Specialization In The Neoclassical Model Allowing For Variable Capital Utilization

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Abstract

We study how specialization, measured by industry shares in GDP, is affected by technology and factor endowments. A flexible specification, pioneered by Kohli (1991) and used by Harrigan (1997), makes it possible to combine technology and factor endowments in the estimating equation, thus combining the Ricardian and Heckscher-Ohlin explanations for specialization. By allowing variable capital utilization and sector-specific capital, our methodology permits estimation using short-span high-frequency data, which is the only kind of data currently available for industry-level studies in international economics. We calculate capital utilization from the consumption of electricity following Burnside, Eichenbaum and Rebelo (1995a) and Baxter and Farr (2001b). In the process of calculating capital utilization we calculate the efficiency of electricity consumption in each country and industry. To estimate the model we compile data for 8 two-digit industries in 23 countries over 21 years. We show that if we were to ignore variable capital utilization, the effects of technology on specialization would be significantly overestimated. The overestimation is greater if we assume that capital is a specific factor as opposed to being freely mobile between industries. We also find that once the variable capital utilization has been accounted for, the assumption about mobility of capital has little effect on the technology coefficients. Using the example of several countries, we show that allowing variable capital utilization changes the explanation of the specialization patterns that we observe in the dataset. For some countries and industries, the accumulation of physical capital, rather than the technology, becomes the most important determinant of industry share.

1 Introduction

We study how specialization, measured by industry shares in GDP, is affected by technology and factor endowments. By allowing variable capital utilization and sector-specific capital, our methodology permits estimation using short-span high-frequency data, which is the only kind of data currently available for industry-level studies in international economics.[1] We show that if we were to assume constant capital utilization, the effects of technology on specialization would be significantly overestimated.

Over the years, several theories have appeared that explain specialization.[2] The Ricardian theory emphasizes the importance of technological differences when technology is not transferable between countries. The Heckscher-Ohlin theory, on the other hand, assumes the same technology in all countries and emphasizes factor endowment differences when factors are not transferable between countries.

Both of these theories have been evaluated empirically. The classic Ricardian theory, which has two countries, had been evaluated several times in the 1950s and 60s with generally positive results. The generalized Ricardian theory, with many countries, was estimated recently by Eaton and Kortum (2002). Different aspects of the Heckscher-Ohlin model have been tested numerous times, with inconclusive results. A very good summary of the related empirical literature is in Leamer and Levinsohn (1995).

The fact that the tests of the Heckscher-Ohlin model produced mixed results has led some researchers to believe that Ricardian technological differences have to be incorporated into the Heckscher-Ohlin model. In an influential 1995 paper, Trefler allowed sector-neutral differences of technology in the context of the Heckscher-Ohlin model.

The assumption of sector-neutral differences of technology, however, was very restrictive. In a series of papers, James Harrigan (1996a, 1996b) had shown that technological differences between countries are not sector-neutral but sector-specific. Then, in his 1997 paper, he developed methodology in which specialization was determined jointly by the factor endowment differences and sector-specific technological differences. In that study specialization was measured by industry shares in GDP. Harrigan used a neoclassical model with a translog revenue function which resulted in a convenient representation of the industry shares. He estimated the model using data for 7 manufacturing sectors of 10 OECD countries for 1970-90.

Harrigan asked the following question: are differences of factor endowments and technology both significant in determining specialization? He found that both technology and factor endowments affect specialization, supporting the generalized Ricardian and Heckscher-Ohlin theories. The estimated effect of technological differences, measured by TFP, was generally large and positive, in accordance with theory. In other words, countries tended to specialize in industries in which they had a technological advantage. Factor endowment differences

[1] Short-span high-frequency data is data which is dominated by business cycles. An example is annual data over 10 or 20 years.

[2] Product mixes produced by countries can be classified along two dimensions. One is vertical where countries produce similar goods but of different quality. Another is horizontal where countries produce very different products. This paper, as most other studies in international economics, addresses the horizontal differentiation.

were also important in determining specialization. Harrigan's study is a major contribution to the understanding of specialization.

In this paper we build on his results. We modify the empirical methodology to make it suitable for estimation with short-span high-frequency data. Several assumptions implicitly made in Harrigan's methodology are more appropriate for the long run than for the short run. However, the 20-year dataset he used to estimate the model is a short-span dataset and is dominated by business cycles. For example, Harrigan's methodology assumes that capital utilization is constant, which is reasonable in the long run, but not in the short run. His methodology also assumes that capital is freely and instantaneously mobile between industries which is, again, a long-run assumption.

We start by replicating Harrigan's (1997) results using our dataset of 8 industries in 23 countries over 21 years. Using these results as the reference point, we correct the TFP measure for capital utilization and reestimate the model. As explained in the next section, we expect the effect of technology on specialization to decrease once the TFP has been corrected. We will also seek to answer the following questions: (i) Will the technology coefficients still be significant after the TFP has been corrected? (ii) What will be the magnitude of the corrected coefficients? (iii) What will happen to the technology and factor endowment coefficients if we assume that capital is a specific factor? (iv) Will both technology and factor endowments still have a significant effect on the specialization of countries?

2 Variable capital utilization

In order to estimate the effect of technology on industry share, a measure of technology is needed. Technological differences are usually measured by the Solow residual, which is obtained by subtracting differences in inputs from differences in output. Inputs should be measured by the quantity of factor services provided in production.

Very often, however, a measure of factor services is not available and a measure of factor stock is used instead. This is particularly true for capital. Using capital stock to proxy for capital services assumes that capital services are a constant proportion of capital stock or, equivalently, that capital utilization is constant. This may be a good approximation in the long run, but a poor one in the short run.

Recent research has shown that there is significant variation of the capital utilization rate during business cycles. In fact, recent literature has documented that behavior and statistical properties of the Solow residual change significantly when variable capital utilization is accounted for. The volatility of the Solow residual σ_A, its relative volatility $\dfrac{\sigma_A}{\sigma_Y}$, and the correlation between the Solow residual and output ρ_{AY} are all significantly reduced when variable capital utilization is accounted for (Burnside et al., 1995a; Burnside, Eichenbaum and Rebelo, 1995b; Baxter and Farr, 2001a).

Harrigan's model is that of a long-run equilibrium, but was estimated with short-span (20 years) high-frequency (annual) data. Both the Total Factor Productivity and industry share fluctuate over the business cycles which dominate the short-run data. We suspect that if the variable capital utilization is not taken into account, the effect of technology on industry share is overestimated.

Our suspicion is supported by the finding that technology shocks are only weakly correlated across industries (Baxter and Farr, 2001a). If the technology shocks were synchronized across industries, then the industry shares would not change over the business cycle. We expect the effect of technological differences on industry share to decrease significantly when variable capital utilization is introduced into the model.

We calculate capital utilization from the consumption of electricity following Burnside et al. (1995a) and Baxter and Farr (2001b). In the process of calculating capital utilization we calculate a parameter that measures the efficiency of electricity consumption in each country and industry.[3]

3 Methodology

In this section we develop our estimation methodology. In Section 3.1 we assume that capital is freely and instantaneously mobile between industries, while in Section 3.2 we assume that it is specific to each industry and, therefore, immobile.

3.1 Small-country model with domestically mobile capital

We use a simple small-country model with trade. Factors are mobile between industries but immobile between countries. Countries trade with each other because of differences in their technologies and/or factor endowments. These differences determine comparative advantage. We assume constant returns to scale and free trade. Capital utilization can vary.

We start with the economy-wide revenue function:

$$Y = R\left(Ap, v\right), \tag{1}$$

where Y is the value added, A is the vector of total factor productivities, p is the vector of prices, and v is the vector of factor endowments.

Using Hotelling's lemma, the revenue share of product i can be obtained by logarithmic differentiation of the revenue function:

$$S_i = \frac{\partial \ln R\left(Ap, v\right)}{\partial \ln p_i}, \tag{2}$$

where $S_i \equiv \dfrac{Y_i}{Y}$ is the share of industry i.

[3] Variable capital utilization in the context of the Heckscher-Ohlin model has been studied by Svensson (1982) and Betancourt, Clague and Panagariya (1985). In their models, only country-wide capital utilization could change.

Following Kohli (1978) and Harrigan (1997), we approximate the economy-wide revenue function by the translog function:

$$\begin{aligned}\ln R\left(Ap,v\right) &= a_{00}+\sum_{i}a_{0i}\ln A_{i}p_{i}+\frac{1}{2}\sum_{i}\sum_{k}a_{ik}\ln A_{i}p_{i}\ln A_{k}p_{k}\\ &+\sum_{j}b_{0j}\ln v_{j}+\frac{1}{2}\sum_{j}\sum_{m}b_{jm}\ln v_{j}\ln v_{m}\\ &+\sum_{i}\sum_{j}c_{ji}\ln A_{i}p_{i}\ln v_{j},\end{aligned} \tag{3}$$

where $i,k=1,...,N$ are industries, and $j,m=1,...,M$ are factors.[4]

Symmetry requires that $a_{ik}=a_{ki}$ and $b_{jm}=b_{mj}$.[5] Linear homogeneity in p and v requires that $\sum\limits_{i}a_{0i}=1$, $\sum\limits_{k}a_{ki}=0$, $\sum\limits_{j}b_{0j}=1$, $\sum\limits_{j}b_{jm}=0$, $\sum\limits_{i}c_{ji}=0$, and $\sum\limits_{j}c_{ji}=0$ (Christensen, Jorgenson and Lau, 1973; Woodland, 1982).

We take the derivative of the revenue function with respect to price and impose linear homogeneity on the resulting share equation.[6] Finally, since we are going to estimate the share equation using a panel of countries over a 20-year period, we add time and country subscripts:

$$S_{ict}=a_{0i}+\sum_{k=2}^{N}a_{ki}\ln\frac{p_{kt}}{p_{1t}}+\sum_{k=2}^{N}a_{ki}\ln\frac{A_{kct}}{A_{1ct}}+\sum_{j=2}^{M}c_{ji}\ln\frac{v_{jct}}{v_{1ct}}. \tag{4}$$

The relative goods prices that enter the share equation are not observed by us. The prices of traded goods are the same in all countries while the prices of nontraded goods are not. In addition, the technologies of many sectors, such as government and service sectors, are not observable in this study. Following Harrigan (1997), we treat the sum of nontraded goods' prices and unobserved technologies as a random variable with country fixed effects η_{ic}, time fixed effects δ_{it}, and a random component e_{ict} with constant variance σ_i^2. Since prices of traded goods are the same in all countries, we can treat their sum as a time fixed effect $\mu_{it}\equiv\sum_{k=2}^{N_1}a_{ki}\ln\left(p_{kt}/p_{1t}\right)$ where the summation is over all traded goods. Our estimating equation is then

[4] The translog functional form $\ln f\left(x\right)=a_{00}+\sum_{i=1}^{n}a_{0i}\ln x_i+\frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n}a_{ij}\ln x_i\ln x_j$ can be used to provide second-order approximation to any function of x. It is also convenient because it results in simple share equations (Woodland, 1982).

[5] The revenue function is twice continuously differentiable so the Hessian must be symmetric.

[6] The linear homogeneity in prices, TFP, and factors is imposed as follows. Prices and TFP are normalized by sector 1. Factors are normalized by factor 1 (in our case, labor). As explained later on in this section, we end up not imposing linear homogeneity restrictions on TFP because we do not observe TFPs of all industries in the economy.

$$S_{ict} = \eta_{ic} + \gamma_{it} + \sum_{k=1}^{N_1} a_{ki} \ln A_{kct} + \sum_{j=2}^{M} c_{ji} \ln \frac{v_{jct}}{v_{1ct}} + e_{ict}, \tag{5}$$

where $\gamma_{it} \equiv a_{0i} + \mu_{it} + \delta_{it}$. There are no linear homogeneity restrictions on the technology coefficients because the summation is over only some of the industries.

The coefficients a_{ki} and c_{ji} have the following interpretation. An increase of the independent variable by the factor of X raises output share by $a \ln X$ percentage points where a is the value of the appropriate coefficient. For example, if $a_{ki} = 2$ and technology A_{kct} doubles, then the industry share S_{ict} increases by 1.4 percentage points. Since the translog revenue function is simply a second order approximation to any revenue function, the coefficients a_{ki} and c_{ji} have no economic interpretation. They simply tell us how much and in what direction relative technology, capital utilization, and factor endowments affect industry shares.

We estimate (5) as a system of 8 seemingly unrelated regressions (SUR) with 28 restrictions given by symmetry requirements.[7] Each equation represents a two-way fixed effects error component model, estimated by a within estimator, as described in Baltagi (2001).

3.2 Model with capital as a specific factor

In the previous section we assumed that capital can move between industries freely and instantaneously. This is an extreme assumption about capital mobility. In reality, there could be costs and delays associated with moving capital between industries. In this section, we make another extreme assumption about capital, one that is the direct opposite of what we assumed in the previous section. In this section we assume that capital is specific to each industry and cannot move between industries. For example, capital can consist of heterogeneous goods that are not substitutable.

We make this assumption because we want to see how the effects of technology and factor endowments on specialization change depending on the assumption about capital mobility. We also want to check that accounting for variable capital utilization is important regardless of the assumption about capital mobility. Finally, we use the two extreme assumptions about capital mobility because they are easy to model in this static setting.[8]

If capital is the specific factor, our estimating equation becomes

$$S_{ict} = \eta_{ic} + \gamma_{it} + \sum_{k=1}^{N_1} a_{ki} \ln A_{kct} + \sum_{k=1}^{N_1} d_{ki} \ln K_{kct} + \sum_{j=3}^{M} c_{ji} \ln \frac{v_{jct}}{v_{1ct}} + e_{ict}. \tag{6}$$

This equation is derived in Appendix A. Note that the last summation excludes physical capital, which is the factor number two.

[7] All restrictions that we imposed on the revenue function (3) are satisfied in our estimation. Symmetry restrictions are imposed during the SUR estimation. Linear homogeneity restrictions are imposed in the estimating equation.

[8] See the conclusion for further thoughts on making this model dynamic and modeling capital adjustment costs explicitly.

3.3 Measuring technology

In order to estimate equations (5) and (6) we need to measure the total factor productivity. To compare total factor productivities across countries we use the multilateral translog productivity index derived by Caves, Christensen and Diewert (1982) and first used by Christensen, Cummings and Jorgenson (1981). In each industry, the relative TFP of country c at time t with respect to the reference point is given by

$$\begin{aligned}\ln A_{ct} - \ln A_1 &= \ln Y_{ct} - \ln Y_1 - \widehat{\alpha}_{ct}\left(\ln S_{Kct} - \overline{\ln S}_K\right) - \widehat{\alpha}_1\left(\overline{\ln S}_K - \ln S_{K1}\right) - \\ &\quad - \left(1-\widehat{\alpha}_{ct}\right)\left(\ln S_{Lct} - \overline{\ln S}_L\right) - \left(1-\widehat{\alpha}_1\right)\left(\overline{\ln S}_L - \ln S_{L1}\right),\end{aligned}$$

where $\widehat{\alpha}_{ct} = 1/2\left(\alpha_{ct} + \overline{\alpha}\right)$, α is capital share, S_K is capital services, S_L is labor services, a bar indicates the average over all countries and years, and subscript 1 denotes the reference point. The choice of the reference point is inconsequential. In this paper we follow Harrigan (1997) and choose the TFP of the United States in 1988 as the reference point.

In order to calculate relative technology we need measures of capital and labor services. We measure capital services by $Z_{ict}K_{jct}$ where Z_{ict} is the capital utilization rate and K is the capital stock. We describe the measurement of the capital utilization rate in the next subsection. We measure labor services by total hours worked: $S_{L,ict} = H_{ict}L_{ict}$, where H is the number of hours worked by an average worker and L is the number of workers employed. We obtain H_{ict} from data.

3.4 Measuring capital utilization

Following Baxter and Farr (2001b) and Burnside et al. (1995b), we assume that energy consumption is proportional to the capital services used:

$$E_{ict} = \phi_{ic} Z_{ict} K_{ict}, \tag{7}$$

where E_{ict} is energy consumption and ϕ_{ic} is a country- and industry-specific parameter that measures the efficiency of electricity consumption. To calculate ϕ_{ic} we assume that the differences of electricity consumption across industries and countries are due to different efficiencies. On the other hand, we assume that the variation of electricity consumption in time is due to changing utilization of capital Z_{ict}.

In other words, we assume that ϕ_{ic} is constant over time. Of course, in the long run ϕ_{ic} may decline as industries become more energy-efficient due to stricter environmental regulations and appearance of new energy-saving technologies. However, the 20 years included in our study (1975-95) is a short enough period of time that we felt we could assume constant ϕ_{ic}. To be sure that our assumption is justified, we calculated ϕ_{ic} separately for 1975-85 and 1986-95. We found no significant decline of ϕ_{ic} in any country and industry between the two time periods.

