities can be written as

$$E\left[log(\frac{A_{ijk}}{A_{iUSk}}|true)\right] = E\left[log(\frac{A_{ijk}}{A_{iUSk}}|measured)\right] + \quad (19)$$

$$E\left[\nu_{jk}log(\frac{w_j^s}{w_j^u}) - (1-\alpha_{kUSs}-\alpha_{kUScap})log(\frac{1-\alpha_{kUSs}-\alpha_{kUScap}}{1-\alpha_{kUSs}-\alpha_{kUScap}-\nu_{jk}}) + \nu_{jk}log(1-\alpha_{kUSs}-\alpha_{kUScap}-\nu_{jk})\right].$$

Using $log(1+x) \approx x$, we obtain

$$= E(log(\frac{A_{ijk}}{A_{iUSk}}|measured)) + E(\nu_{jk})log(\frac{w_j^s}{w_j^u}) + E(\nu_{jk})(1-\alpha_{kUSs}-\alpha_{kUScap}) + E[\nu_{jk}(\nu_{jk}-\alpha_{kUSs}-\alpha_{kUScap})]. \quad (20)$$

Consequently, if the intensity differences are random, i.e. ν_{jk} is i.i.d. with $E(\nu_{jk}) = 0$, we get $E\left[log(\frac{A_{ijk}}{A_{iUSk}}|actual)\right] = E\left[log(\frac{A_{ijk}}{A_{iUSk}}|measured)\right] + E(\nu_{jk}^2)$. Hence, on average we tend to overestimate the sector productivities in those countries that have very - but not systematically - different factor input ratios than the US. If poor countries have a systematically larger wage bill for skilled labor than the US in more skill intensive sectors, we tend to predict systematically lower productivities of poor countries in skill intensive sectors. To see this, assume $E(\nu_{jk}) = f(\alpha_{s,US})$ (+). Then the bias is negative, provided that the only negative term $-(\alpha_{kUSs} + \alpha_{kUScap})E(\nu_{jk})$ does not dominate the other terms, which are all positive. This case seems unlikely. If there is skill biased technological change, such that the gap in the wage share of skilled labor between rich and poor countries is larger in more skill intensive sectors, it should be the other way round - namely that we tend to overestimate the productivity of poor countries in skill intensive sectors - because we overestimate the cost of skilled labor in poor countries (which have on average higher skill premia).

ment, obtained from the NBER-CES Manufacturing Industry Database constructed by Bartelsman et al. (2000) and converting USSIC 87 categories to ISIC rev.2. Capital intensity is computed as one less the share of total compensation in value added, using the same source. In our three factor model intensities are re-scaled such that $\sum_i \alpha_{k,i} = 1; \qquad i = u, s, cap$[15].

Table I shows the skill and capital intensities and the elasticities of substitution for our 24 industries. The capital share in manufacturing is significantly higher than in the aggregate US economy ($\frac{2}{3}$ against $\frac{1}{3}$, practically the double) and all sectors have a capital intensity above 0.5. There is a high correlation between capital and skill intensities (0.63) , so that in general industries with a relatively high capital intensity are also relatively intensive in skilled labor.[16]. It can be seen that elasticities of substitution vary relatively little, which is consistent with the finding of Broda and Weinstein (2006) that the higher the level of aggregation, the smaller the variation in elasticities.

Wages and rental rates at the country level are computed using the methodology exposed in Caselli (2005), Caselli and Coleman (2006) and Caselli and Feyrer (2006). The definition of the rental rate is consistent with a dynamic version of our model in which firms solve an inter-temporal maximization problem and capital markets are competitive[17]. Total payments to capital in country j are $\sum_k p_{jk} MPK_{jk} K_k = p_{jk} MPK_{jk} \sum_k K_k = r_j K_j$ where K_j is the country $j's$ capital stock in physical units. Since $\alpha_{j,cap} = \frac{r_j K_j}{P_Y Y}$, where Y is GDP in Purchasing Power Parities, the following

[15]As in Romalis (2004), $\alpha_{k,cap} = cap.intensity$; $\alpha_{ks} = skill\ intensity * (1 - \alpha_{kcap})$ and $\alpha_{ku} = 1 - \alpha_{ks} - \alpha_{kcap}$

[16]Beverages is the sector that has both the highest capital and the highest skill intensity.

[17]Firms set the marginal value product equal to the rental rate $p_{jk} MPK_{jk} = P_{Kj}(interest_j + \delta)$, where P_{Kj} is the price of capital goods in country j, $interest_j$ is the net interest rate in country j and δ is the depreciation rate. This can be seen considering the decision of firms in sector k in country j to buy an additional unit of capital. The return from such an action is $\frac{p_{jk}(t) MPK_{jk}(t) + P_{Kj}(t+1)(1-\delta)}{P_{Kj}(t)}$. Abstracting from capital gains, firms will be indifferent between investing an additional dollar in the firm or in an alternative investment opportunity that has a return $interest_j$, when the above relationship holds. Because capital is mobile across sectors within a country the marginal value product must be equalized across sectors.

equation follows immediately:

$$r_j = \alpha_{j,cap} \frac{GDP_j}{K_j} \tag{21}$$

Capital stocks in physical units are computed with the permanent inventory method using investment data from the Penn World Table (PWT).[18]. GDP_j is also obtained from the PWT and is expressed in current dollars. $\alpha_{j,cap}$ is country j's aggregate capital income share. We compute the capital share as one minus the labor share in GDP, which we take from Bernanke and Gürkaynak (2002) and Gollin (2002). In turn, the labor share is employee compensation in the corporate sector from the National Accounts plus a number of adjustments to include the labor income of the self-employed and non-corporate employees.

Similarly, to compute the skilled and unskilled wages we use the the following result for the labor share:

$$(1 - \alpha_{j,cap}) = \frac{w_u L_u + w_u \frac{w_s}{w_u} L_s}{GDP_j} \tag{22}$$

The total labor share is equal to payments to both skilled and unskilled workers relative to GDP. Skilled and unskilled workers are expressed in efficiency units of non-educated workers and workers with complete secondary education.[19] . Thus,

$$L_u = L_{noeduc} + e^{\beta * \frac{prim.dur.}{2}} L_{prim.incomp.} + e^{\beta * prim.dur.} L_{prim} + e^{\beta * lowsec.dur.} L_{lowsec.} \tag{23}$$

[18]For details see Caselli (2005)

[19]Changing the base of skilled workers from completed secondary to completed primary, incomplete secondary or incomplete tertiary education does not alter the results significantly. Further details about the construction of the wages and rental rates can be found in the referenced papers of Caselli.

and

$$L_s = L_{secondary} + e^{2\beta} L_{ter.incomp.} + e^{4\beta} L_{tertiary} \tag{24}$$

Educational attainment of workers over 25 years at each educational level are taken from Barro and Lee (2001) and Cohen and Soto (2001). Information on the duration of each level of schooling in years by country is provided by the UNESCO[20]. Skill premia β by country are obtained from Bils and Klenow (2000) and Banerjee and Duflo (2005). The wage premium $\frac{w_s}{w_u}$ equals $e^{\beta*(prim.dur.+lowsec.dur.)}$. The panels of figure 3 plot the computed skilled and unskilled wages, the wage premium, the capital stock per worker and the rental rate for the countries against log income per worker for the mid-nineties. We observe that although wages of both skilled and unskilled workers are much higher in rich countries, the wage premium is negatively related with income per worker, which gives rich countries a relative advantage in skilled labor intensive sectors. The relation between the rental rate and income per worker is slightly positive. The absence of a strong relationship between the marginal product of capital and income per worker is similar to Caselli and Feyrer (2006) once they correct for price differences and natural capital. Although we do not adjust for the fraction of income that goes to natural capital in our three factor model, we do correct for the price level of GDP.

To compute the productivity measures, we also require a number of bilateral variables commonly used in gravity-type regressions. We take them from two sources: Rose (2004) and Mayer and Zignago (2005). We include bilateral distance from the latter, who have developed a distance database which uses city-level data in the calculation of the distance matrix to assess the geographic

[20]Notice that for non-complete levels, we assume that workers have half completed half of the last level (except when we have data of lower secondary duration). For tertiary education we consider a duration of 4 years given lack of data for most of the countries

distribution of population inside each nation. The basic idea is to calculate the distance between two countries based on bilateral distances between cities weighted by the share of each city in the overall country's population. CEPII also provides a bilateral sectoral tariff database. Tariffs are measured at the bilateral level and for each product of the HS6 nomenclature in the TRAINS database from UNCTAD. Those tariffs are aggregated from TRAINS data in order to match the ISIC Rev.2 industry classification using the world imports as weights for HS6 products.

We also use information on common border between exporter and importer, common language between exporter and importer and between the US and the importing country (English), and whether a trading partner has been a colony of the exporter or importer.

5 Results

In this section we report the results of computing productivities using our baseline specification (16). We use a simple stepwise linear panel estimation[21] with sector-country specific fixed effects. We limit the sample to exporter-sector pairs for which we observe exports to at least five destinations but ignore zeros and issues of sample selection in bilateral trade flows at this stage of our analysis.

Table II shows the regression results for our baseline model using data for the mid-nineties (years in which data is more complete). The overall fit is very good with an R^2 of 0.85 and a within R^2 of 0.52. This implies that for a given sector productivity A_{jk}, the transport costs due to the gravity type variables in our regression account for more than half of the variation in $\tilde{A}_{ijk}$ across importers. In addition ρ - the fraction of the variance of the error term that is due to A_{jk} - is

[21]The stepwise procedure starts with the full model that includes all right hand side variables and one by one discards variables that are not significant at 10 percent level of significance, while taking care of the fact that a discarded variable might become significant once another one has been dropped.

80%. Both facts corroborate our interpretation of A_{jk} as an exporter-sector specific productivity measure.

Recall that the sign of the coefficients reflects the impact of the relevant variable on transport costs multiplied by the negative term $\frac{1-\epsilon_k}{\epsilon_k}$, so that a negative coefficient implies that a given variable increases relative transport costs.[22]

Differences in distance have a large and very significant negative effect on our relative raw productivity measure in all sectors. Differences in bilateral sectoral tariffs between country j and the US are also negative and significant for all sectors except Other Chemicals (352). Indicators for common language between the importer and the exporter have a significant positive effect on raw productivity in all sectors but Iron and Steel (371) and Non-ferrous Metals (372). The fact that one of the exporters has a common border or common language with the importer has a significantly positive effect on raw productivity only for some sectors. The same holds true for the common colony dummy.

Having run the regression (16), we use (17) to construct sectoral productivities. We compute almost 1500 sectoral TFPs for each cross section of countries (24 by country for 64 countries[23]). Table III summarizes some information about these productivities in the mid-nineties.[24] We present the unweighted country mean of TFP across industries[25], the standard deviation and the sectors

[22] There is only one coefficient with wrong sign: Common language between the US and importing country for footwear

[23] For some countries we cannot compute TFP for all sectors either because of missing production data or because the country does not export to enough countries in a sector, so that we drop the sector from (16). Ivory Coast is the country with the smallest number of sectors for which we obtain productivity measures (16) and only in 14 (out of 64) countries we construct productivities for less than 20 sectors.

[24] The complete set of productivity estimates is available upon request and will soon be online under http://www.pablofleiss.com.

[25] These means of sector productivities cannot be interpreted as aggregate manufacturing productivity indices in terms of economic theory, since we would need to take into account agents' preferences for a proper aggregation. Nevertheless, they give some sense of the magnitude of average sectoral productivity differences across countries

with maximum and minimum TFP for each country in our sample.

First we observe that there is a strong correlation between a country's income per worker and average relative TFP in manufacturing. Poor countries tend to have far lower sectoral productivities than rich ones, but within countries relative productivities vary a lot across sectors. Taking for example Pakistan, a typical developing country, we measure an average relative manufacturing TFP of 0.17 of the US level. This hides a large amount of heterogeneity across sectors: A productivity of 0.75 of the US level in Apparel (322) and one of only of 0.07 in the Electrical Machinery (383). In general, Plastics (356), Metals (381) and Transports (384) are the sectors in which many of the poor countries tend to be least productive relative to the US, while Footwear (324) and Furniture (332) are the sectors in which rich countries seems to have their smallest productivities relative to the US, although these patterns are not as clear as for poor nations. Many poor countries have their highest relative productivities in the sectors Food (311) and Apparel (322) while again, there is no clear pattern in which sectors rich countries are the most productive relative to the US.

The panels of figure 4 show scatter plots of estimated sectoral productivities against log GDP per worker in the mid-nineties for 8 out of the 24 sectors (the first sector of each 2 digit classification, i.e. 311, 321....)[26]. Again, there is a high correlation between sectoral productivity and log GDP per worker in all sectors. While this is true for all sectors the magnitude of productivity differences varies a lot across sectors. For example, the relation between log income per worker and productivity is much more pronounced in the sector Metal Products (381) than in Food (311). We also note that in general, rich European countries tend to be more productive than the US in most manufacturing sectors. At this point it seems interesting to compare our mean sectoral produc-

[26] We present these 8 scatters to exemplify our results. They extend to the sectors with the same 2 digit classification

tivities for manufacturing with the productivities found in the Development Accounting literature. Figure 5 shows a scatter plot of our average sectoral productivity against Hall and Jones' (1999) aggregate economy productivity indices computed using data on income in PPPs and information on physical and human capital endowments. We note that there is a very strong correlation between the two sets of productivity estimates. Apart from some European countries that we estimate to be on average more productive than Hall and Jones, our productivity differences tend to be even larger than theirs. Countries like Bangladesh, Venezuela and Jordania that are close to the US productivity level according to Hall and Jones are estimated to far less productive than the US in manufacturing when using our methodology.

