# Annex to "Sectoral Energy- and Labour-Productivity Convergence"[1]

**Peter Mulder and Henri L.F. de Groot**

This Annex contains:

(i) a description of the dataset that underlies the analysis in the paper (Section 1);
(ii) descriptive statistics per sector and per country characterizing the dataset (Section 2);
(iii) additional results of the σ-convergence analysis presented in the paper (Section 3);
(iv) additional regression results that for reasons of space constraints have not been included in the paper (Section 4).

## 1. Description of the database

This section describes the International Sectoral Database with Energy (ISDB-E); a newly constructed dataset used in the paper "Sectoral Energy- and Labour-Productivity Convergence" (by Peter Mulder and Henri L.F. de Groot). ISDB-E is a database including economic and energy data at a detailed sectoral level for 14 OECD countries covering the period 1960-1998. The database combines economic data from the International Sectoral Database (ISDB) and the Structural Analysis database (STAN), both published by the OECD, with energy data from the Energy Balances, published by the International Energy Agency (IEA). The main value added of this database is the combination of consistent international economic and energy data, including energy prices, at a detailed sector level. This provides an important basis for sectoral cross-country studies concerning energy economics in combination with other economic issues. The majority of the data is derived directly from the ISDB, STAN and IEA Databases. The Energy Price data and some other data series have been constructed as described in this document. The dataset can be downloaded as an EXCEL file at www.henridegroot.net/pdf/isdbe_dataset.xls.

Our description of the dataset covers an overview of the countries, sectors and variables included in the database (section 1.1) and a detailed definition of the variables (section 1.2). Appendix A and B contain additional details on the calculation of several data series.

### 1.1 Coverage of the database

The ISDB-E database includes economic and energy data for 14 OECD countries and 14 sectors for the period 1960-1998. It is to be noted, however, that not all variables are available for all countries and sectors over this full period. Energy consumption data and economic data are

[1] Published in *Environmental and Resource Economics*, vol. 36(1), pp. 85-112, 2007. The database underlying this paper and described in this Annex was constructed in the context of the NWO research program on Environmental Policy, Economic Reform and Endogenous Technology (1998-2003). The work has been mainly carried out at CPB Netherlands Bureau for Economic Policy Analysis. Their hospitality and support is gratefully acknowledged.

available for most countries and sectors for the period 1970-1997. Energy price data have been constructed for the period 1978-1996. The remainder of this subsection contains a brief overview of the coverage of the database

### 1.1.1 Countries

The database includes information for the OECD countries listed in Table 1.1.

**Table 1.1 Country Classification**

| | Country | Abbreviation |
|---|---|---|
| 1 | Australia | AUS |
| 2 | Belgium | BEL |
| 3 | Canada | CAN |
| 4 | Denmark | DNK |
| 5 | Finland | FIN |
| 6 | France | FRA |
| 7 | West Germany[a] | WGR |
| 8 | Italy | ITA |
| 9 | Japan | JPN |
| 10 | Netherlands | NLD |
| 11 | Norway | NOR |
| 12 | Sweden | SWE |
| 13 | United Kingdom | GBR |
| 14 | United States | USA |

[a] Germany United (DEU) is also included, but only a very limited number of economic data series are available.

### 1.1.2 Sectors

As noted before, the main value added of this database is its combination of economic and energy data at a detailed sectoral level. Because the level of sectoral detail is larger in the ISDB database than in the Energy Balances, the sectoral classification of the Energy Balances has been taken as a point of departure to establish a link with the economic data. The Energy Balances are based on the ISIC Rev. 3 classification while the ISDB is based on the ISIC Rev. 2 classification. Using the classification correspondence tables provided by the UN,[2] the sector classification of the Energy Balances has been converted to ISIC Rev. 2 codes and subsequently this classification was matched with the ISDB classification. As a result, the database includes information for the sectors listed in Table 1.2.

[2] See http://esa.un.org/unsd/cr/registry/regct.asp.

**Table 1.2 Sector Classification**

| | Sector | Abbreviation | ISIC Rev. 2 code | Source Economic Data |
|---|---|---|---|---|
| 1 | Food and Tobacco | FOD | 31 | ISDB |
| 2 | Textiles and Leather | TEX | 32 | ISDB |
| 3 | Wood and Wood Products | WOD | 331[a] | STAN |
| 4 | Paper, Pulp and Printing | PAP | 34 | ISDB |
| 5 | Chemicals | CHE | 351+35[b] | STAN |
| 6 | Non-Metallic Minerals | NMM | 36 | ISDB |
| 7 | Iron and Steel | IAS | 371 | STAN |
| 8 | Non-Ferrous Metals | NFM | 372 | STAN |
| 9 | Machinery | MAC | 381+382+383[c] | ISDB |
| 10 | Transport Equipment | MTR | 384 | ISDB |
| 11 | Construction | CST | 50 | ISDB |
| 12 | Services | SRV | 61+62+63+72+81+82+83+90[d] | ISDB |
| 13 | Transport | TAS | 71[e] | ISDB |
| 14 | Agriculture | AGR | 10 | ISDB |

Notes:
[a] WOD excludes furniture since the sector WOD in the IEA Energy Balances excludes furniture.
[b] CHE includes non-energetic energy consumption, i.e. using energy carriers as feedstock.
[c] MAC = Metal Products (BMA, 381) + Agricultural and Industrial Machinery (MAI, 382) + Electrical Goods (MEL, 383).
[d] SRV = Wholesale and retail trade, restaurants and hotels (RET) + Communication (COM) + Finance, insurance, real estate and business services (FNI) + Community, social and personal services (SOC).
[e] The Total Transport Sector in the IEA Energy Balances is sum of International Civil Aviation, Domestic Air Transport, Road, Rail, Pipeline, Transport, Internal Navigation and Non-Specified Transport.

For the sectors WOD, CHE, IAS and NFM the energy data could not be linked to the corresponding sectors in the ISDB classification. However, a link could be made to these sectors in the STAN classification. Hence, for these four sectors the economic variables included in our database are taken from the STAN database instead of the ISDB database. It is to be noted that the STAN database includes only a limited number of variables as compared to the ISDB.

### 1.1.3 Variables

The database includes the variables listed in Table 1.3. As noted in the previous section, for the sectors WOD, CHE, IAS and NFM the economic variables are taken from the STAN database instead of the ISDB database. The STAN database includes the following variables only: Production, Value Added, Gross Fixed Capital Formation, Number of labourers engaged, Labour Compensation, Export and Import. Combining these data series with ISDB conversion rates, the following data series have been constructed for the above-mentioned sectors: Total employment (ET), Gross value added (GDP, GDPV, GDPD), Gross fixed capital formation at current prices (IT), Compensation of employees (WSSSE), export of goods in US$ (XGS) and import of goods in US$ (MGS).

**Table 1.3 Variables**

| | Variables | Abbreviation |
|---|---|---|
| 1 | Number of employees | EE |
| 2 | Total employment | ET |
| 3 | Average annual hours actually worked | HRS |
| 4a | Gross value added, current prices | GDP |
| 4b | Gross value added, 1990 prices | GDPV |
| 4c | Gross value added, 1990 prices, US$ | GDPD |
| 5a | Gross fixed capital formation, current prices | IT |
| 5b | Gross fixed capital formation, 1990 prices | ITV |
| 5c | Gross fixed capital formation, 1990 prices US$ | ITD |
| 6a | Gross capital stock, current prices | KTO |
| 6b | Gross capital stock, 1990 prices | KTV |
| 6c | Gross capital stock, 1990 prices, US$ | KTVD |
| 6d | Gross capital stock, same as KTVD incl. OECD estimate | CAP |
| 7 | Machinery & equipment / KTVO | RKMV |
| 8a | Net capital stock, current prices | NTO |
| 8b | Net capital stock, 1990 prices | NTVO |
| 8c | Net capital stock, 1990 prices, US$ | NTVD |
| 9a | Consumption of fixed capital, current prices | CTO |
| 9b | Consumption of fixed capital, 1990 prices | CTVO |
| 9c | Consumption of fixed capital, 1990 prices, US$ | CTVD |
| 10 | Net indirect taxes / GDP | IND |
| 11 | Gross operating surplus / GDP at FC | OP |
| 12 | Compensation of employees | WSSS |
| 13 | Export of goods in US dollars | XGS |
| 14 | Import of goods in US dollars | MGS |
| 15 | Total factor productivity (1990=1) | TFP |
| 16 | Energy Consumption in ktoe | EQ |
| 17a | Energy Price per ktoe, current prices, US$ | EPCU |
| 17b | Energy Price per ktoe, 1990 prices, US$ | EPCO |

Finally, all currency denominated variables (GDP, IT, KT, NT, CT and EP) have been converted to constant 1990 US$, using 1990 expenditure purchasing power parities (PPP) as given by the OECD (1999). They are presented in Table 1.4.

**Table 1.4 OECD Exchange rates and Purchasing Power Parities, 1990**

| | Country | Exchange Rates | PPP (GDP) |
|---|---|---|---|
| 1 | Australia | 1.281 | 1.387 |
| 2 | Belgium | 33.418 | 39.450 |
| 3 | Canada | 1.167 | 1.303 |
| 4 | Denmark | 6.189 | 9.393 |
| 5 | Finland | 3.824 | 6.384 |
| 6 | France | 5.445 | 6.614 |
| 7 | Germany West | 1.616 | 2.088 |
| 8 | Italy | 1198.100 | 1421.000 |
| 9 | Japan | 144.790 | 195.300 |
| 10 | Netherlands | 1.821 | 2.165 |
| 11 | Norway | 6.260 | 9.731 |
| 12 | Sweden | 5.919 | 9.336 |
| 13 | United Kingdom | 0.563 | 0.602 |
| 14 | United States | 1.000 | 1.000 |

Source: OECD 1999.

### 1.2 Variable Definitions

This sub-section contains a definition of all the variables included in the ISDB-E database. Note that only a selection of these variables is used in paper "Sectoral Energy- and Labour-Productivity". The description of the variables (1) to (15) is taken from the description of the ISDB as provided by the OECD (1999), *ISDB 98 International Sectoral Database. User Guide* (Paris: OECD). For further details on these variables we refer to this OECD document. The variables Final Energy Consumption (16) and Energy Price (17) are added to the ISDB data. In addition we describe the variables (18-23) that have been calculated for the paper "Sectoral Energy- and Labour-Productivity Convergence", using a selection of other variables in the ISDB-E database.

**1. Number of employees (EE)**

Number of employees measured in full time equivalents.

**2. Total employment (ET)**

Total employment measured in full-time equivalent number of persons. Including self-employed.

**3. Average annual hours actually worked (HRS)**

Average annual hours actually worked per person in employment. It is to be noted that these data are not sector-specific, but country-specific only.

**4. Gross value added (GDP), (GDPV), (GDPD)**

The value added of producers comprises compensation to employees, operating surplus, the consumption of fixed capital and the excess of indirect taxes over subsidies.

**5. Gross fixed capital formation (IT), (ITV), (ITD)**

Gross fixed capital formation consists of the outlays of industries and the producers of government services and of non-profit services to households, on additions of commodities to their fixed assets, reduced by their net sales (sales less purchases) of similar second-hand and scrapped goods. The commodities in question may be purchased or produced on own account. The commodities which enter into fixed capital formation are new items which are produced domestically and new and second-hand goods which are imported.

**6. Gross capital stock (KTO), (KTV), (KTVD), (CAP)**

In the ISDB, gross capital stock data are used as measures of capital input in the production process, representing the total volume of the existing physical capital assets available in the respective countries and industries. Gross capital stocks are not, however, generally available at the detailed industrial level for many of the countries. When official fixed capital stock data are available and when these data are consistent with the gross fixed capital formation in the database, they are stored in ISDB (code: *KTVO*). But where official data are missing, estimates have been made using a perpetual inventory model similar to that used by national administrations (resulting series are stored with code: *CAP*). We now briefly describe the basic procedures involved.

The perpetual inventory method simulates the process of capital accumulation, using data for past capital formation expenditures adjusted for scrapping, according to the following relationship: $GCS = \sum INV_j * g_j$ , where $GCS$ is gross capital stock at constant prices, $INV$ is gross fixed capital formation at constant prices, $g$ is the survival coefficient and $j$ is vintage of investment.

The survival coefficient, $g$, represents the amount of capital formation of a given vintage still installed at a given point in time. The capital stock estimate is thus related to capital which is believed to be available, but not necessarily utilised. The survival coefficient lies between 1 and 0 and is commonly assumed to be a decreasing function of time. The exact values are usually defined in terms of certain "survival" or "mortality" functions, which, in practise, vary widely between different national statistical offices.

A major difficulty in estimating capital stocks, whether at an aggregate or sectoral level, is the lack of sufficiently long capital expenditure time series and adequate historical benchmarks. In this database, specific procedures were adopted using a combination of the available time-series information and 'reasonable' assumptions concerning the capital-output ratio, the scrapping rate and the intersectoral distribution of capital. Essentially, these procedures involved the estimation of capital-stock benchmarks and corresponding investment data for the period 1967 to 1973. The resulting historical time-series estimates for investment by sector were then combined with actual data for the period 1970 to 1995 and passed through a capital stock estimation procedure described in detail in OECD (1999).

**7. Machinery & equipment / KTVO (RKMV)**

Ratio of machinery and equipment over total capital stock, at 1990 prices

**8. Net capital stock (NTO), (NTVO), (NTVD)**

Net Capital Stock is the value of the capital stock, corrected for depreciation of used assets.[3]

**9. Consumption of fixed capital (CTO), (CTVO), (CTVD)**

Consumption of fixed capital may be defined in general terms as that part of the gross product which is required to replace fixed capital used up in the in the process of production during the period of account. This flow is based on the concept of the expected economic lifetime of the individual assets; and is designed to cover the loss in value due to foreseen obsolescence and the normal amount of accidental damage, which is not made good by repair, as well as normal wear and tear. Unforeseen obsolescence is treated as a capital loss at the time at which it actually occurs, rather than as fixed capital consumption. Charges for the depletion of exhaustible natural resources are not included in the consumption of fixed capital.

**10. Net indirect taxes / GDP (IND)**

Net indirect taxes are defined as indirect taxes less subsidies.

[3] Source: The New OECD STAN database for Industrial Analysis.

*Indirect taxes*

Indirect taxes are taxes assessed on producers in respect of the production, sale, purchase or use of goods and services, which they charge to the expenses of production. Common examples of indirect taxes are import, export and excise duties, sales taxes, entertainment duties, betting taxes, business licences and transaction (e.g., stamp) duties, and real estate taxes.

*Subsidies Private industries*

Subsidies include all grants on current account that private industries receive from government. These are transfers that, in view of the basis on which they are made, represent additions to the income of the producers from current production.

*Subsidies Public enterprises*

Subsidies also include all grants on current account that government makes to public corporations, for example, in compensation for operating losses (negative operating surplus).

**11. Gross operating surplus / GDP at FC (OP)**

Ratio of gross operating surplus to value added less net indirect taxes. Gross operating surplus is defined as the sum of operating surplus and consumption of fixed capital.

*Operating surplus*

The operating surplus during a period of account is the excess of the value added by residential producers during the period, over the sum of the costs of employee compensation, consumption of fixed capital and indirect taxes reduced by subsidies, which they incur during the period. Operating surplus can, by definition, be earned by industries only. The gross output of the producers of government services and private non-profit services to household is defined as equivalent to their explicit costs of production.

*Consumption of fixed capital*

Consumption of fixed capital may be defined in general terms as that part of the gross product which is required to replace fixed capital used up in the in the process of production during the period of account. See above.

**12. Compensation of employees (WSSS)**

The compensation of employees comprises all payments by producers of wages and salaries to their employees, in kind as well as in cash, and of contributions in respect of their employees to social security and to private pension, casualty insurance, life insurance and similar schemes. Employees cover all persons engaged in the activity of incorporated units and in the production of government services and private non-profit services. Members of the armed forces, irrespective of the duration and type of their service, are classed as employees. Also included among employees are all persons engaged in the activities of unincorporated businesses, except the proprietors and the unpaid family members of the proprietors.

**13. Export of goods in US dollars (XGS)**
Export of goods in US$.

**14. Import of goods in US dollars (MGS)**
Import of goods in US$.

**15. Total factor productivity (1990=1) (TFP)**
Total factor productivity growth is calculated by the OECD as the difference between output growth and the weighted growth of factor inputs (viz. capital and labour inputs). A common assumption is to use the respective factor shares in total costs as individual factor weights, following a Cobb-Douglas type production function framework.

The lack of data relating to hours worked, both for labour and capital, represents an important limitation to the existing TFP measures, particularly at an industrial level. Hours-worked data are not always ideal, since they often relate to hours paid for rather than hours *actually* worked. The latter might be lower during periods of labour hoarding than in periods of labour scarcity, even with identical numbers of hours worked recorded. For capital, too, working hours may differ from those reported for labour, for example as the result of multiple shift work which in many countries has tended to increase the length of the "work week" of fixed capital over the period. In any event, the relevant data are not available at the industry level used in this database.

Although it is fairly common practise to use calculated factor shares to aggregate labour and capital as a composite measure of inputs into the production process, preliminary inspection of the data sources suggests that the automatic use of the available data for different variables and different sectors may be hazardous. Indeed, in a number of cases important differences in factor shares, both between sectors and countries, seem more likely to reflect differences in the coverage of individual categories of data than actual differences in factor shares. To assess the extent of this kind of problem, factor shares have been calculated by the OECD, by country and industry on the following basis: $SW = COMP * \frac{ET}{EE} / VA$, where $SW$ is the share of labour in value added, $ET$ is total employment, $EE$ is total employees, $COMP$ is compensation of employees and $VA$ is value added, at current prices.

In these calculations, total compensation is re-scaled by the ratio of total employment to total employees in order to include also self-employed in the weighting scheme. In effect, the self-employed are assumed to be paid same average rate of compensation as employees and the same marginal rate of productivity is assumed for dependent and independent workers.[4]
Analysis of these data across countries shows some important outliners, with the most notable differences occurring in the calculated labour shares for agriculture, mining, social services, basic metals and residual manufacturing.

Nonetheless, there is a striking tendency, with the majority of sectors in the majority of countries showing labours shares very close to 70 per cent. The main systematic sectoral differences across countries are for government services with a labour share of 94 per cent and for

[4] In a number of cases, notably in sectors where unpaid family workers are included in the category of independent workers adjustment can introduce a distortion such that the calculated labour weights exceeds 100 per cent. In such cases, the labour weights were set to the sample mean values.

“Electricity, gas and water”, “mining and quarrying” and “Real estate”, with labour shares slightly below one-third.

The main reason for the high labour share in the government sector is the omission of imputed rents for its capital stock in the national account system. The OECD has not tried here to estimate weights for the two production factors and therefore the government TFP has not been calculated. It also might be questioned whether the calculation of TFP for agricultural industry is relevant since e.g. land is not included in the capital stock.

Given these results, the OECD adopted a standardised weighting method across countries. In effect, the calculations were simplified by setting the weight attached to labour inputs to 70 percent for all sectors and countries, with the exception of “Electricity, gas and water, “mining”, “finance, insurance, real estate and business services” and “real estate”, where a labour weight of 33 per cent was used. Given these weights, total factor productivity indices were calculated by the OECD using the formula $TFP = \left[ \frac{VA}{ET^{w} * GCS^{(1-w)}} \right] / TFP_0$ , where *TFP* is Total factor productivity index, *GCS* is Gross capital stock, *VA* is Gross value added, *w* is Standardised labour share weights and $TFP_0$ is Total factor productivity 1990 value.

**16. Final Energy Consumption (EQ)**

Total Final Energy Consumption in kilo tonnes of oil equivalent (Ktoe), a common unit to express total energy consumption from different energy carriers. Ktoe is calculated by converting the different units for the different energy carriers (such as GWh, GJ and Gcal) to one common unit, using standard conversion factors (see www.iea.org/statist/calcul.htm).

**17. Energy Price per ktoe (EPCU), (EPCO)**

Sector-specific constant (1990) energy prices in US$/ktoe. These data have been constructed as follows. First, the energy price data of four energy carriers for the aggregate industrial sector are taken from the series Energy Prices and Taxes, published by the IEA. The four energy carriers are Electricity, Natural Gas, Heavy Fuel Oil and Steam Coal. Second, for each country the sectoral energy consumption of each of these energy carriers is taken from the IEA Energy Balances. Third, the sectoral energy consumption figures of each energy carrier are multiplied with the aggregate industrial energy price (in US$) of that specific carrier to get the energy-carrier specific expenditure per sector. Fourth, these expenditures are added up to get the total weighted expenditure, which is subsequently divided by the total final energy consumption in each sector to arrive at current energy prices. Finally, the obtained current energy prices are converted to 1990 constant prices using conversion rates as given in the ISDB database. Some aggregate energy-price data series were not directly available from the IEA Energy Prices and Taxes series and therefore have been constructed (see Appendix A).

**18. Energy Productivity (ENPROD)**

Gross value added per unit of final energy consumption: GDPD/EQ.

**19. Labour Productivity (ETPROD)**

Gross value added per worker (in full time equivalents): GDPD/ET.

**20. Investment share (ITSHARE)**

Investment (gross fixed capital formation) as share of value added: IT/GDPD.

**21. Openness (OPEN)**

The sum of export and import as share of value added: (XGS + MGS)/GDPD.

**22. Balassa index (BALASSA)**

Measure of relative export performance by country and industry, defined as a country's share of total exports of a sector divided by its share of total exports. The index for sector *i* is

$$\left( XGS_i \middle/ \sum_{i=1}^{14} XGS_i \right) \middle/ \left( \sum_{s=1}^{10} XGS_{i,s} \middle/ \sum_{i=1}^{14} \sum_{s=1}^{10} XGS_{i,s} \right).$$

**23. Economies of Scale (GDPDSHARE)**

Measure of relative size of sector, defined as a country’s value added of a sector divided by the value added of all its sectors.

## 2. Descriptive statistics.

Tables 2.1 and 2.2 contains descriptive statistics (per sector and per country) of the dataset used in the paper.