The efficiency parameter ϕ_{ic} is calculated as follows. From (7) we have

$$Z_{ict} = \frac{E_{ict}}{\phi_{ic} K_{ict}}. \tag{8}$$

The average utilization rate is

$$\overline{Z}_{ic} \equiv \frac{\sum_t Z_{ict}}{T} = \frac{1}{\phi_{ic}} \frac{\sum_t (E_{ict}/K_{ict})}{T},$$

where T is the number of periods. From the equation above we obtain the expression for ϕ_{ic}:

$$\phi_{ic} = \frac{\sum_t (E_{ict}/K_{ict})}{T\overline{Z}_{ic}}. \tag{9}$$

We assume that over the 20-year span of our dataset the average utilization rates $\overline{Z}_{ic}$ are the same in all countries. To calculate ϕ_{ic} we use the values of the U.S. average utilization rates $\overline{Z}_{i,US}$.

Knowing ϕ_{ic} we obtain the capital utilization rate from (8).

4 Data

To perform the estimation we construct our own dataset. We collect data for eight 2-digit industries of 23 OECD countries. The countries were chosen because of easy availability of data. The industries are described in Table 1. The time period analyzed is 1975-1995, though the length of time series varies across countries and industries. Each industry has 404 observations. The list of countries included in the study is presented in Table 2.

The industry-level value added, investment, and employment are obtained from the Industrial Statistics Database of the United Nations Industrial Development Organization (UNIDO). Country-wide value added (GDP) is from the International Financial Statistics (IFS) database of the International Monetary Fund.

Industry capital stock is calculated from the investment time series using the perpetual inventory method with geometric depreciation. Industry-level electricity consumption is from the World Basic Energy Statistics database of the International Energy Agency. The average industry-level U.S. utilization rates, which we use to proxy for $\overline{z}_{ic}$, are from the U.S. Federal Reserve Bank. Labor hours are from the International Labor Organization.

Capital and labor shares obtained from industrial surveys are notoriously unreliable (Shikher, 2004). Capital shares produced by these surveys are much higher than the generally accepted value of slightly less than 0.3. For example, the capital share in U.S. manufacturing, calculated using UNIDO or Annual Survey of Manufactures' data, approaches .7. Shikher (2004) used a variety of data to produce more accurate values of capital and labor shares in

U.S. and Brazilian manufacturing industries. In that study, the average capital share in U.S. manufacturing is 0.26. In this paper we use the average of U.S. and Brazilian shares from Shikher (2004) to proxy for the capital and labor shares of countries.

The country-wide factor endowments that we use in this study are physical capital, total labor force, human capital, and stock of arable land. Country capital stock is calculated from the investment time series using the perpetual inventory method with geometric depreciation. The investment time series are from the IFS. Country capital stock includes all forms of capital, both public and private. Labor force and stock of arable land are from the World Development Indicators database of the World Bank. Human capital is measured by educational attainment rates obtained from the International Data on Educational Attainment accompanying Barro and Lee (2000).

Industry income shares are shown in Tables 3 and 4 for years 1975 and 1995, respectively. Table 5 shows the average shares of industries in the dataset. Machinery is the largest industry in many countries, but not all. For example, Chemicals is the largest industry in Turkey in both 1975 and 1995. The newly industrialized countries, such as Korea, Ireland, Turkey, and Mexico, had seen their Machinery industry grow over the twenty-year period. For example, in 1975 Food was the largest industry in Mexico, but in 1995 it was Machinery. In another example, Korea had seen its Machinery industry grow from 4.5% of GDP in 1975 to 20.5% of GDP in 1995. At the same time, the Machinery industry had decreased in importance in the 'old' industrial powers such as United States, Germany, and Japan.

The share of the Textile industry had declined in all countries, except Turkey, as Textile manufacturing had moved to less developed countries. This decline was particularly noticeable in Ireland, U.K., Greece, and Korea. Food industry had increased its share in some countries over the twenty years. It had become the largest industry in Australia, New Zealand, and Greece by 1995.

Country endowments are shown in Tables 6 and 7. The United States has the largest labor force of all the countries in the sample, 97.8 million. Ireland has the smallest, 1.2 million. Turkey, Mexico, Portugal, and Greece have several times less capital per worker than the more developed countries in the sample. Korea had seen an eight-fold increase of its capital stock per worker between 1975 and 1995, while seeing an almost two-fold increase of its labor force. In Section 6.2 we compare the pattern of technology and factor accumulation in Korea and Turkey and use the estimated model to explain the changes of specialization that occurred in these countries.

There are significant differences of educational attainment among countries in the dataset. Less developed countries tend to have the bulk of their labor forces having at most primary school education. More developed countries tend to have the bulk of their labor forces having secondary or higher education. There had been progress in educational attainment in all countries between 1975 and 1995.

5 Results

We start by calculating capital utilization rates and total factor productivities in Section 5.1. Then, in Section 5.2, we estimate the share equation (5) that assumes that capital is mobile between industries. We estimate it first using the unadjusted and then the capital utilization-adjusted measure of technology. In Section 5.3 we estimate the share equation (6) which assumes that capital is a specific factor. Again, we first estimate this equation using the capital utilization-adjusted measure of technology and then using the unadjusted measure of technology. In Appendix B we estimate (5) and (6) with country fixed effects restricted to zero.[9] In Section 6 we use the estimated model with variable capital utilization and mobile capital to explain the specialization of several countries in the sample.

5.1 Calculating total factor productivities and capital utilization rates

First, we calculate ϕ_{ic} using (9). This parameter may be of interest in itself so we present its values in Table 8. In each industry we ranked countries by their value of ϕ_{ic}. Countries with higher efficiency of electricity consumption (lower ϕ_{ic}) are ranked higher.

European countries generally ranked high while developing countries and non-European developed countries ranked low. United States and Canada ranked low in all industries. France had the highest average rank and Norway had the lowest. We believe that the average rank of a country is influenced, among other things, by how strict the environmental regulations are and how cheap the energy is in that country. Environmental regulations are generally very strict in West European countries. They are weaker in North American and developing countries. The low rank of Norway is most likely explained by the availability of oil and gas on its territory.

There is some variation of rankings across industries. Chart 1 shows the rankings as a bar graph grouped by country. Countries are sorted by their average rank with countries on the left having a lower rank. We can see that despite some heterogeneity of rankings, countries with the higher average ranks tend to have higher ranks in all industries.

Having calculated ϕ_{ic}, we calculate the capital utilization rates and total factor productivities. Relative TFPs adjusted for variable capital utilization, for 1975 and 1990, are shown in Table 9. There are clearly significant differences of relative TFPs across countries and industries. The vast majority of countries have lower productivity than the United States in all industries. The two notable exceptions are Japan and Germany. In 1995 Japan had higher TFP than the U.S. in 6 out of 8 industries. In the same year, Germany had higher TFP than the United States in 5 out of 8 industries.

Less developed countries, of course, have lower TFP than the more developed countries. Most countries have narrowed the TFP gap with the United States between 1975 and 1990. Comparing the TFP in Korea in 1975 and 1990 we see the evidence of the enormous TFP gains made by that country. These gains, of course, are well documented in the literature. Another country with large TFP gains between 1975 and 1990 is Ireland. However, not all

[9] See the appendix for the explanation of why we do it.

countries have had the same degree of success increasing their TFP. In 1975 Mexico had higher TFP than Korea in most industries, but in 1990 the situation was reversed.

Figures 2 through 4 show the unadjusted and adjusted TFPs in levels and differences, as well as some properties of the TFPs for several industries in the dataset.[10] We included these figures to show what happens to Total Factor Productivity when it is adjusted for capital utilization. Consistent with existing literature, the variance of the TFP, measured either in levels or differences, and its correlation with output decrease when variable capital utilization is accounted for.[11]

Figure 2 shows that the TFP in the Metals industry of the United States did not fall during the recessions of the early 1980s and early 1990s as much as the unadjusted TFP would have us believe. This is because the firms have decreased capital utilization during this period. Capital utilization increased during the 1990s and the adjusted TFP did not increase as much as the unadjusted TFP during that time.

In Figure 3 we can see that capital utilization has increased in the U.S. Wood industry between 1975 and late 1980s/early 1990s.[12] We can also see that adjusted TFP is not as volatile as the unadjusted TFP. The same phenomena are observed, albeit to a lesser degree, in Figure 4, which shows Total Factor Productivity for the Machinery industry in Turkey.

5.2 Results obtained under the assumption of domestically mobile capital

We start by replicating the results of Harrigan (1997) using our data. The estimating equation is (5) and the measure of productivity does not take variable utilization into account. We then estimate the same equation using the capital utilization-adjusted measure of productivity and compare the results.

5.2.1 Using the unadjusted measure of productivity

The total factor productivity in this case is calculated using the capital stock instead of capital services:

[10] Though our industry classifications are slightly different, the TFP properties in our data and in Baxter and Farr (2001a) are similar. Baxter and Farr (BF) report 17% reduction (when variable capital utilization is accounted for using electricity consumption) of the standard deviation of the TFP growth in the U.S. Metals industry compared with 20% in our data. They report 26% reduction of the standard deviation of the TFP growth in the U.S. Wood industry compared with 25% in our data. BF report the correlation of unadjusted TFP growth with output growth of 0.86 in the Wood and 0.93 in the Metals industry. The correlation in our data is slightly higher: 0.94 in the Wood industry and 0.97 in the Metals industry. After the adjustment, the correlation in the Wood industry is 0.59 in BF and 0.77 in our data while in the Metals industry it is 0.78 in BF and 0.79 in our data.

[11] This occurs in many but not all industries and countries.

[12] The capital utilization has also increased in many other industries and countries during that period. An alternative explanation for this increase would be an increase of parameter ϕ over time. We use U.S. Federal Reserve Bank data as evidence for the rising utilization rates. According to their data, the average capacity utilization rate in U.S. Wood industry in 1975-85 was 76.5% while in 1985-1995 it was 81.5%. We also do not think it is likely that industries actually become less energy-efficient over time.

$$
\begin{aligned}
\ln A_{ct} - \ln A_1 \quad = \quad & \ln Y_{ct} - \ln Y_1 - \widehat{\alpha}_{ct}\left(\ln K_{ct} - \overline{\ln K}\right) - \widehat{\alpha}_1\left(\overline{\ln K} - \ln K_1\right) \\
& - (1-\widehat{\alpha}_{ct})\left(\ln S_{Lct} - \overline{\ln S}_L\right) - (1-\widehat{\alpha}_1)\left(\overline{\ln S}_L - \ln S_{L1}\right).
\end{aligned}
$$

The results of estimation are reported in Table 10. The eight columns correspond to the eight estimated equations. Own-TFP coefficients are printed in bold to make the tables easier to read. Standard errors are given in parentheses.

Our own-TFP estimates are very similar to those obtained by Harrigan. One difference is in the Food industry where his estimate is negative while ours is positive. In addition, Harrigan's estimate of the own-TFP coefficient in the Paper industry was positive, but not statistically different from zero. In our results, all own-TFP coefficients are positive and statistically significant, as predicted by theory. With the exception of the Food and Paper industries, however, the signs and magnitudes of our own-technology coefficients are very close to Harrigan's.[13]

5.2.2 Using the capital utilization-adjusted measure of productivity

We now estimate (5) using the utilization-corrected measure of TFP. We compare the estimated own-TFP coefficients, reported in Table 11, with those obtained in the previous section using the uncorrected measure of TFP.

As we expected, the own-TFP coefficients in this case are smaller than those of the previous section. Table 16 summarizes the differences between own-TFP coefficients. The coefficients obtained using the utilization-adjusted measure of the TFP are on average 29% smaller than those obtained using the unadjusted measure of the TFP. This is the main finding of our paper: ignoring variable capital utilization overestimates the effects of technology on specialization.

As can be seen in Table 11, all own-TFP coefficients are again positive and statistically significant, as predicted by theory. The own-TFP terms are in the range between 0.28 and 2.41. To make these numbers meaningful, consider the share of the average industry of the dataset, 2.7%, reported in Table 5. For this average industry an own-TFP coefficient of 1.5 means that if relative TFP doubled, the industry share would increase by about 40%.[14]

Most factor endowment coefficients are statistically significant, giving support to the Heckscher-Ohlin explanation of specialization. Physical capital coefficients are significant at 95% in six industries and at 90% in the remaining two industries. They are positive in the Metals and Machinery industries and negative in all other industries. Capital stock has the largest positive effect in the Machinery industry and the largest negative effect in the Textile industry.

[13] There are some differences in the estimated effects of factor endowments. Highly educated workers have a uniformly negative effect in Harrigan's estimation while having a uniformly positive effect in ours. Medium and low-educated workers sometimes match signs but not values. Also, in Harrigan's estimation land has a positive effect in two industries while having negative effect in all industries in our estimation. The coefficients on capital are not comparable because Harrigan has two types of capital while we have one.

[14] It would increase by $1.5\,(\ln 2) = 1.05$ percentage points, from 2.7 to 3.75%.

Low-educated workers have a statistically significant effect on industry share in four industries and in all four the effect is positive. The largest effects are in the Food and Metals industries. Medium-educated workers have a statistically significant effect in five industries and this effect is positive in four industries and negative in the Paper industry. Highly educated workers have a statistically significant effect in six out of eight industries. In all of those six industries the effect is positive. These highly educated workers have the largest effect on the shares of the Machinery industry.

Arable land has a statistically significant effect on industry share in all but one industry. The effect of arable land on the industry share is always negative. The largest negative effect is found in the Machinery industry.

Tables 12 and 13 report the estimated country and time fixed effects, respectively. The country fixed effect captures the cross-country variation of nontraded goods prices and unobserved technologies. The time fixed effect captures the variation of goods prices (both traded and nontraded) and unobserved technologies across time. The time fixed effect exhibits a downward trend in all industries. Thus, the model explains the general decline in the share of manufactures over the period by the decline in their relative price as well as changes of productivity in other sectors, such as services.

We conclude that allowing for variable capital utilization reduced own-technology coefficients by between 1/4 and 1/3. Despite the reduction, though, both technology and factor endowments still have a significant effect on specialization of countries.

In Section 6 we use the estimated model to account for several examples of specialization observed in our dataset. We use the estimated model to compare and analyze the changes of specialization in Korea and Turkey. We also consider what it would take for Portugal to have as significant Machinery industry as Germany's.

5.3 Results obtained under the assumption that capital is a specific factor

Now lets assume that capital is immobile between industries. In other words, the cost of moving capital goods between industries is infinitely large. For example, capital goods used in different industries may not be substitutable. In this case, the estimating equation is (6).

We first estimate this equation using the unadjusted measure of TFP. Looking at the results presented in Table 14, we can see that introducing the immobile capital, by itself, increases the TFP coefficients and reduces the factor endowment coefficients. All own-TFP and own-industry capital coefficients are positive and statistically significant.

We then estimate equation (6) using the utilization-adjusted measure of TFP. The results are reported in Table 15. We can see that, again, there is significant reduction of own-TFP coefficients when utilization-adjusted measure is used. In this case, own-technology coefficients are reduced, on average, by between 1/3 and 1/2. Thus, our main finding - that ignoring variable capital utilization overestimates the effects of technology on specialization - is confirmed in the case of immobile capital.

As Table 16 shows, the reduction of own-TFP coefficients that occurs when we account for variable capital utilization is greater in the case of immobile capital. The average reduction in this case is about 41%. In fact, the own-TFP coefficients obtained with utilization adjusted measure of TFP are approximately the same whether we assume that capital is mobile or a specific factor.[15] Thus, the assumption we make about mobility of capital does not seem to make much of a difference on technology coefficients once the variable capital utilization has been accounted for.

5.4 The main finding of this paper

We have hypothesized that if technology is measured using the capital stock instead of capital services, the effect of technology on industry share will be overestimated. Thus, we have predicted that our estimates of own-TFP coefficients will be smaller than those of Harrigan (1997).

Table 16 summarizes the own-TFP coefficients estimated in this paper. It can be seen that estimates obtained using the capital utilization-adjusted measures of productivity are indeed smaller than those obtained using the unadjusted measure. If the assumption of domestically mobile capital is correct and if variable capital utilization is not taken into account, the effect of TFP on industry share is overestimated, on average, by about 29%. Depending on the industry, the own-TFP coefficient can be overestimated by as much as 36%. If capital is the specific factor and the variable capital utilization is ignored, the own-TFP is overestimated, on average, by about 41%. Thus, the finding that ignoring variable capital utilization overestimates the effect of TFP on industry share is robust to the assumption about mobility of capital. Appendix B shows that our main finding stands as well when the coefficients are estimated only from a cross-sectional variation in the data.

6 Explaining the observed pattern of specialization using the estimated model

In this section we use the estimated model with variable capital utilization and mobile capital to explain the observed pattern of specialization for several countries in our dataset. In Section 6.1 we consider what it would take for Portugal to have the same Machinery industry share as Germany. In Section 6.2 we look at how different rates of technology and factor accumulation in Korea and Turkey have resulted in different patterns of specialization in these two countries.

6.1 Production of machinery in Portugal and Germany

Lets take a look at two European countries, Portugal and Germany. Germany is a world leader of machinery production. Machinery industry constituted almost 14% of its GDP in 1995. In Portugal, the Machinery industry is much smaller, even relative to the size of the

[15] Some factor endowment coefficients change if capital is assumed to be a specific factor. Comparing Tables 11 and 15 we notice that slightly fewer factor endowment coefficients are statistically significant (In Table 11 about 3/4 of factor endowment coefficients are statistically significant, in Table 15 about 2/3 are significant). Several factor endowment coefficients change signs. Thus it seems that when one factor is fixed for each industry, other factors become less important.

economy. It constituted 3.9% of the GDP in 1995. It is Portugal's second-largest industry after Chemicals and only slightly ahead of its third largest industry, Textiles.