To get an even better feeling for the productivity differences between rich and poor countries we split the countries in two samples: Developing countries (with income per worker below 8000 US Dollars in 1995) and developed countries. Figure 6 shows a histogram of sector productivities for the mid-nineties for both subsamples, where each observation is given by a sector-country pair. We observe that the productivity distribution of developing countries is left skewed, so that most sectoral productivities are far below the US level, with a long tail on the right, meaning that there are a few developing countries that are more productive than the US in certain sectors. Developed countries' have a relatively symmetric productivity distribution with a mean sectoral productivity that is slightly below one, and a significant variation to both sides, ranging from around 0.2 to 1.5 of the US level.

Figure 7 shows the evolution of developing countries' relative productivities over time. The black line is the histogram of developing countries' productivities in the mid-eighties, the red line is the histogram for the mid-nineties and the blue line the one for the beginning of the 21st century.

We see that the distribution is shifting to the right over time, meaning that over this twenty year period poor countries are slowly catching up in sectoral TFP relative to the US.

Our productivity estimates also allow us to construct "Ricardian" style curves of comparative advantage due to productivity differences for any country pair. The panels of Figure 8 depict productivities arranged in a decreasing order according to the magnitude of relative productivity differences for four representative countries: Germany, Spain, Uruguay and Zimbabwe. Here, for example, we see that Spain's comparative advantage relative to the US is greatest in the sectors Other Non Metallic Mineral Products (369), Iron and Steel (371) and Rubber Products (355), while its sectors with the greatest comparative disadvantage are Printing and Publishing (342) and Plastic Products (356). The comparative advantage of Zimbabwe, on the other hand, is largest in the sectors Apparel (322), Non Ferrous Metals (372) and Iron and Steel (371), and smallest in the sectors Plastic Products (356), Footwear (324) and Metal Products (381).

5.1 Productivity Differences and Trade Theory

We want to test if introducing Ricardian productivity differences helps to explain trade flows. To this aim, we test our model against several alternatives: First against a pure gravity model with Heckscher-Ohlin type sectoral differences in factor intensities, and second against the same model with country specific aggregate productivity differences. If sectoral productivity differences matter we should see a substantial improvement of model fit compared with the other models.

We consequently test our model against the following alternative specifications

$$\log\left(\frac{\tilde{A}_{ijk}}{\tilde{A}_{i,US,k}}\right) = D_k + \frac{1-\epsilon_k}{\epsilon_k}\log\left(\frac{\tau^i_{jk}}{\tau^i_{US,k}}\right), \tag{25}$$

where D_k is a sector specific dummy.

$$\log\left(\frac{\tilde{A}_{ijk}}{\tilde{A}_{i,US,k}}\right) = \left(\frac{A_j}{A_{US}}\right) + D_k + \frac{1-\epsilon_k}{\epsilon_k}\log\left(\frac{\tau^i_{jk}}{\tau^i_{US,k}}\right), \tag{26}$$

where D_k is a sector specific dummy and $\frac{A_j}{A_{US}}$ is an aggregate country specific productivity.

Looking at table IV it is obvious that the pure Heckscher-Ohlin gravity model, (25) has a hard time to explain trade flows adjusted for factor input costs, $\left(\frac{\tilde{A}_{ijk}}{\tilde{A}_{i,US,k}}\right)$. The R-square of this specification is only 0.35. The second specification, (26) has a much better fit, with an R-square of 0.76 and a within R-square, which measures the contribution of the bilateral variables on the variation of $\left(\frac{\tilde{A}_{ijk}}{\tilde{A}_{i,US,k}}\right)$ is 0.45. Nonetheless, there seems to be an important role for sector specific productivity differences as well. Our preferred specification has an R-square of 0.85 and a within R-square of 0.52. So there is a substantial improvement in fit, that is also confirmed by the Akaike Information criterion (lower values represent better fit). We conclude that Ricardian productivity differences are an important factor for explaining trade in goods.

5.2 Productivity Differences and Theories of Development

In this section we apply our productivity estimates to test a number of development theories that have implications for sectoral productivity differences across countries. At a deeper level differences in sector productivities may reflect differences in institutions, (in)adequate technology or decisions of optimal technology adoption which affect the efficiency with which production is undertaken differentially across sectors.

One potential application is adequateness of technology. Acemoglu and Zilibotti (2001) develop a model in which there is a mismatch between the skill requirements of frontier technologies and poor countries' endowments of skilled and unskilled labor. Their model predicts that - since technology is developed to optimally complement the skill endowments of the industrialized countries - productivity gaps between rich and poor countries are largest in sectors with intermediate skill intensities. The idea is that in those sectors rich countries employ skilled workers using a skill complementary technology, while poor countries use unskilled workers. The authors are not able to test this prediction of their model directly since they lack a measure of sectoral TFP which is not contaminated by differences in sectoral prices across countries.[27]

In a first attempt to scrutinize their prediction that productivity differentials between rich and poor countries should be largest in sectors with intermediate skill intensity, we divide our sample in two parts: developing countries (with a per capita GDP below 8000 International Dollars in 1995[28]) and industrialized countries. Figure 9 plots the average sector productivity for rich relative to poor countries against sectoral skill intensity, α_{ks}. We see that in general productivity gaps tend to be larger in skill intensive sectors than in unskill intensive ones and that the relationship seems to be nonlinear. The productivity differences in the most skill intensive sectors are slightly smaller than in sectors with intermediate skill intensity.

To more formally address this issue, we regress (Table V) a_{jk} on skill intensity, the square of the same variable, to allow for a nonlinear relationship, capital intensity and its square, controlling for country specific effects. We run this regression separately for developing and developed countries. For the sample of developing countries there is indeed a very significant nonlinear relationship that gives us a mostly negative relation between the relative sectoral TFP of developing countries and

[27]They compute a TFP measure that uses value added as an output measure. Their model predicts that for this measure, which includes differences in prices, "TFP" differences should be larger in *un*skill intensive sectors, because labor intensive goods are relatively cheaper in developing countries.

[28]Results are robust to choosing other income values to split the sample.

the sectoral skill intensity. Moving from the 10th to the 90th percentile of skill intensity reduces sectoral productivity of developing countries relative to the US by roughly 8.5%. Only for extreme values of skill intensity productivity differences are predicted to be slightly smaller - moving from the 10th to the 99th percentile reduces sectoral productivity relative to the US by just about 8.2%. Note that also for capital intensities productivity differences seem to be somewhat smaller in more capital intensive sectors. Repeating the same regression for the sample of developed countries, we find no systematic relationship between productivity differences and skill or capital intensity at all. As a next step we use the whole sample and include an interaction term between per capita income and skill intensity as well as capital intensity. The prediction is that this term is positive, since skill intensity should matter only for poor countries. Indeed, we find that the interaction term between income per capita and skill intensity is strongly positive and significant, while the interaction between income per capita and capital intensity is insignificant. Hence, we conclude that relative sectoral productivities are systematically lower in skill intensive sectors in developing countries but not in industrialized ones, while productivity differences in capital intensive sectors relative to the US tend to be lower for both poor and rich countries. Overall, the patterns of productivity differences do not provide much support for the adequate technology hypothesis which predicts that the technology skill mismatch should cause the largest productivity differences in sectors with intermediate skill intensity, even though productivity differences in extremely skill intensive sectors seem to be slightly smaller than in somewhat less skill intensive ones.

We can also relate our sectoral productivities to factors that affect the efficiency of the organization of production differentially across sectors. One such factor is the quality of a country's contracting environment that has a different effect on sector productivity depending on how relationship specific investments are (see Acemoglu et al. (2007) and Nunn (2007)). If the contracting environment is poor and inputs a taylored to a specific firm, this gives rise to a hold up problem and consequently leads to too little investment, which increases the costs for specific inputs and lowers sectoral productivity. Nunn (2007) uses a trade model to show empirically that the interaction between contract enforcement and relationship specificity affects countries' comparative advantage. We follow Nunn in using 'rule of law' from Kaufmann et al. (2003) as a measure for contract enforcement and data that measure what fraction of intermediate inputs is relationship specific constucted by Nunn. This measure is obtained using information whether a product is sold on an organized exchange, or reference priced in trade publications. We test whether our sectoral productivity differences reflect differentials in contract enforcement by regressing them on contract intensity, a variable we obtain by multiplying 'rule of law' with relationship specificity.

As a next point we relate our sectoral productivities to financial development. In a seminal article Rajan and Zingales (1998) show that industries which are more dependent on external finance grow faster in more financially developed countries, while Beck (2003) relates financial development to comparative advantage. We use the fraction of investment that cannot be financed from internal cash flow from Rajan and Zingales as a measure of financial dependence and interact it with financial development of the country measured as private credit as a fraction of GDP in 1995 from Beck et al. (2000) to obtain a measure of financial comparative advantage. We use this as an regressor for our sectoral productivities.

At this point we relax the assumption that the fixed costs are the same across countries. Instead, we assume that $f_{jk} = f_j f_k$.

Let us recall our definition of raw productivity given this new assumption on fixed costs.

$$\log\left(\frac{\tilde{A}_{ijk}}{\tilde{A}_{i,US,k}}\right) = \log\left(\frac{A_{jk}}{A_{US,k}}\right) - 1/\epsilon_k \log\left(\frac{f_j}{f_{US}}\right) + \frac{1-\epsilon_k}{\epsilon_k}\log\left(\frac{\tau^i_{jk}}{\tau^i_{US,k}}\right). \tag{27}$$

We see that the smaller ϵ_k, the more a higher fixed cost should lower our raw productivity measure. The reason for this is the following: If relative fixed costs differ countries, this will influence the number of firms that enter. In particular, a higher fixed cost implies less entry. Consequently, for countries with higher fixed costs we overestimate the number of firms and thus underestimate true productivity. Hence raw productivity, which also includes relative fixed costs is too large because the true productivity is raw productivity plus the adjustment for the difference in fixed costs. In addition, the smaller ϵ_k the more consumers value varities in that sector and the larger is the mistake in the number of firms if we do not consider differences in fixed costs. To proxy for differences in fixed costs across countries we use the Djankov et al. (2002) measure of firm setup costs as a fraction of per capita income relative to the US and interact it with $1/\epsilon_k$, expecting a negative sign in a regression of this variable on sectoral productivities.

The columns of table VI show the results of our regressions. In the first column we regress the log of sectoral productivities on our measure of the importance of setup costs controlling for both country and industry fixed effects. As expected $1/\epsilon_k f_j$ is negative and also significant at the 10% level. In the next column, we regress sector productitivies on Nunn's measure of contract intensitity. The coefficient is strongly positive and significant at the 1% level. The same is true for the interaction between financial dependence and financial development. Finally, in the last column we regress sector productivities on all the previous measures simultaneously. Both the variables for financial comparative advantage remain positive, large and significant at the 1% level. The business setup cost variable, on the other hand, becomes totally insignificant.

6 Robustness

6.1 Relation with Measures of Specialization

Even though we use the ratio between trade and production to construct our measure of productivity, the results of our final productivity estimates are not mainly driven by this ratio. Figure 8 plots t. Although The correlation between he set of estimated TFPs and the exports and production ratio is positive and significant ($\rho = 0.43$), but the relation is far from being one-on-one. For example, if a country sells almost all its production to a single importer country (and very little to the rest of the world) the ratio of exports relative to production is close to one, but productivity in this sector is measured to be relatively low in this country. The reason is that our productivity estimates reflect all bilateral exports relative to production, controlling for elasticities of substitution, factor prices and intensities and transport cost. If a country exports only to a single other one, this implies that it is not competitive in most markets and hence has a low productivity in the particular sector.

We also compare our estimates with some measures of specialization that have been proposed in the literature. Although our estimated productivity is not a measure of specialization, our theory predicts a relatively high correlation between productivity and specialization in the sense that countries will export most of their production in sectors with high productivities. Moreover, some of those measures are usually used as proxies of productivity because of the lack of proper TFP estimates. As we will argue, although there is certain correlation, measures of specialization are not related one to one with our constructed measure of TFP. As an example, Figure 8 shows the correlation between our constructed TFP and two measures of specialization for the case of Japan.

Our first measure of specialization is the coefficient of specialization proposed by Gustavsson et al. (1999). It is defined as the ratio of production to consumption

$$r_{jk} = \frac{Q_{jk}}{C_{jk}} = \frac{C_{jk} + X_{jk} - M_{jk}}{C_{jk}} = 1 + \frac{X_{jk} - M_{jk}}{C_{jk}} \tag{28}$$

This indicator is zero when all the consumption corresponds to imported products and tends to infinity when a country exports all its production and consumes nothing. Balassa (1986) presents a variation of this measure, $1 + \frac{X_{jk} - M_{jk}}{X_{jk} + M_{jk}}$, that scales net exports by total trade rather than consumption.

Another measured is the revealed comparative advantage proposed by Balassa (1965), which is defined as:

$$RCA_{jk} = \frac{X_{jk} / \sum_j X_{jk}}{\sum_k X_{jk} / \sum_j \sum_k X_{jk}} \tag{29}$$

The numerator represents the percentage share of a given sector in national exports[29] and the denominator represents the percentage share of a given sector in world exports. Thus, the RCA index contains a comparison of national export structure (the numerator) with the world export structure (the denominator). When RCA equals 1 for a given sector in a given country, the percentage share of that sector is identical with the world average. When RCA is above 1 the

[29] Recall X_{jk} are exports of country j in sector k

country is said to be specialized in that sector and vice versa if RCA is below 1.[30].

Looking at TableVII we observe a positive correlation between our TFPs and the various measures of specialization for most of the countries. This makes sense, since those measures mix up specialization due to Heckscher-Ohlin determinants, trade barriers and productivity differences, while relative productivity picks up the pure Ricardian element of comparative advantage.

6.2 Zeros in Bilateral Trade

Up till now we have ignored zero bilateral trade flows in our productivity estimations. Clearly, even though we restrict our sample to the largest importing nations and require exporters to export at least to five countries, not all bilateral trade flows are positive in all sectors. To make sure that zeros do not severely distort our productivity estimates, we follow Helpman et al. (2007) and estimate a Heckman-selection model. To this end, we introduce bilateral, sector specific fixed costs to export. In this case we observe a zero in bilateral sectoral trade if exporters' profits are not large enough to make up for the destination specific fixed cost to export.