**Table 2.1 Descriptive Statistics per sector**

| | Growth $Y/E$ | Growth $Y/L$ | Log($Y/E$) | Log($Y/L$) | Log($Y$) | Wage | Energy Price | $I/Y$ | Openness | Balassa | $Y_i/Y$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | | | | | | | | | | | |
| Mean | 0.01 | 0.02 | 1.50 | 10.39 | 26.22 | | | | | | 1.00 |
| Minimum | –0.11 | –0.04 | 0.66 | 9.65 | 23.96 | | | | | | 1.00 |
| Maximum | 0.16 | 0.10 | 2.14 | 10.91 | 29.31 | | | | | | 1.00 |
| Std. Dev. | 0.03 | 0.02 | 0.34 | 0.26 | 1.39 | | | | | | 0.00 |
| # Observations | 286 | 325 | 300 | 339 | 355 | | | | | | 355 |
| # Countries | 14 | 14 | 14 | 14 | 14 | | | | | | 14 |
| **Manufacturing** | | | | | | | | | | | |
| Mean | 0.02 | 0.03 | 0.99 | 10.35 | 24.97 | | | | | | 0.30 |
| Minimum | –0.12 | –0.07 | –0.85 | 9.70 | 22.78 | | | | | | 0.16 |
| Maximum | 1.34 | 0.13 | 1.89 | 11.24 | 27.98 | | | | | | 0.50 |
| Std. Dev. | 0.09 | 0.03 | 0.52 | 0.31 | 1.41 | | | | | | 0.06 |
| # Observations | 314 | 371 | 328 | 385 | 386 | | | | | | 355 |
| # Countries | 14 | 14 | 14 | 14 | 14 | | | | | | 14 |
| **Agriculture** | | | | | | | | | | | |
| Mean | –0.01 | 0.04 | 15.66 | 9.70 | 23.04 | 1.22 | 0.23 | 0.25 | | | 0.05 |
| Minimum | –1.37 | –0.26 | 14.20 | 8.44 | 21.24 | 0.43 | 0.08 | 0.08 | | | 0.02 |
| Maximum | 0.43 | 0.38 | 18.45 | 10.74 | 25.58 | 3.39 | 0.45 | 0.52 | | | 0.17 |
| Std. Dev. | 0.17 | 0.08 | 0.52 | 0.46 | 1.14 | 0.46 | 0.08 | 0.07 | | | 0.02 |
| # Observations | 329 | 355 | 344 | 370 | 382 | 359 | 279 | 349 | | | 355 |
| # Countries | 15 | 15 | 15 | 15 | 15 | 14 | 15 | 14 | | | 14 |
| **Services** | | | | | | | | | | | |
| Mean | 0.01 | 0.01 | 16.80 | 10.54 | 25.71 | 2.08 | 0.47 | 0.29 | | | 0.59 |
| Minimum | –0.29 | –0.02 | 15.51 | 9.88 | 23.08 | 0.77 | 0.19 | 0.14 | | | 0.42 |
| Maximum | 0.53 | 0.08 | 18.06 | 10.91 | 28.93 | 2.88 | 1.22 | 0.52 | | | 0.74 |
| Std. Dev. | 0.08 | 0.02 | 0.60 | 0.22 | 1.46 | 0.56 | 0.23 | 0.08 | | | 0.08 |
| # Observations | 204 | 176 | 214 | 184 | 245 | 166 | 279 | 155 | | | 245 |
| # Countries | 10 | 8 | 10 | 8 | 10 | 8 | 15 | 6 | | | 10 |
| **Transport** | | | | | | | | | | | |
| Mean | 0.00 | 0.02 | 13.54 | 10.41 | 23.47 | 2.45 | 0.22 | 0.29 | | | 0.06 |
| Minimum | –0.23 | –0.18 | 12.56 | 9.39 | 21.52 | 1.04 | 0.09 | 0.13 | | | 0.04 |
| Maximum | 0.22 | 0.18 | 14.41 | 11.13 | 26.13 | 4.01 | 0.92 | 0.54 | | | 0.12 |
| Std. Dev. | 0.05 | 0.04 | 0.43 | 0.32 | 1.14 | 0.65 | 0.11 | 0.08 | | | 0.02 |
| # Observations | 285 | 251 | 297 | 262 | 300 | 249 | 279 | 239 | | | 300 |
| # Countries | 12 | 11 | 12 | 11 | 12 | 11 | 15 | 10 | | | 12 |

**Table 2.1 Continued**

| | Growth $Y/E$ | Growth $Y/L$ | Log($Y/E$) | Log($Y/L$) | Log($Y$) | Wage | Energy Price | $I/Y$ | Openness | Balassa | $Y_i/Y$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Chemicals** | | | | | | | | | | | |
| Mean | 0.03 | 0.04 | 13.65 | 10.73 | 22.52 | 3.09 | 0.29 | 0.24 | 2.45 | 0.94 | 0.03 |
| Minimum | –0.29 | –0.29 | 12.26 | 9.17 | 19.57 | 0.64 | 0.12 | 0.11 | 0.10 | 0.29 | 0.01 |
| Maximum | 0.48 | 0.27 | 15.68 | 11.75 | 25.60 | 5.56 | 0.56 | 0.94 | 9.58 | 1.91 | 0.04 |
| Std. Dev. | 0.10 | 0.07 | 0.65 | 0.45 | 1.55 | 1.08 | 0.08 | 0.12 | 1.82 | 0.37 | 0.01 |
| # Observations | 334 | 330 | 347 | 343 | 364 | 176 | 279 | 298 | 345 | 351 | 332 |
| # Countries | 13 | 13 | 13 | 13 | 13 | 9 | 15 | 12 | 13 | 13 | 13 |
| **Food** | | | | | | | | | | | |
| Mean | 0.01 | 0.02 | 15.66 | 10.53 | 23.04 | 2.22 | 0.37 | 0.15 | 1.15 | 1.28 | 0.04 |
| Minimum | –0.24 | –0.16 | 14.55 | 9.56 | 20.99 | 1.01 | 0.20 | 0.08 | 0.04 | 0.06 | 0.02 |
| Maximum | 0.47 | 0.17 | 16.69 | 11.20 | 25.54 | 3.60 | 0.99 | 0.30 | 5.48 | 5.10 | 0.06 |
| Std. Dev. | 0.08 | 0.04 | 0.50 | 0.30 | 1.34 | 0.60 | 0.13 | 0.05 | 1.16 | 1.14 | 0.01 |
| # Observations | 314 | 324 | 328 | 337 | 364 | 332 | 270 | 310 | 351 | 351 | 332 |
| # Countries | 13 | 13 | 13 | 13 | 13 | 13 | 15 | 12 | 13 | 13 | 13 |
| **Iron and Steel** | | | | | | | | | | | |
| Mean | 0.02 | 0.03 | 13.49 | 10.39 | 21.65 | 3.57 | 0.29 | 0.24 | 3.01 | 0.98 | 0.01 |
| Minimum | –0.40 | –0.42 | 11.99 | 9.18 | 17.96 | 1.35 | 0.12 | 0.00 | 0.09 | 0.14 | 0.00 |
| Maximum | 0.47 | 0.33 | 14.79 | 11.46 | 24.51 | 6.98 | 0.75 | 1.54 | 16.71 | 3.02 | 0.04 |
| Std. Dev. | 0.10 | 0.10 | 0.56 | 0.49 | 1.77 | 1.20 | 0.12 | 0.17 | 3.34 | 0.58 | 0.01 |
| # Observations | 340 | 330 | 353 | 343 | 364 | 109 | 279 | 322 | 351 | 351 | 332 |
| # Countries | 13 | 13 | 13 | 13 | 13 | 6 | 15 | 13 | 13 | 13 | 13 |
| **Machinery** | | | | | | | | | | | |
| Mean | 0.02 | 0.04 | 16.62 | 10.26 | 23.63 | 2.22 | 0.41 | 0.11 | 1.87 | 0.88 | 0.08 |
| Minimum | –0.68 | –0.12 | 15.64 | 8.98 | 20.95 | 0.15 | 0.18 | 0.05 | 0.17 | 0.38 | 0.04 |
| Maximum | 0.68 | 0.19 | 17.99 | 11.19 | 27.01 | 4.84 | 1.36 | 0.20 | 8.24 | 1.61 | 0.17 |
| Std. Dev. | 0.13 | 0.05 | 0.50 | 0.36 | 1.49 | 0.94 | 0.19 | 0.03 | 1.51 | 0.28 | 0.03 |
| # Observations | 294 | 302 | 308 | 315 | 362 | 261 | 270 | 305 | 350 | 351 | 332 |
| # Countries | 13 | 13 | 13 | 13 | 13 | 11 | 15 | 12 | 13 | 13 | 13 |
| **Transport Equipment** | | | | | | | | | | | |
| Mean | –0.01 | 0.02 | 16.72 | 10.44 | 22.63 | 2.80 | 0.47 | 0.15 | 3.19 | 0.87 | 0.03 |
| Minimum | –0.93 | –0.27 | 15.72 | 9.78 | 19.90 | 1.38 | 0.09 | 0.05 | 0.19 | 0.22 | 0.01 |
| Maximum | 0.54 | 0.25 | 17.89 | 11.05 | 25.57 | 4.83 | 1.88 | 0.40 | 16.27 | 1.85 | 0.06 |
| Std. Dev. | 0.16 | 0.08 | 0.48 | 0.27 | 1.58 | 0.83 | 0.33 | 0.05 | 2.85 | 0.38 | 0.01 |
| # Observations | 324 | 229 | 338 | 240 | 364 | 227 | 270 | 222 | 351 | 351 | 332 |
| # Countries | 13 | 11 | 13 | 11 | 13 | 10 | 15 | 9 | 13 | 13 | 13 |

**Table 2.1 Continued**

| | Growth $Y/E$ | Growth $Y/L$ | Log($Y/E$) | Log($Y/L$) | Log($Y$) | Wage | Energy Price | $I/Y$ | Openness | Balassa | $Y_i/Y$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Non-Ferrous Metals** | | | | | | | | | | | |
| Mean | 0.01 | 0.04 | 14.03 | 10.52 | 20.82 | 2.30 | 0.50 | 0.22 | 4.04 | 1.36 | 0.01 |
| Minimum | –0.49 | –0.43 | 12.50 | 8.93 | 16.87 | 0.40 | 0.13 | 0.06 | 0.16 | 0.11 | 0.00 |
| Maximum | 0.38 | 0.36 | 15.17 | 11.58 | 23.66 | 5.12 | 1.08 | 1.04 | 20.18 | 8.68 | 0.01 |
| Std. Dev. | 0.12 | 0.10 | 0.61 | 0.53 | 1.65 | 1.15 | 0.19 | 0.14 | 3.83 | 1.55 | 0.00 |
| # Observations | 309 | 330 | 321 | 343 | 364 | 109 | 272 | 322 | 351 | 351 | 332 |
| # Countries | 12 | 13 | 12 | 13 | 13 | 6 | 15 | 13 | 13 | 13 | 13 |
| **Non-Metallic Minerals** | | | | | | | | | | | |
| Mean | 0.01 | 0.03 | 14.23 | 10.43 | 21.86 | 2.38 | 0.22 | 0.18 | 0.74 | 0.91 | 0.01 |
| Minimum | –0.73 | –0.47 | 13.18 | 9.74 | 19.40 | 1.09 | 0.08 | 0.07 | 0.03 | 0.18 | 0.01 |
| Maximum | 0.62 | 0.25 | 15.25 | 11.11 | 24.11 | 3.91 | 0.42 | 0.37 | 3.18 | 4.04 | 0.03 |
| Std. Dev. | 0.11 | 0.07 | 0.34 | 0.28 | 1.39 | 0.61 | 0.07 | 0.06 | 0.65 | 0.66 | 0.01 |
| # Observations | 327 | 303 | 340 | 315 | 364 | 332 | 279 | 282 | 351 | 351 | 332 |
| # Countries | 13 | 12 | 13 | 12 | 13 | 13 | 15 | 11 | 13 | 13 | 13 |
| **Paper** | | | | | | | | | | | |
| Mean | 0.00 | 0.02 | 15.11 | 10.52 | 22.73 | 2.41 | 0.44 | 0.17 | 0.89 | 1.67 | 0.03 |
| Minimum | –0.63 | –0.16 | 13.35 | 9.82 | 20.98 | 0.53 | 0.22 | 0.07 | 0.02 | 0.11 | 0.01 |
| Maximum | 0.44 | 0.32 | 16.51 | 11.73 | 25.53 | 4.09 | 1.15 | 0.49 | 4.18 | 8.59 | 0.08 |
| Std. Dev. | 0.10 | 0.05 | 0.89 | 0.38 | 1.26 | 0.80 | 0.16 | 0.07 | 0.78 | 1.97 | 0.02 |
| # Observations | 301 | 324 | 314 | 337 | 363 | 332 | 279 | 285 | 351 | 351 | 332 |
| # Countries | 13 | 13 | 13 | 13 | 13 | 13 | 15 | 11 | 13 | 13 | 13 |
| **Textiles** | | | | | | | | | | | |
| Mean | 0.01 | 0.03 | 15.99 | 9.86 | 22.14 | 1.52 | 0.37 | 0.10 | 2.88 | 0.98 | 0.02 |
| Minimum | –0.40 | –0.17 | 15.29 | 9.09 | 18.98 | 0.63 | 0.16 | 0.00 | 0.12 | 0.14 | 0.00 |
| Maximum | 0.46 | 0.25 | 16.83 | 10.46 | 24.78 | 2.60 | 0.74 | 0.23 | 14.05 | 3.71 | 0.06 |
| Std. Dev. | 0.12 | 0.05 | 0.33 | 0.31 | 1.66 | 0.44 | 0.10 | 0.03 | 3.15 | 0.73 | 0.01 |
| # Observations | 306 | 324 | 319 | 337 | 364 | 321 | 279 | 310 | 351 | 351 | 332 |
| # Countries | 13 | 13 | 13 | 13 | 13 | 13 | 15 | 12 | 13 | 13 | 13 |
| **Wood** | | | | | | | | | | | |
| Mean | 0.00 | 0.03 | 15.71 | 10.01 | 21.30 | 1.82 | 0.44 | 0.15 | 1.49 | 1.62 | 0.01 |
| Minimum | –0.49 | –0.28 | 14.11 | 8.30 | 18.37 | 0.46 | 0.08 | 0.04 | 0.05 | 0.01 | 0.00 |
| Maximum | 0.56 | 0.30 | 17.51 | 10.65 | 24.25 | 3.27 | 1.18 | 0.60 | 9.37 | 10.51 | 0.03 |
| Std. Dev. | 0.11 | 0.07 | 0.87 | 0.38 | 1.30 | 0.49 | 0.20 | 0.07 | 1.62 | 2.25 | 0.01 |
| # Observations | 242 | 333 | 254 | 346 | 364 | 236 | 260 | 283 | 351 | 351 | 332 |
| # Countries | 12 | 13 | 12 | 13 | 13 | 11 | 14 | 12 | 13 | 13 | 13 |

**Table 2.2 Descriptive Statistics per country**

| | Growth Y/E | Growth Y/L | Log(Y/E) | Log(Y/L) | Log(Y) | Wage | Energy Price | I/Y | Openness | Balassa | $Y_i/Y$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Australia** | | | | | | | | | | | |
| Mean | 0.01 | 0.02 | 15.57 | 10.20 | 23.79 | 1.63 | 0.26 | 0.25 | | | 0.27 |
| Minimum | -0.34 | -0.26 | 13.15 | 9.38 | 22.38 | 0.47 | 0.12 | 0.17 | | | 0.03 |
| Maximum | 0.43 | 0.38 | 17.77 | 10.73 | 26.06 | 2.63 | 0.47 | 0.32 | | | 0.74 |
| Std. Dev. | 0.11 | 0.09 | 1.77 | 0.36 | 1.31 | 0.56 | 0.07 | 0.04 | | | 0.31 |
| # Observations | 70 | 70 | 73 | 73 | 73 | 61 | 247 | 26 | 0 | 0 | 69 |
| # Sectors | 3 | 3 | 3 | 3 | 3 | 3 | 13 | 1 | 0 | 0 | 3 |
| **Belgium** | | | | | | | | | | | |
| Mean | 0.00 | 0.04 | 15.24 | 10.33 | 21.74 | 2.41 | 0.34 | 0.21 | 4.14 | 1.18 | 0.08 |
| Minimum | -0.93 | -0.32 | 12.79 | 8.30 | 18.37 | 0.60 | 0.09 | 0.04 | 0.36 | 0.23 | 0.00 |
| Maximum | 0.30 | 0.32 | 17.89 | 11.33 | 25.16 | 5.06 | 0.87 | 1.54 | 13.01 | 2.49 | 0.63 |
| Std. Dev. | 0.12 | 0.08 | 1.26 | 0.53 | 1.31 | 0.89 | 0.16 | 0.15 | 2.58 | 0.55 | 0.16 |
| # Observations | 344 | 288 | 357 | 300 | 361 | 254 | 247 | 320 | 275 | 270 | 351 |
| # Sectors | 13 | 12 | 13 | 12 | 13 | 10 | 13 | 12 | 10 | 10 | 13 |
| **Canada** | | | | | | | | | | | |
| Mean | 0.00 | 0.02 | 14.54 | 10.48 | 22.76 | 2.24 | 0.21 | 0.20 | 1.70 | 1.47 | 0.08 |
| Minimum | -0.68 | -0.47 | 12.73 | 9.40 | 21.15 | 0.90 | 0.08 | 0.04 | 0.14 | 0.14 | 0.01 |
| Maximum | 0.68 | 0.25 | 17.99 | 11.48 | 26.30 | 3.66 | 0.42 | 0.78 | 6.90 | 6.57 | 0.68 |
| Std. Dev. | 0.13 | 0.07 | 1.50 | 0.37 | 1.16 | 0.65 | 0.08 | 0.12 | 1.44 | 1.55 | 0.16 |
| # Observations | 267 | 325 | 283 | 338 | 364 | 179 | 220 | 306 | 270 | 270 | 364 |
| # Sectors | 13 | 13 | 13 | 13 | 13 | 8 | 13 | 13 | 10 | 10 | 13 |
| **Denmark** | | | | | | | | | | | |
| Mean | 0.02 | 0.03 | 15.22 | 10.08 | 20.72 | 1.95 | 0.33 | 0.21 | 4.82 | 1.06 | 0.07 |
| Minimum | -0.96 | -0.43 | 12.55 | 8.77 | 16.87 | 0.40 | 0.13 | 0.06 | 0.15 | 0.11 | 0.00 |
| Maximum | 1.88 | 0.34 | 17.02 | 10.85 | 24.16 | 4.98 | 0.61 | 1.04 | 20.18 | 5.10 | 0.59 |
| Std. Dev. | 0.21 | 0.09 | 1.09 | 0.40 | 1.63 | 0.74 | 0.10 | 0.11 | 4.96 | 1.15 | 0.14 |
| # Observations | 314 | 323 | 327 | 336 | 358 | 308 | 240 | 253 | 270 | 270 | 338 |
| # Sectors | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 11 | 10 | 10 | 13 |
| **Finland** | | | | | | | | | | | |
| Mean | 0.00 | 0.04 | 14.83 | 10.15 | 21.01 | 1.72 | 0.35 | 0.23 | 2.22 | 1.91 | 0.07 |
| Minimum | -1.39 | -0.26 | 12.52 | 9.09 | 18.21 | 0.64 | 0.12 | 0.00 | 0.12 | 0.23 | 0.00 |
| Maximum | 0.78 | 0.33 | 17.67 | 11.09 | 23.93 | 3.83 | 1.00 | 0.96 | 6.98 | 10.51 | 0.51 |
| Std. Dev. | 0.16 | 0.07 | 1.38 | 0.41 | 1.20 | 0.60 | 0.17 | 0.13 | 1.60 | 2.71 | 0.12 |
| # Observations | 348 | 328 | 361 | 341 | 361 | 258 | 247 | 346 | 276 | 270 | 351 |
| # Sectors | 13 | 13 | 13 | 13 | 13 | 11 | 13 | 13 | 10 | 10 | 13 |

## Table 2.2 Continued

| | Growth Y/E | Growth Y/L | Log(Y/E) | Log(Y/L) | Log(Y) | Wage | $P_{energy}$ | Openness | Balassa | I/Y | $Y_i/Y$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **France** | | | | | | | | | | | |
| Mean | 0.01 | 0.03 | 15.34 | 10.46 | 23.55 | 2.59 | 0.32 | 0.19 | 1.24 | 0.97 | 0.07 |
| Minimum | -0.42 | -0.27 | 13.42 | 9.08 | 21.22 | 0.44 | 0.11 | 0.00 | 0.10 | 0.16 | 0.00 |
| Maximum | 0.53 | 0.24 | 17.32 | 11.45 | 26.88 | 5.56 | 0.74 | 0.63 | 4.03 | 1.73 | 0.63 |
| Std. Dev. | 0.09 | 0.05 | 1.20 | 0.40 | 1.22 | 0.87 | 0.11 | 0.10 | 0.92 | 0.34 | 0.15 |
| # Observations | 324 | 345 | 337 | 358 | 364 | 273 | 247 | 347 | 276 | 270 | 364 |
| # Sectors | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 10 | 10 | 13 |
| **Germany West** | | | | | | | | | | | |
| Mean | 0.02 | 0.03 | 15.37 | 10.27 | 23.83 | 2.19 | 0.40 | 0.18 | 1.02 | 1.19 | 0.07 |
| Minimum | -0.20 | -0.14 | 13.43 | 8.59 | 22.01 | 0.67 | 0.11 | 0.06 | 0.10 | 0.26 | 0.01 |
| Maximum | 2.55 | 0.24 | 19.45 | 11.05 | 27.00 | 4.02 | 0.92 | 0.45 | 4.43 | 4.44 | 0.58 |
| Std. Dev. | 0.17 | 0.05 | 1.22 | 0.40 | 1.09 | 0.67 | 0.14 | 0.08 | 0.73 | 0.84 | 0.13 |
| # Observations | 263 | 284 | 276 | 296 | 350 | 212 | 169 | 289 | 228 | 270 | 312 |
| # Sectors | 13 | 12 | 13 | 12 | 13 | 9 | 13 | 12 | 10 | 10 | 13 |
| **Italy** | | | | | | | | | | | |
| Mean | 0.00 | 0.04 | 15.67 | 10.27 | 23.45 | 2.05 | 0.52 | 0.21 | 1.10 | 1.04 | 0.07 |
| Minimum | -4.82 | -0.24 | 12.26 | 8.89 | 20.48 | 0.48 | 0.11 | 0.08 | 0.09 | 0.13 | 0.00 |
| Maximum | 0.56 | 0.32 | 19.15 | 11.31 | 26.84 | 4.39 | 1.22 | 0.47 | 4.41 | 3.71 | 0.61 |
| Std. Dev. | 0.27 | 0.07 | 1.60 | 0.48 | 1.29 | 0.80 | 0.28 | 0.08 | 0.93 | 0.84 | 0.15 |
| # Observations | 352 | 310 | 365 | 322 | 365 | 272 | 247 | 252 | 276 | 270 | 364 |
| # Sectors | 13 | 12 | 13 | 12 | 13 | 10 | 13 | 10 | 10 | 10 | 13 |
| **Japan** | | | | | | | | | | | |
| Mean | 0.00 | 0.03 | 15.44 | 10.39 | 24.45 | 1.66 | 0.67 | 0.24 | 0.52 | 0.70 | 0.07 |
| Minimum | -0.88 | -0.29 | 13.47 | 8.44 | 22.31 | 0.46 | 0.14 | 0.07 | 0.02 | 0.01 | 0.00 |
| Maximum | 0.32 | 0.36 | 17.44 | 11.73 | 27.77 | 4.60 | 1.88 | 0.52 | 2.03 | 2.24 | 0.57 |
| Std. Dev. | 0.10 | 0.09 | 1.22 | 0.82 | 1.15 | 0.87 | 0.35 | 0.11 | 0.45 | 0.57 | 0.14 |
| # Observations | 284 | 260 | 296 | 270 | 361 | 221 | 228 | 96 | 276 | 270 | 351 |
| # Sectors | 12 | 10 | 12 | 10 | 13 | 10 | 12 | 4 | 10 | 10 | 13 |
| **Netherlands** | | | | | | | | | | | |
| Mean | 0.00 | 0.03 | 15.05 | 10.52 | 21.76 | 2.44 | 0.34 | 0.19 | 3.55 | 1.01 | 0.07 |
| Minimum | -0.48 | -0.23 | 12.46 | 9.46 | 19.90 | 0.75 | 0.10 | 0.04 | 0.24 | 0.15 | 0.00 |
| Maximum | 0.35 | 0.20 | 18.06 | 11.58 | 25.56 | 4.61 | 1.06 | 0.66 | 13.34 | 3.37 | 0.64 |
| Std. Dev. | 0.12 | 0.06 | 1.35 | 0.40 | 1.18 | 0.66 | 0.17 | 0.09 | 2.76 | 0.76 | 0.16 |
| # Observations | 284 | 307 | 297 | 320 | 326 | 216 | 247 | 276 | 270 | 270 | 130 |
| # Sectors | 13 | 13 | 13 | 13 | 13 | 11 | 13 | 12 | 10 | 10 | 13 |