What explains this difference of specialization between these two countries? In other words, what would it take for Portugal to have as great of a Machinery industry as Germany? How much would the Machinery industry in Portugal grow if Portugal managed to have Germany's amount of capital stock per worker? Germany's TFP? Germany's level of educational attainment?

Table 17 provides the answers to these questions. Portugal's capital stock per worker in 1995 was 3.11 times smaller than Germany's. If Portugal were able to accumulate as much capital stock per worker as Germany, its Machinery industry would grow by 3.6 percentage points, essentially doubling in size.

Turning our attention to technology, we see that Portugal's TFP in the Machinery industry was 3.15 times lower than Germany's in 1995. If Portugal were able to obtain Germany's level of technology, its Machinery industry would grow by another 2.8 percentage points. Having both German TFP and German level of capital stock per worker would give Portugal a Machinery industry that is 10.3% of its GDP. It would be 2.5 times larger than its current Machinery industry. Finally, increasing the level of education of its workers to that of Germany would increase Portuguese Machinery industry by another 1 percentage point.

Thus we have accounted for most of the difference between Portuguese and German Machinery industry shares.[16] Physical capital and TFP differences were the biggest reasons why Portuguese Machinery industry was so much smaller than Germany's in 1995, relative to the size to the economy. Having the same TFP and physical and human capital as Germany would give Portugal a machinery industry that is almost 3 times larger than its current size.

We have explained the difference of the Machinery industry shares in Portugal and Germany using the model with variable capital utilization and mobile capital. Would our conclusions be different if we did not take variable capital utilization into account? If we use capital stock instead of capital services to measure TFP, we get a larger own-TFP coefficient and a smaller capital stock coefficient in the Machinery industry.[17] Table 18 shows how the model with constant capital utilization explains the difference of shares. Comparing Tables 17 and 18 we can see that if we do not take variable capital utilization into account we would conclude that the TFP gap is the biggest reason for the difference of Machinery industry shares in Portugal and Germany. However, once we adjust for utilization, the accumulation of capital becomes the biggest reason for the share difference. Thus, accounting for variable capital utilization makes an important change in the explanation of why Portugal has a less prominent Machinery industry than Germany.

6.2 Changes of specialization in Korea and Turkey

To see how our model explains the changes in the observed pattern of specialization over time, we look at two countries in our dataset, Korea and Turkey. Both countries had experi-

[16] The remaining 2.5 percentage points are accounted by the differences of available arable land per worker, TFPs of other industries, and country fixed effects.

[17] Compare Tables 10 and 11.

enced technological progress and accumulated factors of production between 1975 and 1995. However, the technological progress and factor accumulation did not occur equally in the two countries. We will see how the factor and technology accumulation in the two countries had affected their specialization patterns.

Table 19 summarizes the changes of factor endowments in Korea and Turkey between 1975 and 1995. Both countries had seen near doubling of their labor forces over the 20 years. The available arable land per worker had shrunk by a half in Korea while it had decreased by a little less than a half in Turkey.

Turkey had more physical capital per worker than Korea in 1975. Over the following twenty years, however, Korea had accumulated huge amounts of additional capital while Turkey had accumulated little. Korea's capital per worker had increased 8-fold between 1975 and 1995 while Turkey's had increased only 1.4-fold, meaning that Korea's capital accumulation rate was 5.8 times higher than Turkey's. As the result, Korea had three times more capital per worker than Turkey in 1995.

Both countries had made gains in educating their workers. However, Turkey had a much less educated labor force than Korea in 1975. In fact, most of its workers had no formal education in 1975. So while both countries had increased the average education level of their workers over these twenty years, the patterns of educational attainment were different.

Between 1975 and 1995 the bulk of the Turkish labor force had moved from having no education to having at most the primary school education. At the same time, the bulk of the Korean labor force had moved from having at most the primary school education to having the secondary school education. The proportion of the Korean labor force with at most the primary school education had decreased by a half, from 39 to 18%. Turkey had a slightly greater gain of university-educated workers, perhaps because it had a much lower starting point: less than 2% of its labor force had higher education in 1975.[18]

Finally, Korea had been more successful than Turkey in increasing its total factor productivity. In 1975 the productivity in its industries was around 20%. By 1995, that number had increased to about 60-80%. Turkey had higher productivity than Korea in 1975, but by 1995 Korea was more productive than Turkey in all industries.[19]

Lets take a look now at the changes of specialization that occurred in the two countries between 1975 and 1995. We will focus on the four largest industries in these two countries: Machinery, Chemicals, Textile, and Food.

Both countries had undergone changes of specialization between 1975 and 1995, but the changes were not the same in the two countries. Korea had become much more specialized in the Machinery industry. In fact, while in 1975 its Machinery industry was relatively small, by 1995 Korea had become one of the world's leading machinery-producing countries. At the same time, the shares of its Textile and Food industries had declined.

Turkey did not see as dramatic a change of specialization as Korea. Its Chemical industry

[18] 6.9% of Korea's labor force had higher education in 1975.

[19] We can also compare Turkey to Ireland. Both countries had similar levels of TFP in 1975. However, by 1995 Ireland had productivity just slightly less than that of the US. Turkey, however, had increased its productivity only a little during the same period.

had increased its share the most, remaining the largest industry in the country. Its machinery industry also grew, but not nearly as much as Korea's. Its Textile and Food industries had increased their share as well.

Korea's Machinery industry went from being 4.5% of GDP in 1975 to about 20% in 1995. At the same time, Turkey's Machinery industry had increases from 2.3% to 4.4% of GDP. Korea's Chemical industry had increased by 1.6 percentage points while Turkey's increased by 2.7 percentage points. Korea's Textile and Food industries had declined by 1.5 and 1 percentage points, respectively, while Turkey's Textile and Food industries had grown by 1.8 and 0.6 percentage points.

Thus, between 1975 and 1995 Korea had become much more specialized in the Machinery industry at the expense of Textile and Food industries. Turkey had seen some growth, relative to the size of the economy, in all of the industries we consider here.

Let us see how the differences of technology and factor accumulation in the two countries over the twenty years had translated into changes of specialization. We will start with the Machinery industry. We want to explain why Korea's Machinery industry share had increased by 18 percentage points while Turkey's had increased by only 2.1. In other words, we want to explain why the gap between Korea's and Turkey's Machinery industry shares had increased from 2 to 16 percentage points between 1975 and 1995.

Table 20 shows how the differences in the accumulation of technology and factors by the two countries had contributed to the changes of their Machinery industry shares. We can see that faster accumulation of capital was the biggest reason why the share of the Machinery industry had increased so much more in Korea. Because its capital accumulation rate was 5.8 times higher, Korea's Machinery industry grew by 5.54 percentage points more than Turkey's.

The second biggest reason for Korea's increased specialization in Machinery was its much faster accumulation of technology. Having 3 times higher growth rate of technology gave Korea a 3-percentage-point boost to its Machinery industry share. Faster increase of the population density and education, particularly at the lower end of the education ladder, had helped Korea gain another 1.7-percentage-point advantage over Turkey in the Machinery industry.

We note that in this section, as in the previous section, accounting for variable capital utilization makes a difference. If we had not accounted for variable capital utilization, we would have concluded that capital and technology accumulation had an equal role in determining the difference between Korea's and Turkey's Machinery industry shares.[20] Once we account for variable capital utilization, however, we conclude that capital accumulation played a greater role.

To summarize, while both countries had accumulated human capital over the twenty years, Korea had accumulated physical capital and technology much faster than Turkey. This had increased Korea's comparative advantage in the Machinery industry. If, for example, Turkey had accumulated capital at the same pace as Korea, its Machinery share would have been almost 10% of its GDP. If Turkey had also acquired new technology (TFP) at the same pace

[20] We would have found that both the technology and capital contribute about 4.5 percentage points each to the share gap.

as Korea, its Machinery share would have been almost 14% of its GDP, making Turkey one of the world's leading producers of machinery and equipment.

The pattern of factor accumulation that gave Turkey a disadvantage in the Machinery industry, helped it in other industries. At the same time, the features that have helped Korea to achieve its prominence in the Machinery industry were less important, or even disadvantageous, in other industries.

Capital stock, which is a friend of the Machinery industry, is an enemy of the Chemicals industry and an even bigger enemy of the Food and Textile industries.[21] The technology (TFP) accumulation is less important in the Chemicals industry than in the Machinery industry. It is even less important in the Food and Textile industries. Educational attainment, which is very important in the Machinery industry, is much less important in the other industries. For example, low-educated workers, which were an enemy of the Machinery industry, are a friend of Chemicals, Food, and Textile industries. Medium-educated workers are also a big friend of the Food and Textile industries. Finally, the availability of arable land per worker, or population density, is much less of an enemy of the Chemical and Textile industries than it was of the Machinery industry. Land becomes statistically insignificant in the Food industry.

In line with their pattern of factor accumulation, both Korea and Turkey saw the shares of their Chemical industries increase, but this increase was greater in Turkey. Shares of the Food and Textile industries had increased in Turkey but declined in Korea. The Textile industry's share had declined in Korea by 1.5 percentage points (or by 1/3), while it had doubled in Turkey (increased by 1.8 percentage points). Table 21 shows how the differences in the accumulation of technology and factors by the two countries had contributed to the changes of their Textile industry shares.

To summarize, both countries had undergone some structural transformation in their economies between 1975 and 1995. This transformation was much more pronounced in Korea, where massive accumulation of technology, physical and human capital, and increase in the population density had favored Machinery and to some extent Chemicals and Metals industries at the expense of Textile and Food industries.

The changes of specialization we describe and explain here were very much felt by the people living in these two countries. For example, the number of people employed in the Textile industry in Turkey had increased by 150,000 between 1975 and 1995, while about the same number of people had lost their jobs in that industry in Korea. During the same twenty years, the employment in the Machinery industry in Korea had skyrocketed: it increased by almost 1,000,000, a more than a 4-fold increase.[22]

[21] We use the term 'friend' in the sense similar to that in which Jones and Scheinkman (1977) used it, except that we consider industry share instead of output. Here, a factor is a friend of a particular industry if its increase leads to an increase of the industry share. A factor is an enemy of an industry if its increase leads to the decrease of the industry share.

[22] We can tell another story of two countries: the United States and the United Kingdom. Both countries saw the shares of many industries decrease, particularly the Machinery industry. However, the U.K. saw a much larger decrease than the U.S. Why? Over the twenty years, the time fixed effects (which we can think of as representing declining prices of manufacturing output or the increasing productivity of the service sector)

7 Conclusion

In this paper we estimate the effects of Total Factor Productivity and factor endowments on specialization, measured by industry shares. A very flexible specification, pioneered by Kohli (1978) and used by Harrigan (1997), makes it possible to combine technology and factor endowments in the estimating equation, thus combining the Ricardian and Heckscher-Ohlin explanations for specialization. The innovation of this paper is the empirical methodology that allows us to correctly estimate this equation using the short-span high-frequency data, which is the only data currently available.

Previous literature has established that factor utilization is not constant in the short run. Therefore, to correctly calculate total factor productivity in the short run, factor services must be used as measures of inputs into the production process. If factor stocks are used instead of factor services, the resulting TFP measure would be more volatile and be more correlated with output than the actual TFP. In this case, the effects of Total Factor Productivity on specialization would be overestimated.

Following Burnside et al. (1995a) and Baxter and Farr (2001b) we use the consumption of electricity to calculate the capital utilization rates. We then use the capital and labor services to calculate the Total Factor Productivity. For comparison, we also calculate the TFP using the capital stock. We find that if variable capital utilization is not accounted for, the effect of TFP on specialization is overestimated. This results shows the importance of short-run effects when using short-run data.

We use two alternative assumptions about capital mobility. We assume that capital is either freely and instantaneously mobile between industries or that it is specific to each industry and cannot move between them. These are two extreme assumptions about capital mobility.

We find that the effect of TFP on industry share is overestimated if variable capital utilization is not taken into account, regardless of the assumption about capital mobility. The overestimation is greater if we assume that capital is not mobile. We also find that once the variable capital utilization has been accounted for, the assumption about mobility of capital has little effect on the technology coefficients.

We show how our model explains the pattern of specialization by providing detailed examples for several countries in our dataset. We use the estimated model to explain why the share of the machinery industry is smaller in Portugal than Germany. We consider why the changes of specialization experienced by Korea and Turkey between 1975 and 1995 were so different. We show that accounting for variable capital utilization significantly affects our

had declined. At the same time, not enough happened in these countries to compensate for this decline. There was some increase of the capital stock, educational attainment, technology, and population density, but not enough. Thus, these countries had lost some of their comparative advantage to, for example, Korea. While the U.S. had compensated, to some extent, the declining fixed effects by accumulating factors, little had happened in the U.K. to compensate. For example, educational attainment and population density had increased very little in the U.K during the 20-year period. As the result, between 1975 and 1995 the U.K. Machinery industry had decreased from 14 to 7.5% of GDP, losing 1.5 million or nearly a half of all jobs in that industry. At the same time, the U.S. Machinery industry had added 330,000 new jobs.

explanation of these facts.

Finally, we confirm the main finding of Harrigan (1997), that both technology and factor endowments determine specialization. We find that own-TFP coefficients and most of the factor endowment coefficients are statistically significant, supporting both the Ricardian and the Heckscher-Ohlin explanations. All own-TFP coefficients are positive as predicted by the theory.

The major shortcoming of the model used in this paper is that it is static. Thus, it cannot capture all the dynamic relationships that occur in the data. So the next task is to create a dynamic model of specialization that can capture the short-run movements of specialization, industry factor stocks, and utilization in response to changes of technology and economy-wide factor endowments.

References

Baltagi, B. H. (2001). *Econometric Analysis of Panel Data*, 2nd edn, John Wiley and Sons.

Barro, R. J. and Lee, J.-W. (2000). International data on educational attainment: Updates and implications, *Manuscript, Harvard University*.

Baxter, M. and Farr, D. D. (2001a). The effects of variable capital utilization on the measurement and properties of sectoral productivity: Some international evidence, *NBER Working Paper No. 8475*.

Baxter, M. and Farr, D. D. (2001b). Variable factor utilization and international business cycles, *NBER Working Paper No. 8392*.

Betancourt, R., Clague, C. and Panagariya, A. (1985). Capital utilization and factor specificity, *The Review of Economic Studies* **52**(2): 311–329.

Burnside, C., Eichenbaum, M. and Rebelo, S. (1995a). Capital utilization and returns to scale, *NBER Working Paper No. 5125*.

Burnside, C., Eichenbaum, M. and Rebelo, S. (1995b). Sectoral solow residuals, *NBER Working Paper No. 5286*.

Caves, D. W., Christensen, L. R. and Diewert, W. E. (1982). Multilateral comparisons of output, input, and productivity using superlative index numbers, *The Economic Journal* **92**(365): 73–86.

Christensen, L. E., Cummings, D. and Jorgenson, D. W. (1981). Relative productivity levels, 1947-1973, an international comparison, *European Economic Review* **16**: 61–94.

Christensen, L. R., Jorgenson, D. W. and Lau, L. J. (1973). Transcendental logarithmic production frontiers, *The Review of Economics and Statistics* **55**(1): 28–45.

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

Harrigan, J. (1996a). Cross-country comparisons of industry total factor productivity: Theory and evidence, *Mimeo, Federal Reserve Bank of New York*.

Harrigan, J. (1996b). Estimation of cross-country differences in industry production functions, *Mimeo, Federal Reserve Bank of New York*.

Harrigan, J. (1997). Technology, factor supplies, and international specialization: Estimating the neoclassical model, *The American Economic Review* **87**(4): 475–494.

Jones, R. W. and Scheinkman, J. A. (1977). The relevance of the two-sector production model in trade theory, *Journal of Political Economy* **85**(5): 909–935.

Kohli, U. (1991). *Technology, Duality, and Foreign Trade: The GNP Function Approach to Modeling Imports and Exports*, University of Michigan Press, Ann Arbor, Michigan.

Kohli, U. R. (1978). A gross national product function and the derived demand for imports and supply of exports, *The Canadian Journal of Economics* **11**(2): 167–182.

Leamer, E. E. and Levinsohn, J. (1995). International trade theory: The evidence, *in* G. Grossman and K. Rogoff (eds), *Handbook of International Economics*, North-Holland, Amsterdam, pp. 1339–94.

Shikher, S. (2004). An improved measure of industry value added and factor shares: Description of a new dataset of the U.S. and Brazilian manufacturing industries, *Working Paper*.

Svensson, L. E. O. (1982). On variable capital utilization and international trade theory, *NBER Working Paper No. 992*.

Trefler, D. (1995). The case of the missing trade and other mysteries, *The American Economic Review* **85**(5): 1029–1046.

Woodland, A. D. (1982). *International Trade and Resource Allocation*, North-Holland, Amsterdam.