Profits from exporting to country i for producers in sector k of country j can be written as

$$\Pi_{ijk} = \frac{1}{\epsilon_k}\left(\frac{\epsilon_k \tau_{ijk} p_{jk}}{(\epsilon_k - 1)P_{ik}}\right)^{1-\epsilon_k} \sigma_{ik} Y_i - f_{ijk} \tag{30}$$

Hence, we observe positive exports from j to i in sector k if $\Pi_{ijk} > 0$. For convenience, let us define the variable Z_{ijk}, which is the ratio of variable profits to bilateral fixed costs to export.

[30]Since the RCA turns out to produce an output which cannot be compared on both sides of 1, the index is made symmetric, by constructing the ratio $(RCA_{jk} - 1)/(RCA_{jk} + 1)$. This measure ranges from -1 to +1 and is labeled Revealed Symmetric Comparative Advantage (RSCA). See Laursen (1998) for further details.

$$Z_{ijk} = \frac{\frac{1}{\epsilon_k}\left(\frac{\epsilon_k \tau_{ijk} p_{jk}}{(\epsilon_k - 1)P_{ik}}\right)^{1-\epsilon_k} \sigma_{ik} Y_i}{f_{ijk}} \tag{31}$$

So firms will export from j to i in sector k if and only if $Z_{ijk} \geq 1$.

Taking logs, we obtain

$$z_{ijk} = -log(\epsilon_k) + (1-\epsilon_k)log(\frac{\epsilon_k}{\epsilon_k - 1}) + (\epsilon_k - 1)log(P_{ik}) + log(Y_i) + (1-\epsilon_k)log(p_{jk}) + (1-\epsilon_k)log(\tau_{ijk}) - log(f_{ijk}). \tag{32}$$

We assume that bilateral sectoral variable transport cost can again be written as a function of bilateral variables, X_{ijk}, an exporter-sector specific term ϕ_{jk} and an importer-sector specific term ϕ_{ik} as well as an idiosyncratic normally distributed error term $u_{ijk} \sim N(0, \sigma_u^2)$, so that $\tau_{ijk} = exp(\phi_{jk} + \phi_{ik} + \kappa_k X_{ijk} - u_{ijk})$. For f_{ijk} we make a similar assumption , such that $f_{ijk} = exp(\varphi_{jk} + \varphi_{ik} + \delta_k X_{ijk} - \nu_{ijk})$, where φ_{jk} and φ_{ik} are exporter-sector and importer-sector specific and $\nu_{ijk} \sim N(0, \sigma_\nu^2)$.

Consequently, we can write

$$z_{ijk} = \xi_{jk} + \xi_{ik} - \gamma_k X_{ijk} + \eta_{ijk}, \tag{33}$$

where $\eta_{ijk} = u_{ijk} + \nu_{ijk} \sim N(0, \sigma_u^2 + \sigma_\nu^2)$.

As a next step define the latent variable T_{ijk} which equals one if $z_{ijk} > 0$ and zero otherwise.

Exporting countries with many zeros in bilateral trade are likely to have low unobserved trade barriers vis a vis those countries to which they export (high η_{ijk}). This introduces a correlation between the unobserved η_{ijk} and the exporter-sector fixed effect A_{jk}, which tends to upward bias the sectoral productivity estimates for those countries. In order to correct for this selection bias we estimate a standard Heckman-selection model.

$$E(\log\left(\frac{A_{ijk}}{A_{i,US,k}}\right)|X, T_{ijk}=1) = \log\left(\frac{A_{jk}}{A_{US,k}}\right) + \frac{1-\epsilon_k}{\epsilon_k}\log\left(\frac{\tau_{ijk}}{\tau_{iUSk}}\right) + E(e_{ijk}|T_{ijk}=1) = \quad (34)$$

$$\log\left(\frac{A_{jk}}{A_{US,k}}\right) + \frac{1-\epsilon_k}{\epsilon_k}\log\left(\frac{\tau_{ijk}}{\tau_{iUSk}}\right) + \beta_{\eta e}\lambda_{ijk} \quad (35)$$

where $\lambda_{ijk} = E(\eta_{ijk}|T_{ijk}=1) = \frac{\phi(\hat{z}_{ijk})}{\Phi(\hat{z}_{ijk})}$ is the inverse Mill's ratio and $\beta_{\eta e} = corr(\eta, e)(\sigma_e/\sigma_\eta)$.

Consequently, if $\beta_{\eta e} > 0$, since the inverse Mill's ratio is larger for a country the more zeros there are in bilateral trade in a sector, we tend to overestimate $\frac{A_{jk}}{A_{USk}}$ if we omit this variable.

The productivities we obtain after correcting for the selection bias (results not reported) are very similar to our baseline estimates. If anything, productivity differences between rich and poor countries are slightly augmented, which is intuitive since the countries that have many zeros in bilateral sectoral trade are mostly poor.

7 Conclusion

Starting from a hybrid Ricardo-Heckscher-Ohlin model with transport costs and using trade and production data, we have estimated sectoral -3 digit manufacturing- productivity as observed trade that cannot be explained by differences in factor intensities and factor prices or by differences in trade barriers across countries. The advantage of our methodology is that we can estimate comparable sectoral productivities for a broad set of developed and developing countries, with no need of sectoral input data or output price series.

Productivity differences in manufacturing sectors are large and systematically related to income per capita. In addition, productivity variation between rich and poor countries is more pronounced in skill intensive sectors. Some poor countries have higher productivities than the US in a small set of sectors. Moreover, our methodology permits to compute bilateral rankings of comparative advantage that are due to productivity for any two countries. Finally, there is a robust correlation between sectoral productivities and various measures of specialization.

We also relate our productivity estimates to a number of theories on productivity differences, like adequate technology, financial development or contract enforcement and show that there is a strong correlation between variation in sectoral TFP and proxies for the above factors. Moreover, we test a number of trade models and show that Ricardian productivity differences are an important factor for trade.

Appendix

A two Country General Equilibrium Model

In this section we present a two country general equilibrium version of the model we estimate in the paper which is based on Romalis (2004). Several features of the model in this section are more restrictive than the model estimated in the main text. These assumptions are just made to simplify the exposition and do not affect the basic results of the model.

There are two countries, Home and Foreign ($*$). Transport costs are allowed to be sector specific and asymmetric and are denoted by τ_k and τ_k^*. We assume in this section that there are only two factors of production, capital, K and labor, L The total number of varieties in each sector at the world level is $N_k = n_k + n_k^*$.

It follows from (4) that the Home price index in sector k is defined as

$$P_k = \left[n_k p_k^{1-\epsilon_k} + n_k^* (p_k^* \tau^*)^{1-\epsilon_k} \right]^{\frac{1}{1-\epsilon_k}} . \tag{A-1}$$

A similar expression holds for the Foreign price index.

The revenue of a Home firm is given by the sum of domestic and Foreign revenue and using the expressions for Home and Foreign demand (3), we get

$$p_k q_{jk} = \sigma_k Y \left(\frac{p_k}{P_k} \right)^{1-\epsilon_k} + \sigma_k^* Y^* \left(\frac{p_k \tau_k}{P_k^*} \right)^{1-\epsilon_k} . \tag{A-2}$$

An analogous expression applies to Foreign Firms.

Given the demand structure firms optimally set prices as a fixed mark up over their marginal cost.

$$p_k = \frac{\epsilon_k}{\epsilon_k - 1}\frac{1}{A_{jk}}\left(\frac{w_j}{1-\alpha_k}\right)^{1-\alpha_k}\left(\frac{r_j}{\alpha_k}\right)^{\alpha_k} \tag{A-3}$$

Since firms can enter freely, in equilibrium they make zero profits and price at their average cost. Combining this with (A-3), it is easy to solve for equilibrium firm size, which depends positively on the fixed cost and the elasticity of substitution.

$$q_{jk} = q_k = f_k(\epsilon_k - 1) \tag{A-4}$$

Let us now solve for partial equilibrium in a single sector. For convenience, define the relative price of Home varieties in sector k, to be $\tilde{p}_k \equiv \frac{p_k}{p_k^*}$ and the relative fixed cost in sector k as $\tilde{f}_k \equiv \frac{f_k}{f_k^*}$.

Dividing the Home market clearing condition by its Foreign counter part, one can derive an expression for $\frac{n_k}{n_k^*}$, the relative number of home varieties in sector k.

A sector is not necessarily always located in both countries. In fact, if Home varieties are too expensive relative to Foreign ones, Home producers may not be able to recoup the fixed cost of production and do not enter this sector at Home.

Consequently, if $\tilde{p} \geq \underline{p}_k$, we have that $n_k = 0$ and $n_k^* = \frac{\sigma_k(Y+Y^*)}{f_k^*(\epsilon_k-1)}$, while if $\tilde{p} \leq \underline{p}_k$, the whole sector is located in Home, $n_k = \frac{\sigma_k(Y+Y^*)}{f_k(\epsilon_k-1)}$ and $n_k^* = 0$.

For intermediate relative prices of Home varieties sectoral production is split across both countries, and the relative number of home varieties is given by the following expression

$$\frac{n_k}{n_k^*} = \frac{[\sigma_k Y(\tilde{p}_k\tilde{f}_k - \tilde{p}_k^{1-\epsilon_k}(\tau_k^*)^{\epsilon_k-1}) + \sigma_k^* Y^*(\tilde{p}_k\tilde{f}_k - \tilde{p}_k^{1-\epsilon_k}\tau_k^{1-\epsilon_k})]}{[\sigma_k^* Y^*\tilde{p}_k^{1-\epsilon_k}(\tau_k^*)^{\epsilon_k-1}(\tilde{p}_k\tau_k^{1-\epsilon_k} - \tilde{p}_k\tilde{f}_k) - \sigma_k Y\tilde{p}_k^{1-\epsilon_k}\tau_k^{1-\epsilon_k}(\tilde{p}_k\tilde{f}_k - \tilde{p}_k^{1-\epsilon_k}(\tau_k^*)^{\epsilon_k-1})]} \tag{A-5}$$

for $\tilde{p}_k \in (\underline{p}_k, \bar{p}_k)$, where

$$\underline{p}_k = \left[\frac{(\sigma_k^* Y^* + \sigma_k Y)(\tau_k^*)^{\epsilon_k - 1} \tau_k^{1-\epsilon_k}}{\sigma_k Y \tau_k^{1-\epsilon_k} \tilde{f}_k + \sigma_k^* Y^* (\tau_k^*)^{\epsilon_k - 1} \tilde{f}_k} \right]^{1/\epsilon_k} \tag{A-6}$$

and

$$\bar{p}_k = \left[\frac{\sigma_k^* Y^* \tau^{1-\epsilon_k} + \sigma_k Y (\tau_k^*)^{\epsilon_k - 1}}{\tilde{f}_k \sigma_k^* Y^* + \tilde{f}_k \sigma_k Y} \right]^{1/\epsilon_k}. \tag{A-7}$$

Defining the Home revenue share in industry k as $v_k \equiv \frac{n_k p_k x_k^s}{n_k p_k x_k^s + n_k^* p_k^* x_k^{s*}}$ we can derive that $v_k = 0$ if $\tilde{p}_k \geq \bar{p}_k$. On the other hand, v_k is given by $\frac{1}{1+(\frac{n}{n^*})^{-1}\tilde{p}^{-1}\tilde{f}^{-1}}$if $\tilde{p}_k \in (\underline{p}_k, \bar{p}_k)$ and finally $v_k = 1$ if $\tilde{p}_k \leq \underline{p}_k$.

The model is closed by substituting the pricing condition (6) into $\tilde{p}$ and the expressions for v_k in the factor market clearing conditions for Home and Foreign.

$$\sum_{k=1}^{K} (1 - \alpha_k) v_k \sigma_k (Y + Y^*) + (1 - \alpha_{NT}) \sigma_{NT} Y = wL \tag{A-8}$$

$$\sum_{k=1}^{K} \alpha_k v(k) \sigma_k (Y + Y^*) + \alpha_{NT} \sigma_{NT} Y = rK \tag{A-9}$$

$$\sum_{k=1}^{K} (1 - \alpha_k)(1 - v_k) \sigma_k (Y + Y^*) + (1 - \alpha_{NT}) \sigma_{NT} Y^* = w^* L^* \tag{A-10}$$

$$\sum_{k=1}^{K} \alpha_k (1 - v_k) \sigma_k (Y + Y^*) + \alpha_{NT} \sigma_{NT} Y^* = r^* K^* \tag{A-11}$$

Here σ_{NT} is the share of expenditure spent on non-tradable goods. Normalizing one relative factor price, we can use 3 factor market clearing conditions to solve for the remaining factor prices.

One can show that the home revenue share in sector k, v_k, is decreasing in the relative price of home varieties $\tilde{p}_k$. This implies that countries have larger revenue shares in sectors in which they can produce relatively cheaply. Cost advantages may arise both because a sector uses the relatively cheap factor intensively and because of high relative sectoral productivity.

Romalis' Model

In the special case in which sectoral productivity differences are absent, $\frac{A_k}{A_k^*} = 1$ for all $k \in K$, relative fixed costs of production are equal to one, $\tilde{f}_k = 1$ for all $k \in K$, sectoral elasticities of substitution are the same in all sectors, $\epsilon_k = \epsilon$, trade costs are symmetric and identical across sectors $\tau_k = \tau_k^* = \tau$, preferences are identical, such that $\sigma_k = \sigma_k^*$, the model reduces to Romalis' (2004) model.