**Table 2.2 Continued**

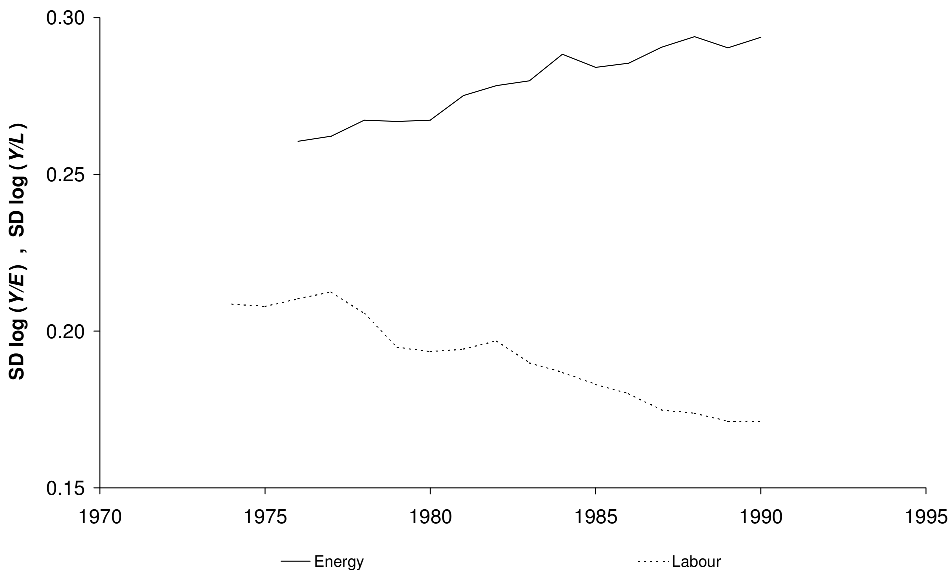
| | Growth Y/E | Growth Y/L | Log(Y/E) | Log(Y/L) | Log(Y) | Wage | $P_{energy}$ | Openness | Balassa | I/Y | $Y_i/Y$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Norway** | | | | | | | | | | | |
| Mean | -0.01 | 0.03 | 14.63 | 10.14 | 20.81 | 1.87 | 0.29 | 0.21 | 3.48 | 1.45 | 0.08 |
| Minimum | -1.37 | -0.21 | 11.99 | 9.13 | 18.98 | 0.43 | 0.11 | 0.02 | 0.21 | 0.20 | 0.00 |
| Maximum | 0.37 | 0.26 | 18.45 | 11.03 | 24.09 | 5.17 | 0.46 | 0.94 | 14.05 | 8.68 | 0.59 |
| Std. Dev. | 0.15 | 0.07 | 1.49 | 0.41 | 1.27 | 0.81 | 0.07 | 0.12 | 3.05 | 1.65 | 0.14 |
| # Observations | 314 | 253 | 327 | 264 | 364 | 215 | 247 | 244 | 270 | 270 | 364 |
| # Sectors | 13 | 11 | 13 | 11 | 13 | 9 | 13 | 9 | 10 | 10 | 13 |
| **Sweden** | | | | | | | | | | | |
| Mean | 0.02 | 0.03 | 14.71 | 10.16 | 21.56 | 1.87 | 0.36 | 0.19 | 2.53 | 1.30 | 0.07 |
| Minimum | -0.46 | -0.16 | 12.87 | 9.16 | 19.51 | 0.89 | 0.15 | 0.06 | 0.19 | 0.21 | 0.00 |
| Maximum | 0.66 | 0.24 | 17.54 | 11.15 | 24.66 | 2.81 | 0.73 | 0.44 | 10.71 | 5.05 | 0.59 |
| Std. Dev. | 0.11 | 0.06 | 1.12 | 0.39 | 1.14 | 0.47 | 0.10 | 0.08 | 1.94 | 1.29 | 0.14 |
| # Observations | 319 | 312 | 332 | 325 | 355 | 189 | 247 | 308 | 270 | 270 | 325 |
| # Sectors | 13 | 13 | 13 | 13 | 13 | 8 | 13 | 13 | 10 | 10 | 13 |
| **United Kingdom** | | | | | | | | | | | |
| Mean | 0.02 | 0.03 | 15.31 | 10.12 | 23.40 | 2.12 | 0.32 | 0.13 | 1.33 | 0.87 | 0.07 |
| Minimum | -0.33 | -0.16 | 13.42 | 9.36 | 21.11 | 0.15 | 0.08 | 0.05 | 0.08 | 0.03 | 0.00 |
| Maximum | 0.54 | 0.22 | 17.24 | 11.30 | 26.80 | 4.89 | 0.62 | 0.39 | 6.77 | 1.68 | 0.63 |
| Std. Dev. | 0.09 | 0.06 | 1.11 | 0.39 | 1.27 | 1.05 | 0.12 | 0.06 | 1.18 | 0.35 | 0.15 |
| # Observations | 342 | 207 | 355 | 218 | 361 | 268 | 247 | 293 | 276 | 270 | 351 |
| # Sectors | 13 | 11 | 13 | 11 | 13 | 11 | 13 | 11 | 10 | 10 | 13 |
| **United States** | | | | | | | | | | | |
| Mean | 0.01 | 0.02 | 15.40 | 10.69 | 25.12 | 3.12 | 0.35 | 0.14 | 0.48 | 0.79 | 0.07 |
| Minimum | -0.89 | -0.20 | 12.56 | 9.48 | 23.30 | 0.67 | 0.08 | 0.06 | 0.04 | 0.14 | 0.00 |
| Maximum | 0.47 | 0.20 | 17.40 | 11.75 | 28.93 | 6.98 | 0.67 | 0.37 | 2.40 | 1.30 | 0.71 |
| Std. Dev. | 0.14 | 0.06 | 1.33 | 0.39 | 1.24 | 1.15 | 0.15 | 0.06 | 0.40 | 0.32 | 0.18 |
| # Observations | 320 | 335 | 333 | 348 | 361 | 327 | 247 | 319 | 270 | 270 | 351 |
| # Sectors | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 12 | 10 | 10 | 13 |

## 3. Detailed results for the σ-convergence analysis.

Figures 3.1-3.3 present information on the standard deviation of the log of energy- and labour productivity at different levels of sectoral aggregation for all years for which information is available,[5] including a short description of the main results.

Figure 3.1 presents the development over time of the standard deviation of the log of 'macroeconomic' energy- and labour-productivity levels (with 'macroeconomic' referring to the sum of aggregate Manufacturing, Transport, Services and Agriculture). The figure shows that cross-country differences in energy-productivity levels are substantially larger than cross-country differences of labour-productivity levels. Moreover, it can be seen that over time the standard deviation of the log of energy-productivity performance is increasing, indicating σ-divergence, while the opposite is true for cross-country labour-productivity performance, displaying a pattern of σ-convergence.

**Figure 3.1 Standard deviation of log energy- and labour productivity at the macroeconomic level**




In Figures 3.2a and 3.2b we present the standard deviation of the log of, respectively, energy- and labour productivity for aggregate Manufacturing, Transport, Services and Agriculture.

[5] The choice of the period and sample used in Figures 3.1–3.3 is based on the criterion of achieving a maximum time span for the largest number of countries (see Table 2 in the paper for the countries included in the sample for the different sectors). We also performed the analysis for somewhat different time periods where we had to drop a number of additional countries because of restricted data availability. The results of these analyses revealed that although in some sectors the dispersion of productivity is somewhat different as shown in the various figures, the overall pattern is similar. Details are available upon request.

**Figure 3.2a Standard deviation of log energy productivity in main sectors**

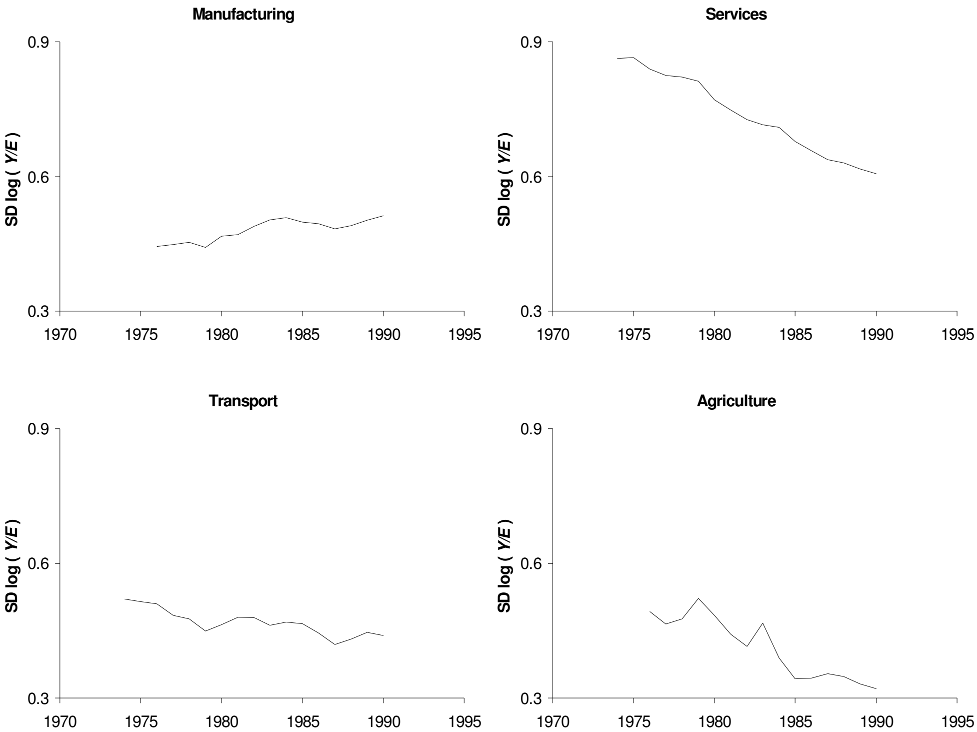
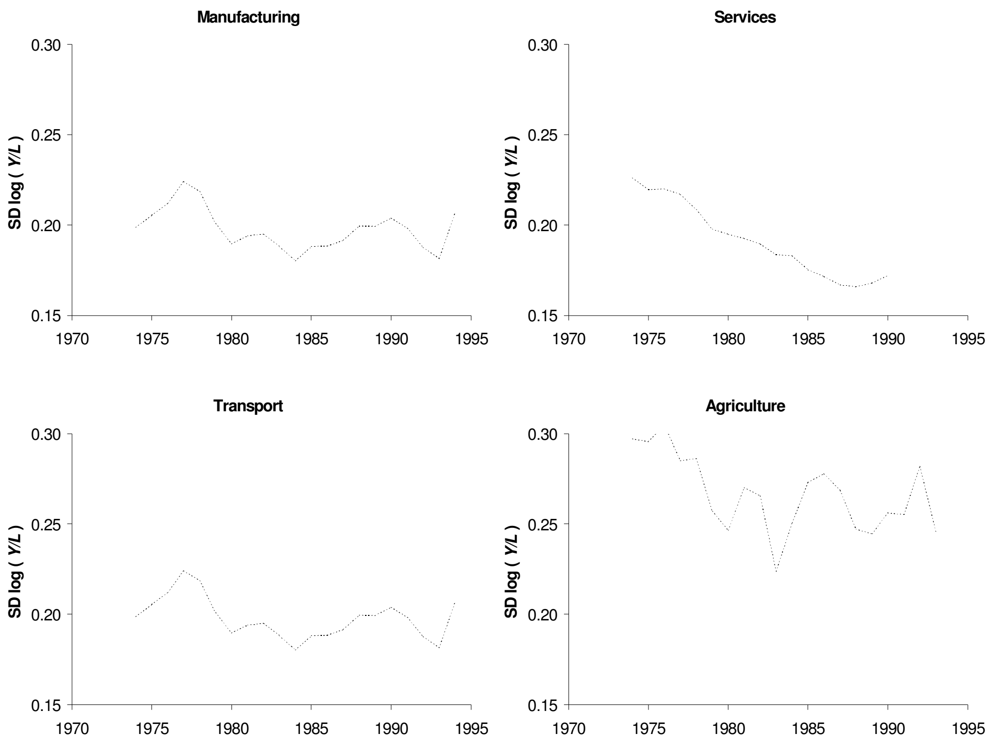



**Figure 3.2b Standard deviation of log labour productivity in main sectors**



From Figure 3.2a it can be seen that only Manufacturing resembles the macroeconomic pattern of σ-divergence for energy productivity. Transport, Agriculture, and, in particular, Services, display evidence of σ-convergence. Note that the cross-country variation is relatively high in Services, which is to a large extent due to the exceptional and so far unexplained energy-productivity performance of Finland and Italy.[6] Figure 3.2b shows that the macroeconomic pattern of σ-convergence for labour productivity is only evident in Services and to a lesser extent in the Agricultural sector. Variation in cross-country productivity differentials remains overall fairly constant within aggregate Manufacturing and Transport (although with fluctuations over time).

In Figures 3.3a and 3.3b we present the standard deviation of the log of, respectively, energy- and labour productivity for each of the 10 Manufacturing sub-sectors included in our dataset. Figure 3.3a reveals that the pattern of divergence in cross-country energy-productivity performance at the level of aggregate Manufacturing is to be found only in Iron and Steel and Non-Ferrous Metals. On the contrary, Food, Machinery, Non-metallic Minerals (until 1980) and Textiles all display evidence of (strong) σ-convergence. Cross-country productivity differences remain more or less constant in Non-Metallic Minerals (after 1980), Chemicals, Transport Equipment, Paper and Wood.

From Figure 3.3b it can be seen that the lack of labour-productivity convergence in aggregate Manufacturing is the result of mixed convergence patterns in different manufacturing sectors. Chemicals, Iron and Steel, Non-ferrous Metals and Wood exhibit (strong) convergence, while Machinery shows the opposite pattern of divergence. The sectors Food, Non-Metallic Minerals, Textile, Paper and Transport Equipment display no clear evidence for either convergence or divergence, although the latter shows substantial fluctuations over time. Moreover, it is to be noted that in Chemicals, Iron and Steel, Non-Ferrous Metals and Non-Metallic Minerals convergence of labour-productivity performance is particularly strong during the first half of the 1980s.

[6] Excluding Finland and Italy from the sample for Services reduces the cross-country dispersion by about 40% while leaving the pattern of σ-convergence unchanged. Note that the Netherlands also exhibits an exceptional development of energy-productivity performance in Services, but has already been excluded form the sample used in Figure 3.2a.

**Figure 3.3a Standard deviation of log energy productivity in Manufacturing sectors**

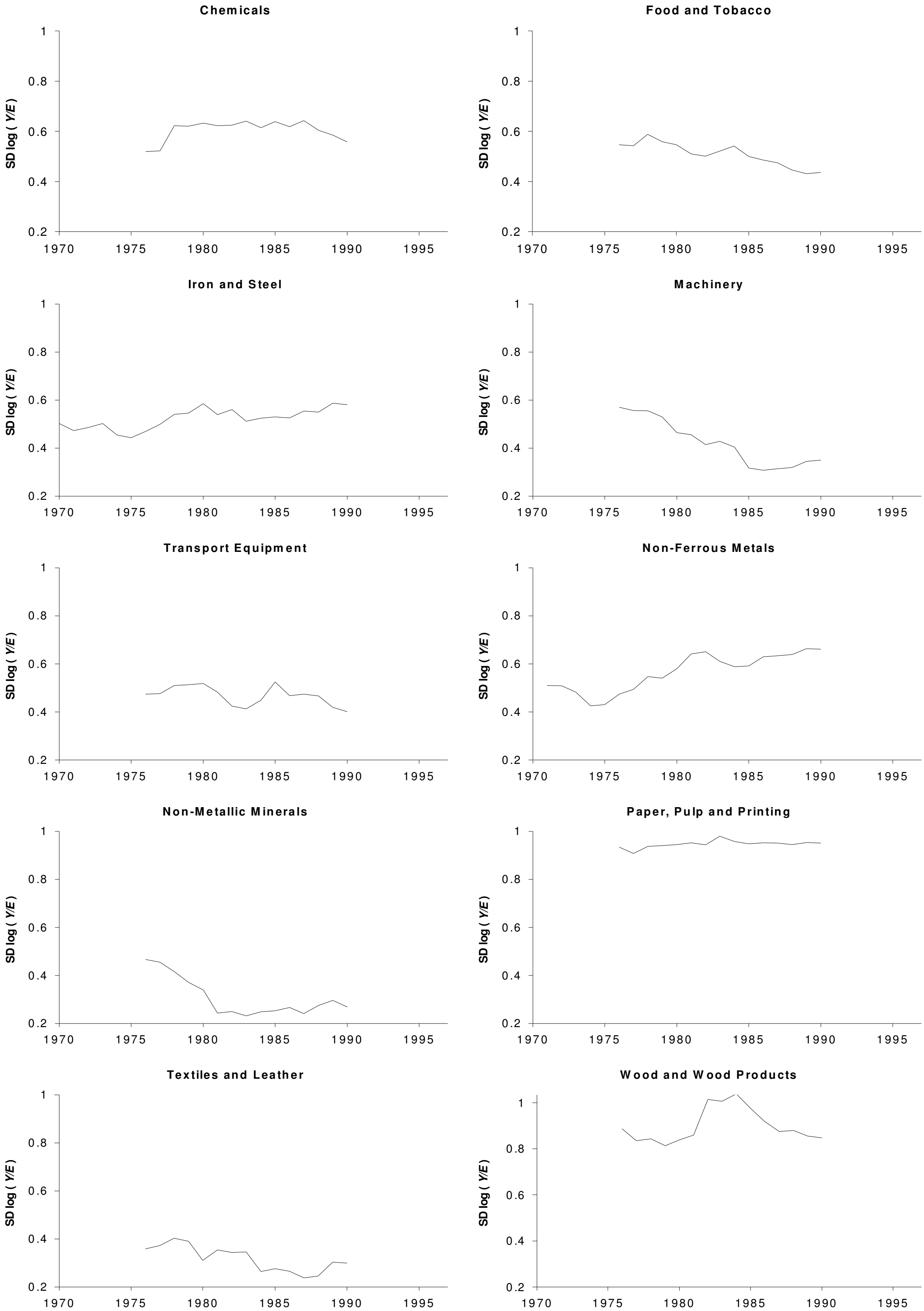
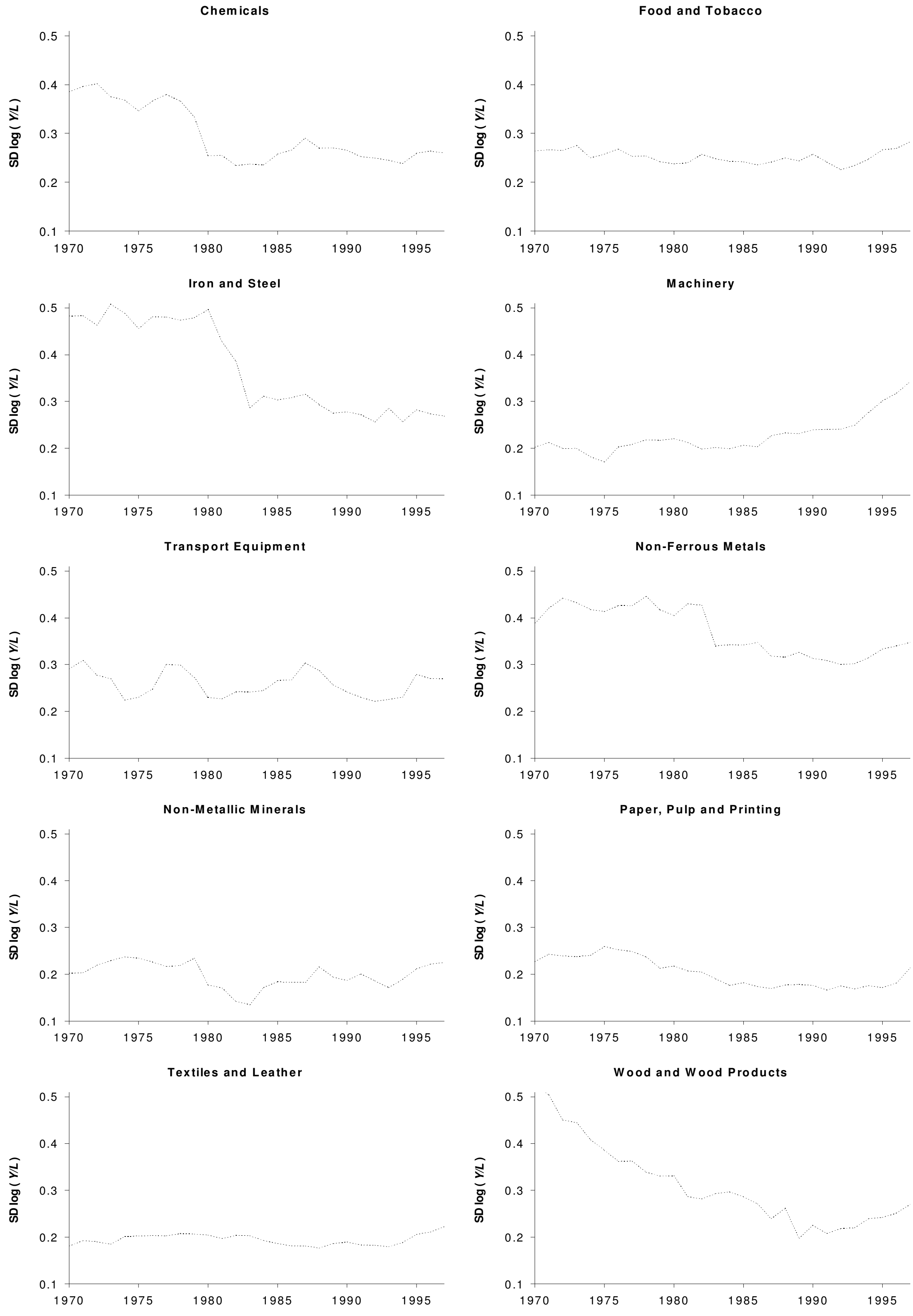


**Figure 3.3b Standard deviation of log labour productivity in Manufacturing sectors**



## 4. Further regression results - β–convergence.

This section contains a more elaborate regression analysis than presented in Section 5 of the paper. Apart from the fixed effects results presented in the paper, we here also show the pooled ordinary least squares results, the random effects results, and the Mundlak results (and a discussion of their respective pros and cons). We also extensively report specification tests. As such, these analyses provide a justification for only reporting the fixed effects estimates in the paper.