Appendix A Small-country model with capital as the specific factor

In this appendix we derive equation (6).

If capital is the specific factor, the economy-wide revenue function is:

$$Y = R\left(Ap, K, v\right), \tag{10}$$

where Y is the value added, A is the vector of total factor productivities, p is the vector of prices, K is the vector of industry capital stocks, and v is the vector of factor endowments other than capital.

As in section 3.1, the revenue share of product i can be obtained by logarithmic differentiation of the revenue function:

$$S_i = \frac{\partial \ln R\left(Ap, K, v\right)}{\partial \ln p_i}, \tag{11}$$

where $S_i \equiv \dfrac{Y_i}{Y}$ is share of industry i.

When approximated by the translog function, the economy-wide revenue is:

$$\begin{aligned}\ln R\left(Ap, K, v\right) \quad = \quad & a_{00} + \sum_i a_{0i} \ln A_i p_i + \frac{1}{2} \sum_i \sum_k a_{ik} \ln A_i p_i \ln A_k p_k \\ & + \sum_i f_{0i} \ln K_i + \frac{1}{2} \sum_i \sum_k f_{ik} \ln K_i \ln K_k \\ & + \sum_i \sum_k d_{ik} \ln A_i p_i \ln K_k + \sum_j b_{0j} \ln v_j \\ & + \frac{1}{2} \sum_j \sum_m b_{jm} \ln v_j \ln v_m + \sum_i \sum_j c_{ji} \ln A_i p_i \ln v_j \\ & + \sum_i \sum_j h_{ji} \ln K_i \ln v_j, \end{aligned} \tag{12}$$

where $i, k = 1, ..., N$ are industries, and $j, m = 1, ..., M$ are factors.

Symmetry requires that $a_{ik} = a_{ki}$, $f_{ik} = f_{ki}$, and $b_{jm} = b_{mj}$. Linear homogeneity in p, K, and v requires that $\sum\limits_i a_{0i} = 1$, $\sum\limits_k a_{ki} = 0$, $\sum\limits_i f_{0i} = 1$, $\sum\limits_k f_{ki} = 0$, $\sum\limits_k d_{ik} = 0$, $\sum\limits_j b_{0j} = 1$, $\sum\limits_j b_{jm} = 0$, $\sum\limits_i c_{ji} = 0$, $\sum\limits_j c_{ji} = 0$, $\sum\limits_i h_{ji} = 0$, and $\sum\limits_j h_{ji} = 0$. We take the derivative of the revenue function with respect to price and impose linear homogeneity on the resulting share equation. We also add time and country subscripts:

$$S_{ict} = a_{0i} + \sum_{k=2}^{N} a_{ki} \ln \frac{p_{kt}}{p_{1t}} + \sum_{k=2}^{N} a_{ki} \ln \frac{A_{kct}}{A_{1ct}} + \sum_{k=2}^{N} d_{ki} \ln \frac{K_{kct}}{K_{1ct}} + \sum_{j=2}^{M} c_{ji} \ln \frac{v_{jct}}{v_{1ct}}. \quad (13)$$

As in section 3.1 we treat the sum of traded goods' prices as a time fixed effect $\mu_{it} \equiv \sum_{k=2}^{N_1} a_{ki} \ln(p_{kt}/p_{1t})$ where the summation is over all traded goods. We treat the sum of nontraded goods' prices and unobserved technologies and industry capital stocks as a random variable with country fixed effects η_{ic}, time fixed effects δ_{it}, and a random component e_{ict} with constant variance σ_i^2. We then obtain the estimating equation (6):

$$S_{ict} = \eta_{ic} + \gamma_{it} + \sum_{k=1}^{N_1} a_{ki} \ln A_{kct} + \sum_{k=1}^{N_1} d_{ki} \ln K_{kct} + \sum_{j=2}^{M} c_{ji} \ln \frac{v_{jct}}{v_{1ct}} + e_{ict},$$

where $\gamma_{it} \equiv a_{0i} + \mu_{it} + \delta_{it}$. There are no linear homogeneity restrictions on the technology and capital stock coefficients because the summations are over only some of the industries. Also note that there are no symmetry restrictions on the capital stock coefficients. We estimate (6) as a system of 8 seemingly unrelated regressions (SUR) with 28 restrictions given by symmetry requirements.[23]

[23] All restrictions that we imposed on the revenue function (3) are satisfied in our estimation. Symmetry restrictions are imposed during the SUR estimation. Linear homogeneity restrictions are imposed in the estimating equation.

Appendix B Estimation using only the country dimension

The estimating equations (5) and (6) have both time and country fixed effects. A more typical empirical specification in international trade would include only the time fixed effects so that the coefficients are estimated using the cross-sectional variation of the data. In this section we follow this approach and impose zero restrictions on the country fixed effects in our estimating equations. From the point of view of our model this means that unobserved technologies and prices of nontraded goods are now equal to a time fixed effect δ_{it} and a random component e_{ict} with constant variance σ_i^2. The estimating equation is now

$$S_{ict} = \gamma_{it} + \sum_{k=1}^{N_1} a_{ki} \ln A_{kct} + \sum_{j=2}^{M} c_{ji} \ln \frac{v_{jct}}{v_{1ct}} + e_{ict} \tag{14}$$

in case of the mobile capital and

$$S_{ict} = \gamma_{it} + \sum_{k=1}^{N_1} a_{ki} \ln A_{kct} + \sum_{k=1}^{N_1} d_{ki} \ln K_{kct} + \sum_{j=2}^{M} c_{ji} \ln \frac{v_{jct}}{v_{1ct}} + e_{ict} \tag{15}$$

if capital is the specific factor.

The results of estimating these equations are reported in Table B1-B4. Table B5 summarizes the own-TFP coefficients. We can see that in this case there is still a reduction of own-technology coefficients. Table B5, which summarizes our findings, shows that the reduction of own-TFP coefficients that occurs when variable capital utilization is accounted for is 18% in the case of mobile capital and 30% if capital is a specific factor. The results confirm the main finding of this paper: the own-technology parameters are overestimated if variable capital utilization is not accounted for.

Table 1 Description of Industries

ISIC	Name	Description
31	Food	Food, beverage, and tobacco
32	Textile	Textiles, wearing apparel, leather products, footwear (except rubber of plastic)
33	Wood	Wood products including furniture
34	Paper	Paper, paper products, printing, and publishing
35	Chemicals	Industrial chemicals, products of petroleum and coal, rubber, plastics
36	Nonmetals	Pottery, china, glass, other nonmetallic mineral products (except petroleum and coal)
37	Metals	Iron, steel, other metals
38	Machinery	Fabricated metal products, machinery, transport equipment

Table 2 Availability of Industry-Level Data

	Available Years
Australia	1975-1990
Austria	1979-1994
Belgium	1975-1992
Canada	1975-1990
Denmark	1975-1991
Finland	1975-1998
France	1975-1998
Germany	1975-1992
Greece	1975-1992
Ireland	1975-1991
Italy	1975-1994
Japan	1975-1998
Korea	1975-1998
Mexico	1980-1991
Netherlands	1975-1993
New Zealand	1975-1990
Norway	1975-1998
Portugal	1981-1995
Spain	1975-1998
Sweden	1975-1987
Turkey	1975-1997
United Kingdom	1975-1998
United States	1975-1995

Table 3 Income shares of industries and total manufacturing in GDP, 1975

	Food	Textile	Wood	Paper	Chemicals	Nonmetals	Metals	Machinery	Total
Australia	3.6%	1.5%	1.2%	1.7%	2.4%	1.1%	2.2%	6.9%	20.7%
Austria	3.2%	2.2%	1.0%	1.6%	2.8%	1.6%	2.1%	7.3%	21.7%
Belgium	4.4%	2.6%	1.2%	1.5%	3.7%	1.2%	3.4%	7.9%	25.9%
Canada	3.3%	1.7%	1.4%	3.1%	2.7%	0.9%	1.7%	7.4%	22.2%
Denmark	3.9%	1.1%	0.6%	1.7%	2.1%	1.2%	0.3%	6.3%	17.4%
Finland	3.4%	2.3%	1.5%	5.4%	2.9%	1.1%	1.3%	8.1%	26.0%
France	3.5%	2.4%	0.9%	1.8%	4.3%	1.3%	1.7%	9.7%	25.6%
Germany	4.3%	2.2%	1.3%	1.5%	6.0%	1.5%	3.2%	14.3%	34.2%
Greece	2.6%	3.2%	0.4%	0.6%	2.4%	1.0%	1.1%	2.6%	13.8%
Ireland	9.9%	3.2%	0.6%	1.9%	3.1%	2.3%	0.4%	5.5%	27.0%
Italy	2.1%	2.8%	0.6%	1.3%	4.2%	1.4%	2.4%	8.8%	23.8%
Japan	3.1%	2.5%	1.3%	2.6%	4.6%	1.6%	2.6%	12.5%	30.7%
Korea	4.8%	6.1%	0.7%	1.1%	6.0%	1.5%	1.8%	4.5%	26.5%
Mexico	1.9%	0.4%	0.0%	0.4%	1.4%	0.6%	1.1%	1.3%	7.1%
Netherlands	3.8%	1.1%	0.8%	1.9%	3.7%	0.9%	0.9%	7.6%	20.6%
New Zealand	4.8%	2.3%	1.6%	2.3%	1.8%	0.9%	0.6%	5.0%	19.3%
Norway	3.2%	0.9%	1.8%	2.6%	2.3%	0.8%	2.5%	7.6%	21.6%
Portugal	3.4%	4.2%	1.3%	1.8%	2.7%	1.6%	0.6%	4.4%	19.9%
Spain	2.2%	2.4%	0.9%	1.1%	3.4%	1.3%	1.3%	5.0%	17.6%
Sweden	2.9%	1.2%	2.1%	4.3%	2.5%	1.0%	2.0%	12.9%	28.9%
Turkey	2.8%	1.9%	0.2%	0.5%	3.6%	0.6%	1.2%	2.3%	13.0%
United Kingdom	4.5%	2.8%	1.1%	2.7%	5.4%	1.5%	2.3%	14.0%	34.3%
United States	3.2%	1.9%	0.8%	2.6%	4.3%	0.9%	1.8%	11.2%	26.6%

Table 4 Income shares of industies and total manufacturing in GDP, 1995

	Food	Textile	Wood	Paper	Chemicals	Nonmetals	Metals	Machinery	Total
Australia	2.5%	0.6%	0.8%	0.7% *	0.8%	0.6%	0.8% *	1.8%	8.6%
Austria	2.7%	0.9%	1.1%	1.3%	2.4%	1.2%	1.1%	7.1%	17.9%
Belgium	3.5%	1.3%	0.8%	1.3%	3.3%	0.9%	1.3%	5.7%	18.1%
Canada	3.0%	1.0%	1.6%	2.5%	3.3%	0.5%	1.3%	7.5%	20.7%
Denmark	4.1% **	0.7% **	0.9% **	1.6% **	2.8% **	0.8% **	0.2% **	6.0% **	17.1% **
Finland	2.0%	0.6%	1.5%	6.0%	0.9%	0.5%	1.3%	4.4%	17.1%
France	2.7%	1.0%	0.6%	1.6%	3.7%	0.8%	0.9%	7.5%	18.9%
Germany	3.2% ***	1.0% ***	0.9% ***	1.3% ***	5.9% ***	1.1% ***	1.0% ***	13.7% ***	28.1% ***
Greece	2.8%	1.5%	0.3%	0.6%	2.1%	0.7%	0.5%	1.7%	10.2%
Ireland	10.2%	1.0%	0.5%	1.7%	9.5%	1.4%	0.1%	16.7%	41.1%
Italy	1.3%	1.9%	0.5%	0.8%	2.4%	0.8%	0.7%	5.5%	14.0%
Japan	2.6%	1.0%	0.6%	2.1%	3.9%	1.0%	1.2%	11.9%	24.3%
Korea	3.8%	4.6%	0.8%	2.2%	7.6%	2.1%	3.1%	20.5%	44.7%
Mexico	2.0%	0.2%	0.0%	0.3%	1.9%	0.6%	0.9%	2.3%	8.1%
Netherlands	3.4%	0.4%	0.3%	1.6%	2.9%	0.5%	0.6%	4.6%	14.2%
New Zealand	5.3%	1.1% ****	0.9% ****	2.4%	2.4%	0.5% ****	0.5% ****	3.7%	13.8%
Norway	1.9%	0.2%	0.7%	2.0%	0.7%	0.3%	0.7%	2.9%	9.5%
Portugal	2.8%	3.7%	1.0%	1.8%	4.2%	1.7%	0.3%	3.9%	19.3%
Spain	2.8%	1.2%	0.8%	1.4%	2.7%	1.3%	0.9%	5.4%	16.6%
Sweden	1.5%	0.2%	1.1%	2.6%	2.4%	0.4%	1.1%	8.7%	17.9%
Turkey	3.4%	3.7%	0.2%	0.7%	6.2%	1.5%	1.5%	4.4%	21.7%
United Kingdom	2.5%	1.0%	0.6%	2.2%	3.5%	0.7%	0.8%	7.5%	18.9%
United States	2.8%	1.1%	0.7%	2.8%	4.2%	0.6%	0.9%	10.0%	23.1%

(*) 1992
(**) 1991
(***) 1993
(****) 1990

Table 5 Average industry shares, 1975-1995

(percent of GDP)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Food	3.82	3.81	3.78	3.85	3.66	3.54	3.53	3.58	3.53	3.49	3.40	3.32	3.33	3.32	3.26	3.25	3.38	2.98	2.88	2.71	2.75
Textile	2.31	2.37	2.24	2.23	2.15	2.00	2.04	1.92	1.85	1.86	1.81	1.78	1.80	1.72	1.60	1.58	1.57	1.72	1.76	1.89	1.89
Wood	1.05	1.08	1.08	1.09	1.09	1.03	0.92	0.84	0.86	0.83	0.79	0.75	0.77	0.73	0.73	0.74	0.68	0.72	0.75	0.81	0.78
Paper	2.11	2.01	1.99	2.03	2.06	1.98	1.91	1.84	1.86	1.96	1.90	1.84	1.93	1.79	1.82	1.74	1.61	1.69	1.88	1.95	2.30
Chemicals	3.56	3.59	3.50	3.53	3.68	3.49	3.59	3.39	3.45	3.57	3.51	3.63	3.56	3.68	3.65	3.57	3.50	3.44	3.46	3.51	3.75
Nonmetals	1.21	1.21	1.22	1.22	1.22	1.19	1.18	1.10	1.08	1.06	1.02	1.03	1.06	1.09	1.06	1.05	1.04	1.02	1.07	1.07	1.06
Metals	1.73	1.65	1.63	1.62	1.71	1.62	1.44	1.32	1.29	1.35	1.29	1.18	1.18	1.35	1.35	1.14	0.96	1.01	0.92	1.09	1.16
Machinery	7.99	8.18	8.15	8.19	7.99	7.55	7.43	7.35	7.26	7.38	7.39	7.04	7.22	6.90	7.16	7.18	7.04	6.96	6.68	6.97	7.39
Average	2.97	2.99	2.95	2.97	2.95	2.80	2.75	2.67	2.65	2.69	2.64	2.57	2.61	2.57	2.58	2.53	2.47	2.44	2.43	2.50	2.64

Industry	**Average Share**	**Min. Share**	**Max. Share**
Food	3.444	1.06	9.88
Textile	1.917	0.20	6.74
Wood	0.872	0.02	2.82
Paper	1.908	0.25	6.18
Chemicals	3.55	0.45	7.60
Nonmetals	1.112	0.29	2.43
Metals	1.357	0.18	3.44
Machinery	7.433	0.98	20.45
Average	2.70		

Table 6 Country Endowments
(Labor, Physical Capital, and Land)

	Labor Force (millions)		Capital Stock per Worker (1994 USD)		Arable Land per Worker (hectares)	
	1975	**1995**	**1975**	**1995**	**1975**	**1995**
Australia	6.041	9.079	59,638	71,963	6.99	5.30
Austria	3.253	3.655	45,307	87,954	0.46	0.39
Belgium	3.774	4.126	52,482	90,799	0.26	0.18
Canada	10.281	15.550	61,288	64,927	4.28	2.92
Denmark	2.544	2.916	49,883	78,703	1.04	0.80
Finland	2.304	2.588	48,760	79,216	1.15	0.98
France	22.705	25.744	54,340	83,641	0.76	0.71
Germany	29.070	32.300	52,349	99,227	0.33	0.29
Greece	3.584	4.405	20,966	35,025	0.81	0.55
Ireland	1.189	1.418	25,318	50,482	1.04	0.94
Italy	21.815	24.907	37,045	67,335	0.43	0.33
Japan	55.219	66.093	41,799	134,962	0.08	0.06
Korea	13.314	21.617	4,557	36,809	0.15	0.08
Mexico	18.113	35.808	12,424	14,624	1.23	0.72
Netherlands	5.210	7.120	52,648	75,297	0.15	0.12
New Zealand	1.205	1.735	48,430	48,833	2.08	0.91
Norway	1.766	2.215	66,428	111,200	0.45	0.45
Portugal	4.041	4.904	13,525	31,864	0.61	0.47
Spain	12.920	16.601	26,223	51,583	1.22	0.92
Sweden	3.969	4.682	61,985	73,834	0.76	0.59
Turkey	17.356	27.991	7,630	10,662	1.44	0.88
United Kingdom	26.256	29.111	31,003	49,686	0.26	0.20
United States	97.780	132.622	59,205	72,080	1.91	1.40