In his framework, the relative price of home varieties, $\tilde{p}_k = \frac{\left(\frac{w}{1-\alpha_k}\right)^{1-\alpha_k}\left(\frac{r}{\alpha_k}\right)^{\alpha_k}}{\left(\frac{w^*}{1-\alpha_k}\right)^{1-\alpha_k}\left(\frac{r^*}{\alpha_k}\right)^{\alpha_k}}$, is decreasing in the capital intensity, α_k, if and only if Home is relatively abundant in capital, i.e. $\frac{K}{L} > \frac{K^*}{L^*}$.

Factor prices are not equalized across countries because of transport costs, which gives Home a cost advantage in the sectors that use its abundant factor intensively. This in turn leads to a larger market share of the Home country in those sectors as consumers shift their expenditure towards the relatively cheap home varieties. This is the intuition for the Quasi-Heckscher-Ohlin prediction that countries are net exporters of those goods which use their relatively abundant factor intensively. The main advantage of Romalis' model is that it solves the production indeterminacy present in the standard Heckscher-Ohlin model with more goods than factors whenever countries are not fully specialized[31] and that it provides a direct link between factor abundance and sectoral

[31]For more on the determinacy of production patterns in the Heckscher-Ohlin model see for example the excellent

trade patterns. This makes it ideal for empirical applications.

A Ricardian Model

If we make the alternative assumption that all sectors use labor as the only input, i.e. $\alpha_k = 0$ for all $k \in K$ and we order sectors according to home comparative advantage, such that $\frac{A_k}{A_k^*}$ is increasing in k, we obtain a Ricardian model. The advantage of this model is that because of love for variety, consumers are willing to buy both Home and Foreign varieties in a sector even when they do not have the same price. The setup implies that $\tilde{p}_k = \frac{w}{w^*}\frac{A_k^*}{A_k}$ is decreasing in k, so that Home offers lower relative prices in sectors with higher k. Consequently, Home captures larger market shares in sectors with larger comparative advantage since v_k is decreasing in $\tilde{p}_k$ and $\tilde{p}_k$ is decreasing in $\frac{A_k}{A_k^*}$.

The Hybrid Ricardo-Heckscher-Ohlin Model

In the more general case comparative advantage is both due to differences in factor endowments and due to differences in sectoral productivities. Note that $\tilde{p}_k$ is given by the following expression:

$$\tilde{p}_k = \frac{\frac{1}{A_k}\left(\frac{w}{1-\alpha_k}\right)^{1-\alpha_k}\left(\frac{r}{\alpha_k}\right)^{\alpha_k}}{\frac{1}{A_k^*}\left(\frac{w^*}{1-\alpha_k}\right)^{1-\alpha_k}\left(\frac{r^*}{\alpha_k}\right)^{\alpha_k}} \tag{A-12}$$

Assume again that Home is relatively capital abundant, $\frac{K}{L} > \frac{K^*}{L^*}$. Then, conditional on $\frac{w}{r}, \frac{w^*}{r^*}$, Home has lower prices and a larger market share in sectors where $\frac{A_k}{A_k^*}$ is larger. In addition, factor prices depend negatively on endowments unless the productivity advantages are systematically much larger in sectors that use the abundant factor intensively. A very high relative productivity in the capital intensive sectors can increase demand for capital so much that $\frac{w}{r} < \frac{w^*}{r^*}$ even though

exposition in Feenstra (2005).

$\frac{K}{L} > \frac{K^*}{L^*}$. As long as this is not the case, locally abundant factors are relatively cheap and - holding constant productivity differences - this increases market shares in sectors that use the abundant factor intensively.

The model is illustrated in figure 1. In this example, $\epsilon_k = 4$, Home is relatively capital abundant, $\frac{K/L}{K^*/L^*} = 4$, and transport costs are high, $\tau_k = \tau_k^* = 2$. The panels of figure 1 plot Homes' relative productivity, Homes' sectoral revenue share, Homes' relative prices, as well as Homes' net exports, Homes' exports relative to production and Homes' imports relative to production against the capital intensity of the sectors, which is ordered on the zero-one interval. In the first case (solid lines) there are no productivity differences between Home and Foreign. Because Home is capital abundant it has lower rentals and higher wages which leads to lower prices and larger revenue shares in capital intensive sectors. In addition, Home is a net importer in labor intensive sectors and a net exporter in capital intensive ones and its exports relative to production are larger in capital intensive sectors, while its imports relative to production are much larger in labor intensive sectors. This illustrates neatly the Quasi-Heckscher-Ohlin prediction of the model.

In the second case (dashed lines) - besides being more capital abundant - Home also has systematically higher productivities in more capital intensive sectors. This increases home comparative advantage in capital intensive sectors even further. The consequence of higher productivity is an increased demand for both factors that increases home factor prices and makes home even less competitive in labor abundant sectors, while the relative price in capital abundant sectors is lower than without productivity differences. The result is a higher revenue share in capital intensive sectors and more extreme import and export patterns than without productivity differences.

Figure 2 is an example of the Quasi-Rybczynski effect. Initially both Home and Foreign have the same endowments, $\frac{K/L}{K^*/L^*} = 1$, and Home has a systematically higher productivity than Foreign in capital intensive sectors (solid lines), which explains Homes' larger market share in those sectors. In the case with the dashed lines Home has doubled its capital stock, so that now $\frac{K/L}{K^*/L^*} = 2$. This leads to an expansion of production and revenue shares in the capital intensive sectors and a decline of production in the labor intensive sectors. The additional capital is absorbed both through more capital intensive production and an expansion of production in capital intensive sectors. The increased demand for labor in those sectors drives up wages and makes Home less competitive in labor intensive sectors.

Summing up, the general prediction of the Hybrid-Ricardo-Heckscher-Ohlin model is that exporting countries capture larger market shares in sectors in which their abundant factors are used intensively (Quasi-Heckscher-Ohlin prediction) and in which they have high productivities relative to the rest of the world (Quasi-Ricardian prediction). In addition, the model has a Quasi-Rybczynski effect. Holding productivities constant, factor accumulation leads to an increase in revenue shares in sectors that use the factor intensively and a decrease in those sectors that use little the factor.

References

Acemoglu, D., Antràs, P., and Helpman, E. (2007). Contracts and technology adoption. *The American Economic Review*, Forthcoming.

Acemoglu, D. and Zilibotti, F. (2001). Productivity differences. *Quarterly Journal of Economics*, 116(2):563–606.

Antweiler, W. and Trefler, D. (2002). Increasing returns and all that: A view from trade. *American Economic Review*, 92(1):93–119.

Balassa, B. (1965). Trade liberalization and revealed comparative advantage. *The Manchester School of Economic and Social Studies*, 32:99–123.

Balassa, B. (1986). Comparative advantage in manufactured goods: A reappraisal. *Review of Economics and Statistics*, 68:315–319.

Banerjee, A. and Duflo, E. (2005). Growth theory through the lens of development economics. *Handbook of Economic Growth*, 1(A):473–552.

Barro, R. J. and Lee, J.-W. (2001). International data on educational attainment: Updates and implications. *Oxford Economic Papers*, 3(3):541–563.

Bartelsman, E. J., Becker, R. A., and Gray, W. B. (2000). Nber-ces manufacturing industry database. *National Bureau of Economic Research and Census Bureau's Center for Economic Studies.*

Baumol, W., Dollar, D., and Wolf, E. N. (1988). The factor price equalization model and industry labor productvity: An empirical test across countries. In *Empirical Methods for International Trade, Robert Feenstra Ed.* MIT Press, Cambridge MA.

Beck, T. (2003). Financial dependence and international trade. *Review of International Economics*, 11:296–316.

Beck, T., Demirgüç-Kunt, A., and Levine, R. (2000). A new database on financial development and structure. *World Bank Economic Review*, 14:597–605.

Bernanke, B. S. and Gürkaynak, R. S. (2002). Is growth exogenous? taking mankiw, romer, and weil seriously. *NBER macroeconomics annual.*

Bils, M. and Klenow, P. J. (2000). Does schooling cause growth? *The American Economic Review*, 90(5):1160–1183.

Broda, C. and Weinstein, D. E. (2006). Globalization and the gains from variety. *Quarterly Journal of Economics*, 121(2):541–585.

Caselli, F. (2005). Accounting for cross-country income differences. *Handbook of Economic Growth.*

Caselli, F. and Coleman, W. J. (2006). The world technology frontier. *The American Economic Review*, 96(3):499–522.

Caselli, F. and Feyrer, J. (2006). The marginal product of capital. *CEP Discussion Papers dp0735.*

Chor, D. (2006). Unpacking sources of comparative advantage: A quantitative approach. *Job Market Paper, Harvard University.*

Cohen, D. and Soto, M. (2001). Growth and human capital: Good data, good results. *Centre for Economic Policy Research (London)*, Discussion Paper No. 3025.

Davis, D. and Weinstein, D. E. (2001). An account of global factor trade. *The American Economic Review*, 91(5):1423–1453.

Djankov, S., Porta, R. L., Lopez-De-Silanes, F., and Shleifer, A. (2002). The regulation of entry. *Quarterly Journal of Economics*, 117(1):1–37.

Dollar, D. and Wolff, E. N. (1993). Competitiveness, convergence and international specialization. *MIT Press, Cambridge MA*.

Eaton, J. and Kortum, S. (2002). Technology, geography, and trade. *Econometrica*, 70(5):1741–1779.

Gollin, D. (2002). Getting income shares right. *Journal of Political Economy*, 110(2):458–474.

Golub, S. S. and Hsieh, C.-T. (2000). Classical ricardian theory of comparative advantage revisited. *Review of International Economics*, 8(2):221–234.

Gustavsson, P., Hansson, P., and Lundberg, L. (1999). Technology, resource endowments and international competitivenesss. *European Economic Review*, 43:1501–1530.

Hall, R. E. and Jones, C. I. (1999). Why do some countries produce so much more output per worker than others? *Quarterly Journal of Economics*, 114(1):83–116.

Harrigan, J. (1997). Technology, factor supplies, and international specialization: Estimating the neoclassical model. *American Economic Review*, 87(4):475–94.

Harrigan, J. (1999). Estimation of cross-country differences in industry production functions. *Journal of International Economics*, 47(2):267–293.

Helpman, E., Melitz, M., and Rubinstein, Y. (2007). Estimating trade flows: Trading partners and trading volumes. *NBER Working Papers*, 12927.

Kaufmann, D., Kraay, A., and Mastruzzi, M. (2003). Government matters iii, governance indicators for 1996-2002. *World Bank Policy Research Working Paper*, 3106.

Krugman, P. R. (1979). Increasing returns, monopolistic competition, and international trade. *Journal of International Economics*, 9(4):469–479.

Laursen, K. (1998). Revealed comparative advantage and the alternatives as measures of international specialisation. DRUID Working Papers 98-30, DRUID, Copenhagen Business School, Department of Industrial Economics and Strategy/Aalborg University, Department of Business Studies.

Maskus, K. E. (1991). Comparing international trade data and product and national characteristics data for the analysis of trade models. *International Economic Transaction: Issues in Measurement and Empirical Research.*

Mayer, T. and Zignago, S. (2005). Market acces in global and regional trade. *CEPII Working Paper 02.*

Nunn, N. (2007). Relationship-specificity, incomplete contracts and the pattern of trade. *Quarterly Journal of Economics*, 122(2):569–600.

Rajan, R. G. and Zingales, L. (1998). Financial dependence and growth. *The American Economic Review*, 88(3):559–586.

Romalis, J. (2004). Factor proportions and the structure of commodity trade. *The American Economic Review*, 94(1):67–97.

Rose, A. K. (2004). Do we really know that the wto increases trade? *The American Economic Review*, 94(1):98–114.

Trefler, D. (1993). International factor price differences: Leontief was right! *Journal of Political Economy*, 101(6):961–87.

Trefler, D. (1995). The case of the missing trade and other mysteries. *American Economic Review*, 85(5):1029–46.

Yamada, T. (2005). Relevance and applicability of the unido industrial statistics database for research purposes. *United Nations Industrial Development Organisation (UNIDO)*, ESA/STAT/AC.105/21.