### 4.1 Sectoral Patterns of β-Convergence

We start by implementing a pooled Ordinary Least Squares (OLS) model for each sector, regressing the growth rate ($g$) of, respectively, energy- and labour productivity ($y$), on the log of its initial level ($y_{t-1}$) and a constant $\alpha$, to estimate $\beta$, according to:

$$g_{it} \equiv \ln(y)_{i,t} - \ln(y)_{i,t-1} = \alpha + \beta \ln(y)_{i,t-1} + \varepsilon_{it} \tag{4.1}$$

with $i$ and $t$ denoting, respectively, the cross-country and the time-series dimension, while $\varepsilon_{it}$ is the standard error that is assumed to be well-behaved. We use five-year time intervals in order to reduce the influence of business-cycle fluctuations and serial correlation of the error term. Hence, the growth rate ($g$) in equation (4.1) is an average over a five-year period (if $t$ = 1975, for example, $t$–1 = 1970). Because of notational ease we use the symbol $y$ interchangeably for energy productivity ($y_E$) and labour productivity ($y_L$). The proper interpretation will be clear from the context.

The OLS estimation method is valid only under the assumption that the error term $\varepsilon_{it}$ is independent of the explanatory variable $y_{t-1}$. However, it is very likely that the error term $\varepsilon_{it}$ in the cross-country regression (4.1) does contain all sorts of (unobserved) country-specific tangible and intangible factors that affect productivity growth. Persistent differences in, for example, the technology level and institutions are an important factor in understanding cross-country differences in productivity and economic growth. Hence, any permanent unobserved factors will necessarily be correlated with the initial level of, respectively, energy- and labour productivity ($y_{t-1}$). As a result, this will cause the OLS estimates to be biased and inconsistent (Hsiao 1986). Therefore, we have also adopted a panel-data approach to regress average energy- and labour-productivity growth rates on initial productivity levels. This approach is capable of allowing for cross-country differences in steady states in the form of unobservable individual 'country-effects', thus diminishing the omitted-variables problem (Islam 1995). Essentially, we can apply two basic procedures within a panel-data framework, commonly referred to as the fixed-effects model and the random-effects model. Reformulating equation (4.1) into a fixed effects panel-data model gives:

$$g_{it} = \alpha_i + \beta \ln(y)_{i,t-1} + \varepsilon_{it} \tag{4.2}$$

with $\alpha_i$ representing unspecified country-specific (fixed) effects. We assume $\varepsilon_{it}$ to be an independently identically distributed random variable with mean 0 and variance $\sigma^2_\varepsilon$. Reformulating equation (4.1) into a random effects panel-data model gives:

$$g_{it} = \mu + \beta \ln(y)_{i,t-1} + \delta_{it} \quad \text{with} \quad \delta_{it} = \alpha_i + \varepsilon_{it} \tag{4.3}$$

with $\alpha_i$ and $\varepsilon_{it}$ representing, respectively, the time-invariant cross-sectional component and the combined error component. It is assumed that $\alpha_i$ and $\varepsilon_{it}$ are mutually independent, uncorrelated with the explanatory variable(s) and that they are realisations of independent random variables with mean 0 and respective variances $\sigma_\alpha^2$ and $\sigma_\varepsilon^2$ (Hsiao 1986). Both panel-data models have their advantages and disadvantages. The random effects model uses up fewer degrees of freedom than the fixed effects model and is conceptually appealing because of its characterisation of the sources of the errors in a dataset with cross-section and time-series variation. However, the assumption of zero correlation between the individual country-effects ($\alpha_i$) and the observed explanatory variable ($y_{t-1}$) is problematic. As argued above, it is precisely this fact of likely dependence between the initial productivity level and unobserved country-specific factors, that forms the basis for adopting a panel approach instead of a pooled OLS regression. Hence, the random effects model is most likely to be an inadequate formulation in the context of our study. This problem can be solved by explicitly specifying the individual country-effects as a function of the variables with which it is supposedly correlated. We do so by following the specification suggested by Mundlak (1978) which leads to an extended random effects model according to

$$g_{it} = \mu + \beta \ln(y)_{i,t-1} + \nu_{it} \text{ with } \nu_{it} = \psi_i + \phi \overline{\ln(y)}_i + \varepsilon_{it} . \tag{4.4}$$

In this model the individual country effect $\alpha_i$ is assumed to be a linear function of the mean of the explanatory variable (initial productivity), according to

$$\alpha_i = \phi \overline{\ln(y)}_i + \psi_i \text{ with } \overline{\ln(y)}_i = \frac{1}{T_i} \sum_{t=1}^{T_i} \ln(y)_{i,t-1} \tag{4.5}$$

where $\overline{\ln(y)}_i$ is the average over time of the log of the initial productivity level ($y_{t-1}$) and $\psi_i$ is now the random country-specific effect, which is again assumed to be a random variable with mean 0 and variance $\sigma_\psi^2$. As a result this formulation minimizes the bias induced by the correlation between individual effects and explanatory variables in a random-effects model – sometimes referred to as the heterogeneity bias (Chamberlain 1982).

In conclusion, given the distribution assumptions of the errors in equations (4.1)-(4.4) as discussed above, there is reason to believe that the fixed-effects model or the random-effects model with Mundlak adjustment are to be preferred over the pooled OLS regression model and the normal random effects model. Our estimation strategy, however, has been to estimate equations (4.1), (4.2), (4.3) and (4.4), and to use various specification tests to verify the aforementioned assumptions and to discriminate between the different models. We have done so by using the software packages STATA and Eviews. We apply OLS to estimate the pooled model in equation (4.1) and a Least Squares Dummy Variables (LSDV) estimator to estimate the fixed effects model of equation (4.2). To estimate the random effects models of equations (4.3) and (4.4) we have used a generalized method of moments (GMM) estimator. In the paper, we have in the end only reported the fixed effects results, since they are clearly preferable. In the remainder of this section, we will show the results of the other estimators and briefly discuss the specification tests that we performed. For a discussion of the substantive conclusions, we refer to the paper.

In ***Table 4.1***, we present for each sector the estimated coefficient $\beta$ obtained from equation (4.1)–(4.4), in terms of energy productivity ( $y = y_E$ ), including various indicators and specification tests, which we will discuss below.[7] It can be seen that the fixed-effects model substantially improves the explanatory power of the regression equation, as compared to the pooled OLS approach. Moreover, the individual country effect explains between 16% (Machinery) and 97% (Wood) of the total unexplained variance, as indicated by $\rho$ in ***Table 4.1***. These results suggest that energy-productivity convergence depends to a large extent on individual country-effects, indicating energy productivity convergence to be conditional rather than absolute in virtually all sectors. The latter is also illustrated by the higher estimates of $\beta$ and the resulting high speed of convergence: from the OLS model it follows that the time $t$ needed for energy-productivity to move halfway its initial level ($y_0$) and the steady state $y^*$ varies from 8 years (Textiles) to 225 years (Non-Ferrous metals), whereas the fixed effects model leads to a half life between 1 year (Transport Equipment) and 14 years (Total). This is not surprising since the specification of equation (4.1) implicitly builds upon the assumption that energy-productivity levels converge towards a uniform steady state. However, economies differ and so do (most likely) their steady states. As noted before, contrary to a framework of single cross-country regressions, a fixed-effects panel data framework is capable of allowing for cross-country differences in steady states through individual country-effects that might include all sorts of country-specific factors affecting productivity growth. These factors have not been included in equation (4.1) or, to state it differently, have been subsumed in the error term of the OLS regression.

The results from estimating the random effects model according to equation (4.3) are relatively poor as compared to the fixed effects model. Although all sectors show again a negative estimate of $\beta$ , contrary to the fixed effects model these estimates are not statistically significant in the sectors Total, Chemicals, Iron and Steel, Non-Ferrous Metals, Paper and Wood. Moreover, the individual random effect explains only between 1% (Chemicals) and 34% (aggregate Manufacturing) of the total unexplained variance, while in almost half of the sectors the variance due to the random error component is close to zero, essentially reducing the random effects model to a pooled OLS estimator. In order to test for inconsistency in the random effects estimate, we used a Hausman specification test comparing the fixed effects and random effects slope parameters. Except for the sectors Services and Machinery, the test results are significant (at the 1% level, except from Agriculture (5%) and Non-Metallic Minerals (2%)), indicating that – except for Services and Machinery – the random effects model is estimated inconsistently, due to correlation between the explanatory variable and the error component. As noted before, using Mundlak's specification can solve this problem. The results as shown in Table 4.1 indicate that the Mundlak specification of our model according to equations (4.4) and (4.5) indeed improves the random effects model, as can be seen from the $F$-test and the significant estimate of the auxiliary coefficient $\phi\beta$ in all sectors (except again for Services and Machinery). The latter coefficient can be interpreted as the correlation effect between the unobserved country characteristics and the explanatory variable. For most sectors the Mundlak specification results also show a relatively small difference with the unbiased estimator of the fixed effect model, suggesting that the Mundlak specification indeed decreases the so-called heterogeneity bias. At the same time, however,

[7] We also estimated equation (4.1) including a period-specific fixed effect $\eta_t$ according to $g_{it} = \alpha + \beta \ln(y)_{i,t-1} + \eta_t + \varepsilon_{it}$ . The regression results with these period dummies included do not substantially improve the estimates in most sectors while most time-dummies are statistically insignificant. Exceptions are found in the sectors Non-Ferrous Metals and in terms of labour productivity (see Table 4.2) also for the sectors Chemicals, Iron and Steel and Machinery. These findings suggest that, in spite of a few exceptions, in general there is not much evidence for substantial differences in growth rates between the time periods included. Details are available upon request.

using the Mundlak specification does not yield much additional insights. Apart from the fact that the estimated coefficients for β are similar to those obtained by using the fixed effects model, the meaning of the auxiliary coefficient ϕβ is limited since in our model we assume the individual country-effects to be a function of one explanatory variably only. Moreover, in most sectors the individual random effect does not contribute much to explaining the total unexplained variance, as indicated by ρ in ***Table 4.1***. Hence, we conclude that overall the preferred model here is the fixed effect model of equation (4.2).

Comparable results for labour productivity are presented in ***Table 4.2***. As compared to energy productivity, in most sectors the estimates of β are rather small, indicating that lagging countries catch-up only very slow. The implied values for the speed of convergence (λ) confirm the finding of a slow rate of convergence: from the OLS model it follows that the time needed for energy productivity to move halfway its initial level ($y_0$) and the steady state $y^*$ varies from 16 years (Wood) to 87 years (Manufacturing), while in the fixed effects model this period lies in between 47 years (Transport Equipment) and 77 years (Non-Ferrous Metals). Similar to the results for energy productivity, the fixed-effects model improves the explanatory power of the regression equation, while in most sectors the individual country effects explain a substantial part of the total unexplained variance, as indicated by ρ in ***Table 4.2***. However, the evidence on conditional labour-productivity convergence is less clear-cut than it is for energy-productivity convergence: in the sectors Total, Chemicals, Iron and Steel, Machinery and Non-Ferrous Metals, allowing for individual country-effects in explaining labour-productivity growth yields statistically less significant or even insignificant estimates of β. As compared to energy productivity (see Table 4.1), the individual country effects also play a smaller role in explaining total unexplained variance in all sectors, of course except for Services and Machinery (where the random effects model is to preferred in the case of energy productivity). For labour productivity these percentages lie in between 6% (Iron and Steel) and 62% (Services). Moreover, ***Table 4.2*** shows that, except for Machinery and Textiles, the Hausman specification test fails to reject the null hypothesis that initial labour productivity growth and the error component are uncorrelated, indicating that the random effects model is estimated consistently for all other sectors. At the same time, the individual random effect explains a relatively small percentage of the total unexplained variance, while in 6 sectors the variance due to the random error component is again close to zero, essentially reducing the random effects model to a pooled OLS estimator. ***Table 4.2*** also shows that, except for the sectors Food, Transport Equipment, Non-Metallic Minerals and Textiles, the Mundlak specification does not substantially improve the random-effects model. Furthermore, in most sectors the results of both the standard as well as the Mundlak adjusted random-effects model show a relatively small difference with the unbiased estimator of the fixed-effect model, suggesting that the heterogeneity bias does play a much smaller role than in the estimates of energy-productivity convergence.

### 4.2 Sectoral determinants of β-Convergence

In our search for country-specific sectoral determinants of energy- and labour-productivity growth, we included a number of country-specific explanatory variables in the various regression models (see the paper for details). We changed, respectively, the OLS model, the fixed-effects model, the random-effects model and the Mundlak adjusted random effects model in equations (4.1)-(4.4) according to:

$$g_{it} = \alpha + \beta \ln(y)_{i,t-1} + \sum_{j=1}^{5} \gamma_j x_{it}^j + \varepsilon_{it} \tag{4.1b}$$

$$g_{it} = \alpha_i + \beta \ln(y)_{i,t-1} + \sum_{j=1}^{5} \gamma_j x_{it}^j + \varepsilon_{it} \tag{4.2b}$$

$$g_{it} = \mu + \beta \ln(y)_{i,t-1} + \sum_{j=1}^{5} \gamma_j x_{it}^j + \delta_{it} \text{ with } \delta_{it} = \alpha_i + \varepsilon_{it} \tag{4.3b}$$

$$g_{it} = \mu + \beta \ln(y)_{i,t-1} + \sum_{j=1}^{5} \gamma_j x_{it}^j + \nu_{it} \text{ with } \nu_{it} = \psi_i + \phi_0 \overline{\ln(y)}_i + \sum_{j=1}^{5} \phi_j \bar{x}_i^j + \varepsilon_{it} \tag{4.4b}$$

where

$$\alpha_i = \phi_0 \overline{\ln(y)}_i + \sum_{j=1}^{5} \phi_j \bar{x}_i^j + \psi_i \quad \text{with } \overline{\ln(y)}_i = \frac{1}{T_i} \sum_{t=1}^{T_i} \ln(y)_{i,t-1} \text{ and } \bar{x}_i^j = \frac{1}{T_i} \sum_{t=1}^{T_i} x_{i,t}^j \tag{4.5b}$$

with $x_i^j$ the additional country-specific explanatory variables (see the paper) and all other variables defined as in equation (4.1)-(4.5).

In ***Table 4.3*** we present the results of regressing average energy-productivity growth rates on initial energy productivity levels ( $y = y_E$ ) and these additional explanatory variables, according to equation (4.1b) and (4.2b).[8] The table shows that the Hausman test indicates again that for most sectors the fixed-effects model is to be preferred over the random-effects model, since the latter is estimated inconsistently, due to correlation between the explanatory variables and the error components. The estimation results of the random-effects models according to equation (4.3b) and (4.4b) are presented in ***Table 4.5***. In ***Table 4.4*** we present the results of regressing average labour-productivity growth rates on initial labour productivity levels ( $y = y_L$ ) and the additional explanatory variables, according to equation (4.1b) and (4.2b).[9] From the table it can be seen that the Hausman test results indicate that, at least for the sectors Services, Transport, Chemicals, Machinery and Wood, the random-effects model is estimated inconsistently and the fixed-effect model is to be preferred instead. The estimation results of the random-effects models for labour productivity, according to equation (4.3b) and (4.4b), are presented in ***Table 4.6***.

[8] We also controlled for different specifications of energy prices (current prices, 5-year moving average, and log 3-year and log 5-year moving average), investment share ($(I/Y)_{t-1}$, $(I/K)$, $(I/K)_{t-1}$ and $\ln(I/K)_{t-1}$), as well as an interaction term of investment share and log initial energy productivity ($\ln(Y/E)_0$* $(I/Y)$). All these specifications did not substantially alter the estimates. Details are available upon request.

[9] For labour productivity we also controlled for different specifications of the explanatory variables, including wages (current wage, 5-year moving average, and log 3-year and log 5-year moving average), investment share ($(I/Y)_{t-1}$, $(I/K)$, $(I/K)_{t-1}$ and $\ln(I/K)_{t-1}$), as well as an interaction term of investment share and log initial labour productivity ($\ln(Y/E)_0$* $(I/Y)$). All these specifications again did not substantially alter the estimates.

**Table 4.1 β -convergence for energy productivity**

| | Total | | | | Manufacturing | | | | Agriculture | | | | Services | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak |
| β | -0.0368 | -0.2214*** | -0.0382 | -0.2617*** | -0.1524 | -0.6162*** | -0.2757*** | -0.6611*** | -0.3227*** | -0.4797*** | -0.3624*** | -0.5867*** | -0.1432*** | -0.2181* | -0.1432*** | -0.2644** |
| | (0.0246) | (0.0691) | (0.0251) | (0.0636) | (0.0459) | (0.0680) | (0.0570) | (0.0690) | (0.0598) | (0.0888) | (0.0668) | (0.0788) | (0.0424) | (0.1169) | (0.0424) | (0.1147) |
| Implied λ | 0.0075 | 0.0501 | 0.0078 | 0.0607 | 0.0331 | 0.1915 | 0.0645 | 0.2164 | 0.0779 | 0.1307 | 0.0900 | 0.1767 | 0.0309 | 0.0492 | 0.0309 | 0.0614 |
| φβ | | | | 0.2561*** | | | | 0.6517*** | | | | 0.5117*** | | | | 0.1485 |
| | | | | (0.0680) | | | | (0.0797) | | | | (0.1150) | | | | (0.1307) |
| F-stat[2] | 2.24 | 10.26 | 2.33 | 17.05 | 11.01 | 82.22 | 23.39 | 92.67 | 29.11 | 29.15 | 29.45 | 58.48 | 11.40 | 3.48 | 11.40 | 12.79 |
| Prob>F | 0.1416 | 0.0030 | 0.1271 | 0.0002 | 0.0017 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0019 | 0.0740 | 0.0007 | 0.0017 |
| $R^2$ | 0.0464 | 0.4146 | 0.0445 | 0.2748 | 0.1747 | 0.7592 | 0.3174 | 0.6439 | 0.3380 | 0.6131 | 0.3411 | 0.5109 | 0.2568 | 0.4426 | 0.2423 | 0.2856 |
| ρ | | 0.6529 | 0.0150 | 0.0000 | | 0.8773 | 0.3413 | 0.0134 | | 0.4483 | 0.2123 | 0.0000 | | 0.2835 | 0.0000 | 0.0000 |
| Hausman | | | 8.08 | | | | 84.77 | | | | 4.01 | | | | 0.47 | |
| Prob>Chi$^2$ | | | 0.0045 | | | | 0.0000 | | | | 0.0453 | | | | 0.4918 | |
| regobs | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| ncrossest | 13 | 13 | 13 | 13 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 9 | 9 | 9 | 9 |
| totalobs | 48 | 48 | 48 | 48 | 54 | 54 | 54 | 54 | 59 | 59 | 59 | 59 | 35 | 35 | 35 | 35 |

| | Transport | | | | Chemicals | | | | Food and Tobacco | | | | Iron and Steel | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak |
| β | -0.0827** | -0.6301*** | -0.0827*** | -0.6993*** | -0.019 | -0.2620*** | -0.0226 | -0.2955*** | -0.0782** | -0.5180*** | -0.0782** | -0.5542*** | -0.0442 | -0.3889*** | -0.0442 | -0.4158*** |
| | (0.0312) | (0.1593) | (0.0312) | (0.1397) | (0.0436) | (0.0836) | (0.0444) | (0.0805) | (0.0385) | (0.1292) | (0.0385) | (0.1161) | (0.0507) | (0.1113) | (0.0507) | (0.1057) |
| Implied λ | 0.0173 | 0.1989 | 0.0173 | 0.2403 | 0.0038 | 0.0608 | 0.0046 | 0.0701 | 0.0163 | 0.1460 | 0.0163 | 0.1616 | 0.0090 | 0.0985 | 0.0090 | 0.1075 |
| φβ | | | | 0.6718*** | | | | 0.3508*** | | | | 0.5365*** | | | | 0.4530*** |
| | | | | (0.1494) | | | | (0.0892) | | | | (0.1253) | | | | (0.1162) |
| F-stat | 7.04 | 15.65 | 7.04 | 29.90 | 0.19 | 9.83 | 0.26 | 15.69 | 4.13 | 16.07 | 4.13 | 23.81 | 0.76 | 12.21 | 0.76 | 16.12 |
| Prob>F | 0.0106 | 0.0003 | 0.0080 | 0.0000 | 0.6645 | 0.0030 | 0.6109 | 0.0004 | 0.0471 | 0.0003 | 0.0421 | 0.0000 | 0.3873 | 0.0010 | 0.3839 | 0.0003 |
| $R^2$ | 0.1213 | 0.4183 | 0.1213 | 0.3742 | 0.0032 | 0.3281 | 0.0035 | 0.2129 | 0.0723 | 0.3639 | 0.0723 | 0.3141 | 0.0123 | 0.3166 | 0.0123 | 0.2118 |
| ρ | | 0.8799 | 0.0000 | 0.0000 | | 0.5136 | 0.0133 | 0.0000 | | 0.7834 | 0.0000 | 0.0000 | | 0.5622 | 0.0000 | 0.0000 |
| Hausman | | | 12.28 | | | | 11.43 | | | | 12.71 | | | | 12.11 | |
| Prob>Chi$^2$ | | | 0.0005 | | | | 0.0007 | | | | 0.0004 | | | | 0.0005 | |
| regobs | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| ncrossest | 12 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| totalobs | 53 | 53 | 53 | 53 | 61 | 61 | 61 | 61 | 55 | 55 | 55 | 55 | 63 | 63 | 63 | 63 |

Standard errors in parentheses. Asterisks denote levels of significance: *** (1%), ** (5%), * (10%). The symbol ρ indicates the % variance due to the fixed or random error component.