Table 7 Country Endowments

(Educational Attainment Rates)

	Educational Attainment of Workers							
	No School (% of total)		Primary School (% of total)		Secondary School (% of total)		Higher Education (% of total)	
	1975	**1995**	**1975**	**1995**	**1975**	**1995**	**1975**	**1995**
Australia	3.6	2.1	28.7	25.1	47	48.6	20.8	24.2
Austria	3.5	1.1	47.3	31.6	45.6	55.7	3.6	11.7
Belgium	2.9	4.6	60.1	48.8	30.3	30.5	6.7	16.1
Canada	1.8	1.6	30.7	20.3	36.6	29.4	30.9	48.7
Denmark	1.7	0.8	37.6	34.1	44.9	47	15.8	18.9
Finland	0.9	0.4	62	31.3	29.9	49.6	7.2	18.7
France	0.9	0.5	67.2	47.6	26.8	37.3	5.2	14.5
Germany	0.6	4	47.1	27.5	46.8	53.5	5.5	15
Greece	14.4	5.5	67.8	52.2	12.9	31.8	5	10.5
Ireland	3.5	3	62.4	35.4	28.4	45.2	5.7	16.4
Italy	6.6	13.5	70.6	42.5	18.6	32.4	4.3	11.5
Japan	0.8	0	53.8	31.2	38.1	46.8	7.3	22
Korea	25.2	8.7	39.2	18.2	28.7	51.9	6.9	21.1
Mexico	34.4	15	54	47.9	8.3	26.7	3.3	10.3
Netherlands	2.3	2.7	44.4	32	44.3	46.3	9.1	19
New Zealand	1	0	21.8	34.2	57.1	26.6	20.1	39.2
Norway	1.8	1	54.3	11.6	34.8	66.7	9.1	20.8
Portugal	38.7	14.3	49.3	61.4	9.6	14.7	2.4	9.6
Spain	13.6	4	73.9	55.5	8.2	28.6	4.3	11.9
Sweden	1.4	2.1	52	18.1	34.3	58.8	12.3	21
Turkey	59	30.6	31.9	47.2	7.3	15.7	1.8	6.5
United Kingdom	2.4	2.9	55.6	41.4	31	39.9	11	15.8
United States	1.4	0.6	30.7	8.2	42.6	44.6	25.3	46.5

Table 8 Electricity Consumption Efficiency Parameter Φ_{ic} for Years 1975-1995

Country	Av. Rank	Food		Textile		Wood		Paper		Chemicals		Non-metals		Metals		Machinery	
France	**(3.25)**	(3)	3.66	(8)	5.52	(2)	3.45	(3)	5.84	(4)	5.65	(1)	5.01	(3)	13.94	(2)	2.66
Austria	**(5.75)**	(2)	3.19	(1)	3.92	(7)	5.17	(13)	11.08	(8)	7.06	(4)	7.38	(6)	16.72	(5)	2.81
Denmark	**(6.38)**	(14)	5.47	(4)	4.43	(10)	5.79	(2)	5.67	(2)	4.16	(2)	6.21	(2)	13.61	(15)	4.66
Ireland	**(6.88)**	(11)	5.19	(5)	4.76	(15)	8.53	(1)	4.41	(3)	5.27	(3)	7.17	(10)	20.02	(7)	3.32
Belgium	**(7.63)**	(6)	4.59	(7)	5.25	(4)	3.84	(4)	6.28	(16)	10.78	(10)	9.68	(4)	16.53	(10)	3.51
Netherlands	**(7.88)**	(9)	4.96	(3)	4.36	(3)	3.55	(6)	6.58	(14)	8.83	(5)	7.51	(15)	28.71	(8)	3.41
Greece	**(8.13)**	(1)	2.87	(9)	5.62	(1)	3.41	(7)	9.11	(9)	7.47	(16)	13.42	(19)	42.32	(3)	2.73
United Kingdom	**(8.13)**	(8)	4.86	(11)	6.38	(5)	4.17	(5)	6.37	(5)	6.35	(9)	9.57	(5)	16.56	(17)	4.88
Japan	**(8.88)**	(4)	3.82	(12)	7.17	(8)	5.30	(9)	10.16	(11)	7.59	(13)	12.26	(8)	18.07	(6)	2.95
Germany	**(10.75)**	(7)	4.83	(13)	7.46	(9)	5.32	(11)	10.78	(21)	14.32	(11)	10.99	(13)	23.67	(1)	2.55
Korea	**(10.88)**	(10)	5.17	(17)	8.40	(6)	4.94	(15)	12.06	(10)	7.47	(17)	13.51	(1)	9.53	(11)	3.66
Finland	**(11.13)**	(5)	4.34	(6)	4.86	(13)	7.14	(20)	21.65	(17)	11.22	(6)	8.40	(9)	19.34	(13)	4.20
Italy	**(11.88)**	(15)	5.97	(14)	7.58	(11)	6.34	(10)	10.49	(12)	8.23	(12)	12.22	(7)	16.95	(14)	4.65
Sweden	**(12.13)**	(12)	5.24	(2)	4.16	(12)	6.40	(19)	19.25	(18)	13.03	(7)	9.03	(11)	22.14	(16)	4.80
New Zealand	**(12.50)**	(16)	6.06	(10)	5.81	(22)	65.32	(12)	11.00	(1)	2.40	(8)	9.23	(22)	69.30	(9)	3.47
Portugal	**(13.75)**	(13)	5.41	(15)	7.98	(17)	8.74	(8)	9.28	(13)	8.27	(14)	12.51	(12)	22.16	(18)	4.96
Turkey	**(15.88)**	(23)	13.59	(18)	9.85	(23)	84.40	(17)	13.00	(6)	6.70	(22)	21.32	(14)	23.79	(4)	2.75
Australia	**(16.13)**	(17)	6.89	(22)	13.73	(14)	7.79	(18)	13.42	(7)	6.78	(15)	12.79	(16)	31.32	(20)	5.53
Mexico	**(19.13)**	(18)	7.50	(19)	11.20	(20)	15.00	(21)	22.38	(22)	18.40	(23)	22.75	(18)	41.36	(12)	4.10
United States	**(19.25)**	(22)	8.59	(23)	14.56	(21)	15.14	(14)	11.81	(19)	13.09	(19)	14.83	(17)	33.98	(19)	5.51
Canada	**(19.75)**	(20)	8.22	(20)	11.21	(19)	12.31	(23)	30.75	(15)	9.23	(20)	18.12	(20)	44.94	(21)	6.67
Spain	**(19.75)**	(19)	7.50	(21)	11.32	(18)	8.90	(16)	12.38	(20)	14.13	(21)	21.27	(21)	56.87	(22)	6.93
Norway	**(20.25)**	(21)	8.47	(16)	8.08	(16)	8.66	(22)	26.70	(23)	22.61	(18)	13.59	(23)	135.40	(23)	8.00

* Numbers in parentheses are countries' ranks. 1 is the highest rank (lowest Φ_{ic}), 23 is the lowest rank (highest Φ_{ic}).

Figure 1 Electricity Consumption Efficiency Rankings, by Country

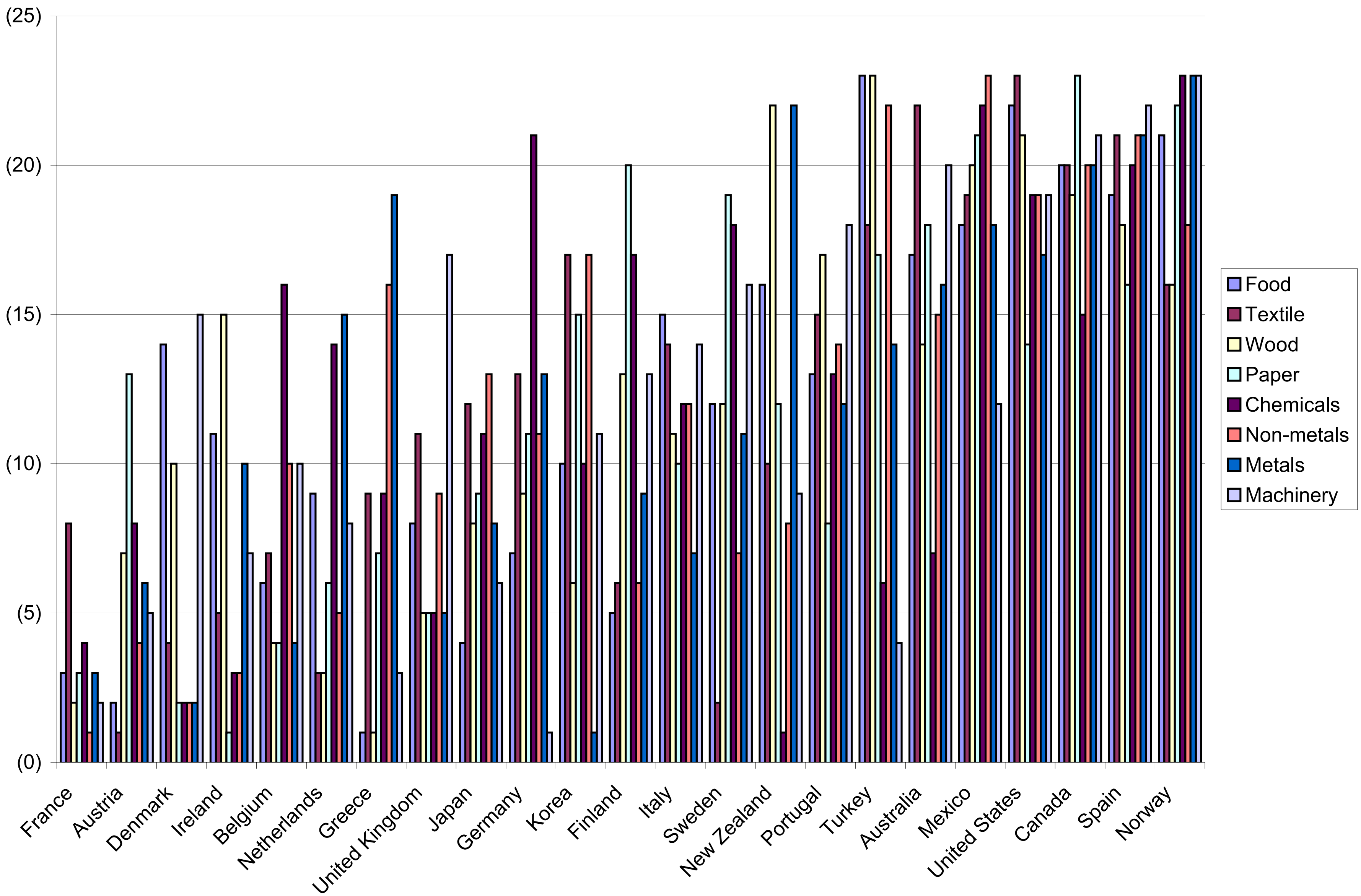


Table 9 Relative Total Factor Productivity, 1975 and 1990
(Adjusted for Variable Capital Utilization)

		Food	Textile	Wood	Paper	Chemicals	Nonmetals	Metals	Machinery
Australia	**1975**	56.7%	81.5%	96.9%	71.2%	60.5%	70.3%	67.1%	65.6%
	1990	58.5%	89.9%	90.5%	83.6%	74.2%	86.8%	81.7%	74.2%
Austria	**1975**	44.2%	44.6%	54.1%	42.1%	34.9%	47.7%	35.8%	43.4%
	1990	59.5%	65.6%	80.9%	66.1%	48.4%	72.3%	70.2%	62.5%
Belgium	**1975**	64.8%	56.4%	86.7%	52.5%	43.4%	41.8%	66.2%	54.3%
	1990	60.7%	64.8%	93.1%	63.6%	45.6%	60.8%	70.3%	72.6%
Canada	**1975**	73.5%	82.1%	90.6%	74.9%	52.4%	84.2%	62.9%	80.7%
	1990	80.5%	99.3%	91.0%	80.0%	60.8%	101.1%	67.6%	85.1%
Denmark	**1975**	64.7%	71.7%	61.5%	76.5%	58.3%	63.4%	51.4%	70.1%
	1990	53.9%	80.1%	92.2%	63.8%	84.0%	74.9%	65.7%	67.9%
Finland	**1975**	40.4%	57.3%	44.6%	52.5%	45.1%	49.7%	51.4%	52.2%
	1990	54.5%	76.7%	99.2%	72.9%	67.0%	85.3%	72.7%	86.4%
France	**1975**	61.6%	63.0%	76.8%	63.5%	50.0%	51.9%	43.8%	50.7%
	1990	47.7%	93.5%	76.6%	77.7%	65.6%	78.6%	65.0%	69.6%
Germany	**1975**	87.9%	77.1%	85.3%	61.3%	60.9%	73.4%	65.1%	61.3%
	1990	97.7%	107.4%	108.2%	95.7%	113.6%	106.2%	93.9%	103.0%
Greece	**1975**	28.5%	41.5%	30.7%	34.3%	30.6%	32.7%	45.2%	26.2%
	1990	32.2%	44.7%	46.3%	47.4%	41.1%	41.2%	59.0%	33.4%
Ireland	**1975**	42.4%	46.2%	46.5%	39.7%	41.7%	48.7%	44.4%	44.0%
	1990	79.3%	59.3%	83.9%	100.4%	98.8%	90.4%	48.4%	97.1%
Italy	**1975**	48.4%	59.3%	55.6%	59.5%	39.4%	47.4%	49.2%	52.9%
	1990	48.5%	83.9%	94.1%	95.1%	49.3%	73.7%	60.8%	70.9%
Japan	**1975**	56.0%	67.9%	64.5%	59.5%	42.9%	62.3%	47.1%	57.6%
	1990	61.7%	97.9%	108.2%	113.2%	103.1%	105.8%	107.3%	103.6%
Korea	**1975**	27.0%	21.0%	18.7%	16.7%	25.0%	22.8%	23.1%	15.0%
	1990	56.8%	46.6%	58.6%	60.9%	51.7%	62.3%	66.0%	49.8%
Mexico	**1975**	59.9%	40.6%	56.4%	51.2%	45.7%	48.4%	54.3%	63.6%
	1990	86.4%	36.0%	39.5%	33.3%	40.5%	50.0%	57.3%	56.2%
Netherlands	**1975**	50.6%	60.3%	81.2%	58.9%	42.8%	59.9%	47.6%	64.5%
	1990	55.0%	80.2%	78.0%	75.5%	54.0%	68.2%	70.7%	63.1%
New Zealand	**1975**	28.3%	50.2%	67.9%	38.3%	26.9%	50.0%	40.9%	42.2%
	1990	31.2%	49.0%	54.2%	60.5%	29.7%	65.2%	36.3%	43.3%
Norway	**1975**	42.8%	61.0%	82.9%	45.6%	35.2%	56.2%	65.3%	61.7%
	1990	42.9%	72.9%	75.9%	61.6%	49.5%	66.4%	66.8%	63.9%
Portugal	**1975**	26.1%	27.1%	29.1%	27.7%	23.7%	23.1%	19.5%	27.4%
	1990	28.8%	28.8%	26.8%	33.7%	22.2%	31.3%	33.5%	27.8%
Spain	**1975**	32.9%	54.0%	42.3%	39.8%	43.6%	38.6%	46.7%	35.4%
	1990	63.5%	78.3%	79.3%	88.0%	79.8%	86.9%	79.0%	79.5%
Sweden	**1975**	66.5%	83.9%	84.6%	79.8%	50.2%	68.0%	56.4%	73.4%
	1987	55.5%	75.5%	78.9%	75.9%	65.7%	73.5%	62.0%	66.7%
Turkey	**1975**	54.4%	36.6%	39.7%	33.0%	71.8%	28.1%	40.0%	33.1%
	1990	50.5%	41.5%	41.5%	52.7%	86.3%	55.6%	34.8%	45.2%
United Kingdom	**1975**	43.6%	47.1%	69.7%	49.3%	41.4%	54.4%	39.5%	44.0%
	1990	59.5%	85.2%	94.8%	100.2%	78.6%	89.5%	69.9%	79.8%
United States	**1975**	81.4%	85.0%	89.4%	93.8%	76.3%	85.2%	79.4%	89.1%
	1990	101.8%	100.0%	95.8%	101.0%	93.5%	94.2%	93.5%	96.4%

* Relative to the U.S. of 1988

Figure 2 TFP of the Metals Industry in the United States

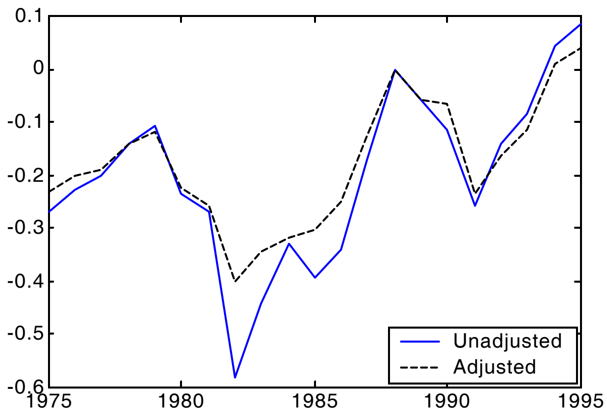


Figure 2a
Unadjusted and Adjusted TFP (in levels) of the Metals Industry in the United States