Figure 1
Quasi-Heckscher-Ohlin and Quasi-Ricardo

Example: K=2/3; L=1/3; K*=1/3; L*=2/3

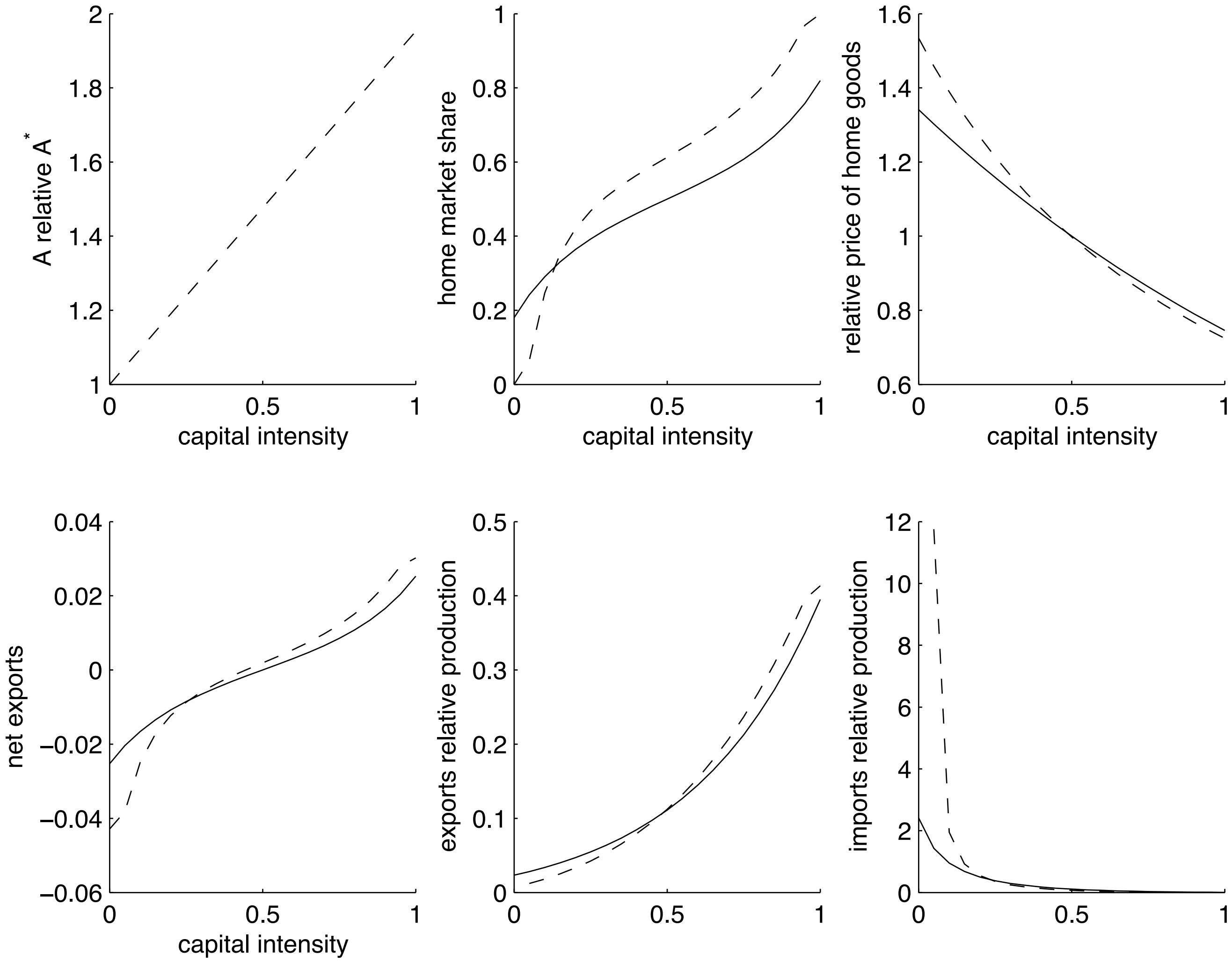


Figure 1

Figure 2
Quasi-Rybczynski Effect

Example: K=1/3; L=1/3; K*=1/3; L*=1/3; Home doubles Capital stock K'=2/3

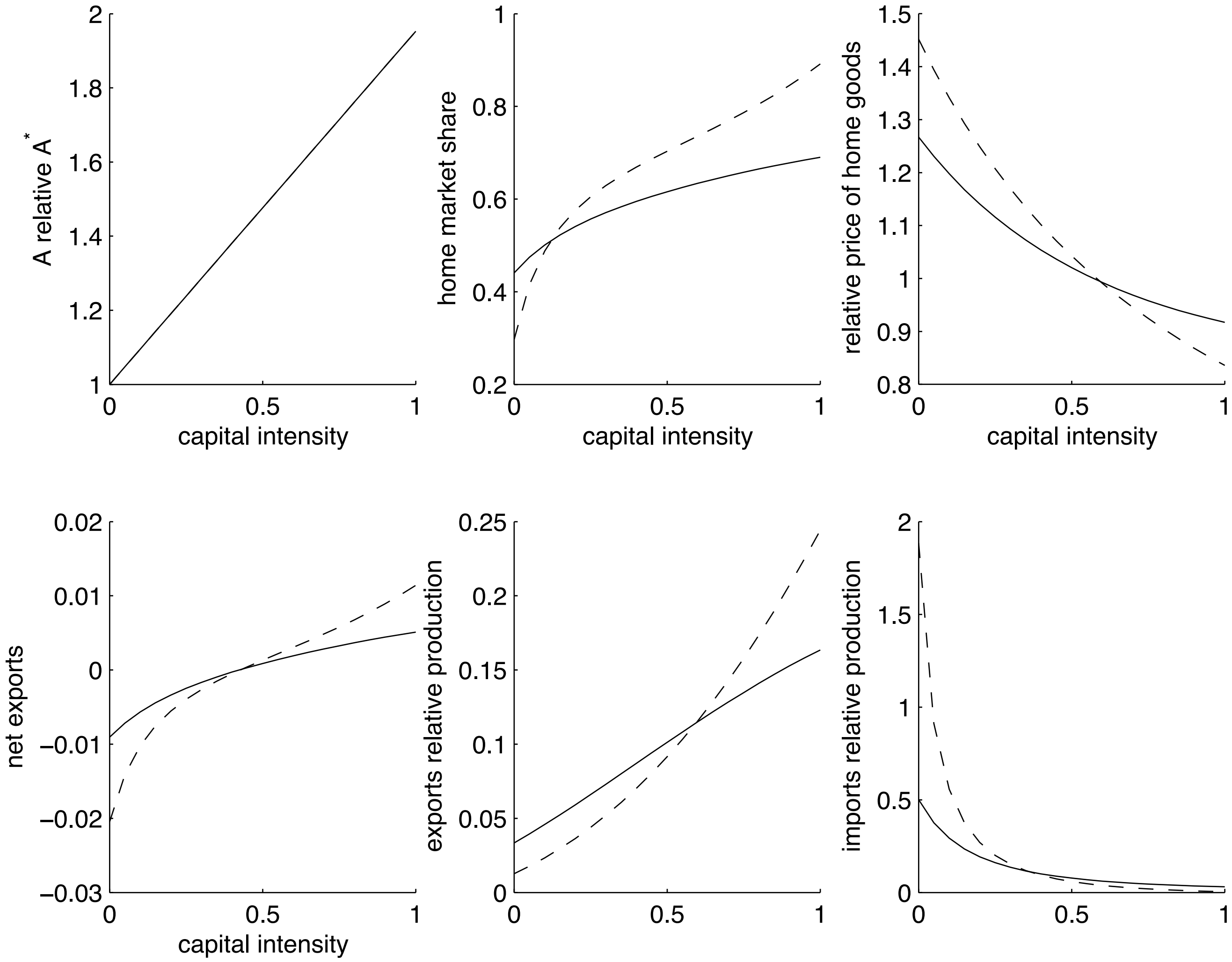


Figure 2

TABLE I: INDUSTRY STATISTICS

ISIC Rev. 2	Sector Name	Skill Intensity	Capital Intensity	Elasticity of Substitution
311	FOOD	0.24	0.77	5.33
313	BEVERAGES	0.49	0.85	3.72
321	TEXTILES	0.15	0.59	3.27
322	APPAREL	0.16	0.60	2.90
323	LEATHER	0.17	0.63	3.80
324	FOOTWEAR	0.15	0.60	3.29
331	WOOD	0.17	0.59	8.38
332	FURNITURE	0.19	0.55	2.29
341	PAPER	0.23	0.72	4.72
342	PRINTING	0.47	0.64	2.73
351	IND.CHEMICHALS	0.41	0.82	3.77
352	OTHER.CHEMICALS	0.45	0.82	3.27
355	RUBBER	0.22	0.62	3.80
356	PLASTIC	0.23	0.68	1.81
361	POTTERY	0.18	0.57	3.26
362	GLASS	0.18	0.66	3.38
369	MINERALS	0.25	0.65	4.52
371	IRON.STEEL	0.21	0.63	7.58
372	METALS	0.22	0.66	12.68
381	METAL.PRODUCTS	0.25	0.56	3.54
382	MACHINERY	0.35	0.62	4.19
383	ELECTRICAL.MACH	0.35	0.70	3.39
384	TRANSPORT	0.32	0.62	3.86
385	SCIENTIFIC.EQUIP	0.47	0.67	3.17
	MEAN	**0.27**	**0.66**	**4.28**

Source: Own computations using data of Bartelsman et al (2000) and Broda & Weinstein (2006). Skill Intensity is defined as the ratio of non-production workers over total employment. Capital intensity is defined as 1 minus the share of total compensation in value added.

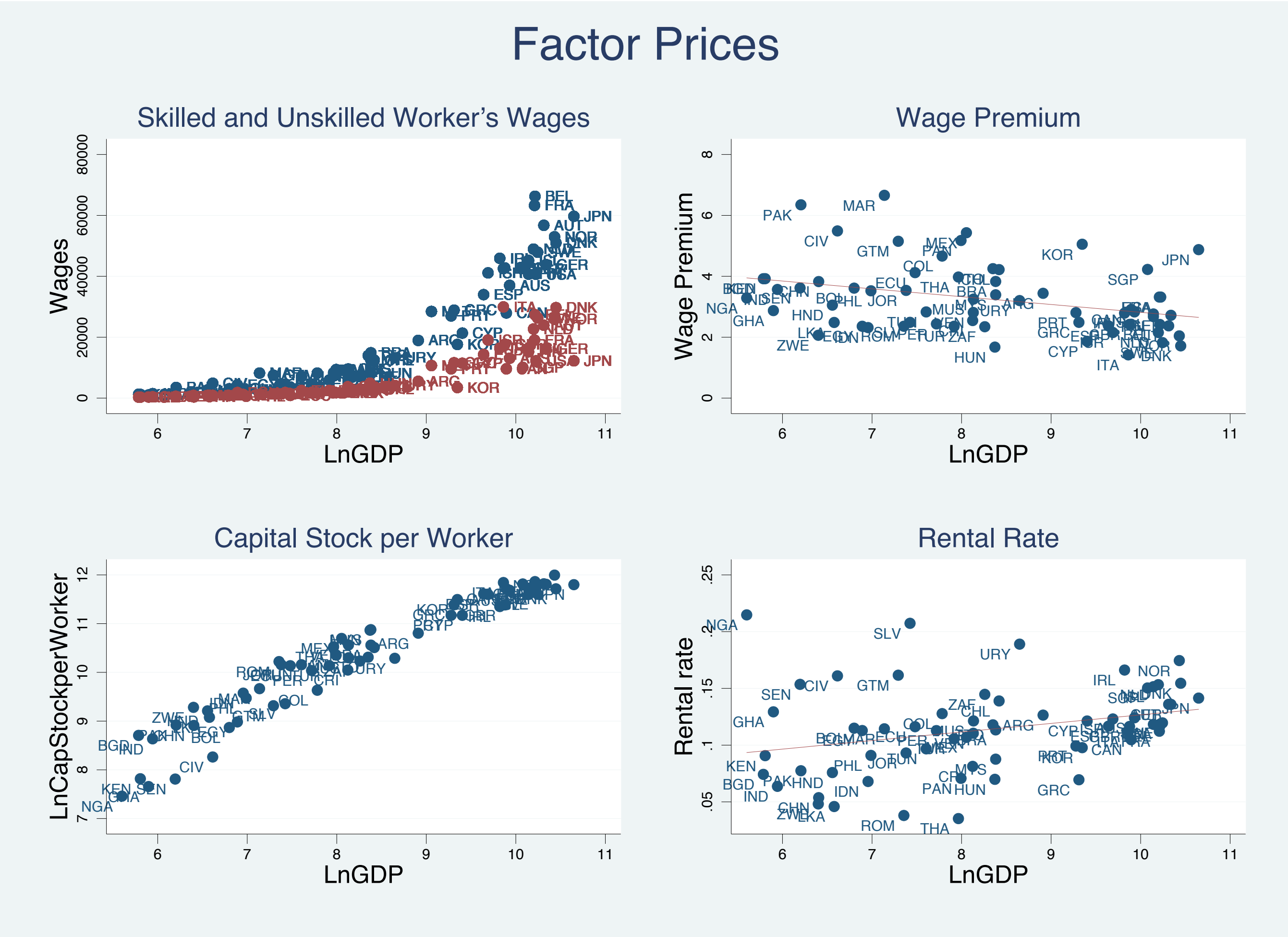

Factor Prices
Skilled and Unskilled Worker's Wages
Wages
LnGDP
Wage Premium
Wage Premium
LnGDP
Capital Stock per Worker
LnCapStockperWorker
LnGDP
Rental Rate
Rental rate
LnGDP

Figure 3

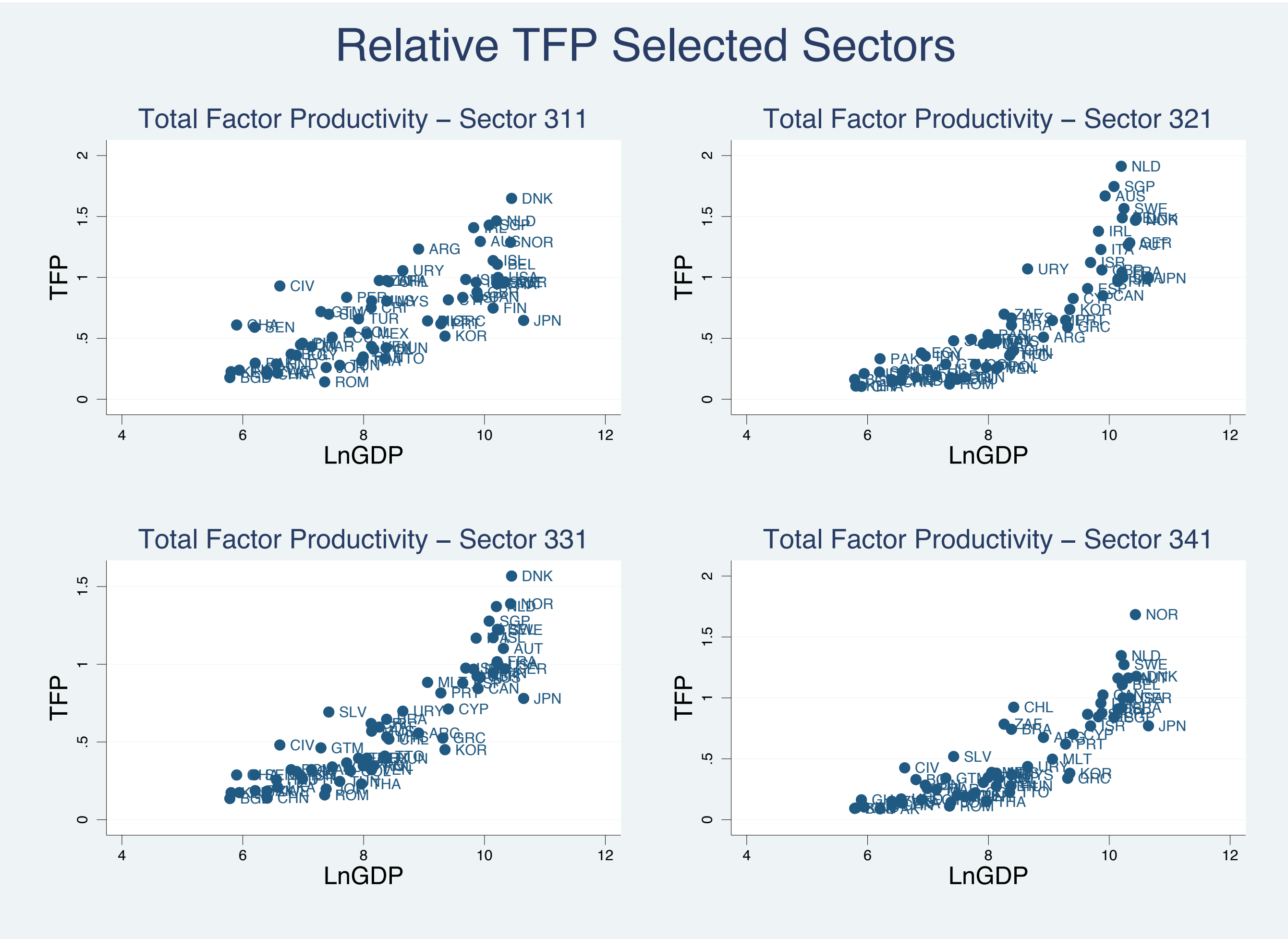
Results: Stepwise Regression. Panel with Fixed Country-Industry Effect