**Table 4.1 Continued**

| | Machinery | | | | Transport Equipment | | | | Non-Ferrous Metals | | | | Non-Metallic Minerals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak |
| β | -0.1729*** | -0.2305 | -0.1729*** | -0.2395* | -0.3082*** | -0.9504*** | -0.4199*** | -0.9558*** | -0.0153 | -0.5924*** | -0.0153 | -0.6105*** | -0.3156*** | -0.5087*** | -0.37*** | -0.5894*** |
| | (0.0557) | (0.1365) | (0.0557) | (0.1261) | (0.0823) | (0.1127) | (0.0922) | (0.1099) | (0.0617) | (0.1426) | (0.0617) | (0.1283) | (0.0761) | (0.0980) | (0.0791) | (0.0942) |
| Implied λ | 0.0380 | 0.0524 | 0.0380 | 0.0548 | 0.0737 | 0.6008 | 0.1089 | 0.6238 | 0.0031 | 0.1795 | 0.0031 | 0.1886 | 0.0758 | 0.1421 | 0.0924 | 0.1780 |
| φβ | | | | 0.0852 | | | | 0.9546*** | | | | 0.6705*** | | | | 0.5237*** |
| | | | | (0.1447) | | | | (0.1448) | | | | (0.1327) | | | | [0.1268] |
| F-stat | 9.66 | 2.85 | 9.66 | 9.87 | 14.01 | 71.07 | 20.77 | 75.96 | 0.06 | 17.26 | 0.06 | 25.63 | 17.20 | 26.96 | 21.89 | 39.28 |
| Prob>F | 0.0032 | 0.1004 | 0.0019 | 0.0072 | 0.0004 | 0.0000 | 0.0000 | 0.0000 | 0.8051 | 0.0002 | 0.8041 | 0.0000 | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| $R^2$ | 0.1735 | 0.3111 | 0.1735 | 0.1798 | 0.2060 | 0.6845 | 0.2775 | 0.5741 | 0.0012 | 0.3800 | 0.0012 | 0.3345 | 0.2383 | 0.5464 | 0.2873 | 0.4211 |
| ρ | | 0.1639 | 0.0000 | 0.0000 | | 0.7746 | 0.1476 | 0.0943 | | 0.7288 | 0.0000 | 0.0000 | | 0.4163 | 0.1685 | 0.0000 |
| Hausman | | | 0.21 | | | | 66.71 | | | | 20.16 | | | | 5.75 | |
| Prob>$Chi^2$ | | | 0.6439 | | | | 0.0000 | | | | 0.0000 | | | | 0.0165 | |
| regobs | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| ncrossest | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 12 | 12 | 12 | 12 | 13 | 13 | 13 | 13 |
| totalobs | 48 | 48 | 48 | 48 | 56 | 56 | 56 | 56 | 54 | 54 | 54 | 54 | 57 | 57 | 57 | 57 |

| | Paper | | | | Textiles | | | | Wood | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak |
| β | -0.0435 | -0.6513*** | -0.0523 | -0.7093*** | -0.3497*** | -0.8612*** | -0.4628*** | -0.8536*** | -0.0236 | -1.0637*** | -0.0236 | -0.9512*** |
| | (0.0355) | (0.1033) | (0.0384) | (0.0955) | (0.1020) | (0.1285) | (0.1091) | (0.1225) | (0.0349) | (0.1941) | (0.0349) | (0.1594) |
| Implied λ | 0.0089 | 0.2107 | 0.0107 | 0.2471 | 0.0861 | 0.3949 | 0.1243 | 0.3843 | 0.0048 | NA | 0.0048 | 0.6040 |
| φβ | | | | 0.7168*** | | | | 0.7955*** | | | | 0.9515*** |
| | | | | (0.0992) | | | | (0.1450) | | | | (0.1614) |
| F-stat | 1.50 | 39.72 | 1.86 | 55.26 | 11.74 | 44.95 | 17.98 | 48.69 | 0.46 | 30.03 | 0.46 | 35.61 |
| Prob>F | 0.2259 | 0.0000 | 0.1728 | 0.0000 | 0.0012 | 0.0000 | 0.0000 | 0.0000 | 0.5025 | 0.0000 | 0.4984 | 0.0000 |
| $R^2$ | 0.0292 | 0.5978 | 0.0438 | 0.53 | 0.1902 | 0.5962 | 0.1924 | 0.4984 | 0.0119 | 0.6034 | 0.0130 | 0.4904 |
| ρ | | 0.9276 | 0.0555 | 0.0000 | | 0.6224 | 0.1300 | 0.0000 | | 0.9784 | 0.0000 | 0.0000 |
| Hausman | | | 38.97 | | | | 34.59 | | | | 29.67 | |
| Prob>$Chi^2$ | | | 0.0000 | | | | 0.0000 | | | | 0.0000 | |
| regobs | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| ncrossest | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 12 | 12 | 12 | 12 |
| totalobs | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 40 | 40 | 40 | 40 |

Standard errors in parentheses. Asterisks denote levels of significance: *** (1%), ** (5%), * (10%). The symbol ρ indicates the % variance due to the fixed or random error component.

**Table 4.2 β -convergence for labour productivity**

| | Total | | | | Manufacturing | | | | Agriculture | | | | Services | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak |
| β | -0.1138*** | -0.1068*** | -0.1107*** | -0.1204*** | -0.0392 | -0.0553 | -0.0449 | -0.0775* | -0.0575* | -0.0831* | -0.0666** | -0.1112** | -0.1445*** | -0.1783*** | -0.1690*** | -0.2067*** |
| | (0.0218) | (0.0262) | (0.0225) | (0.0302) | (0.0324) | (0.0382) | (0.0332) | (0.0407) | (0.0300) | (0.0431) | (0.0330) | (0.0467) | (0.0300) | (0.0422) | (0.0350) | (0.0540) |
| Implied λ | 0.0242 | 0.0226 | 0.0235 | 0.0257 | 0.0080 | 0.0114 | 0.0092 | 0.0161 | 0.0118 | 0.0174 | 0.0138 | 0.0236 | 0.0312 | 0.0393 | 0.0370 | 0.0463 |
| φβ | | | | 0.0178 | | | | 0.0992 | | | | 0.0931 | | | | 0.091 |
| | | | | (0.0476) | | | | (0.0646) | | | | (0.0623) | | | | (0.0709) |
| F-stat | 27.17 | 16.66 | 24.25 | 25.75 | 1.46 | 2.09 | 1.83 | 3.85 | 3.67 | 3.71 | 4.08 | 5.97 | 23.26 | 17.86 | 23.38 | 25.01 |
| Prob>F | 0.0000 | 0.0002 | 0.0000 | 0.0000 | 0.2311 | 0.1537 | 0.1759 | 0.1459 | 0.0598 | 0.0596 | 0.0433 | 0.0505 | 0.0000 | 0.0003 | 0.0000 | 0.0000 |
| $R^2$ | 0.3190 | 0.6786 | 0.2570 | 0.3223 | 0.0217 | 0.3334 | 0.0211 | 0.0559 | 0.0542 | 0.3870 | 0.0658 | 0.0866 | 0.4368 | 0.8017 | 0.4090 | 0.4737 |
| ρ | | 0.4757 | 0.4070 | 0.1153 | | 0.2841 | 0.1716 | 0.0000 | | 0.3090 | 0.1998 | 0.0000 | | 0.6207 | 0.6059 | 0.1094 |
| Hausman | | | 0.09 | | | | 0.30 | | | | 0.35 | | | | 0.15 | |
| Prob>Chi$^2$ | | | 0.7684 | | | | 0.5833 | | | | 0.5544 | | | | 0.6951 | |
| regobs | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| ncrossest | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 8 | 8 | 8 | 8 |
| totalobs | 60 | 60 | 60 | 60 | 68 | 68 | 68 | 68 | 66 | 66 | 66 | 66 | 32 | 32 | 32 | 32 |

| | Transport | | | | Chemicals | | | | Food and Tobacco | | | | Iron and Steel | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak |
| β | -0.1046** | -0.104 | -0.1046** | -0.1115 | -0.1027*** | -0.0929* | -0.1026*** | -0.1194** | -0.1058** | -0.1879*** | -0.1412*** | -0.2398*** | -0.1060* | -0.0642 | -0.1060* | -0.0782 |
| | (0.0465) | (0.1115) | (0.0465) | (0.1013) | (0.0366) | (0.0484) | (0.0372) | (0.0480) | (0.0401) | (0.0542) | (0.0446) | (0.0591) | (0.0568) | (0.1055) | (0.0568) | (0.0970) |
| Implied λ | 0.0221 | 0.0220 | 0.0221 | 0.0236 | 0.0217 | 0.0195 | 0.0217 | 0.0254 | 0.0224 | 0.0416 | 0.0304 | 0.0548 | 0.0224 | 0.0133 | 0.0224 | 0.0163 |
| φβ | | | | 0.0095 | | | | 0.0421 | | | | 0.2268*** | | | | -0.0461 |
| | | | | (0.1247) | | | | (0.0778) | | | | (0.0770) | | | | (0.1298) |
| F-stat | 5.07 | 0.87 | 5.07 | 4.96 | 7.86 | 3.68 | 7.60 | 8.06 | 6.96 | 12.03 | 10.01 | 16.54 | 3.48 | 0.37 | 3.48 | 3.56 |
| Prob>F | 0.0294 | 0.3577 | 0.0244 | 0.0838 | 0.0068 | 0.0607 | 0.0058 | 0.0178 | 0.0107 | 0.0011 | 0.0016 | 0.0003 | 0.0668 | 0.5452 | 0.0620 | 0.1687 |
| $R^2$ | 0.1033 | 0.1566 | 0.1033 | 0.1034 | 0.1141 | 0.2945 | 0.1140 | 0.1184 | 0.1055 | 0.4938 | 0.1355 | 0.2219 | 0.0540 | 0.1121 | 0.0540 | 0.056 |
| ρ | | 0.0726 | 0.0000 | 0.0000 | | 0.1854 | 0.0315 | 0.0000 | | 0.4393 | 0.3036 | 0.0000 | | 0.0615 | 0.0000 | 0.0000 |
| Hausman | | | 0.00 | | | | 0.10 | | | | 2.31 | | | | 0.22 | |
| Prob>Chi$^2$ | | | 0.9949 | | | | 0.7554 | | | | 0.1282 | | | | 0.6380 | |
| regobs | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| ncrossest | 11 | 11 | 11 | 11 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| totalobs | 46 | 46 | 46 | 46 | 63 | 63 | 63 | 63 | 61 | 61 | 61 | 61 | 63 | 63 | 63 | 63 |

Standard errors in parentheses. Asterisks denote levels of significance: *** (1%), ** (5%), * (10%). The symbol ρ indicates the % variance due to the fixed or random error component.

**Table 4.2 Continued**

| | Machinery | | | | Transport Equipment | | | | Non-Ferrous Metals | | | | Non-Metallic Minerals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak |
| β | -0.1247*** | -0.0543 | -0.0925** | -0.0994* | -0.1475* | -0.2949** | -0.1475* | -0.3078*** | -0.0683 | -0.0439 | -0.0683 | -0.0658 | -0.1459*** | -0.2089*** | -0.1625*** | -0.2371*** |
| | (0.0451) | (0.0488) | (0.0449) | (0.0543) | (0.0822) | (0.1206) | (0.0822) | (0.1109) | (0.0494) | (0.0932) | (0.0494) | (0.0860) | (0.0536) | (0.0635) | (0.0546) | (0.0650) |
| Implied λ | 0.0266 | 0.0112 | 0.0194 | 0.0209 | 0.0319 | 0.0699 | 0.0319 | 0.0736 | 0.0141 | 0.0090 | 0.0141 | 0.0136 | 0.0315 | 0.0469 | 0.0355 | 0.0541 |
| φβ | | | | -0.0854 | | | | 0.3011** | | | | -0.0037 | | | | 0.2439** |
| | | | | (0.1015) | | | | (0.1462) | | | | (0.1027) | | | | (0.1058) |
| F-stat | 7.64 | 1.23 | 4.25 | 8.31 | 3.22 | 5.98 | 3.22 | 7.72 | 1.91 | 0.22 | 1.91 | 1.88 | 7.40 | 10.83 | 8.87 | 13.30 |
| Prob>F | 0.0078 | 0.2725 | 0.0391 | 0.0157 | 0.0802 | 0.0204 | 0.0726 | 0.0210 | 0.1716 | 0.6394 | 0.1666 | 0.3900 | 0.0087 | 0.0020 | 0.0029 | 0.0013 |
| $R^2$ | 0.1220 | 0.4521 | 0.0667 | 0.1333 | 0.0745 | 0.2212 | 0.0745 | 0.1653 | 0.0304 | 0.1048 | 0.0304 | 0.0304 | 0.1186 | 0.3889 | 0.1404 | 0.1977 |
| ρ | | 0.3655 | 0.1973 | 0.0000 | | 0.2099 | 0.0000 | 0.0000 | | 0.0761 | 0.0000 | 0.0000 | | 0.2826 | 0.1127 | 0.0000 |
| Hausman | | 3.94 | | | | 2.79 | | | | 0.10 | | | | 2.05 | | |
| Prob>$Chi^2$ | | 0.0472 | | | | 0.0950 | | | | 0.7575 | | | | 0.1526 | | |
| regobs | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| ncrossest | 12 | 12 | 12 | 12 | 10 | 10 | 10 | 10 | 13 | 13 | 13 | 13 | 12 | 12 | 12 | 12 |
| totalobs | 57 | 57 | 57 | 57 | 42 | 42 | 42 | 42 | 63 | 63 | 63 | 63 | 57 | 57 | 57 | 57 |

| | Paper | | | | Textiles | | | | Wood | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak | OLS | FE | RE | Mundlak |
| β | -0.0755** | -0.1053 | -0.0755** | -0.1522** | -0.1577*** | -0.2330*** | -0.1577*** | -0.2368*** | -0.1925*** | -0.2298*** | -0.1973*** | -0.2763*** |
| | (0.0376) | (0.0783) | (0.0376) | (0.0756) | (0.0433) | (0.0545) | (0.0433) | (0.0510) | (0.0381) | (0.0650) | (0.0406) | (0.0644) |
| Implied λ | 0.0157 | 0.0223 | 0.0157 | 0.0330 | 0.0343 | 0.0531 | 0.0343 | 0.0540 | 0.0428 | 0.0522 | 0.0440 | 0.0647 |
| φβ | | | | 0.1062 | | | | 0.2275*** | | | | 0.1432 |
| | | | | (0.0910) | | | | (0.0862) | | | | (0.0894) |
| F-stat | 4.03 | 1.81 | 4.03 | 5.42 | 13.24 | 18.28 | 13.24 | 21.55 | 25.47 | 12.52 | 23.64 | 28.69 |
| Prob>F | 0.0492 | 0.1850 | 0.0446 | 0.0665 | 0.0006 | 0.0001 | 0.0003 | 0.0003 | 0.0000 | 0.0009 | 0.0000 | 0.0000 |
| $R^2$ | 0.0640 | 0.2446 | 0.0638 | 0.0855 | 0.1833 | 0.3299 | 0.1833 | 0.2709 | 0.2946 | 0.4679 | 0.2828 | 0.3235 |
| ρ | | 0.1710 | 0.0000 | 0.0000 | | 0.1977 | 0.0000 | 0.0000 | | 0.2227 | 0.0739 | 0.0000 |
| Hausman | | 0.19 | | | | 5.19 | | | | 0.41 | | |
| Prob>$Chi^2$ | | 0.6645 | | | | 0.0227 | | | | 0.5213 | | |
| regobs | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| ncrossest | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| totalobs | 61 | 61 | 61 | 61 | 61 | 61 | 61 | 61 | 63 | 63 | 63 | 63 |

Standard errors in parentheses. Asterisks denote levels of significance: *** (1%), ** (5%), * (10%). The symbol ρ indicates the % variance due to the fixed or random error component.

**Table 4.3 Determinants of β -convergence for energy productivity**

| | **Agriculture** | | **Services** | | **Transport** | | **Chemicals** | | **Food and** | | **Iron and Steel** | | **Machinery** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OLS | FE | OLS | FE | OLS | FE | OLS | FE | OLS | FE | OLS | FE | OLS | FE |
| β | -0.3153*** | -0.8079*** | -0.2431 | -0.7400*** | -0.1829*** | -0.3899* | -0.0615 | -0.7227*** | -0.0997 | -0.7759*** | -0.1931** | -0.7181*** | -0.2253*** | -0.3419* |
| | (0.0898) | (0.1395) | (0.1672) | (0.2053) | (0.0425) | (0.2076) | (0.0648) | (0.1254) | (0.0902) | (0.2407) | (0.0790) | (0.1579) | (0.0525) | (0.1874) |
| Implied λ | 0.0758 | 0.3299 | 0.0557 | 0.2694 | 0.0404 | 0.0988 | 0.0127 | 0.2565 | 0.0210 | 0.2991 | 0.0429 | 0.2532 | 0.0511 | 0.0837 |
| $P_E$ | 0.3618 | 0.0945 | -0.0319 | 0.9100 | 0.0546 | 0.0535 | 0.5331 | 1.2352* | 0.9546 | 0.8418 | 1.1856*** | 1.519 | 0.3285 | 0.0741 |
| | (0.6146) | (0.8667) | (0.5345) | (0.5494) | (0.1180) | (0.1379) | (0.5390) | (0.6198) | (0.5744) | (0.7351) | (0.4135) | (1.1381) | (0.3854) | (0.7471) |
| I/Y | -1.1408* | -0.3985 | -0.0328 | -0.9974 | 0.6051** | -0.1329 | 0.4219 | 0.0079 | 0.2019 | -0.3378 | -0.7716* | -0.5828 | 1.7097 | 2.8057 |
| | (0.6454) | (0.9603) | (0.8408) | (0.8305) | (0.2190) | (0.3188) | (0.4560) | (0.3484) | (1.0790) | (1.1145) | (0.4380) | (0.5995) | (1.1380) | (1.9633) |
| Open | | | | | | | -0.0279 | 0.0096 | 0.0119 | 0.038 | -0.0132 | 0.0011 | 0.0008 | 0.0086 |
| | | | | | | | (0.0186) | (0.0270) | (0.0301) | (0.0587) | (0.0128) | (0.0210) | (0.0189) | (0.0415) |
| Balassa | | | | | | | 0.0537 | -0.652* | -0.0184 | -0.3335 | 0.0031 | 0.3050* | -0.1213 | 0.7941 |
| | | | | | | | (0.1405) | (0.3159) | (0.0359) | (0.3144) | (0.0831) | (0.1514) | (0.1537) | (0.6379) |
| $Y_i/Y$ | -1.7468 | 9.4356 | 0.1487 | 6.5448* | 3.1736** | 17.5733*** | -0.1847 | 53.823*** | 4.31 | -3.2062 | 0.7634 | -8.1232 | 2.0596 | -1.3788 |
| | (2.0433) | (6.6142) | (0.8380) | (2.8418) | (1.1736) | (3.7142) | (5.9553) | (10.1168) | (3.9771) | (10.1163) | (8.2397) | (16.6715) | (1.2195) | (4.6100) |
| F-stat | 5.41 | 9.58 | 2.39 | 3.60 | 5.40 | 13.71 | 0.67 | 10.67 | 0.95 | 3.00 | 2.18 | 6.03 | 4.73 | 1.19 |
| Prob>F | 0.0014 | 0.0000 | 0.1088 | 0.0581 | 0.0027 | 0.0000 | 0.6763 | 0.0000 | 0.4760 | 0.0310 | 0.0690 | 0.0007 | 0.0016 | 0.3502 |
| $R^2$ | 0.3455 | 0.6927 | 0.4434 | 0.8037 | 0.4537 | 0.7979 | 0.1144 | 0.7915 | 0.1594 | 0.5815 | 0.2717 | 0.7268 | 0.4777 | 0.6411 |
| ρ | | 0.7701 | | 0.9677 | | 0.9399 | | 0.9404 | | 0.8769 | | 0.8930 | | 0.6926 |
| Hausman | | 19.20 | | 1.60 | | 43.37 | | 58.27 | | 14.70 | | 56.48 | | 3.31 |
| $Prob>Chi^2$ | | 0.0007 | | 0.8095 | | 0.0000 | | 0.0000 | | 0.0227 | | 0.0000 | | 0.7685 |
| LR-test | 5.54 | 3.38 | 0.16 | 9.11 | 12.8900 | 28.1400 | 4.5000 | 35.5600 | 4.2600 | 8.46 | 13.0700 | 9.39 | 7.1400 | 7.4200 |
| $Prob>Chi^2$ | 0.1365 | 0.3363 | 0.9838 | 0.0279 | 0.0049 | 0.0000 | 0.4805 | 0.0000 | 0.5128 | 0.1328 | 0.0227 | 0.0943 | 0.2101 | 0.1910 |
| regobs | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| ncrossest | 13 | 13 | 5 | 5 | 9 | 9 | 12 | 12 | 12 | 12 | 13 | 13 | 12 | 12 |
| totalobs | 46 | 46 | 17 | 17 | 31 | 31 | 38 | 38 | 37 | 37 | 42 | 42 | 38 | 38 |

Standard errors in parentheses. Asterisks denote levels of significance: *** (1%), ** (5%), * (10%). The symbol ρ indicates the % variance due to the fixed or random error component.