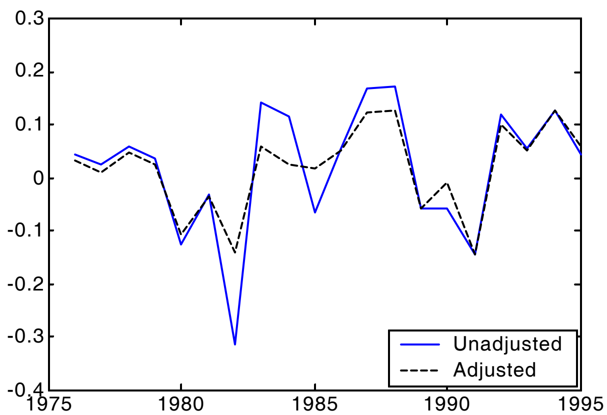


Figure 2b
Unadjusted and Adjusted TFP (in differences) of the Metals Industry in the United States

Selected Properties of Unadjusted and Adjusted Measures of TFP

	Unadjusted	Adjusted		Unadjusted	Adjusted
s^2_{TFP}	0.026	0.016	$s^2_{\Delta TFP}$	0.015	0.010
$r_{TFP,Y}$	0.83	0.58	$r_{\Delta TFP,\Delta Y}$	0.97	0.79

Figure 3 TFP of the Wood Industry in the United States

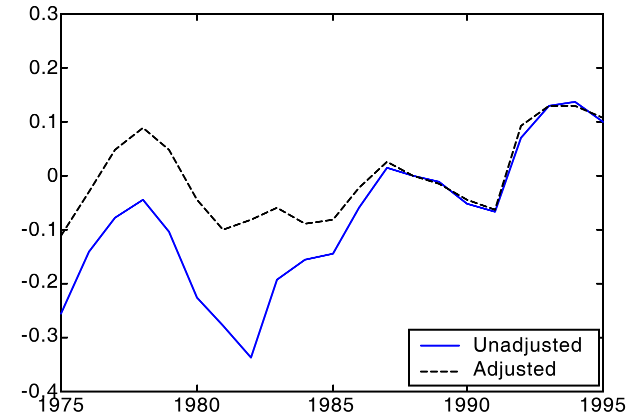


Figure 3a
Unadjusted and Adjusted TFP (in levels) of the Wood Industry in the United States

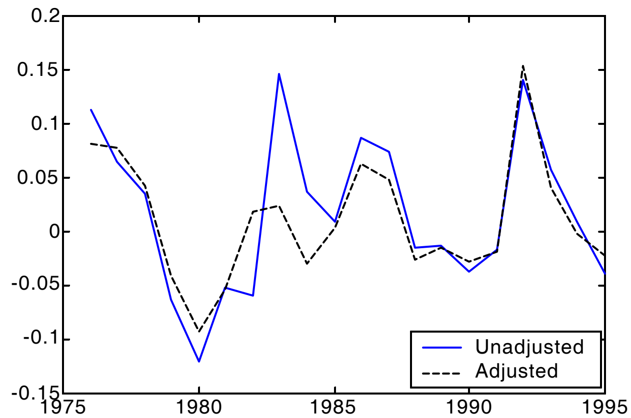


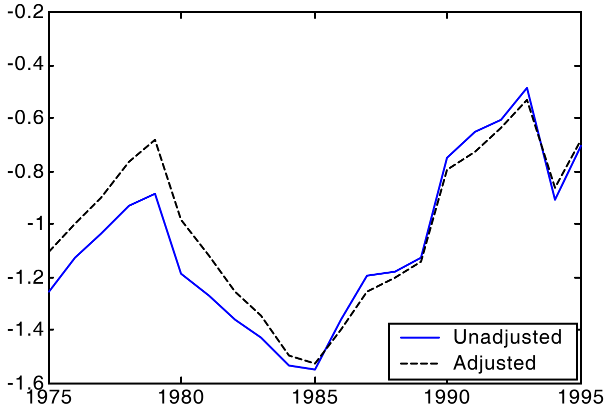
Figure 3b
Unadjusted and Adjusted TFP (in differences) of the Wood Industry in the United States

Selected Properties of Unadjusted and Adjusted Measures of TFP

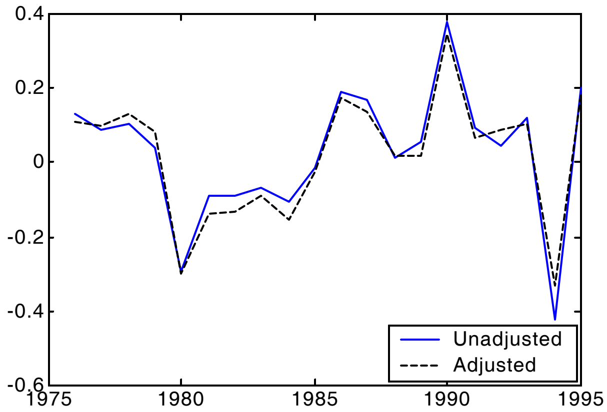
	Unadjusted	Adjusted
s^2_{TFP}	0.018	0.006
$r_{TFP,Y}$	0.96	0.89

	Unadjusted	Adjusted
$s^2_{\Delta TFP}$	0.0053	0.0032
$r_{\Delta TFP,\Delta Y}$	0.94	0.77

<u>Figure 4 TFP of the Machinery Industry in Turkey</u>



<u>Figure 4a</u>
Unadjusted and Adjusted TFP (in levels) of the Machinery Industry in Turkey



<u>Figure 4b</u>
Unadjusted and Adjusted TFP (in differences) of the Machinery Industry in Turkey

<u>Selected Properties of Unadjusted and Adjusted Measures of TFP</u>

	Unadjusted	Adjusted		Unadjusted	Adjusted
s^2_{TFP}	0.095	0.081	$s^2_{\Delta TFP}$	0.031	0.029
$r_{TFP,Y}$	0.93	0.82	$r_{\Delta TFP,\Delta Y}$	0.98	0.93

Table 10 - Estimates
(Constant capital utilization and mobile capital)

	Food	Textile	Wood	Paper	Chemicals	Nonmetals	Metals	Machinery
TFP Food	**1.778**	-0.105	0.038	-0.211	-0.234	-0.135	-0.123	-0.614
	(0.09)†	(0.08)	(0.05)	(0.06)†	(0.06)†	(0.05)†	(0.06)†	(0.12)†
TFP Textile	-0.105	**0.421**	-0.110	-0.085	-0.228	-0.007	-0.056	-0.564
	(0.08)	**(0.01)†**	(0.07)	(0.08)	(0.07)†	(0.06)	(0.07)	(0.15)†
TFP Wood	0.038	-0.110	**0.723**	-0.002	-0.077	0.071	0.016	-0.373
	(0.05)	(0.07)	**(0.07)†**	(0.06)	(0.04)††	(0.04)††	(0.04)	(0.09)†
TFP Paper	-0.211	-0.085	-0.002	**0.394**	-0.238	0.034	0.058	-0.789
	(0.06)†	(0.08)	(0.06)	**(0.07)†**	(0.05)†	(0.05)	(0.05)	(0.11)†
TFP Chemicals	-0.234	-0.228	-0.077	-0.238	**2.035**	-0.149	-0.202	0.367
	(0.06)†	(0.07)†	(0.04)††	(0.05)†	**(0.10)†**	(0.03)†	(0.06)†	(0.14)†
TFP Nonmetals	-0.135	-0.007	0.071	0.034	-0.149	**0.408**	-0.010	-0.432
	(0.05)†	(0.06)	(0.04)††	(0.05)	(0.03)†	**(0.05)†**	(0.04)	(0.08)†
TFP Metals	-0.123	-0.056	0.016	0.058	-0.202	-0.010	**0.592**	-0.251
	(0.06)†	(0.07)	(0.04)	(0.05)	(0.06)†	(0.04)	**(0.03)†**	(0.12)†
TFP Machinery	-0.614	-0.564	-0.373	-0.789	0.367	-0.432	-0.251	**3.479**
	(0.12)†	(0.15)†	(0.09)†	(0.11)†	(0.14)†	(0.08)†	(0.12)†	**(0.12)†**
Capital	-0.907	-1.370	-0.070	-0.119	-0.503	-0.001	0.297	2.671
	(0.11)†	(0.12)†	(0.07)	(0.10)	(0.22)†	(0.07)	(0.12)†	(0.46)†
Low-ed. workers[1]	0.358	0.274	0.150	0.016	0.049	0.029	0.280	-0.516
	(0.07)†	(0.07)†	(0.04)†	(0.06)	(0.13)	(0.04)	(0.07)†	(0.28)††
Mid-ed. workers[2]	0.468	0.372	-0.091	-0.327	0.004	0.163	0.451	-0.010
	(0.09)†	(0.10)†	(0.06)	(0.08)†	(0.18)	(0.06)†	(0.10)†	(0.38)
High-ed. workers[3]	0.745	0.579	0.292	0.251	0.178	0.131	0.088	1.592
	(0.11)†	(0.12)†	(0.07)†	(0.10)†	(0.22)	(0.07)†	(0.12)	(0.47)†
Arable land	-0.527	-1.610	-0.713	-1.081	-3.055	-1.270	-1.139	-9.195
	(0.22)†	(0.24)†	(0.14)†	(0.19)†	(0.44)†	(0.13)†	(0.24)†	(0.92)†

† means that the estimate is significant at 95% level
†† means that the estimate is significant at 90% level
Standard errors in parentheses
[1] Those having primary education
[2] Those having secondary education
[3] Those having higher education

Table 11 - Estimates
(Variable capital utilization and mobile capital)

	Food	Textile	Wood	Paper	Chemicals	Nonmetals	Metals	Machinery
TFP Food	**1.237**	-0.032	-0.028	-0.122	-0.059	-0.054	0.045	-0.601
	(0.09)†	(0.07)	(0.05)	(0.06)†	(0.06)	(0.04)	(0.06)	(0.11)†
TFP Textile	-0.032	**0.340**	0.002	0.121	-0.174	0.146	-0.065	-0.986
	(0.07)	**(0.02)†**	(0.06)	(0.08)	(0.06)†	(0.05)†	(0.07)	(0.12)†
TFP Wood	-0.028	0.002	**0.613**	-0.028	-0.093	0.049	-0.149	-0.075
	(0.05)	(0.06)	**(0.06)†**	(0.05)	(0.04)†	(0.04)	(0.04)†	(0.08)
TFP Paper	-0.122	0.121	-0.028	**0.283**	-0.230	-0.047	0.162	-0.557
	(0.06)†	(0.08)	(0.05)	**(0.04)†**	(0.05)†	(0.04)	(0.05)†	(0.10)†
TFP Chemicals	-0.059	-0.174	-0.093	-0.230	**1.678**	-0.117	-0.334	0.017
	(0.06)	(0.06)†	(0.04)†	(0.05)†	**(0.09)†**	(0.03)†	(0.05)†	(0.13)
TFP Nonmetals	-0.054	0.146	0.049	-0.047	-0.117	**0.312**	0.121	-0.531
	(0.04)	(0.05)†	(0.04)	(0.04)	(0.03)†	**(0.05)†**	(0.03)†	(0.06)†
TFP Metals	0.045	-0.065	-0.149	0.162	-0.334	0.121	**0.513**	-0.268
	(0.06)	(0.07)	(0.04)†	(0.05)†	(0.05)†	(0.03)†	**(0.06)†**	(0.10)†
TFP Machinery	-0.601	-0.986	-0.075	-0.557	0.017	-0.531	-0.268	**2.409**
	(0.11)†	(0.12)†	(0.08)	(0.10)†	(0.13)	(0.06)†	(0.10)†	**(0.17)†**
Capital	-1.097	-1.257	-0.286	-0.318	-0.394	-0.149	0.270	3.158
	(0.13)†	(0.13)†	(0.07)†	(0.10)†	(0.23)††	(0.07)†	(0.14)††	(0.51)†
Low-ed. workers	0.349	0.165	0.167	-0.026	0.216	0.046	0.234	-0.398
	(0.07)†	(0.07)†	(0.04)†	(0.06)	(0.14)	(0.04)	(0.08)†	(0.29)
Mid-ed. workers	0.357	0.368	-0.083	-0.150	-0.022	0.178	0.284	-0.107
	(0.10)†	(0.10)†	(0.06)	(0.08)††	(0.18)	(0.05)†	(0.11)†	(0.40)
High-ed. workers	0.655	0.669	0.251	0.092	0.605	0.127	0.060	1.700
	(0.12)†	(0.12)†	(0.07)†	(0.09)	(0.22)†	(0.06)†	(0.13)	(0.49)†
Arable land	-0.202	-1.701	-0.608	-1.132	-3.007	-1.198	-1.056	-9.521
	(0.24)	(0.24)†	(0.14)†	(0.19)†	(0.45)†	(0.13)†	(0.26)†	(0.96)†

† means that the estimate is significant at 95% level
†† means that the estimate is significant at 90% level
Standard errors in parentheses

Table 12 - Estimated country fixed effects
(assuming variable capital utilization rate and mobile capital)

	Food	Textile	Wood	Paper	Chemicals	Nonmetals	Metals	Machinery
Australia	1.04	1.88	0.90	0.57	2.51	1.67	1.86	9.35
Austria	0.84	-1.15	-0.18	-2.19	-4.21	-0.75	-0.95	-11.15
Belgium	1.24	-2.32	-1.11	-3.32	-5.72	-1.85	-1.36	-20.04
Canada	0.35	0.98	0.89	1.27	1.50	0.84	1.05	3.36
Denmark	1.43	-1.52	-0.38	-1.59	-3.09	-0.32	-1.45	-7.51
Finland	1.02	-0.22	0.81	2.27	-1.95	-0.10	-0.60	-4.67
France	0.98	-0.51	-0.43	-1.76	-1.63	-0.44	-0.67	-5.33
Germany	0.69	-2.30	-0.74	-2.74	-1.92	-1.36	-0.79	-6.10
Greece	0.11	-0.05	-0.80	-2.83	-3.58	-0.31	-0.95	-7.14
Ireland	6.26	0.18	-0.46	-1.33	-0.71	0.85	-1.24	-3.68
Italy	-0.49	-1.05	-1.04	-3.27	-4.33	-1.02	-1.05	-11.96
Japan	-0.21	-4.75	-1.74	-3.81	-8.55	-3.08	-2.30	-24.93
Korea	0.12	-1.43	-1.67	-4.07	-5.38	-2.01	-0.92	-14.52
Mexico	-1.61	-1.89	-1.01	-2.69	-4.02	-0.26	-0.13	-5.91
Netherlands	0.72	-4.70	-1.82	-3.59	-7.28	-2.93	-3.22	-25.31
New Zealand	2.92	0.26	0.61	0.12	-1.05	0.19	-0.38	-2.24
Norway	0.70	-2.34	-0.36	-1.83	-5.14	-1.62	-1.53	-17.16
Portugal	0.64	1.18	-0.22	-2.09	-3.82	0.31	-0.75	-6.55
Spain	0.87	0.08	-0.14	-1.84	-1.63	0.44	-0.02	-2.19
Sweden	0.02	-1.97	0.34	0.24	-3.61	-0.89	-0.66	-6.12
Turkey	-0.15	0.38	-0.76	-2.39	-0.86	0.70	1.44	1.80
United Kingdom	0.69	-3.00	-1.30	-2.21	-4.76	-1.66	-1.59	-12.66
United States	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 13 - Estimated time fixed effects
(assuming variable capital utilization rate and mobile goods)

	Food	Textile	Wood	Paper	Chemicals	Nonmetals	Metals	Machinery
1975	10.89	12.72	3.46	7.38	8.14	2.18	-2.38	-20.70
1976	10.91	12.75	3.47	7.33	8.14	2.15	-2.46	-21.02
1977	10.90	12.60	3.45	7.26	8.01	2.11	-2.54	-21.57
1978	10.92	12.56	3.42	7.24	7.93	2.05	-2.63	-22.09
1979	10.80	12.47	3.42	7.25	7.99	1.99	-2.66	-22.66
1980	10.82	12.37	3.38	7.21	7.85	1.94	-2.74	-23.28
1981	10.95	12.33	3.33	7.23	7.96	1.98	-2.74	-23.30
1982	11.02	12.19	3.27	7.20	7.85	1.93	-2.83	-23.31
1983	11.00	12.09	3.28	7.22	7.76	1.91	-2.84	-23.51
1984	10.95	12.07	3.27	7.30	7.84	1.90	-2.80	-23.38
1985	10.88	11.96	3.23	7.21	7.68	1.85	-2.86	-23.48
1986	10.67	11.78	3.16	7.07	7.61	1.71	-3.05	-24.13
1987	10.61	11.73	3.12	7.02	7.42	1.62	-3.21	-24.67
1988	10.50	11.62	3.11	6.98	7.48	1.57	-3.23	-25.08
1989	10.52	11.57	3.13	6.99	7.43	1.56	-3.27	-25.34
1990	10.44	11.53	3.09	6.91	7.24	1.49	-3.43	-26.02
1991	10.54	11.47	3.05	6.88	6.93	1.48	-3.50	-26.89
1992	10.51	11.43	3.01	6.81	6.72	1.45	-3.65	-27.83
1993	10.58	11.45	3.03	6.90	6.82	1.48	-3.64	-27.94
1994	10.45	11.43	3.09	6.90	6.78	1.41	-3.68	-28.18
1995	10.34	11.38	3.03	6.94	6.86	1.39	-3.73	-28.34