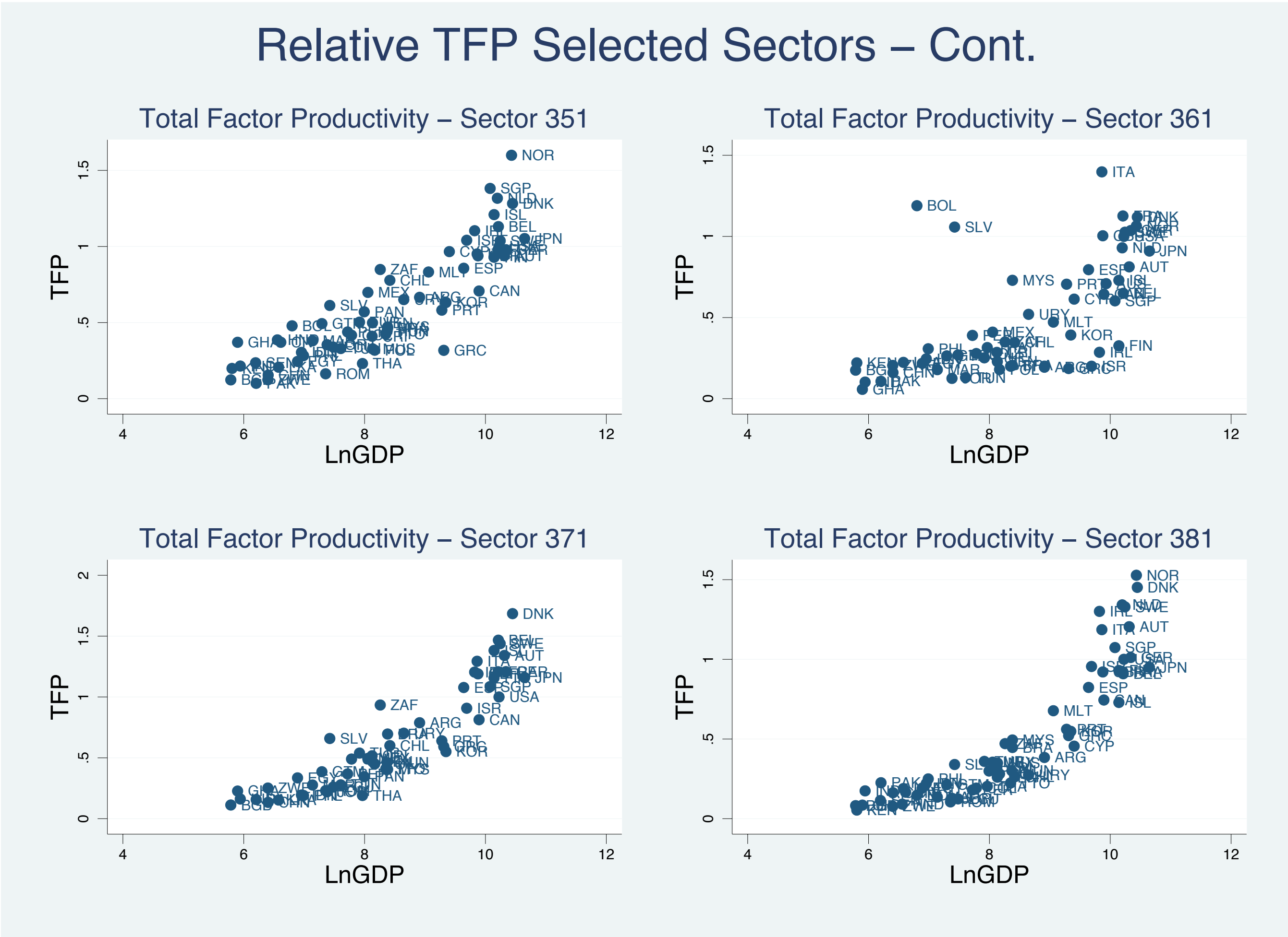
Sector	Difference Distance	Difference Tariff	Common Language	Common English	Common Border	Common Colony
311 Food Products	-0.277	-0.003	0.100	-0.104		0.235
	(0.012)	(0.001)	(0.033)	(0.023)		(0.053)
313 Beverages	-0.285	-0.003	0.179	-0.077	0.289	0.263
	(0.015)	(0.002)	(0.04)	(0.027)	(0.059)	(0.059)
321 Textiles	-0.404	-0.020	0.162	-0.101		0.233
	(0.014)	(0.002)	(0.033)	(0.023)		(0.053)
322 Apparel	-0.409	-0.037	0.132			0.417
	(0.014)	(0.002)	(0.033)			(0.054)
323 Leather Products	-0.307	-0.032	0.172			0.257
	(0.013)	(0.003)	(0.034)			(0.054)
324 Footwear	-0.304	-0.013	0.177	0.061	0.352	
	(0.016)	(0.002)	(0.038)	(0.029)	(0.062)	
331 Wood Products	-0.145	-0.020	0.104		0.118	
	(0.014)	(0.005)	(0.031)		(0.056)	
332 Furniture	-0.520	-0.098	0.251	-0.050	0.286	0.388
	(0.016)	(0.004)	(0.039)	(0.027)	(0.061)	(0.058)
341 Paper And Products	-0.366	-0.017	0.107			
	(0.013)	(0.003)	(0.034)			
342 Printing And Publishing	-0.394	-0.067	0.517	-0.441	0.242	0.467
	(0.014)	(0.005)	(0.036)	(0.025)	(0.057)	(0.056)
351 Industrial Chemicals	-0.356	-0.008	0.103	-0.128		0.139
	(0.012)	(0.003)	(0.035)	(0.024)		(0.054)
352 Other Chemicals	-0.387		0.300	-0.086		0.200
	(0.011)		(0.035)	(0.024)		(0.054)
355 Rubber Products	-0.288	-0.059	0.213	-0.066	0.125	
	(0.014)	(0.004)	(0.036)	(0.026)	(0.058)	
356 Plastic Products	-0.692	-0.064	0.474	-0.117	0.152	0.325
	(0.015)	(0.002)	(0.039)	(0.026)	(0.064)	(0.059)
361 Pottery	-0.306	-0.034	0.256			0.181
	(0.013)	(0.002)	(0.037)			(0.057)
362 Glass And Products	-0.404	-0.027	0.219		0.132	0.143
	(0.014)	(0.003)	(0.039)		(0.058)	(0.059)
369 Other Non-Metallic	-0.288	-0.022	0.107		0.133	
	(0.015)	(0.004)	(0.034)		(0.059)	
371 Iron And Steel	-0.193	-0.016				
	(0.013)	(0.005)				
372 Non-Ferrous Metals	-0.137	-0.014				
	(0.014)	(0.008)				
381 Fabricated Metal	-0.354	-0.038	0.183	-0.087		0.277
	(0.013)	(0.003)	(0.034)	(0.024)		(0.055)
382 Machinery, Non Electric	-0.264	-0.023	0.223	-0.113		0.211
	(0.012)	(0.004)	(0.033)	(0.023)		(0.054)
383 Machinery Electric	-0.280	-0.042	0.250	-0.058	0.104	0.243
	(0.013)	(0.003)	(0.034)	(0.023)	(0.056)	(0.054)
384 Transport Equipment	-0.314	-0.034	0.155	-0.057		0.290
	(0.013)	(0.003)	(0.035)	(0.024)		(0.055)
385 Professional & Scientific	-0.240	-0.024	0.263	-0.143	0.108	0.270
	(0.014)	(0.003)	(0.037)	(0.025)	(0.057)	(0.057)

Standard Deviation in parenthesis.

TABLE III: DESCRIPTIVE STATISTICS OF ESTIMATED TFP

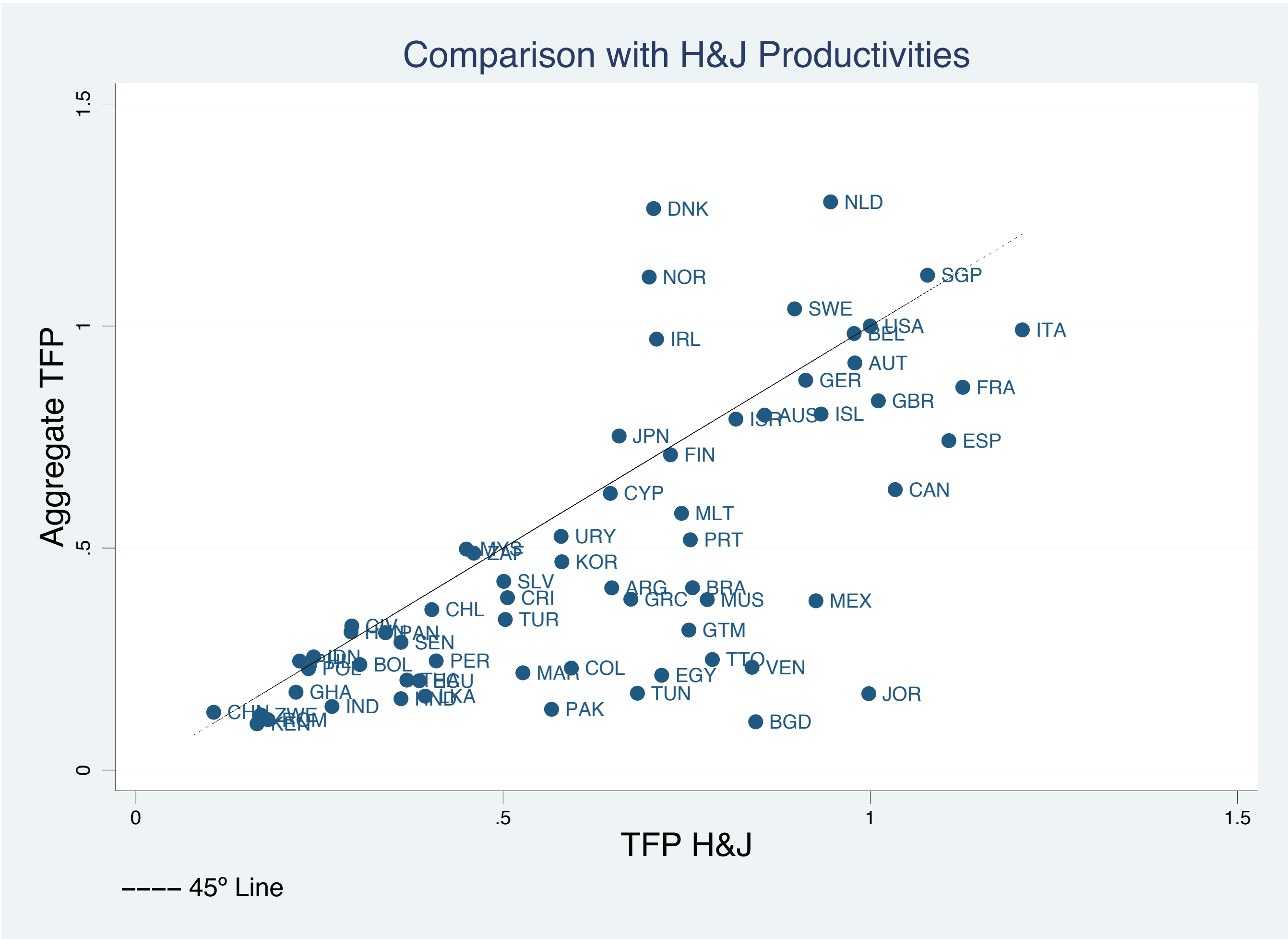
Country	Mean TFP	S.D.	Lowest TFP		Highest TFP	
ARG	0.45	0.25	Plastic	0.08	Food	1.21
AUS	0.87	0.29	Footwear	0.51	Textiles	1.61
AUT	1.05	0.24	Furniture	0.54	Apparel	1.55
BEL	1.10	0.27	Pottery	0.46	Other.Chemicals	1.51
BGD	0.14	0.10	Furniture	0.06	Plastic	0.45
BOL	0.29	0.24	Plastic	0.07	Pottery	1.21
BRA	0.51	0.20	Plastic	0.23	Food	1.04
CAN	0.70	0.14	Footwear	0.41	Paper	1.01
CHL	0.43	0.31	Plastic	0.11	Beverages	1.26
CHN	0.17	0.10	Transport	0.10	Plastic	0.55
CIV	0.36	0.19	Metal.Products	0.15	Food	0.90
COL	0.27	0.13	Plastic	0.08	Food	0.60
CRI	0.29	0.10	Plastic	0.09	Metals	0.52
CYP	0.64	0.22	Metal.Products	0.39	Transport	1.30
DNK	1.38	0.20	Glass	1.01	Rubber	1.68
ECU	0.27	0.13	Footwear	0.12	Food	0.61
EGY	0.27	0.10	Plastic	0.13	Metals	0.47
ESP	0.84	0.13	Plastic	0.56	Minerals	1.10
FIN	0.88	0.20	Footwear	0.37	Paper	1.23
FRA	0.95	0.16	Footwear	0.70	Beverages	1.52
GBR	0.92	0.17	Plastic	0.63	Beverages	1.47
GER	1.04	0.12	Footwear	0.72	Textiles	1.33
GHA	0.21	0.13	Metal.Products	0.08	Food	0.62
GRC	0.44	0.13	Other.Chemicals	0.28	Scientific.Equipm	0.71
GTM	0.39	0.18	Plastic	0.15	Apparel	0.81
HND	0.20	0.15	Metal.Products	0.09	Transport	0.71
HUN	0.36	0.08	Plastic	0.18	Apparel	0.50
IDN	0.33	0.20	Transport	0.16	Plastic	0.94
IND	0.17	0.12	Plastic	0.10	Furniture	0.60
IRL	1.17	0.24	Pottery	0.67	Other.Chemicals	1.56
ISL	0.89	0.29	Furniture	0.24	Iron.Steel	1.35
ISR	0.89	0.25	Pottery	0.47	Scientific.Equipm	1.45
ITA	1.18	0.18	Other.Chemicals	0.88	Apparel	1.50
JOR	0.23	0.10	Footwear	0.09	Rubber	0.45
JPN	0.78	0.25	Footwear	0.31	Rubber	1.27
KEN	0.13	0.07	Electrical.Mach	0.06	Food	0.27
KOR	0.54	0.14	Furniture	0.32	Rubber	0.86
LKA	0.21	0.07	Transport	0.11	Furniture	0.40
MAR	0.26	0.10	Metal.Products	0.14	Metals	0.48
MEX	0.42	0.14	Transport	0.24	Beverages	0.77
MUS	0.42	0.16	Furniture	0.21	Food	0.77
MYS	0.60	0.24	Minerals	0.36	Apparel	1.46
NGA	0.25	0.27	Metal.Products	0.08	Ind.Chemichals	1.05
NLD	1.43	0.15	Pottery	0.93	Beverages	1.61
NOR	1.12	0.28	Printing	0.56	Paper	1.50
PAK	0.17	0.17	Electrical.Mach	0.07	Apparel	0.75
PAN	0.32	0.08	Plastic	0.19	Ind.Chemichals	0.52
PER	0.27	0.18	Footwear	0.10	Food	0.83
PHL	0.27	0.13	Rubber	0.12	Furniture	0.72
PRT	0.63	0.14	Furniture	0.35	Beverages	0.97
ROM	0.12	0.04	Scientific.Equipm	0.07	Iron.Steel	0.21
SEN	0.32	0.22	Plastic	0.09	Apparel	0.86
SGP	1.24	0.30	Pottery	0.57	Footwear	1.69
SLV	0.54	0.22	Plastic	0.19	Pottery	1.19
SWE	1.22	0.22	Printing	0.84	Textiles	1.64
THA	0.26	0.12	Beverages	0.14	Furniture	0.67
TTO	0.47	0.19	Printing	0.22	Beverages	0.81
TUN	0.22	0.09	Plastic	0.09	Metals	0.39
TUR	0.31	0.10	Printing	0.13	Food	0.53
URY	0.63	0.29	Plastic	0.12	Apparel	1.28
USA	1.00	-				
VEN	0.27	0.13	Furniture	0.08	Metals	0.59
ZAF	0.52	0.21	Printing	0.24	Food	0.92
ZWE	0.13	0.06	Metal.Products	0.06	Metals	0.23