**Table 4.3 Continued**

| | Transport Equip | | Non-Fer. Metals | | Non-Met. Min. | | Paper | | Textiles | | Wood | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OLS | FE | OLS | FE | OLS | FE | OLS | FE | OLS | FE | OLS | FE |
| β | -0.3287** | -0.8758** | -0.0453 | -0.3822*** | -0.4362*** | -0.8374*** | -0.1062* | -0.5177** | -0.4906*** | -0.9178*** | -0.0319 | -1.4567*** |
| | (0.1421) | (0.3099) | (0.1046) | (0.1221) | (0.1176) | (0.1507) | (0.0538) | (0.1847) | (0.1595) | (0.1995) | (0.1109) | (0.2847) |
| Implied λ | 0.0797 | 0.4172 | 0.0093 | 0.0963 | 0.1146 | 0.3633 | 0.0225 | 0.1458 | 0.1349 | 0.4997 | 0.0065 | NA |
| $P_E$ | 0.1733 | -0.4853 | 0.3490 | 0.5400 | 1.5284* | -0.0352 | 0.6957** | 0.8399* | -0.4368 | 0.7422 | -0.0701 | -0.5295 |
| | (0.2739) | (0.5464) | (0.2689) | (0.7562) | (0.8703) | (1.4965) | (0.2679) | (0.4319) | (0.5514) | (0.8695) | (0.3235) | (0.4226) |
| I/Y | -0.0619 | 0.7894 | -0.0935 | -0.0938 | 0.0855 | 1.6049 | 0.1258 | -0.0152 | -0.575 | 0.6194 | -1.6485 | -2.0922** |
| | (1.1952) | (1.3564) | (0.2389) | (0.3301) | (0.8505) | (0.9417) | (0.6836) | (0.7147) | (1.1830) | (1.4782) | (0.9518) | (0.9002) |
| Open | -0.0225 | -0.025 | -0.0135 | -0.0203 | 0.0166 | -0.0184 | -0.0069 | 0.0256 | -0.019 | -0.0303 | -0.0028 | 0.0351 |
| | (0.0199) | (0.0456) | (0.0129) | (0.0274) | (0.0647) | (0.1141) | (0.0336) | (0.0624) | (0.0146) | (0.0284) | (0.0293) | (0.0363) |
| Balassa | 0.2336 | 0.967 | -0.0151 | 0.0108 | 0.2129** | -0.1499 | -0.1219* | -0.0254 | 0.1379 | 0.1604 | 0.0478 | 0.0209 |
| | (0.1664) | (0.5962) | (0.0491) | (0.0557) | (0.0885) | (0.1715) | (0.0611) | (0.0750) | (0.1410) | (0.1760) | (0.0652) | (0.0524) |
| $Y_i/Y$ | -14.0250* | -14.4620 | 2.4532 | 87.2827 | -30.2750** | -26.782 | 8.0745 | 14.9648 | -2.2926 | -13.079 | -9.245 | 54.457 |
| | (6.8969) | (19.6515) | (20.6547) | (50.8980) | (14.1374) | (22.2532) | (4.7923) | (10.5271) | (9.6588) | (11.2779) | (17.8540) | (55.8291) |
| F-stat | 1.29 | 2.08 | 0.93 | 3.45 | 3.58 | 6.04 | 2.07 | 3.90 | 3.20 | 5.57 | 0.58 | 6.01 |
| Prob>F | 0.3045 | 0.1257 | 0.4896 | 0.0157 | 0.0093 | 0.0000 | 0.0912 | 0.0136 | 0.0155 | 0.0020 | 0.7434 | 0.0089 |
| $R^2$ | 0.2693 | 0.5608 | 0.1479 | 0.6483 | 0.4340 | 0.7767 | 0.3238 | 0.6828 | 0.3985 | 0.7353 | 0.1692 | 0.8344 |
| ρ | | 0.8494 | | 0.8608 | | 0.7907 | | 0.9661 | | 0.6689 | | 0.9935 |
| Hausman | | 7.83 | | 15.77 | | 207.25 | | 14.36 | | -16.18 | | 35.01 |
| $Prob>Chi^2$ | | 0.2507 | | 0.0150 | | 0.0000 | | 0.0259 | | chi2<0 * | | 0.0000 |
| LR-test | 5.4900 | 7.1000 | 4.9600 | 10.9800 | 10.0800 | 11.2000 | 12.75 | 11.45 | 10.8 | 5.15 | 4.3 | 14.41 |
| $Prob>Chi^2$ | 0.3590 | 0.2134 | 0.4212 | 0.0518 | 0.0731 | 0.0476 | 0.0259 | 0.0431 | 0.0554 | 0.3973 | 0.5067 | 0.0132 |
| regobs | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| ncrossest | 9 | 9 | 12 | 12 | 11 | 11 | 11 | 11 | 12 | 12 | 9 | 9 |
| totalobs | 28 | 28 | 39 | 39 | 35 | 35 | 33 | 33 | 36 | 36 | 24 | 24 |

Standard errors in parentheses. Asterisks denote levels of significance: *** (1%), ** (5%), * (10%). The symbol ρ indicates the % variance due to the fixed or random error component.

**Table 4.4 Determinants of β -convergence for labour productivity**

| | Agriculture | | Services | | Transport | | Chemicals | | Food | and | Iron and Steel | | Machinery | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OLS | FE | OLS | FE | OLS | FE | OLS | FE | OLS | FE | OLS | FE | OLS | FE |
| β | -0.2055*** | -0.2807*** | 0.0715 | -0.0342 | - 0.4489*** | -0.8702*** | -0.1897* | -0.4800*** | -0.2557** | -0.4933*** | -0.7401*** | -0.8416* | -0.2544 | -0.3974*** |
| | (0.0447) | (0.0887) | (0.0704) | (0.1355) | (0.1129) | (0.1376) | (0.1012) | (0.1519) | (0.1069) | (0.1038) | (0.2129) | (0.4085) | (0.1657) | (0.1076) |
| Implied λ | 0.0460 | 0.0659 | -0.0138 | 0.0070 | 0.1192 | 0.4084 | 0.0421 | 0.1308 | 0.0591 | 0.1360 | 0.2695 | 0.3685 | 0.0587 | 0.1013 |
| Wage | 0.1353*** | 0.1724*** | -0.0099 | -0.2134 | 0.1898*** | 0.3995*** | 0.0799 | 0.0431 | 0.0991* | 0.2862*** | 0.2085** | 0.1878 | 0.0985 | 0.1474*** |
| | (0.0405) | (0.0611) | (0.0340) | (0.1216) | (0.0538) | (0.0678) | (0.0538) | (0.0688) | (0.0499) | (0.0496) | (0.0942) | (0.1249) | (0.0661) | (0.0363) |
| I/Y | -0.3674* | -0.4532 | 0.1324 | -0.0573 | -0.0651 | -0.406 | 0.4881 | 0.8086 | -0.7945* | -0.4432 | 1.3803** | 1.4897 | 0.0193 | 0.0715 |
| | (0.2026) | (0.2871) | (0.1359) | (0.1779) | (0.2489) | (0.2394) | (0.9040) | (0.8060) | (0.4469) | (0.3989) | (0.6118) | (1.5461) | (0.9642) | (0.5991) |
| Open | | | | | | | -0.0263* | 0.0036 | 0.0086 | -0.0307 | 0.0086 | 0.02 | -0.0196 | -0.0091 |
| | | | | | | | (0.0146) | (0.0282) | (0.0165) | (0.0206) | (0.0170) | (0.0469) | (0.0176) | (0.0178) |
| Balassa | | | | | | | -0.0453 | -0.0113 | -0.0021 | -0.1747** | -0.2345* | -0.178 | 0.0247 | -0.1577 |
| | | | | | | | (0.0882) | (0.3344) | (0.0174) | (0.0823) | (0.1188) | (0.5304) | (0.1244) | (0.2974) |
| $Y_i/Y$ | 0.0281 | 0.1643 | -0.4727* | 0.7003 | 2.6418** | 10.9707*** | 1.0912 | 54.5215** | 1.0966 | 0.9224 | 44.5478* | -0.3079 | 0.1996 | 6.4291** |
| | (0.5597) | (2.1193) | (0.2501) | (0.7859) | (1.0721) | (3.0681) | (4.0763) | (18.2454) | (2.0094) | (2.3888) | (22.2528) | (80.2697) | (0.8410) | (2.4721) |
| F-stat | 6.71 | 3.51 | 7.54 | 2.18 | 4.77 | 16.39 | 1.26 | 3.66 | 1.77 | 8.65 | 3.77 | 1.65 | 1.21 | 12.65 |
| Prob>F | 0.0002 | 0.0154 | 0.0019 | 0.1453 | 0.0039 | 0.0000 | 0.3206 | 0.0238 | 0.1298 | 0.0000 | 0.0275 | 0.2801 | 0.3321 | 0.0000 |
| $R^2$ | 0.3447 | 0.5195 | 0.6830 | 0.8440 | 0.3734 | 0.7736 | 0.2738 | 0.7240 | 0.2056 | 0.7790 | 0.6728 | 0.7101 | 0.2054 | 0.8818 |
| ρ | | 0.2613 | | 0.9006 | | 0.8349 | | 0.9650 | | 0.9564 | | 0.7646 | | 0.9269 |
| Hausman | | 1.24 | | 12.24 | | 127.42 | | 21.71 | | 4.59 | | 0.70 | | 14.95 |
| $Prob>Chi^2$ | | 0.8709 | | 0.0157 | | 0.0000 | | 0.0014 | | 0.5971 | | 0.9944 | | 0.0207 |
| LR-test | 18.72 | 15.4 | 13.71 | 5.49 | 12.3 | 46.77 | 7.9 | 24.19 | 7.18 | 41.25 | 13.2400 | 9.21 | 6.2800 | 52.7800 |
| $Prob>Chi^2$ | 0.0003 | 0.0015 | 0.0033 | 0.1395 | 0.0064 | 0.0000 | 0.1619 | 0.0002 | 0.2075 | 0.0000 | 0.0212 | 0.1012 | 0.2804 | 0.0000 |
| regobs | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| ncrossest | 13 | 13 | 5 | 5 | 9 | 9 | 8 | 8 | 12 | 12 | 6 | 6 | 9 | 9 |
| totalobs | 56 | 56 | 19 | 19 | 37 | 37 | 27 | 27 | 48 | 48 | 18 | 18 | 35 | 35 |

Standard errors in parentheses. Asterisks denote levels of significance: *** (1%), ** (5%), * (10%). The symbol ρ indicates the % variance due to the fixed or random error component.

**Table 4.4 Continued**

| | **Transport Equip** | | **Non-Fer. Metals** | | **Non-Met. Min.** | | **Paper** | | **Textiles** | | **Wood** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OLS | FE | OLS | FE | OLS | FE | OLS | FE | OLS | FE | OLS | FE |
| β | -0.3265 | -0.3597 | -0.3617*** | -0.8018** | -0.4501*** | -0.9127*** | -0.3714*** | -0.5806*** | -0.7264*** | -1.0423*** | -0.3222*** | - 0.6563*** |
| | (0.2368) | (0.5110) | (0.1099) | (0.2927) | (0.1119) | (0.1560) | (0.0920) | (0.1474) | (0.1151) | (0.1524) | (0.0925) | (0.1203) |
| Implied λ | 0.0791 | 0.0892 | 0.0898 | 0.3237 | 0.1196 | 0.4877 | 0.0929 | 0.1738 | 0.2592 | NA | 0.0778 | 0.2136 |
| Wage | 0.1637** | 0.1823 | 0.0601 | 0.1685 | 0.1784*** | 0.3626*** | 0.1605*** | 0.2582*** | 0.5295*** | 0.6855*** | 0.1867** | 0.3183*** |
| | (0.0649) | (0.2260) | (0.0437) | (0.0933) | (0.0557) | (0.0719) | (0.0439) | (0.0631) | (0.0975) | (0.1128) | (0.0784) | (0.0616) |
| I/Y | 0.0658 | 0.0935 | 0.9385** | -0.4719 | -0.6339 | -0.4068 | -0.4479* | -0.2624 | 0.1309 | 0.2038 | 0.235 | -0.7774* |
| | (0.7417) | (1.3221) | (0.3738) | (0.7817) | (0.3781) | (0.3524) | (0.2313) | (0.1926) | (0.4409) | (0.4724) | (0.4248) | (0.4188) |
| Open | 0.0096 | 0.0269 | 0.0021 | 0.0255 | 0.0481 | 0.1430** | 0.0499*** | 0.0391 | -0.0028 | 0.0112 | -0.049 | -0.0095 |
| | (0.0140) | (0.0458) | (0.0096) | (0.0257) | (0.0309) | (0.0575) | (0.0155) | (0.0287) | (0.0062) | (0.0092) | (0.0255)* | (0.0323) |
| Balassa | -0.502 | -0.9237 | -0.023 | 0.0346 | 0.0581 | 0.3159*** | 0.0115 | -0.0306 | -0.0004 | 0.0048 | -0.0154 | -0.0193 |
| | (0.2899) | (1.0580) | (0.0370) | (0.0428) | (0.0403) | (0.1083) | (0.0143) | (0.0277) | (0.0401) | (0.0626) | (0.0136) | (0.0156) |
| $Y_i/Y$ | 7.7576 | 10.0852 | 15.7769 | 100.344 | 6.4588 | -2.2014 | 2.3943 | 8.7556** | 2.408 | -3.2686 | 15.3643*** | 3.453 |
| | (6.0207) | (17.7287) | (24.3919) | (85.4649) | (5.8143) | (8.8290) | (1.6597) | (4.1050) | (2.7859) | (4.4019) | (5.4698) | (12.9583) |
| F-stat | 1.52 | 1.00 | 2.93 | 3.40 | 4.69 | 7.40 | 6.56 | 13.13 | 8.16 | 11.12 | 4.67 | 10.46 |
| Prob>F | 0.2355 | 0.4775 | 0.0584 | 0.0808 | 0.0012 | 0.0001 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0016 | 0.0000 |
| $R^2$ | 0.3625 | 0.4327 | 0.6151 | 0.8523 | 0.4319 | 0.7131 | 0.5154 | 0.8136 | 0.5443 | 0.7360 | 0.4671 | 0.8257 |
| ρ | | 0.4809 | | 0.9510 | | 0.7651 | | 0.6888 | | 0.7337 | | 0.7994 |
| Hausman | | 0.72 | | 9.95 | | 12.47 | | -1705.14 | | -28.52 | | 20.18 |
| Prob>$Chi^2$ | | 0.9940 | | 0.1267 | | 0.0522 | | chi2<0 * | | chi2<0 * | | 0.0026 |
| LR-test | 9.9700 | 9.6700 | 12.4800 | 16.2200 | 17.7700 | 32.2500 | 28.6700 | 60.0500 | 28.4300 | 45.0700 | 15.3000 | 38.8700 |
| Prob>$Chi^2$ | 0.0761 | 0.0852 | 0.0287 | 0.0063 | 0.0032 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0092 | 0.0000 |
| regobs | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| ncrossest | 7 | 7 | 6 | 6 | 11 | 11 | 11 | 11 | 12 | 12 | 10 | 10 |
| totalobs | 23 | 23 | 18 | 18 | 44 | 44 | 44 | 44 | 48 | 48 | 39 | 39 |

**Table 4.5 β -convergence for energy productivity: random effects models**

| | Agriculture | | Services | | Transport | | Chemicals | | Food | and | Iron and Steel | | Machinery | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | RE | Mundlak | RE | Mundlak | RE | Mundlak | RE | Mundlak | RE | Mundlak | RE | Mundlak | RE | Mundlak |
| β | -0.3875*** | -0.8611*** | -0.2431 | -0.7400*** | -0.1829*** | -0.5669*** | -0.0615 | -0.6971*** | -0.1056 | -0.7027*** | -0.2918*** | -0.7581*** | -0.2253*** | -0.2839* |
| | (0.0996) | (0.1311) | (0.1672) | (0.2053) | (0.0425) | (0.1725) | (0.0648) | (0.1231) | (0.0939) | (0.2337) | (0.0857) | (0.1316) | (0.0525) | (0.1675) |
| Implied λ | 0.0980 | 0.3948 | 0.0557 | 0.2694 | 0.0404 | 0.1674 | 0.0127 | 0.2389 | 0.0223 | 0.2426 | 0.0690 | 0.2838 | 0.0511 | 0.0668 |
| $P_E$ | 0.3038 | 0.3090 | -0.0319 | 0.9100 | 0.0546 | 0.0525 | 0.5331 | 1.299** | 0.9715* | 0.4221 | 1.2223** | 1.5958* | 0.3285 | 0.0149 |
| | (0.6664) | (0.8324) | (0.5345) | (0.5494)* | (0.1180) | (0.1368) | (0.5390) | (0.6104) | (0.5861) | (0.7133) | (0.4848) | (0.9145) | (0.3854) | (0.6670) |
| I/Y | -0.9729 | -0.198 | -0.0328 | -0.9974 | 0.6051*** | 0.1124 | 0.4219 | 0.224 | 0.2125 | -0.2754 | -0.9142* | -0.7454* | 1.7097 | 2.7168 |
| | (0.7142) | (0.8620) | (0.8408) | (0.8305) | (0.2190) | (0.2788) | (0.4560) | (0.3327) | (1.0767) | (1.1100) | (0.4854) | (0.4219) | (1.1380) | (1.9018) |
| Open | | | | | | | -0.0279 | 0.0079 | 0.0156 | 0.0651 | -0.0204 | -0.0014 | 0.0008 | -0.0103 |
| | | | | | | | (0.0186) | (0.0273) | (0.0310) | (0.0562) | (0.0143) | (0.0181) | (0.0189) | (0.0377) |
| Balassa | | | | | | | 0.0537 | -0.6712** | -0.0215 | -0.2092 | 0.0165 | 0.3270** | -0.1213 | 0.9245 |
| | | | | | | | (0.1405) | (0.2898) | (0.0378) | (0.3083) | (0.0980) | (0.1301) | (0.1537) | (0.6057) |
| $Y_i/Y$ | -1.6514 | 9.7318 | 0.1487 | 6.5448** | 3.1736*** | 13.1889*** | -0.1847 | 50.4735*** | 4.2683 | 5.4414 | 2.2408 | -11.244 | 2.0596* | -2.9342 |
| | (2.4535) | (6.3308) | (0.8380) | (2.8418) | (1.1736) | (2.6753) | (5.9553) | (10.1048) | (4.1634) | (8.5016) | (9.4222) | (13.8587) | (1.2195) | (4.2571) |
| $\varphi P_E$ | | 0.1865 | | -3.5131*** | | -0.0806 | | -0.4305 | | -0.0136 | | -1.0811 | | 0.6539 |
| | | (0.9530) | | (1.1889) | | (0.1819) | | (0.6622) | | (1.1079) | | (0.8768) | | (0.9230) |
| $I\varphi/Y$ | | -1.1492 | | 2.755 | | 0.1349 | | 0.4504 | | -1.9173 | | 0.4127 | | -0.8222 |
| | | (1.0884) | | (1.9671) | | (0.3595) | | (0.5521) | | (2.2696) | | (0.3979) | | (2.4176) |
| φOpen | | | | | | | | -0.0557 | | -0.051 | | 0.0318 | | 0.0076 |
| | | | | | | | | (0.0407) | | (0.1126) | | (0.0208) | | (0.0685) |
| φBalassa | | | | | | | | 0.8172*** | | 0.1876 | | -0.3973** | | -1.0709* |
| | | | | | | | | (0.3165) | | (0.3045) | | (0.1804) | | (0.5705) |
| $\varphi Y_i/Y$ | | -10.519* | | -5.4232** | | -11.712*** | | -53.809*** | | -7.5909 | | 26.4089 | | 3.8548 |
| | | (5.8470) | | (2.5560) | | (2.5528) | | (10.8919) | | (9.6824) | | (18.1939) | | (3.8836) |
| φβ | | 0.7753*** | | 1.5146*** | | 0.4688** | | 0.689*** | | 0.5107* | | 0.8194*** | | 0.0679 |
| | | (0.1556) | | (0.4478) | | (0.1944) | | (0.1322) | | (0.2807) | | (0.1549) | | (0.2063) |
| $Chi^2$ | 22.61 | 59.58 | 9.56 | 32.75 | 21.59 | 68.05 | 4.01 | 67.80 | 5.74 | 20.22 | 17.57 | 70.30 | 28.36 | 31.41 |
| $Prob>Chi^2$ | 0.0002 | 0.0000 | 0.0485 | 0.0001 | 0.0002 | 0.0000 | 0.6759 | 0.0000 | 0.4526 | 0.0630 | 0.0074 | 0.0000 | 0.0001 | 0.0017 |
| $R^2$ | 0.3576 | 0.6169 | 0.4434 | 0.8037 | 0.4537 | 0.7557 | 0.1144 | 0.7306 | 0.1620 | 0.4573 | 0.3134 | 0.708 | 0.4515 | 0.5568 |
| ρ | 0.1720 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0548 | 0.0000 | 0.3046 | 0.0000 | 0.0000 | 0.0000 |
| Hausman | 19.20 | | 1.60 | | 43.37 | | 58.27 | | 14.70 | | 56.48 | | 3.31 | |
| $Prob>Chi^2$ | 0.0007 | | 0.8095 | | 0.0000 | | 0.0000 | | 0.0227 | | 0.0000 | | 0.7685 | |
| regobs | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| ncrossest | 13 | 13 | 5 | 5 | 9 | 9 | 12 | 12 | 12 | 12 | 13 | 13 | 12 | 12 |
| totalobs | 46 | 46 | 17 | 17 | 31 | 31 | 38 | 38 | 37 | 37 | 42 | 42 | 38 | 38 |