Table 14 - Estimates
(Constant capital utilization and immobile capital)

	Food	Textile	Wood	Paper	Chemicals	Nonmetals	Metals	Machinery
TFP Food	**1.840**	0.047	0.045	-0.305	-0.415	-0.165	-0.015	-0.926
	(0.09)†	(0.07)	(0.05)	(0.06)†	(0.05)†	(0.04)†	(0.05)	(0.11)†
TFP Textile	0.047	**0.513**	-0.170	-0.181	-0.385	-0.233	-0.018	-0.813
	(0.07)	**(0.02)†**	(0.06)†	(0.07)†	(0.06)†	(0.05)†	(0.06)	(0.13)†
TFP Wood	0.045	-0.170	**0.756**	0.049	-0.279	0.081	-0.122	-0.277
	(0.05)	(0.06)†	**(0.07)†**	(0.06)	(0.04)†	(0.04)†	(0.04)†	(0.09)†
TFP Paper	-0.305	-0.181	0.049	**0.492**	-0.454	0.029	-0.099	-0.611
	(0.06)†	(0.07)†	(0.06)	**(0.02)†**	(0.05)†	(0.04)	(0.05)†	(0.10)†
TFP Chemicals	-0.415	-0.385	-0.279	-0.454	**2.456**	-0.168	-0.127	-0.121
	(0.05)†	(0.06)†	(0.04)†	(0.05)†	**(0.08)†**	(0.03)†	(0.05)†	(0.12)
TFP Nonmetals	-0.165	-0.233	0.081	0.029	-0.168	**0.441**	0.000	-0.527
	(0.04)†	(0.05)†	(0.04)†	(0.04)	(0.03)†	**(0.01)†**	(0.03)	(0.06)†
TFP Metals	-0.015	-0.018	-0.122	-0.099	-0.127	0.000	**0.679**	-0.620
	(0.05)	(0.06)	(0.04)†	(0.05)†	(0.05)†	(0.03)	**(0.01)†**	(0.10)†
TFP Machinery	-0.926	-0.813	-0.277	-0.611	-0.121	-0.527	-0.620	**3.836**
	(0.11)†	(0.13)†	(0.09)†	(0.10)†	(0.12)	(0.06)†	(0.10)†	**(0.15)†**
K(i) Food	**0.675**	-1.362	0.036	-0.053	-1.558	-0.567	0.149	-1.412
	(0.20)†	(0.22)†	(0.14)	(0.18)	(0.31)†	(0.11)†	(0.17)	(0.69)†
K(i) Textile	0.175	**1.067**	0.088	0.097	-0.191	0.015	-0.078	-0.484
	(0.12)	**(0.14)†**	(0.09)	(0.11)	(0.19)	(0.07)	(0.11)	(0.42)
K(i) Wood	0.304	-0.056	**0.270**	0.226	-0.078	0.001	-0.274	-0.033
	(0.09)†	(0.10)	**(0.06)†**	(0.08)†	(0.15)	(0.05)	(0.08)†	(0.32)
K(i) Paper	-1.180	-0.698	-0.365	**0.191**	-0.951	-0.282	-0.598	-1.666
	(0.14)†	(0.15)†	(0.09)†	**(0.04)†**	(0.21)†	(0.07)†	(0.12)†	(0.47)†
K(i) Chemicals	-0.219	-0.006	-0.094	-0.088	**1.764**	0.062	0.135	0.805
	(0.09)†	(0.10)	(0.06)	(0.08)	**(0.14)†**	(0.05)	(0.08)††	(0.31)†
K(i) Nonmetals	-0.295	0.373	-0.071	-0.380	0.102	**0.599**	0.333	-0.465
	(0.14)†	(0.15)†	(0.09)	(0.12)†	(0.21)	**(0.08)†**	(0.12)†	(0.46)
K(i) Metals	0.324	0.296	-0.081	-0.002	0.297	0.159	**0.615**	0.188
	(0.06)†	(0.07)†	(0.05)††	(0.06)	(0.10)†	(0.04)†	**(0.06)†**	(0.22)
K(i) Machinery	0.191	-0.031	0.325	0.498	0.956	0.157	0.378	**5.669**
	(0.12)	(0.13)	(0.08)†	(0.11)†	(0.19)†	(0.07)†	(0.11)†	**(0.41)†**

	Food	Textile	Wood	Paper	Chemicals	Nonmetals	Metals	Machinery
Low-ed. workers	0.254	0.174	0.122	0.031	0.464	-0.011	0.203	-0.283
	(0.07)†	(0.08)†	(0.05)†	(0.06)	(0.11)†	(0.04)	(0.06)†	(0.25)
Mid-ed. workers	-0.175	-0.085	-0.216	-0.357	-0.309	-0.219	-0.303	-0.966
	(0.13)	(0.14)	(0.09)†	(0.11)†	(0.20)	(0.07)†	(0.11)†	(0.44)†
High-ed. workers	0.523	0.284	0.192	0.115	0.500	0.089	0.111	1.660
	(0.11)†	(0.13)†	(0.08)†	(0.10)	(0.18)†	(0.06)	(0.10)	(0.39)†
Arable land	0.048	-0.178	-0.294	-0.487	0.251	-0.547	0.152	-1.548
	(0.27)	(0.30)	(0.19)	(0.24)†	(0.42)	(0.15)†	(0.23)	(0.93)††

† means that the estimate is significant at 95% level
†† means that the estimate is significant at 90% level
Standard errors in parentheses

Table 15 - Estimates
(Variable capital utilization and immobile capital)

	Food	Textile	Wood	Paper	Chemicals	Nonmetals	Metals	Machinery
TFP Food	**1.253**	0.062	-0.020	-0.168	-0.110	-0.050	-0.047	-0.897
	(0.05)†	(0.07)	(0.05)	(0.06)†	(0.06)††	(0.03)	(0.05)	(0.11)†
TFP Textile	0.062	**0.310**	-0.104	-0.051	-0.211	-0.039	-0.062	-0.905
	(0.07)	**(0.01)†**	(0.06)††	(0.07)	(0.06)†	(0.05)	(0.06)	(0.12)†
TFP Wood	-0.020	-0.104	**0.591**	0.059	-0.218	0.018	-0.149	-0.053
	(0.05)	(0.06)††	**(0.06)†**	(0.05)	(0.04)†	(0.03)	(0.04)†	(0.08)
TFP Paper	-0.168	-0.051	0.059	**0.334**	-0.353	-0.174	0.088	-0.515
	(0.06)†	(0.07)	(0.05)	**(0.04)†**	(0.05)†	(0.04)†	(0.05)††	(0.10)†
TFP Chemicals	-0.110	-0.211	-0.218	-0.353	**1.651**	-0.110	-0.373	-0.319
	(0.06)††	(0.06)†	(0.04)†	(0.05)†	**(0.09)†**	(0.03)†	(0.05)†	(0.12)†
TFP Nonmetals	-0.050	-0.039	0.018	-0.174	-0.110	**0.297**	0.134	-0.489
	(0.03)	(0.05)	(0.03)	(0.04)†	(0.03)†	**(0.06)†**	(0.03)†	(0.06)†
TFP Metals	-0.047	-0.062	-0.149	0.088	-0.373	0.134	**0.499**	-0.381
	(0.05)	(0.06)	(0.04)†	(0.05)††	(0.05)†	(0.03)†	**(0.07)†**	(0.09)†
TFP Machinery	-0.897	-0.905	-0.053	-0.515	-0.319	-0.489	-0.381	**2.384**
	(0.11)†	(0.12)†	(0.08)	(0.10)†	(0.12)†	(0.06)†	(0.09)†	**(0.19)†**
K(i) Food	**0.323**	-1.198	0.218	0.379	-2.149	-0.562	-0.084	-1.932
	(0.09)†	(0.22)†	(0.14)	(0.17)†	(0.36)†	(0.10)†	(0.20)	(0.72)†
K(i) Textile	-0.017	**0.728**	0.157	0.291	-0.094	0.088	-0.461	-0.040
	(0.13)	**(0.14)†**	(0.09)††	(0.11)†	(0.23)	(0.06)	(0.13)†	(0.45)
K(i) Wood	0.169	-0.142	**0.112**	0.207	0.272	-0.031	-0.053	-0.042
	(0.10)††	(0.10)	**(0.02)†**	(0.08)†	(0.17)	(0.05)	(0.09)	(0.34)
K(i) Paper	-1.248	-0.684	-0.326	**0.411**	-0.687	-0.284	-0.982	-1.534
	(0.15)†	(0.15)†	(0.10)†	**(0.08)†**	(0.25)†	(0.07)†	(0.14)†	(0.50)†
K(i) Chemicals	-0.015	0.067	-0.012	-0.046	**1.024**	0.204	0.193	0.913
	(0.10)	(0.10)	(0.06)	(0.08)	**(0.16)†**	(0.05)†	(0.09)†	(0.32)†
K(i) Nonmetals	-0.116	0.572	-0.215	-0.565	-0.033	**0.412**	0.671	-0.161
	(0.15)	(0.15)†	(0.09)†	(0.12)†	(0.25)	**(0.07)†**	(0.14)†	(0.49)
K(i) Metals	0.325	0.298	-0.040	0.116	0.382	0.150	**0.197**	0.412
	(0.07)†	(0.07)†	(0.04)	(0.06)†	(0.12)†	(0.03)†	**(0.06)†**	(0.23)††
K(i) Machinery	0.301	0.063	0.179	0.280	1.329	0.109	0.975	**5.461**
	(0.13)†	(0.13)	(0.08)†	(0.11)†	(0.22)†	(0.06)††	(0.12)†	**(0.44)†**

	Food	Textile	Wood	Paper	Chemicals	Nonmetals	Metals	Machinery
Low-ed. workers	0.302	0.086	0.134	-0.098	0.561	0.053	0.273	-0.309
	(0.08)†	(0.08)	(0.05)†	(0.06)	(0.13)†	(0.04)	(0.07)†	(0.27)
Mid-ed. workers	-0.343	-0.237	-0.187	-0.327	-0.185	-0.122	-0.477	-0.976
	(0.14)†	(0.14)††	(0.09)†	(0.11)†	(0.23)	(0.06)††	(0.13)†	(0.46)†
High-ed. workers	0.537	0.378	0.142	-0.109	0.779	0.103	0.145	1.747
	(0.12)†	(0.13)†	(0.08)††	(0.10)	(0.21)†	(0.06)††	(0.12)	(0.41)†
Arable land	0.536	-0.278	-0.243	-0.442	-0.128	-0.414	0.463	-1.444
	(0.29)††	(0.30)	(0.19)	(0.24)††	(0.49)	(0.14)†	(0.27)††	(0.99)

† means that the estimate is significant at 95% level
†† means that the estimate is significant at 90% level
Standard errors in parentheses

Table 16 - Summary of estimated own-TFP coefficients

Capital mobility:	Mobile			Immobile		
Capital utilization:	Constant	Variable	% change[1]	Constant	Variable	% change[1]
Food	1.78	1.24	35.87%	1.84	1.25	38.19%
Textile	0.42	0.34	21.52%	0.51	0.31	48.78%
Wood	0.72	0.61	16.56%	0.76	0.59	25.04%
Paper	0.39	0.28	33.84%	0.49	0.33	39.02%
Chemicals	2.04	1.68	18.96%	2.46	1.66	38.71%
Nonmetals	0.41	0.31	28.02%	0.44	0.30	37.84%
Metals	0.59	0.51	14.63%	0.68	0.50	29.73%
Machinery	3.48	2.41	36.33%	3.84	2.38	46.99%
Value-weighted average			**29.21%**			**41.19%**

[1]Percent change is measured as the change divided by the average of the end values

Tables 17-18 Explaining the difference of the Machinery industry shares in 1995 between Portugal and Germany, using the estimated model

Table 17 Using the model with variable capital utilization

	Relative factor stock(1)	Contrib. to share(2)	Share
Portugal			3.9
TFP	3.15	2.8	
Capital per worker	3.11	3.6	
Low-educated	-2.23	0.3	
Medium-educated	3.64	-0.1	
Highly educated	1.56	0.8	
Total TFP and factors			7.3
All other			2.5
Germany			13.7

Table 18 Using the model with constant capital utilization

	Relative factor stock(1)	Contrib. to share(2)	Share
Portugal			3.9
TFP	3.15	4.0	
Capital per worker	3.11	3.0	
Low-educated	-2.23	0.4	
Medium-educated	3.64	0.0	
Highly educated	1.56	0.7	
Total TFP and factors			8.1
All other differences			1.6
Germany			13.7

(1)Germany(95)/Portugal(95)

(2)Contribution of the relative factor stock to the difference of shares

Tables 19-21 Explaining the evolution of the Machinery and Textile industries' shares between 1975 and 1995 in Korea and Turkey, using the estimated model

Table 19 Industry shares, technology, and factors in Korea and Turkey

	Korea			Turkey			Relative
	1975	1995	Change(1)	1975	1995	Change(1)	accumulation rate(2)
Machinery share	4.5%	20.5%	15.9%	2.3%	4.4%	2.1%	
Machinery TFP	15	81	5.4	33	51	1.5	3.49
Textile share	6.1%	4.6%	4.6%	1.9%	3.7%	1.8%	
Textile TFP	21	65	3.1	37	48	1.3	2.35
Capital per worker	$4,557	$36,809	8.1	$7,630	$10,662	1.4	5.78
Low-educated	39.20	18.20	0.5	31.90	47.20	1.5	0.31
Medium-educated	28.70	51.90	1.8	7.30	15.70	2.2	0.84
Highly educated	6.90	21.10	3.1	1.80	6.50	3.6	0.85
Land per worker	0.15	0.08	0.5	1.44	0.88	0.6	0.87

Table 20 Machinery industry in Korea vs Turkey

	Relative accum. rate	Contrib. to share(3)	Share
1975 share difference			2.2
TFP	3.49	3.03	
Capital per worker	5.78	5.54	
Low-educated	0.31	0.46	
Medium-educated	0.84	0.02	
Highly educated	0.85	-0.28	
Land per worker	0.87	1.30	
Total due to accumulation			10.1
All other			3.8
1995 share difference			16.1

Table 21 Textile industry in Korea vs Turkey

	Relative accum. rate	Contrib. to share(3)	Share
1975 share difference			4.2
TFP	2.35	0.29	
Capital per worker	5.78	-2.21	
Low-educated	0.31	-0.19	
Medium-educated	0.84	-0.06	
Highly educated	0.85	-0.11	
Land per worker	0.87	0.23	
Total due to accumulation			-2.1
All other			-1.2
1995 share difference			0.9

(1) Change of TFP and factors is measured by 1+growth rate or the 1995 value divided by the 1975 value
Change of share is measured as share(1995)-share(1975)
(2) [Korea(95)/Korea(75)]/[Turkey(95)/Turkey(75)]
(3) Contribution of the relative accumulation rate of this factor to the difference of shares

Table B1 - Estimates

(Constant capital utilization and mobile capital, country fixed effects constrained to zero)