Relative TFP Selected Sectors
Total Factor Productivity – Sector 311
Total Factor Productivity – Sector 321
Total Factor Productivity – Sector 331
Total Factor Productivity – Sector 341
TFP
LnGDP
DNK
NOR
JPN
KOR
ROM
NLD
SGP
AUS
URY
CIV
SLV
CHL



Relative TFP Selected Sectors – Cont.
Total Factor Productivity – Sector 351
Total Factor Productivity – Sector 361
Total Factor Productivity – Sector 371
Total Factor Productivity – Sector 381
TFP
LnGDP

Figure 4



Comparison with H&J Productivities
Aggregate TFP
TFP H&J
0
.5
1
1.5
45° Line
DNK
NLD
NOR
SGP
SWE
USA
BEL
ITA
IRL
AUT
GER
FRA
GBR
ISR
AUS
ISL
JPN
ESP
FIN
CYP
CAN
MLT
URY
PRT
MYS
ZAF
KOR
SLV
ARG
BRA
CRI
GRC
MUS
MEX
CHL
TUR
CIV
HUN
PAN
GTM
SEN
IDN
PER
TTO
VEN
POL
BOL
MAR
COL
EGY
THA
ECU
GHA
TUN
JOR
IND
NND
LKA
PAK
CHN
ZWE
KEN
BGD

Figure 5

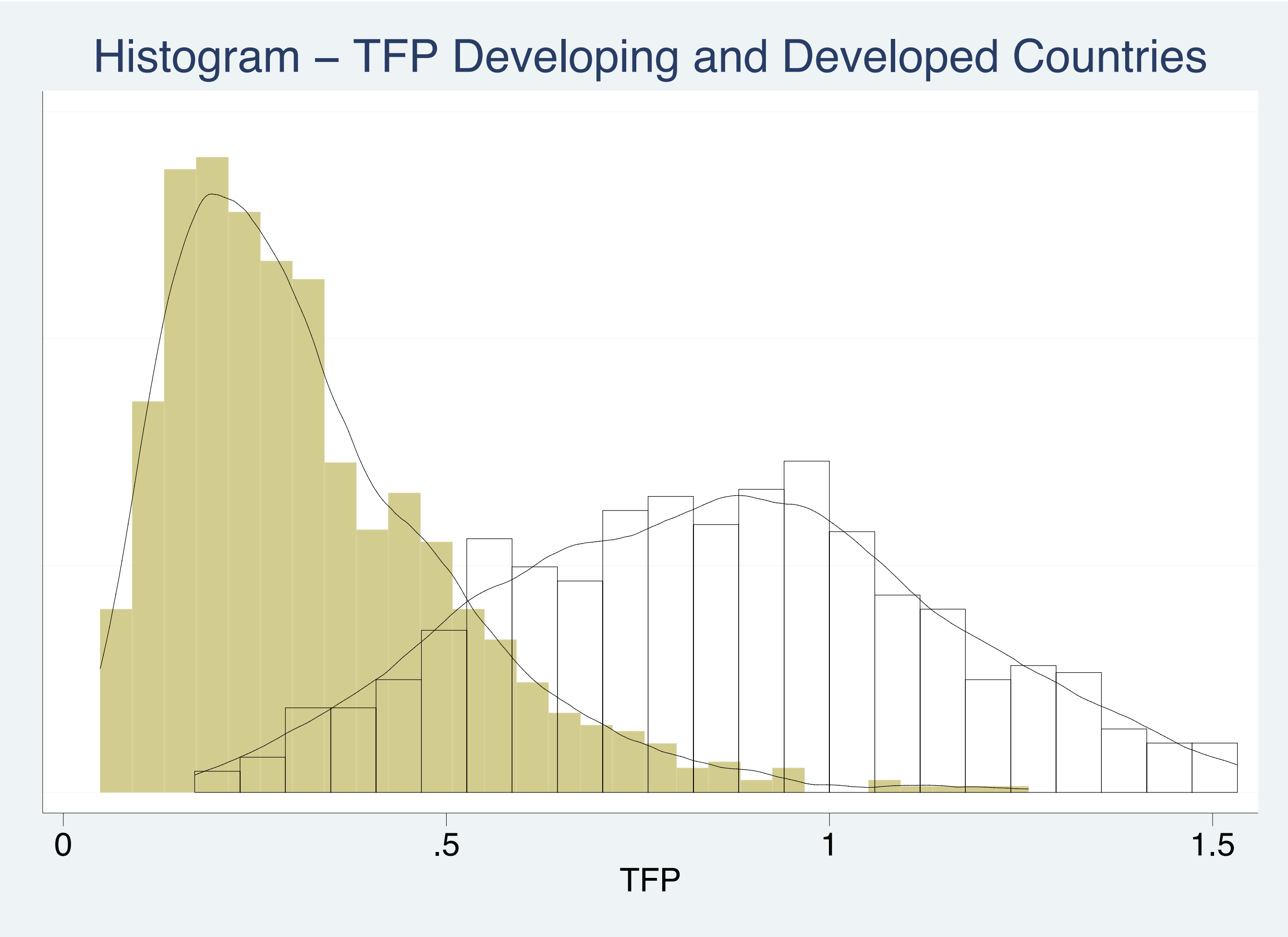
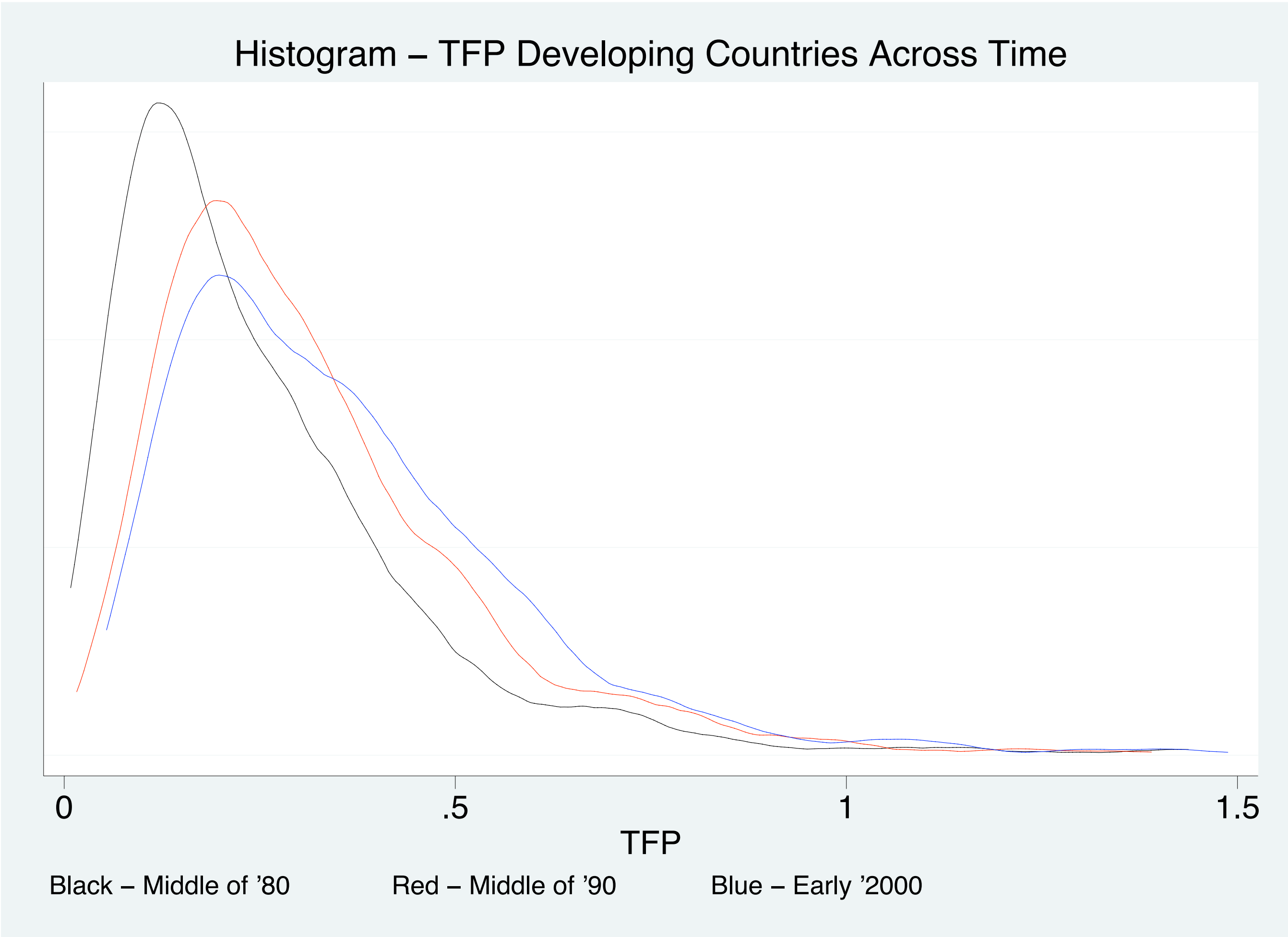

Histogram – TFP Developing and Developed Countries
0
.5
1
1.5
TFP

Figure 6



Histogram – TFP Developing Countries Across Time
0
.5
1
1.5
TFP
Black – Middle of ’80
Red – Middle of ’90
Blue – Early ’2000