**Table 4.5 Continued**

| | Transport Equip | | Non-Fer. Metals | | Non-Met. Min. | | Paper | | Textiles | | Wood | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | RE | Mundlak | RE | Mundlak | RE | Mundlak | RE | Mundlak | RE | Mundlak | RE | Mundlak |
| $\beta$ | -0.3287** | -0.6593*** | -0.0453 | -0.4004*** | -0.4959*** | -0.8234*** | -0.1103* | -0.5477*** | -0.4906*** | -0.8557*** | -0.0575 | -1.2760*** |
| | (0.1421) | (0.2522) | (0.1046) | (0.1116) | (0.1230) | (0.1550) | (0.0564) | (0.1811) | (0.1595) | (0.1739) | (0.1250) | (0.2300) |
| Implied $\lambda$ | 0.0797 | 0.2154 | 0.0093 | 0.1023 | 0.1370 | 0.3468 | 0.0234 | 0.1587 | 0.1349 | 0.3872 | 0.0118 | -- |
| $P_E$ | 0.1733 | -0.423 | 0.3490 | 0.3671 | 1.4462 | 0.1957 | 0.7340*** | 0.7449* | -0.4368 | 0.405 | -0.0498 | -0.4823** |
| | (0.2739) | (0.5371) | (0.2689) | (0.5920) | (0.9683) | (1.5364) | (0.2780) | (0.4476) | (0.5514) | (0.7898) | (0.3628) | (0.4051) |
| I/Y | -0.0619 | 1.0087 | -0.0935 | 0.0132 | 0.3633 | 1.4315 | 0.059 | 0.1525 | -0.575 | 0.7168 | -1.5832 | -2.2307 |
| | (1.1952) | (1.3090) | (0.2389) | (0.2827) | (0.8686) | (0.8392)* | (0.6807) | (0.6803) | (1.1830) | (1.3153) | (1.0323) | (0.8774) |
| Open | -0.0225 | -0.0343 | -0.0135 | -0.0178 | 0.0005 | -0.0135 | -0.0066 | 0.0304 | -0.019 | -0.0208 | -0.0075 | 0.028 |
| | (0.0199) | (0.0416) | (0.0129) | (0.0198) | (0.0679) | (0.1015) | (0.0354) | (0.0624) | (0.0146) | (0.0246) | (0.0324) | (0.0355) |
| Balassa | 0.2336 | 0.9945 | -0.0151 | 0.01 | 0.1804 | -0.0651 | -0.1194* | -0.0208 | 0.1379 | 0.2049 | 0.0462 | 0.0454 |
| | (0.1664) | (0.5872)* | (0.0491) | (0.0494) | (0.0964)* | (0.1244) | (0.0610) | (0.0778) | (0.1410) | (0.1528) | (0.0668) | (0.0460) |
| $Y_i/Y$ | -14.0250** | -9.076 | 2.4532 | 79.4415* | -29.5530* | -29.591 | 7.8333 | 18.8562* | -2.2926 | -9.4402 | -11.088 | 87.8499* |
| | (6.8969) | (15.9618) | (20.6547) | (45.7648) | (15.1570) | (19.3791) | (4.9635) | (10.5490) | (9.6588) | (10.2658) | (18.8191) | (47.1778) |
| $\varphi$Pe | | 0.1332 | | -0.4674 | | 0.6053 | | -0.5425 | | -1.7508* | | -0.1037 |
| | | (0.7164) | | (0.5485) | | (1.6214) | | (0.6527) | | (0.9923) | | (0.4746) |
| $I\varphi/Y$ | | 0.2312 | | 0.2363 | | -0.5943 | | -1.7999 | | -12.054** | | 5.6798** |
| | | (3.6145) | | (0.4972) | | (1.7345) | | (4.2358) | | (5.5470) | | (2.0917) |
| $\varphi$Open | | -0.0291 | | -0.0118 | | 0.0563 | | 0.0295 | | 0.0919 | | -0.1041 |
| | | (0.0631) | | (0.0376) | | (0.1953) | | (0.2399) | | (0.0755) | | (0.0736) |
| $\varphi$Balassa | | -0.844 | | 0.1274 | | 0.3867 | | -0.0093 | | 0.3976 | | 0.0395 |
| | | (0.6330) | | (0.0911) | | (0.3027) | | (0.1027) | | (0.2941) | | (0.0542) |
| $\varphi Y_i/Y$ | | -8.1433 | | -126.47** | | -10.785 | | -14.975 | | -8.6004 | | -108.88** |
| | | (16.2715) | | (55.0455) | | (37.1911) | | (11.9013) | | (13.5079) | | (55.1949) |
| $\varphi\beta$ | | 0.4994 | | 0.6584*** | | 0.5987 | | 0.5082** | | 1.2028*** | | 1.3562*** |
| | | (0.3937) | | (0.1612) | | (0.4207) | | (0.2039) | | (0.3014) | | (0.2607) |
| $Chi^2$ | 7.74 | 15.38 | 5.56 | 41.68 | 21.04 | 51.58 | 13.10 | 26.32 | 19.21 | 52.97 | 2.90 | 44.64 |
| Prob>$Chi^2$ | 0.2579 | 0.2211 | 0.4747 | 0.0000 | 0.0018 | 0.0000 | 0.0415 | 0.0097 | 0.0038 | 0.0000 | 0.8208 | 0.0000 |
| $R^2$ | 0.2693 | 0.5063 | 0.1479 | 0.6159 | 0.4321 | 0.701 | 0.3434 | 0.5683 | 0.3985 | 0.6973 | 0.1535 | 0.8023 |
| $\rho$ | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.1611 | 0.0000 | 0.1041 | 0.0000 | 0.0000 | 0.0000 | 0.1566 | 0.0000 |
| Hausman | 7.83 | | 15.77 | | 207.25 | | 14.36 | | -16.18 | | 35.01 | |
| Prob>$Chi^2$ | 0.2507 | | 0.0150 | | 0.0000 | | 0.0259 | | chi2<0 * | | 0.0000 | |
| regobs | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| ncrossest | 9 | 9 | 12 | 12 | 11 | 11 | 11 | 11 | 12 | 12 | 9 | 9 |
| totalobs | 28 | 28 | 39 | 39 | 35 | 35 | 33 | 33 | 36 | 36 | 24 | 24 |

**Table 4.6 $\beta$-convergence for labour productivity: random effect models**

| | Agriculture | | Services | | Transport | | Chemicals | | Food | and | Iron and Steel | | Machinery | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | RE | Mundlak | RE | Mundlak | RE | Mundlak | RE | Mundlak | RE | Mundlak | RE | Mundlak | RE | Mundlak |
| β | -0.2128*** | -0.2997*** | 0.0715 | -0.0342 | -0.5067*** | -0.8248*** | -0.2597 | -0.4836*** | -0.3630*** | -0.5672*** | -0.7401*** | -0.8416** | -0.3612*** | -0.4763*** |
| | (0.0491) | (0.0820) | (0.0704) | (0.1355) | (0.1179) | (0.1232) | (0.1076) | (0.1464) | (0.1032) | (0.1133) | (0.2129) | (0.4085) | (0.1023) | (0.1485) |
| Implied λ | 0.0479 | 0.0712 | -0.0138 | 0.0070 | 0.1413 | 0.3484 | 0.0601 | 0.1322 | 0.0902 | 0.1675 | 0.2695 | 0.3685 | 0.0896 | 0.1294 |
| $P_E$ | 0.1393*** | 0.2078*** | -0.0099 | -0.2134* | 0.2221*** | 0.3791*** | 0.0972* | 0.0483 | 0.1871*** | 0.2930*** | 0.2085** | 0.1878 | 0.1591*** | 0.1299*** |
| | (0.0420) | (0.0568) | (0.0340) | (0.1216) | (0.0561) | (0.0613) | (0.0508) | (0.0643) | (0.0479) | (0.0553) | (0.0942) | (0.1249) | (0.0383) | (0.0503) |
| I/Y | -0.3813* | -0.3369 | 0.1324 | -0.0573 | -0.0784 | -0.3749* | 0.4748 | 0.8116 | -0.6827* | -0.7600* | 1.3803** | 1.4897 | 0.0851 | 0.0555 |
| | (0.2112) | (0.2878) | (0.1359) | (0.1779) | (0.2489) | (0.2245) | (0.8102) | (0.7791) | (0.4066) | (0.4249) | (0.6118) | (1.5461) | (0.6273) | (0.8247) |
| Open | | | | | | | -0.028 | 0.003 | -0.0031 | -0.0031 | 0.0086 | 0.02 | -0.0218 | 0.0156 |
| | | | | | | | (0.0184) | (0.0272) | (0.0161) | (0.0216) | (0.0170) | (0.0469) | (0.0127)* | (0.0236) |
| Balassa | | | | | | | -0.0923 | 0.0238 | -0.0056 | -0.0663 | -0.2345** | -0.178 | 0.0636 | -0.3348 |
| | | | | | | | (0.1170) | (0.3017) | (0.0208) | (0.0873) | (0.1188) | (0.5304) | (0.1637) | (0.4102) |
| $Y_i/Y$ | 0.0517 | 1.2778 | -0.4727* | 0.7003 | 3.1475*** | 10.6976*** | 5.5159 | 53.4959*** | 3.0884 | 2.0423 | 44.5478** | -0.3079 | 3.2263** | 9.5209*** |
| | (0.6453) | (2.0723) | (0.2501) | (0.7859) | (1.1600) | (2.6924) | (5.9860) | (17.3111) | (2.0056) | (2.7666) | (22.2528) | (80.2697) | (1.3727) | (3.3317) |
| φPe | | -0.1735 | | 0.1909 | | -0.4055*** | | -0.1594 | | -0.3630*** | | -0.4253** | | -0.2308* |
| | | (0.1093) | | (0.1439) | | (0.0793) | | (0.1901) | | (0.0662) | | (0.1917) | | (0.1225) |
| Iφ/Y | | -0.1018 | | -0.1532 | | 0.1476 | | 3.3355** | | -0.4945 | | -6.0039 | | -1.656 |
| | | (0.4754) | | (0.3753) | | (0.3768) | | (1.4465) | | (0.6670) | | (4.5166) | | (1.5601) |
| φOpen | | | | | | | | -0.1885*** | | 0.0464 | | 0.0337 | | -0.0398 |
| | | | | | | | | (0.0597) | | (0.0371) | | (0.0516) | | (0.0380) |
| φBalassa | | | | | | | | 0.639 | | 0.0577 | | -0.0985 | | 0.2392 |
| | | | | | | | | (0.4875) | | (0.0893) | | (0.5217) | | (0.4118) |
| $φY_i/Y$ | | -1.1205 | | -1.684 | | -10.184*** | | -66.275*** | | -6.439 | | 58.3089 | | -10.200*** |
| | | (2.0618) | | (1.1875) | | (2.6755) | | (18.9229) | | (4.1158) | | (71.3804) | | (2.7733) |
| φβ | | 0.1607 | | 0.2295 | | 0.7954*** | | 0.1014 | | 0.5030*** | | 0.9723*** | | 0.5985*** |
| | | (0.1133) | | (0.1461) | | (0.1570) | | (0.2789) | | (0.1287) | | (0.3632) | | (0.2248) |
| $Chi^2$ | 24.19 | 30.63 | 30.17 | 54.08 | 21.78 | 89.27 | 9.78 | 36.39 | 24.97 | 62.30 | 22.61 | 27.54 | 57.15 | 64.80 |
| $Prob>Chi^2$ | 0.0001 | 0.0002 | 0.0000 | 0.0000 | 0.0002 | 0.0000 | 0.1340 | 0.0003 | 0.0003 | 0.0000 | 0.0009 | 0.0038 | 0.0000 | 0.0000 |
| $R^2$ | 0.3241 | 0.3945 | 0.6830 | 0.8439 | 0.4180 | 0.7612 | 0.3081 | 0.7221 | 0.3934 | 0.6403 | 0.6728 | 0.7101 | 0.6716 | 0.7466 |
| ρ | 0.0969 | 0.0000 | 0.0000 | 0.0000 | 0.0818 | 0.0000 | 0.4857 | 0.0000 | 0.3987 | 0.0000 | 0.0000 | 0.0000 | 0.8323 | 0.0000 |
| | 1.24 | | | | 127.42 | | 21.71 | | 4.59 | | 0.70 | | 14.95 | |
| Hausman | | | 12.24 | | | | | | | | | | | |
| $Prob>Chi^2$ | 0.8709 | | 0.0157 | | 0.0000 | | 0.0014 | | 0.5971 | | 0.9944 | | 0.0207 | |
| regobs | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| ncrossest | 13 | 13 | 5 | 5 | 9 | 9 | 8 | 8 | 12 | 12 | 6 | 6 | 9 | 9 |
| totalobs | 56 | 56 | 19 | 19 | 37 | 37 | 27 | 27 | 48 | 48 | 18 | 18 | 35 | 35 |

**Table 4.6 Continued**

| | **Transport Equip** | | **Non-Fer. Metals** | | **Non-Met. Min.** | | **Paper** | | **Textiles** | | **Wood** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | RE | Mundlak | RE | Mundlak | RE | Mundlak | RE | Mundlak | RE | Mundlak | RE | Mundlak |
| $\beta$ | -0.3265 | -0.3597 | -0.3617*** | -0.8018*** | -0.5611*** | -0.8423*** | -0.3714*** | -0.5387*** | -0.7264*** | -0.9517*** | -0.4764*** | -0.6555*** |
| | (0.2368) | (0.5110) | (0.1099) | (0.2927) | (0.1200) | (0.1370) | (0.0920) | (0.1197) | (0.1151) | (0.1319) | (0.0922) | (0.1372) |
| Implied $\lambda$ | 0.0791 | 0.0892 | 0.0898 | 0.3237 | 0.1647 | 0.3694 | 0.0929 | 0.1547 | 0.2592 | 0.6061 | 0.1294 | 0.2131 |
| $P_E$ | 0.1637** | 0.1823 | 0.0601 | 0.1685* | 0.2226*** | 0.3185*** | 0.1605*** | 0.2294*** | 0.5295*** | 0.6319*** | 0.2788*** | 0.2865*** |
| | (0.0649) | (0.2260) | (0.0437) | (0.0933) | (0.0577) | (0.0642) | (0.0439) | (0.0572) | (0.0975) | (0.0997) | (0.0644) | (0.0698) |
| I/Y | 0.0658 | 0.0935 | 0.9385** | -0.4719 | -0.5536 | -0.5002 | -0.4479* | -0.282 | 0.1309 | 0.1647 | -0.3239 | -0.7958 |
| | (0.7417) | (1.3221) | (0.3738) | (0.7817) | (0.3584) | (0.3512) | (0.2313) | (0.1875) | (0.4409) | (0.4388) | (0.4021) | (0.4813) |
| Open | 0.0096 | 0.0269 | 0.0021 | 0.0255 | 0.0596* | 0.1253** | 0.0499*** | 0.0473* | -0.0028 | 0.0106 | -0.0318 | 0.0346 |
| | (0.0140) | (0.0458) | (0.0096) | (0.0257) | (0.0346) | (0.0527) | (0.0155) | (0.0275) | (0.0062) | (0.0084) | (0.0264) | (0.0331) |
| Balassa | -0.5020* | -0.9237 | -0.023 | 0.0346 | 0.0876* | 0.1654*** | 0.0115 | -0.0194 | -0.0004 | -0.0096 | -0.0187 | -0.0331* |
| | (0.2899) | (1.0580) | (0.0370) | (0.0428) | (0.0471) | (0.0630) | (0.0143) | (0.0237) | (0.0401) | (0.0545) | (0.0144) | (0.0173) |
| $Y_i/Y$ | 7.7576 | 10.0852 | 15.7769 | 100.344 | 3.0643 | -2.0452 | 2.3943 | 10.2196*** | 2.408 | -1.4632 | 15.4711** | 12.1356 |
| | (6.0207) | (17.7287) | (24.3919) | (85.4649) | (6.2667) | (8.7321) | (1.6597) | (3.7080) | (2.7859) | (4.0522) | (6.7929) | (14.6190) |
| $\varphi$Pe | | -0.3008 | | -0.0191 | | -0.3945*** | | -0.1705* | | -0.4461*** | | -0.2345 |
| | | (0.5532) | | (0.2174) | | (0.1339) | | (0.0903) | | (0.1658) | | (0.1465) |
| $I\varphi/Y$ | | 0.1853 | | 0.9032 | | -0.7066 | | -0.247 | | 0.0675 | | 1.6823** |
| | | (2.9324) | | (0.9808) | | (0.7311) | | (1.2666) | | (1.4297) | | (0.8322) |
| $\varphi$Open | | -0.0261 | | -0.0247 | | -0.065 | | -0.0337 | | -0.0256 | | -0.1084* |
| | | (0.0616) | | (0.0600) | | (0.0733) | | (0.0834) | | (0.0170) | | (0.0592) |
| $\varphi$Balassa | | 0.6296 | | -0.1937* | | -0.0856 | | 0.0596* | | 0.0731 | | 0.0583** |
| | | (0.9505) | | (0.1143) | | (0.0982) | | (0.0358) | | (0.0894) | | (0.0249) |
| $\varphi Y_i/Y$ | | -8.2045 | | 0 | | -2.5042 | | -12.251*** | | -1.6575 | | -15.887 |
| | | (21.1031) | | (0.0000) | | (14.1962) | | (4.5986) | | (5.8013) | | (15.5207) |
| $\varphi\beta$ | | 1.2527 | | 0.2072 | | 0.7953*** | | 0.3534 | | 0.5640** | | 0.5341*** |
| | | (1.9457) | | (0.3628) | | (0.1890) | | (0.2197) | | (0.2413) | | (0.1975) |
| $Chi^2$ | 9.10 | 7.63 | 17.58 | 34.63 | 32.83 | 61.35 | 39.35 | 113.89 | 48.98 | 86.56 | 47.35 | 73.46 |
| $Prob>Chi^2$ | 0.1682 | 0.8135 | 0.0074 | 0.0003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| $R^2$ | 0.3625 | 0.4327 | 0.6151 | 0.8523 | 0.4731 | 0.6643 | 0.5154 | 0.786 | 0.5443 | 0.7121 | 0.5853 | 0.7386 |
| $\rho$ | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.2210 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.5216 | 0.0000 |
| Hausman | 0.72 | | 9.95 | | 12.47 | | -1705.14 | | -28.52 | | 20.18 | |
| $Prob>Chi^2$ | 0.9940 | | 0.1267 | | 0.0522 | | chi2<0 * | | chi2<0 * | | 0.0026 | |
| regobs | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| ncrossest | 7 | 7 | 6 | 6 | 11 | 11 | 11 | 11 | 12 | 12 | 10 | 10 |
| totalobs | 23 | 23 | 18 | 18 | 44 | 44 | 44 | 44 | 48 | 48 | 39 | 39 |

## Appendix A. Additional Details on Energy Prices

Energy prices have been constructed using the energy-price data of 4 energy carriers (Electricity, Natural Gas, Heavy Fuel Oil and Steam Coal), including tax, for the aggregate industrial sector as they are published in the IEA Energy Prices &Taxes series (see section 2.3). Consistent series are available for the period 1978-1996. For some countries and years, however, price data are not provided by the IEA and hence they had to be estimated. This Appendix describes which energy-price data were lacking as well as the estimation procedure followed to complete the series as far as possible. In all calculations $P$ is the price of an energy carrier in US$ per toe including tax, unless otherwise stated, and $t$ is yearly time. Where it leads to no confusion, indices have been omitted for expositional clarity.

**Electricity** In the following calculations $P_t$ = Price Electricity and $n$ = all countries included in the database, except for DEU, ITA and JPN. Because the price of electricity in these countries differs significantly from all other countries (that show a similar pattern), they have not been used to estimate lacking energy-price data.

*Estimation Procedure per Country:*

AUS 1978-1996 Electricity prices are only available exclusive of Tax and in Australian $ per kWh. Therefore they first have been converted to electricity prices per toe (excluding tax) using the conversion rate from kWh to toe as given by the IEA. Next they have been converted to US$, using the exchange rate from Australian $ to US$ that has been derived from the price of natural gas, incl. tax (given by IEA).

CAN 1996

$$P_t = P_{t-1} * \frac{\overline{P_t}}{\overline{P_{t-1}}} \quad \text{with} \quad \overline{P} = \frac{1}{n}\sum_{i=1}^{n} P$$

DNK 1978

$$P_t = P_{t+1} * \frac{\overline{P_t}}{\overline{P_{t+1}}} \quad \text{with} \quad \overline{P} = \frac{1}{n}\sum_{i=1}^{n} P$$

NOR 1992-1996

$$P_t = P_{t-1} * \frac{\overline{P_t}}{\overline{P_{t-1}}} \quad \text{with} \quad \overline{P} = \frac{1}{n}\sum_{i=1}^{n} P$$

USA 1978-1996 Electricity prices are only available exclusive of Tax in US$ per kWh. Therefore, they have been converted to electricity prices per toe in US$ (excluding tax) using the conversion rate from kWh to toe as given by the IEA.

**Natural Gas** In the following calculations $P_t$ = Price Natural Gas, unless stated other wise, and $n$ = all countries included in the database, except for JAP, DNK, NOR and SWE. The price of natural gas in JPN differs significantly from the other countries, which show a similar pattern, and the price of natural gas in DNK, NOR and SWE has to be estimated. Therefore they have not been used to estimate lacking energy-price data.
For most countries the price of natural gas is in 1978 rather similar to the price of oil and coal. Therefore the price of natural gas in 1978 for DNK, NOR and SWE is taken as the average of the price of oil and coal for these countries.