	Food	Textile	Wood	Paper	Chemicals	Nonmetals	Metals	Machinery
TFP Food	**-0.023**	-1.020	-0.183	-0.617	0.757	-0.631	-0.116	1.863
	(0.30)	(0.16)†	(0.08)†	(0.21)†	(0.13)†	(0.08)†	(0.13)	(0.30)†
TFP Textile	-1.020	**0.404**	-0.055	0.037	-0.240	-0.549	-0.057	-0.356
	(0.16)†	**(0.03)†**	(0.10)	(0.21)	(0.11)†	(0.11)†	(0.12)	(0.22)
TFP Wood	-0.183	-0.055	**0.571**	-0.602	-0.187	-0.005	0.131	0.163
	(0.08)†	(0.10)	**(0.08)†**	(0.11)†	(0.06)†	(0.07)	(0.06)†	(0.11)
TFP Paper	-0.617	0.037	-0.602	**0.326**	-0.464	0.230	-0.141	0.727
	(0.21)†	(0.21)	(0.11)†	**(0.01)†**	(0.14)†	(0.11)†	(0.14)	(0.28)†
TFP Chemicals	0.757	-0.240	-0.187	-0.464	**2.098**	0.018	-0.036	0.615
	(0.13)†	(0.11)†	(0.06)†	(0.14)†	**(0.12)†**	(0.06)	(0.08)	(0.18)†
TFP Nonmetals	-0.631	-0.549	-0.005	0.230	0.018	**0.306**	0.024	0.430
	(0.08)†	(0.11)†	(0.07)	(0.11)†	(0.06)	**(0.01)†**	(0.06)	(0.12)†
TFP Metals	-0.116	-0.057	0.131	-0.141	-0.036	0.024	**0.837**	-0.115
	(0.13)	(0.12)	(0.06)†	(0.14)	(0.08)	(0.06)	**(0.09)†**	(0.16)
TFP Machinery	1.863	-0.356	0.163	0.727	0.615	0.430	-0.115	**2.311**
	(0.30)†	(0.22)	(0.11)	(0.28)†	(0.18)†	(0.12)†	(0.16)	**(0.32)†**
Capital	-1.450	-1.951	0.046	0.027	-1.391	-0.550	-0.451	-2.065
	(0.17)†	(0.13)†	(0.06)	(0.15)	(0.14)†	(0.06)†	(0.09)†	(0.32)†
Low-ed. workers	1.494	0.084	0.288	0.339	0.401	0.238	-0.014	0.738
	(0.17)†	(0.13)	(0.06)†	(0.15)†	(0.15)†	(0.06)†	(0.09)	(0.36)†
Mid-ed. workers	2.445	0.901	0.219	0.223	1.267	0.447	0.370	3.240
	(0.20)†	(0.15)†	(0.07)†	(0.17)	(0.17)†	(0.07)†	(0.11)†	(0.42)†
High-ed. workers	0.606	0.270	0.230	0.800	0.077	-0.200	-0.247	-0.011
	(0.15)†	(0.11)†	(0.05)†	(0.13)†	(0.13)	(0.05)†	(0.08)†	(0.32)
Arable land	0.224	-0.212	0.086	0.017	-0.530	0.003	-0.136	-1.231
	(0.06)†	(0.05)†	(0.02)†	(0.06)	(0.06)†	(0.02)	(0.04)†	(0.14)†

† means that the estimate is significant at 95% level
†† means that the estimate is significant at 90% level
Standard errors in parentheses

Table B2 - Estimates

(Variable capital utilization and mobile capital, country fixed effects constrained to zero)

	Food	Textile	Wood	Paper	Chemicals	Nonmetals	Metals	Machinery
TFP Food	**-0.557**	-0.752	-0.222	-0.793	0.781	-0.549	0.538	1.908
	(0.30)††	(0.16)†	(0.09)†	(0.21)†	(0.13)†	(0.09)†	(0.13)†	(0.31)†
TFP Textile	-0.752	**0.318**	0.034	0.361	-0.273	-0.475	0.134	-0.790
	(0.16)†	**(0.02)†**	(0.10)	(0.20)††	(0.11)†	(0.11)†	(0.12)	(0.22)†
TFP Wood	-0.222	0.034	**0.377**	-0.781	-0.179	0.048	-0.011	0.505
	(0.09)†	(0.10)	**(0.08)†**	(0.11)†	(0.06)†	(0.07)	(0.06)	(0.12)†
TFP Paper	-0.793	0.361	-0.781	**0.233**	-0.318	0.090	-0.245	1.297
	(0.21)†	(0.20)††	(0.11)†	**(0.03)**	(0.15)†	(0.11)	(0.14)††	(0.28)†
TFP Chemicals	0.781	-0.273	-0.179	-0.318	**1.999**	-0.027	-0.192	0.516
	(0.13)†	(0.11)†	(0.06)†	(0.15)†	**(0.13)†**	(0.06)	(0.09)†	(0.19)†
TFP Nonmetals	-0.549	-0.475	0.048	0.090	-0.027	**0.257**	0.289	0.292
	(0.09)†	(0.11)†	(0.07)	(0.11)	(0.06)	**(0.02)†**	(0.07)†	(0.13)†
TFP Metals	0.538	0.134	-0.011	-0.245	-0.192	0.289	**0.618**	-0.594
	(0.13)†	(0.12)	(0.06)	(0.14)††	(0.09)†	(0.07)†	**(0.04)†**	(0.17)†
TFP Machinery	1.908	-0.790	0.505	1.297	0.516	0.292	-0.594	**2.011**
	(0.31)†	(0.22)†	(0.12)†	(0.28)†	(0.19)†	(0.13)†	(0.17)†	**(0.31)†**
Capital	-1.632	-1.870	0.062	0.021	-1.364	-0.593	-0.288	-1.987
	(0.18)†	(0.13)†	(0.07)	(0.16)	(0.14)†	(0.07)†	(0.09)†	(0.32)†
Low-ed. workers	1.570	0.083	0.299	0.354	0.415	0.295	-0.038	0.623
	(0.18)†	(0.13)	(0.07)†	(0.15)†	(0.15)†	(0.07)†	(0.09)	(0.36)††
Mid-ed. workers	2.532	0.857	0.219	0.283	1.242	0.454	0.205	3.151
	(0.21)†	(0.15)†	(0.08)†	(0.18)	(0.18)†	(0.08)†	(0.10)†	(0.42)†
High-ed. workers	0.589	0.248	0.249	0.818	0.142	-0.197	-0.193	0.044
	(0.16)†	(0.11)†	(0.06)†	(0.13)†	(0.13)	(0.06)†	(0.08)†	(0.31)
Arable land	0.215	-0.185	0.067	-0.028	-0.536	0.006	-0.158	-1.214
	(0.07)†	(0.05)†	(0.03)†	(0.06)	(0.06)†	(0.03)	(0.03)†	(0.14)†

† means that the estimate is significant at 95% level
†† means that the estimate is significant at 90% level
Standard errors in parentheses

Table B3 - Estimates

(Constant capital utilization and immobile capital, country fixed effects constrained to zero)

	Food	Textile	Wood	Paper	Chemicals	Nonmetals	Metals	Machinery
TFP Food	**1.516**	-0.224	-0.160	-0.166	0.163	-0.196	-0.225	0.733
	(0.14)†	(0.09)†	(0.07)†	(0.10)††	(0.08)†	(0.06)†	(0.07)†	(0.18)†
TFP Textile	-0.224	**0.431**	-0.439	0.037	-0.414	-0.008	-0.128	-0.588
	(0.09)†	**(0.03)†**	(0.08)†	(0.11)	(0.07)†	(0.08)	(0.06)†	(0.15)†
TFP Wood	-0.160	-0.439	**0.903**	-0.215	-0.344	0.122	0.154	0.000
	(0.07)†	(0.08)†	**(0.08)†**	(0.08)†	(0.05)†	(0.05)†	(0.05)†	(0.11)
TFP Paper	-0.166	0.037	-0.215	**0.628**	-0.279	0.063	0.003	-0.731
	(0.10)††	(0.11)	(0.08)†	**(0.07)†**	(0.08)†	(0.07)	(0.07)	(0.16)†
TFP Chemicals	0.163	-0.414	-0.344	-0.279	**2.482**	-0.128	0.041	-0.476
	(0.08)†	(0.07)†	(0.05)†	(0.08)†	**(0.09)†**	(0.05)†	(0.05)	(0.14)†
TFP Nonmetals	-0.196	-0.008	0.122	0.063	-0.128	**0.691**	-0.099	-0.279
	(0.06)†	(0.08)	(0.05)†	(0.07)	(0.05)†	**(0.07)†**	(0.04)†	(0.09)†
TFP Metals	-0.225	-0.128	0.154	0.003	0.041	-0.099	**0.647**	-0.271
	(0.07)†	(0.06)†	(0.05)†	(0.07)	(0.05)	(0.04)†	**(0.06)†**	(0.11)†
TFP Machinery	0.733	-0.588	0.000	-0.731	-0.476	-0.279	-0.271	**2.551**
	(0.18)†	(0.15)†	(0.11)	(0.16)†	(0.14)†	(0.09)†	(0.11)†	**(0.29)†**
K(i) Food	**1.939**	-0.869	-0.365	-0.659	-0.668	-0.258	-0.637	-1.669
	(0.18)†	(0.14)†	(0.09)†	(0.13)†	(0.18)†	(0.08)†	(0.10)†	(0.43)†
K(i) Textile	1.430	**1.856**	0.234	0.660	1.125	0.500	0.320	1.376
	(0.11)†	**(0.08)†**	(0.05)†	(0.08)†	(0.11)†	(0.05)†	(0.06)†	(0.26)†
K(i) Wood	-0.351	0.048	**0.099**	-0.515	-0.330	-0.041	0.017	-0.920
	(0.10)†	(0.08)	**(0.05)††**	(0.08)†	(0.11)†	(0.05)	(0.06)	(0.25)†
K(i) Paper	-0.436	-0.302	0.327	**1.623**	-0.459	-0.069	-0.200	-0.045
	(0.10)†	(0.07)†	(0.05)†	**(0.07)†**	(0.10)†	(0.04)	(0.05)†	(0.23)
K(i) Chemicals	-0.458	-0.261	-0.360	-0.355	**1.399**	-0.172	-0.070	-2.204
	(0.16)†	(0.13)†	(0.08)†	(0.12)†	**(0.17)†**	(0.07)†	(0.09)	(0.39)†
K(i) Nonmetals	-1.844	-0.527	-0.182	-1.074	-1.755	**0.119**	-0.453	-1.642
	(0.17)†	(0.13)†	(0.09)†	(0.13)†	(0.18)†	**(0.02)†**	(0.09)†	(0.41)†
K(i) Metals	-0.591	-0.091	-0.114	-0.276	-0.319	-0.209	**0.598**	-1.031
	(0.08)†	(0.06)	(0.04)†	(0.06)†	(0.08)†	(0.03)†	**(0.04)†**	(0.19)†
K(i) Machinery	-0.032	0.074	0.290	0.375	0.833	0.060	0.324	**6.178**
	(0.20)	(0.16)	(0.10)†	(0.15)†	(0.21)†	(0.09)	(0.11)†	**(0.48)†**

	Food	Textile	Wood	Paper	Chemicals	Nonmetals	Metals	Machinery
Low-ed. workers	0.511	-0.003	0.247	0.587	0.643	0.074	0.206	0.875
	(0.12)†	(0.09)	(0.06)†	(0.09)†	(0.12)†	(0.05)	(0.07)†	(0.29)†
Mid-ed. workers	1.017	0.386	0.072	0.548	1.291	0.159	0.292	1.597
	(0.15)†	(0.11)†	(0.07)	(0.11)†	(0.15)†	(0.07)†	(0.08)†	(0.35)†
High-ed. workers	0.099	0.585	0.124	0.157	0.039	-0.059	-0.057	0.485
	(0.11)	(0.09)†	(0.06)†	(0.08)††	(0.12)	(0.05)	(0.06)	(0.27)††
Arable land	0.045	-0.189	0.070	0.073	-0.054	-0.070	-0.032	-0.523
	(0.06)	(0.04)†	(0.03)†	(0.04)††	(0.06)	(0.03)†	(0.03)	(0.14)†

† means that the estimate is significant at 95% level
†† means that the estimate is significant at 90% level
Standard errors in parentheses

Table B4 - Estimates
(Variable capital utilization and immobile capital, country fixed effects constrained to zero)

	Food	Textile	Wood	Paper	Chemicals	Nonmetals	Metals	Machinery
TFP Food	**1.293**	-0.191	-0.003	-0.173	0.261	-0.056	-0.021	0.403
	(0.15)†	(0.10)†	(0.06)	(0.11)	(0.09)†	(0.06)	(0.07)	(0.19)†
TFP Textile	-0.191	**0.287**	-0.324	0.118	-0.318	-0.001	-0.018	-0.726
	(0.10)†	**(0.01)†**	(0.07)†	(0.11)	(0.08)†	(0.08)	(0.07)	(0.16)†
TFP Wood	-0.003	-0.324	**0.635**	-0.192	-0.363	0.020	0.043	0.292
	(0.06)	(0.07)†	**(0.06)†**	(0.07)†	(0.05)†	(0.05)	(0.05)	(0.10)†
TFP Paper	-0.173	0.118	-0.192	**0.394**	-0.128	0.100	-0.084	-0.648
	(0.11)	(0.11)	(0.07)†	**(0.02)†**	(0.08)	(0.08)	(0.08)	(0.17)†
TFP Chemicals	0.261	-0.318	-0.363	-0.128	**2.081**	-0.185	-0.187	-0.228
	(0.09)†	(0.08)†	(0.05)†	(0.08)	**(0.10)†**	(0.05)†	(0.06)†	(0.15)
TFP Nonmetals	-0.056	-0.001	0.020	0.100	-0.185	**0.417**	0.020	-0.312
	(0.06)	(0.08)	(0.05)	(0.08)	(0.05)†	**(0.02)†**	(0.05)	(0.10)†
TFP Metals	-0.021	-0.018	0.043	-0.084	-0.187	0.020	**0.519**	-0.136
	(0.07)	(0.07)	(0.05)	(0.08)	(0.06)†	(0.05)	**(0.06)†**	(0.11)
TFP Machinery	0.403	-0.726	0.292	-0.648	-0.228	-0.312	-0.136	**2.107**
	(0.19)†	(0.16)†	(0.10)†	(0.17)†	(0.15)	(0.10)†	(0.11)	**(0.28)†**
K(i) Food	**1.779**	-0.904	-0.270	-0.550	-0.449	-0.185	-0.669	-1.859
	(0.19)†	(0.14)†	(0.08)†	(0.13)†	(0.19)†	(0.08)†	(0.09)†	(0.44)†
K(i) Textile	1.486	**1.795**	0.242	0.662	1.239	0.514	0.261	1.406
	(0.11)†	**(0.09)†**	(0.05)†	(0.08)†	(0.12)†	(0.05)†	(0.06)†	(0.26)†
K(i) Wood	-0.367	0.094	**0.119**	-0.470	-0.405	-0.050	0.008	-0.934
	(0.11)†	(0.08)	**(0.05)†**	(0.08)†	(0.11)†	(0.05)	(0.05)	(0.25)†
K(i) Paper	-0.431	-0.322	0.316	**1.629**	-0.421	-0.067	-0.250	-0.009
	(0.10)†	(0.08)†	(0.04)†	**(0.07)†**	(0.10)†	(0.05)	(0.05)†	(0.24)
K(i) Chemicals	-0.263	-0.219	-0.353	-0.339	**0.980**	-0.172	-0.127	-1.934
	(0.17)	(0.13)††	(0.07)†	(0.12)†	**(0.17)†**	(0.08)†	(0.09)	(0.39)†
K(i) Nonmetals	-1.871	-0.417	-0.340	-1.087	-1.917	**0.094**	-0.544	-1.568
	(0.18)†	(0.14)†	(0.08)†	(0.13)†	(0.19)†	**(0.00)†**	(0.09)†	(0.42)†
K(i) Metals	-0.688	-0.102	-0.054	-0.227	-0.267	-0.205	**0.607**	-1.095
	(0.08)†	(0.06)	(0.03)	(0.06)†	(0.08)†	(0.04)†	**(0.04)†**	(0.19)†
K(i) Machinery	-0.039	0.011	0.275	0.214	1.089	0.063	0.568	**6.024**
	(0.21)	(0.16)	(0.09)†	(0.15)	(0.22)†	(0.09)	(0.11)†	**(0.49)†**

	Food	Textile	Wood	Paper	Chemicals	Nonmetals	Metals	Machinery
Low-ed. workers	0.518	-0.020	0.299	0.562	0.617	0.099	0.186	0.918
	(0.13)†	(0.10)	(0.05)†	(0.09)†	(0.13)†	(0.06)††	(0.06)†	(0.29)†
Mid-ed. workers	1.100	0.407	0.085	0.589	1.081	0.154	0.118	1.749
	(0.16)†	(0.12)†	(0.07)	(0.11)†	(0.16)†	(0.07)†	(0.08)	(0.36)†
High-ed. workers	0.087	0.589	0.094	0.117	0.055	-0.101	-0.008	0.522
	(0.12)	(0.09)†	(0.05)††	(0.09)	(0.12)	(0.05)††	(0.06)	(0.28)††
Arable land	0.083	-0.184	0.072	0.044	-0.077	-0.056	-0.039	-0.496
	(0.06)	(0.05)†	(0.02)†	(0.04)	(0.06)	(0.03)†	(0.03)	(0.14)†

† means that the estimate is significant at 95% level
†† means that the estimate is significant at 90% level
Standard errors in parentheses

Table B5 - Summary of estimated own-TFP coefficients

Capital mobility:	Mobile			Immobile		
Capital utilization:	Constant	Variable	% change[1]	Constant	Variable	% change[1]
Food	-0.02	-0.56	N/A	1.52	1.29	15.88%
Textile	0.40	0.32	23.82%	0.43	0.29	40.11%
Wood	0.57	0.38	40.93%	0.90	0.64	34.85%
Paper	0.33	0.23	33.27%	0.63	0.39	45.79%
Chemicals	2.10	2.00	4.83%	2.48	2.08	17.58%
Nonmetals	0.31	0.26	17.41%	0.69	0.42	49.46%
Metals	0.84	0.62	30.10%	0.65	0.52	21.96%
Machinery	2.31	2.01	13.88%	2.55	2.11	19.06%
Value-weighted average			**17.98%**			**29.80%**

[1]Percent change is measured as the change divided by the average of the end values