Figure 7

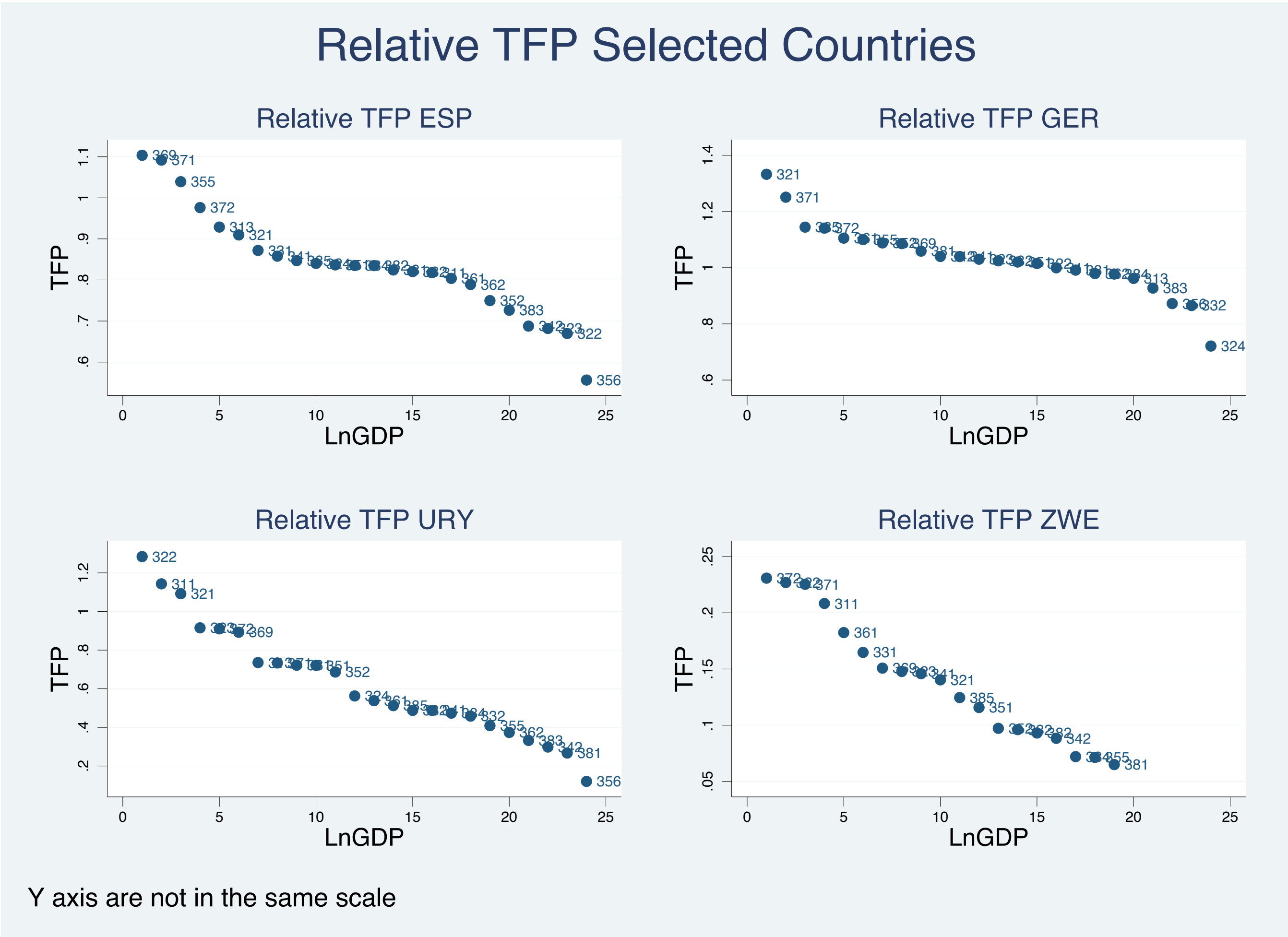

Relative TFP Selected Countries
Relative TFP ESP
Relative TFP GER
Relative TFP URY
Relative TFP ZWE
TFP
LnGDP
Y axis are not in the same scale

Figure 8

TABLE: MODEL FIT

Fit	HO - no productivity	HO + aggregate productivit	HO + sector productivities
R-squared	0.35	0.76	0.85
within R-squared		0.45	0.52
Akaike IC	97675	57988	40572
fraction error variance due to fixed effects		0.66	0.8

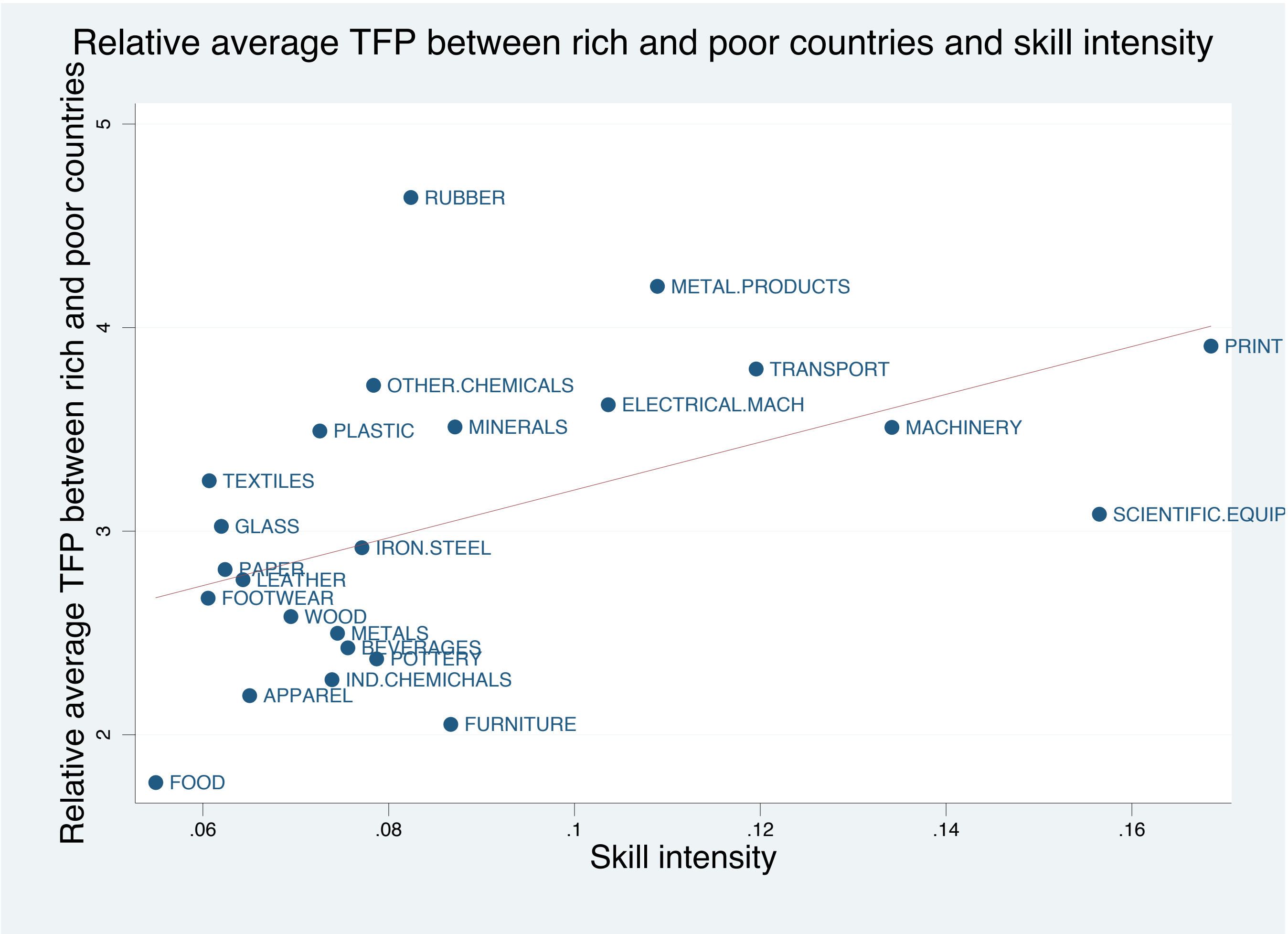

Relative average TFP between rich and poor countries and skill intensity
Relative average TFP between rich and poor countries
Skill intensity
2
3
4
5
.06
.08
.1
.12
.14
.16
RUBBER
METAL.PRODUCTS
PRINT
TRANSPORT
OTHER.CHEMICALS
ELECTRICAL.MACH
PLASTIC
MINERALS
MACHINERY
TEXTILES
SCIENTIFIC.EQUIP
GLASS
IRON.STEEL
PAPER
LEATHER
FOOTWEAR
WOOD
METALS
BEVERAGES
POTTERY
IND.CHEMICHALS
APPAREL
FURNITURE
FOOD

Figure 9

TABLE: PRODUCTIVITY AND SKILL INTENSITY

sample	**developing**	**developed**	**all**
skill intensity	-16.821	-0.421	-10.549
	(4.73)***	-0.16	(4.72)***
skill^2	66.934	-1.494	33.004
	(3.91)***	-0.12	(3.16)***
capital intensity	-10.116	1.694	-3.961
	(2.70)***	-0.64	(1.70)*
capital^2	7.566	-1.003	3.256
	(2.85)***	-0.53	(2.00)**
skill*income			4.823
			(4.19)***
capital*income			-0.57
			-1.4
Observations	735	736	1471
R-squared	0.48	0.65	0.78

Robust t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
This table shows the results of a fixed effect panel regression on skill intensity and capital intensity.

PRODUCTIVITY AND DEVELOPMENT THEORY

	Financial Development	Contract Enforcement	Business Setup Cost	All
findep*findev	0.581			0.487
	(6.98)***			(5.43)***
contr*custom		0.425		0.368
		(8.25)***		(5.65)***
elast*cost			-0.534	0.078
			(1.70)*	-0.2
Observations	1402	1471	1244	1198
R-squared	0.83	0.83	0.83	0.84

Robust t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

This table shows the results of a panel regression with country- and sector- fixed effects.

CORRELATION BETWEEN ESTIMATED SECTORAL TFP AND MEASURES OF SPECIALIZATION

Country	**Ratio Exp/Prod**	**Coef. Spec.**	**Modif Balassa**	**RSCA**	**Country**	**Ratio Exp/Prod**	**Coef. Spec.**	**Modif Balassa**	**SRCA**
Argentina	**0.51**	0.49	**0.69**	**0.71**	Italy	0.10	**0.68**	**0.67**	**0.68**
Australia	**0.78**	0.38	**0.79**	**0.83**	Jordan	0.29	-0.24	-0.01	-0.04
Austria	0.37	-0.08	0.05	0.19	Japan	**0.74**	**0.73**	**0.87**	**0.88**
Belgium	**0.63**	0.25	0.14	0.09	Kenya	0.17	-0.23	0.22	0.19
Bangladesh	**0.51**	-0.06	0.24	0.26	Korea, Rep.	**0.61**	**0.58**	**0.70**	**0.66**
Bolivia	**0.81**	-0.11	0.14	0.12	Sri Lanka	0.43	0.12	**0.55**	0.41
Brazil	**0.63**	**0.56**	**0.60**	**0.76**	Morocco	**0.61**	0.23	0.40	0.40
Canada	0.27	**0.59**	**0.52**	0.46	Mexico	0.28	0.05	0.18	0.02
Chile	**0.53**	0.39	**0.70**	**0.69**	Mauritius	**0.54**	0.49	**0.73**	**0.72**
China	**0.56**	0.36	0.48	0.47	Malaysia	0.40	**0.56**	**0.64**	0.27
Cote d'Ivoire	0.37	0.03	0.42	0.30	Nigeria	0.32	-0.06	-0.09	-0.02
Colombia	0.36	0.09	0.23	0.37	Netherlands	0.44	-0.20	0.04	0.17
Costa Rica	0.48	0.18	0.43	0.09	Norway	**0.51**	0.10	0.43	0.41
Cyprus	0.30	-0.21	0.07	-0.11	Pakistan	**0.69**	0.09	**0.69**	**0.55**
Denmark	0.33	0.49	0.49	0.49	Panama	0.15	-0.30	0.11	-0.08
Ecuador	0.50	0.32	**0.59**	0.38	Peru	**0.64**	0.42	**0.76**	**0.83**
Egypt,	**0.53**	0.43	**0.61**	**0.56**	Philippines	0.50	**0.74**	**0.69**	**0.58**
Spain	0.01	**0.51**	**0.62**	**0.59**	Portugal	0.11	**0.53**	**0.57**	**0.58**
Finland	0.38	**0.57**	0.47	**0.60**	Romania	**0.55**	0.27	**0.81**	**0.78**
France	0.21	**0.72**	**0.60**	**0.50**	Senegal	0.40	-0.53	-0.28	-0.33
U.K.	-0.04	0.24	0.34	0.43	Singapore	0.15	-0.02	**0.52**	0.22
Germany	0.18	-0.15	0.07	0.02	El Salvador	0.47	-0.37	-0.05	-0.15
Ghana	0.43	**0.61**	**0.59**	**0.58**	Sweden	**0.50**	0.07	0.16	0.22
Greece	**0.55**	0.24	0.49	0.48	Thailand	**0.57**	-0.04	**0.72**	**0.66**
Guatemala	0.35	0.10	0.21	0.04	Trinidad	0.18	0.32	0.50	0.36
Honduras	**0.81**	-0.18	0.12	-0.18	Tunisia	-0.06	0.20	0.19	-0.01
Hungary	-0.05	-0.05	-0.04	-0.05	Turkey	**0.51**	0.35	0.48	**0.58**
Indonesia	0.44	0.49	**0.70**	**0.62**	Uruguay	0.28	**0.58**	**0.64**	**0.61**
India	0.47	-0.28	0.31	0.18	Venezuela	**0.64**	**0.53**	**0.60**	**0.64**
Ireland	0.33	0.19	0.27	0.37	South Africa	-0.42	0.02	-0.14	-0.03
Iceland	0.44	0.17	0.44	0.46	**MEAN**	**0.40**	**0.21**	**0.40**	**0.37**
Israel	**0.71**	0.12	0.43	**0.65**	**MEDIAN**	**0.44**	**0.22**	**0.47**	**0.41**

Note: Correlation between estimated relative sectoral TFP with respect of a world average (weighted by income) and measures of specialization. See the text for explanation about the construction of the variables. In bold values of country correlation higher than 0.5