*Estimation Procedure per Country:*

AUS 1997
$$P_t = P_{t-1} * \frac{\overline{P_t}}{\overline{P_{t-1}}} \quad \text{with} \quad \overline{P} = \frac{1}{n}\sum_{i=1}^{n} P$$

DNK 1978-1996
$$P_t = P_{t-1} * \frac{\overline{P_t}}{\overline{P_{t-1}}} \quad \text{with} \quad \overline{P} = \frac{1}{n}\sum_{i=1}^{n} P \quad \text{and} \quad P_{1978} = \frac{P_{oil,1978} + P_{coal,1978}}{2}$$

NOR 1978-1996
$$P_t = P_{t-1} * \frac{\overline{P_t}}{\overline{P_{t-1}}} \quad \text{with} \quad \overline{P} = \frac{1}{n}\sum_{i=1}^{n} P \quad \text{and} \quad P_{1978} = \frac{P_{oil,1978} + P_{coal,1978}}{2}$$

SWE 1978-1996
$$P_t = P_{t-1} * \frac{\overline{P_t}}{\overline{P_{t-1}}} \quad \text{with} \quad \overline{P} = \frac{1}{n}\sum_{i=1}^{n} P \quad \text{and} \quad P_{1978} = \frac{P_{oil,1978} + P_{coal,1978}}{2}$$

**Oil** In the following calculation $P_t$ = Price Oil and $n$ = all countries included in the database, except for AUS. The price of heavy fuel oil in AUS has to be estimated and is therefore not taken as a source for estimation.
The price of heavy fuel oil is rather similar among most countries, both in terms of price levels and price development, except for NOR and SWE where significant higher prices are reported due to a high tax rate. Nevertheless these two countries are included in the sample from which an average is taken because of lack of information about the tax rates in AUS. This may cause an upward bias in the estimated price for AUS. On the other hand, the price of AUS as given in the period 1978-1984 is also relatively high, and therefore it has been decided to include NOR and SWE in the sample.

*Estimation Procedure per Country:*

AUS 1985-1996
$$P_t = P_{t-1} * \frac{\overline{P_t}}{\overline{P_{t-1}}} \quad \text{with} \quad \overline{P} = \frac{1}{n}\sum_{i=1}^{n} P$$

**Coal** In the following calculations $P_t$ = Price Coal.

Furthermore:

- $n$ = all countries included in the database, except for AUS, DEU. The price of coal in DEU differs significantly from the other countries, which show a similar pattern, and the price of coal in AUS has to be estimated for that period. Therefore they have not been taken as a source for the estimations of lacking energy-price series.

- $m$ = all countries included in the database, except for AUS, DEU, CAN, BEL, NLD and SWE. The price of coal in DEU differs significantly from the other countries, which show a similar pattern, while the price of coal in AUS, CAN, BEL, NLD and SWE has to be estimated for that period. Therefore they have not been taken as a source for the estimations of lacking energy-price series.
- $q$ = all countries included in the database, except for AUS, DEU, DNK and NOR. The price of coal in DEU differs significantly from the other countries, which show a similar pattern, and the price of coal in AUS, DNK and NOR has to be estimated for that period. Therefore they have not been taken as a source for the estimations of lacking energy-price series.
- $s$ = all countries included in the database except AUS, DEU, CAN, BEL, NLD, NOR and SWE. The price of coal in DEU differs significantly from the other countries, which show a similar pattern. The price of coal in AUS, CAN, BEL, NLD, NOR and SWE has to be estimated for that period Therefore they have not been taken as a source for the estimations of lacking energy-price series.

*Estimation Procedure per Country:*

AUS 1978-1981
$$P_t = P_{t+1} * \frac{\overline{P_t}}{\overline{P_{t+1}}} \quad \text{with} \quad \overline{P} = \frac{1}{n}\sum_{i=1}^{n} P$$

AUS 1991-1996
$$P_t = P_{t-1} * \frac{\overline{P_t}}{\overline{P_{t-1}}} \quad \text{with} \quad \overline{P} = \frac{1}{m}\sum_{i=1}^{m} P$$

BEL 1992-1996
$$P_t = P_{t-1} * \frac{\overline{P_t}}{\overline{P_{t-1}}} \quad \text{with} \quad \overline{P} = \frac{1}{m}\sum_{i=1}^{m} P$$

CAN 1991-1996
$$P_t = P_{t-1} * \frac{\overline{P_t}}{\overline{P_{t-1}}} \quad \text{with} \quad \overline{P} = \frac{1}{m}\sum_{i=1}^{m} P$$

DEU 1996 Since the price of DEU differs significantly from the other countries, instead of using an average, the price of coal in DEU for 1996 has been estimated by multiplying the price of coal in DEU in 1995 with the average growth rate of the price of coal in DEU over the period 1990-1995, according to:
$$P_t = P_{t-1} * \frac{\ln P_{1995} - \ln P_{1990}}{5}$$

DNK 1978
$$P_t = P_{t+1} * \frac{\overline{P_t}}{\overline{P_{t+1}}} \quad \text{with} \quad \overline{P} = \frac{1}{q}\sum_{i=1}^{q} P$$

NLD 1992-1996
$$P_t = P_{t-1} * \frac{\overline{P_t}}{\overline{P_{t-1}}} \quad \text{with} \quad \overline{P} = \frac{1}{m}\sum_{i=1}^{m} P$$

| | | |
|---|---|---|
| NOR | 1978 | $P_t = P_{t+1} * \frac{\overline{P_t}}{\overline{P_{t+1}}}$ with $\overline{P} = \frac{1}{q}\sum_{i=1}^{q} P$ |
| | 1996 | $P_t = P_{t-1} * \frac{\overline{P_t}}{\overline{P_{t-1}}}$ with $\overline{P} = \frac{1}{s}\sum_{i=1}^{s} P$ |
| SWE | 1993-1996 | $P_t = P_{t-1} * \frac{\overline{P_t}}{\overline{P_{t-1}}}$ with $\overline{P} = \frac{1}{m}\sum_{i=1}^{m} P$ |

At the *sectoral* level the following energy prices could not be constructed due to a lack of sectoral energy consumption data:

| Country | Sectors | Period |
|---|---|---|
| CAN | MTR, MAC, FOD, TEX | 1988-1996 |
| JAP | WOD | 1978-1996 |
| USA | CST | 1978-1984 |

Note that for the price of petroleum products as one of the four main energy carriers, only the price of heavy fuel oil is used in the calculation of the energy prices, in combination with the sectoral data on the consumption of all petroleum products. Two remarks are in place here. First, heavy fuel oil consists of either high sulphur fuel oil or low sulphur fuel oil. The IEA commonly provides only one of these two series, depending on what is most used in a country. Second, heavy fuel oil forms of course only part of the petroleum products. Petroleum products comprise refinery gas, ethane, LPG, aviation gasoline, motor gasoline, jet fuels, kerosene, gas/diesel oil, heavy fuel oil, naphtha, white spirit, lubricants, bitumen, paraffin waxes, petroleum coke and other petroleum products (source: IEA/OECD Energy Balances). Using the IEA/OECD data presented in Energy Prices & Taxes, it is possible to construct a weighted petroleum price by making use of not only the Heavy Fuel Oil price, but also of the price of Light Fuel Oil (the sum of Gas/Diesel Oil + LPG+ Naphtha). At the aggregate industrial level both price and consumption data for these two types of oil are available. As said above, at the sectoral level only consumption data for petroleum products as a whole are available. Therefore using this refined (weighted) petroleum price in constructing sectoral energy prices, requires the assumption that the shares of the two types of fuel oil are the same for each sector. This is a strong assumption and therefore using the refined petroleum price may not add so much information as compared to the situation in which only heavy fuel oil price is used as a proxy for the price of petroleum products.

The conversion of *current* sector-specific energy prices (EPCU) to *constant* sector-specific energy prices (EPCO) is based on the following sector-specific conversion rates, which are derived from the ISDB database (OECD 1999). See Table A.1.

**Table A.1 Sector-specific currency conversion rates[a]**

| | IAS | NFM | MNM | MTR | MAC | FOD | PAP | WOD | CST | TEX | TAS | AGR | SRV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1978 | 0.591 | 0.591 | 0.696 | 0.553 | 0.689 | 0.543 | 0.458 | 0.701 | 0.493 | 0.73 | 0.626 | 1.022 | 0.554 |
| 1979 | 0.699 | 0.699 | 0.749 | 0.591 | 0.735 | 0.568 | 0.503 | 0.769 | 0.554 | 0.754 | 0.666 | 1.134 | 0.59 |
| 1980 | 0.759 | 0.759 | 0.813 | 0.642 | 0.801 | 0.599 | 0.553 | 0.757 | 0.616 | 0.796 | 0.744 | 1.048 | 0.634 |
| 1981 | 0.825 | 0.825 | 0.856 | 0.755 | 0.877 | 0.656 | 0.592 | 0.785 | 0.664 | 0.861 | 0.83 | 1.044 | 0.691 |
| 1982 | 0.829 | 0.829 | 0.933 | 0.826 | 0.958 | 0.676 | 0.634 | 0.779 | 0.704 | 0.893 | 0.822 | 0.979 | 0.734 |
| 1983 | 0.808 | 0.808 | 0.921 | 0.895 | 0.975 | 0.729 | 0.656 | 0.834 | 0.736 | 0.906 | 0.817 | 0.954 | 0.773 |
| 1984 | 0.858 | 0.858 | 0.975 | 0.93 | 1.018 | 0.792 | 0.713 | 0.861 | 0.78 | 0.919 | 0.857 | 1.08 | 0.792 |
| 1985 | 0.797 | 0.797 | 1.011 | 0.915 | 1.017 | 0.794 | 0.758 | 0.872 | 0.798 | 0.93 | 0.885 | 0.941 | 0.839 |
| 1986 | 0.769 | 0.769 | 1.065 | 0.952 | 1.029 | 0.843 | 0.816 | 0.889 | 0.895 | 0.952 | 0.9 | 0.906 | 0.862 |
| 1987 | 0.815 | 0.815 | 1.055 | 0.93 | 0.984 | 0.844 | 0.846 | 0.912 | 0.919 | 0.945 | 0.893 | 0.946 | 0.898 |
| 1988 | 0.983 | 0.983 | 1.007 | 0.903 | 0.966 | 0.843 | 0.909 | 0.938 | 0.949 | 0.971 | 0.965 | 1.039 | 0.921 |
| 1989 | 1.063 | 1.063 | 1 | 0.957 | 0.988 | 0.923 | 0.973 | 0.992 | 0.972 | 0.988 | 0.981 | 1.089 | 0.957 |
| 1990 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1991 | 0.932 | 0.932 | 1.028 | 1.113 | 1.014 | 1.085 | 1.036 | 1.028 | 1.006 | 1.019 | 1 | 0.964 | 1.037 |
| 1992 | 0.909 | 0.909 | 1.028 | 1.181 | 1.003 | 1.14 | 1.074 | 1.116 | 1.007 | 1.044 | 0.998 | 0.943 | 1.069 |
| 1993 | 0.89 | 0.89 | 1.053 | 1.257 | 0.987 | 1.132 | 1.097 | 1.265 | 1.043 | 1.041 | 1.009 | 0.977 | 1.101 |
| 1994 | 0.939 | 0.939 | 1.1 | 1.319 | 0.96 | 1.141 | 1.134 | 1.335 | 1.085 | 1.013 | 1.026 | 0.944 | 1.131 |
| 1995 | 1.075 | 1.075 | 1.147 | 1.377* | 1.002* | 1.102 | 1.271 | 1.334 | 1.135 | 1 | 1.058 | 0.94 | 1.167 |
| 1996 | 0.991 | 0.991 | 1.166 | 1.401* | 1.019* | 1.203 | 1.301 | 1.314 | 1.168 | 1.027 | 1.06 | 1.094 | 1.198 |

[a] Derived from OECD 1999

* For the sectors MTR (Transport Equipment) en MAC (Machinery) a conversion rate could not be derived directly from the ISDB for the period 1995-1996. Therefore these conversion rates (CR) are constructed according to:

$$CR_{m,t} = CR_{m,t-1} * \frac{\sum_{n=1}^{N-m} CR_{n,t}}{\sum_{n=1}^{N-m} CR_{n,t-1}}$$

with *N* the sum of *n* sectors and *m* is MTR, MAC.

## Germany

Finally, note that starting in the first quarter of 1991, the energy prices and taxes as presented in IEA Energy Prices & Taxes include both Eastern and Western Germany (DEU). Until 1990 IEA Energy Prices and Taxes Series include only West Germany (WGR).

In the database, the used energy prices of the aggregate industrial sector are assumed to be the same as in WGR. Therefore, to be precise, only the data from 1991 onwards may be used. However, the presented energy prices in the database are sector-specific energy prices and the *sectoral* energy consumption data of DEU are used to calculate the sector-specific energy-prices. Thus, it is assumed that the use of the aggregate industrial energy price of WGR in the period 1978-1990 weighted by the sectoral energy consumption for DEU does not lead to energy prices that are very different form the actual energy prices in the sum of Eastern and Western Germany over that period. In other words, it is assumed that the aggregate industrial energy price of WGR in the period 1978-1990 is not too different from the aggregate industrial energy price of DEU (weighted average of WGR and EGR).

**Appendix B: Additional Details on Energy Consumption**

The data on Total Final Energy Consumption (EQ) show several breaks. In most cases, the IEA provides information explaining these breaks. In this appendix, this information is summarised in order to provide the user of the database some background information regarding the breaks in energy data.[10]

| Sector | Country | Year | Reason: |
|---|---|---|---|
| AGR | CAN | 72-73 | Data for gas/diesel oil are available only from '73 |
| | JAP | 81-82 | Break in oil series due to a change in the reporting system. Break in gas/diesel oil explains almost the whole break. |
| | NLD | 83-84 | Break in oil and natural gas series due to introduction of a more comprehensive survey on end-use consumption. Break in Natural Gas explains the whole break |
| | NOR | 75-76 | Detailed breakdown for gas/diesel oil and heavy fuel oil is available from '76. Sum of these two (of which 80% gas/diesel oil) explains whole break. |
| SRV | BEL | 75-76 | The break in series for heavy fuel oil between 1975 and 1976 is due to a change in classification between the industrial and commercial sectors. |
| | DNK | 72-73 | Electricity is not available prior to '73. This explains exactly the break. |
| | | 74-75 | Heavy fuel oil is not available prior to '75. This explains the main part of the break. |
| | | 75-76 | Output of heat is not available prior to '76. Prior to '76 all consumption of oil in the service sector has been included with residential consumption. The sum of heat, heavy fuel oil and gas/diesel oil reported from '76 explains the main part of the break. |
| | FIN | 95-96 | In 1995, there is a break in series for petroleum products trade due to the aligning of the National Board of Customs trade data collection system with the European Union's Intrastat system. |
| | FRA | 84-85 | Break in petroleum products between commercial/ public services & residential. Not explained by OECD but very obvious. |
| | WGR | 75-76 | Petroleum products is not available prior to '76. This explains exactly the break. |
| | SWE | 85-86 | Petroleum products is not available prior to '86. This explains exactly the break. |
| IAS | USA | 94-95 | A detailed breakdown for natural gas and oil products is not available prior to '95. Heat data are estimated from 1995 onwards by the US Administration since they are no longer collected. The sum of petroleum products and natural gas plus the break in heat reported in '95 explains the whole break. |
| NFM | BEL | 70-71 | Coal (products) is not available prior to '71. Natural gas increases sharply in '71. The sum of these two (of which 70% coal) explains exactly the break. The reason behind the increase in natural gas is not clear. |
| | FIN | 70-71 | Electricity is not available prior to '71. This explains whole break. |
| | JPN | 70-71 | Electricity is not available prior to '71. This explains whole break. |

[10] Note that 'Petroleum products' comprise refinery gas, ethane, LPG, aviation gasoline, motor gasoline, jet fuels, kerosene, gas/diesel oil, heavy fuel oil, naphtha, white spirit, lubricants, bitumen, paraffin waxes, petroleum coke and other petroleum products.

| | | | |
|---|---|---|---|
| | DNK | 70-97 | EQ data are far too low for al years. General problem. The Danish Administration is expecting to revise the historical series in 1999. |
| | USA | 94-95 | A detailed breakdown for natural gas and oil products are not available prior to '95. The sum of petroleum products and natural gas explains exactly the break. |
| NMM | BEL | 70-71 | Petroleum products is not available prior to '71. This explains whole break. |
| | DNK | 71-72 | Petroleum products and electricity are not available prior to '72. The sum of these two explains exactly the break. |
| | NOR | 75-76 | Detailed consumption breakdown for gas/diesel oil and heavy fuel oil is not available prior to '76. |
| | FRA | 72-73 | Petroleum products consumption decreases sharply (with 75%). The reason behind the decrease in petroleum products is not clear. |
| | USA | 94-95 | A detailed breakdown for natural gas and oil products are not available prior to '95. The sum of petroleum products and natural gas explains exactly the break. |
| MTR | CAN | 87-88 | The time series from 1990 to 1997 have been revised by the Canadian Administration, which causes a break between 1989 and 1990; no data after 1987. |
| | NLD | 70-80 | Large steadily increase in energy consumption. Due to increase in natural gas consumption (200%). Note that Electricity and Petroleum Products consumption are not available prior to '82 and '84 respectively. They form, however, only 20% of the total consumption - the rest is natural gas. |
| | FRA | 70-71 | Petroleum products is not available prior to '71. This explains whole break. |
| MAC | BEL | 70-71 | Petroleum products, electricity and coal are not available prior to '71. The sum of these three explains exactly the break. |
| | CAN | 84 | 1984 shows sharp fall (with 50%) due to 50% decrease in electricity consumption. Reason of decrease in electricity is not clear. |
| | | 87-88 | The time series from 1990 to 1997 have been revised by the Canadian Administration, which causes a break between 1989 and 1990: no data after 1987. |
| | DNK | 71-72 | Petroleum products, electricity and coal are not available prior to '72. The sum of these three explains exactly the break. |
| | FRA | 70-71 | Petroleum products and coal are not available prior to '71. The sum of these two explains exactly the break. |
| | JPN | 81-82 | Petroleum products and coal are not available prior to '82. The sum of these two explains exactly the break. |
| | NLD | 81-82 | Break (increase) in energy consumption. Due to increase in natural gas consumption (300%). Significant breaks in series of natural gas between 81 and 82 reflect the introduction of more comprehensive surveys on end-use consumption. |
| | NOR | 75-76 | Detailed consumption breakdown for gas/diesel oil and heavy fuel oil is not available prior to '76. |
| | SWE | 70-71 | Electricity is not available prior to '71. This explains whole break. |
| | SWE | 96-97 | Electricity. Reason is unclear. |
| FOD | CAN | 72-73 | Large increase in energy consumption. Due to increase in petroleum products consumption (300%). Reason: Data for gas/diesel oil and heavy fuel oil are available only from '73. |
| | | 78-79 | Large temporary decrease in energy consumption. Due to absence of data on petroleum products. |

| | | | |
|---|---|---|---|
| | | 87-88 | The time series from 1990 to 1997 have been revised by the Canadian Administration, which causes a break between 1989 and 1990: no data after 1987. |
| | DNK | 71-72 | Petroleum products is not available prior to ’72. This explains whole break. |
| | NOR | 75-76 | Petroleum products is not available prior to ’76. This explains whole break. |
| | USA | 94-95 | A detailed breakdown for natural gas and oil products is not available prior to ’95. The sum of petroleum products and natural gas explains exactly the break. |
| PAP | DNK | 71-72 | Petroleum products and electricity are not available prior to ’71. The sum of these two explains exactly the break. |
| | FIN | 83-84 | Combustible Renewables and Waste is not available prior to ’84. This explains whole break. |
| | JPN | 81-82 | Combustible Renewables and Waste is not available prior to ’82. This explains whole break. |
| | NOR | 75-76 | Petroleum products is not available prior to ’76. This explains whole break. |
| | SWE | 72-73 | Combustible Renewables and Waste is not available prior to ’73. This explains whole break. |
| | USA | 94-95 | Break. A detailed breakdown for natural gas and oil products are not available prior to ’95. The sum of petroleum products and natural gas explains exactly the break. |
| WOD | CAN | 87-88 | Break. Due to absence of data on electricity from ’88 onwards |
| | FIN | 83-84 | Combustible Renewables and Waste is not available prior to ’84. This explains whole break. |
| | FRA | 88-89 | Combustible Renewables and Waste is not available prior to ’89. This explains whole break. |
| | | 97-98 | Break due to increase in Combustible Renewables and Waste. "From 1998, the French Administration (l'Observatoire de l'énergie) started to report combustible renewables and waste data to the Secretariat, which may lead to breaks in series between 1997 and 1998." |
| | NOR | 75-76 | Petroleum Products and Combustible Renewables and Waste are not available prior to ’76. This explains whole break. |
| | SWE | 72-73 | Combustible Renewables and Waste is not available prior to ’73. This explains whole break. |
| | GBR | 91-92 | Break. Due to absence of data on natural gas from ’92 onwards |
| | USA | 92-93 | Combustible Renewables and Waste is not available prior to ’93. This explains whole break. |
| | | 94-95 | Petroleum products, heat and natural gas are not available prior to ’95. The sum of these three explains exactly the break. |
| TEX | BEL | 70-71 | Electricity is not available prior to ’71. This explains whole break. |
| | CAN | 79-80 | Petroleum products is not available prior to ’80. This explains whole break. |
| | | 87-88 | The time series from 1990 to 1997 have been revised by the Canadian Administration, which causes a break between 1989 and 1990: no data after 1987. |
| | FRA | 72-73 | Petroleum products is not available prior to ’73. This explains whole break. |
| | NOR | 75-76 | Petroleum products is not available prior to ’76. This explains whole break. |
| | USA | 94-95 | Break. A detailed breakdown for natural gas and oil products are |

| | | | |
|---|---|---|---|
| | | | not available prior to ’95. The sum of petroleum products and natural gas explains exactly the break. |
| CST | DNK | 74-75 | Petroleum products is not available prior to ’75. This explains whole break. |
| | FRA | 72-73 | Petroleum products is not available prior to ’73. This explains whole break. |
| | NOR | 75-76 | Petroleum products is not available prior to ’73. This explains whole break. |
| | NLD | 81-82 | Natural Gas is not available prior to ’82. Due to introduction of a more comprehensive survey on end-use consumption This explains whole break. |
| | | 85 | Temporary low energy consumption, due to sharp decrease in petroleum products. |
| CHE | CAN | 75-76 | Natural Gas is not available prior to ’76. This explains whole break. |
| | USA | 94-95 | Break. A detailed breakdown for natural gas is not available prior to ’95. This explains whole break. |
| NSI | NLD | 92-93 | Heat produced for sale by autoproducers is not available prior to 1996. |
| | FRA | 81-82 | The separation of petroleum coke consumption into energy and non-energy use is not available prior to 1982. |
| | WGR | 84-85 | Unknown reason. |
| | NOR | 92-93 | Unknown reason. |
| | DNK | 91-92 | Unknown reason. |
| | SWE | 95-96 | Unknown reason. |
| | GBR | 95-96 | Unknown reason. |
| | FIN | 95-96 | Electricity and heat production from biogas are available from 1996. Heat output from autoproducer CHP is available from 1996. |