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A Glimpse on Sectoral Convergence of Productivity Levels

Gerald Müller

November 2000 Nr. 133

Diskussionspapiere
Discussion Papers

Department: Structural Change

Gerald Müller
++49-345-7753-850, gmr@iwh-halle.de

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Herausgeber:

INSTITUT FÜR WIRTSCHAFTSFORSCHUNG HALLE (IWH)
Postanschrift: Postfach 11 03 61, 06017 Halle (Saale)
Hausanschrift: Kleine Märkerstraße 8, 06108 Halle (Saale)
Telefon: (03 45) 77 53-60
Telefax: (03 45) 77 53-8 20
Internet: http://www.iwh-halle.de

A Glimpse on Sectoral Convergence of Productivity Levels

von

Gerald Müller

Institut für Wirtschaftsforschung Halle, IWH

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Abstract

This paper examines the presence of sectoral convergence of labor productivity between 14 OECD countries. Using the OECD International Sectoral Data Base (ISDB), the paper looks at the developments within 12 distinct sectors during the period 1970-1995. The change of the coefficients of variance suggests that there is strong sectoral convergence within most service sectors while the evidence of convergence for *Manufacturing* as well as for *Communication* is rather weak. These findings are in line with most studies undertaken on this subject so far. It is concluded that economic theories at hand to explain growth and convergence (or divergence respectively) are of different importance for the sectors concerned. While models of the *New Growth Theory* seemed to be useful to explain growth mechanisms within Manufacturing and Communication, traditional models seemed to apply to most other sectors.

Inhaltsangabe

In diesem Papier wird die sektorale Konvergenz der Arbeitsproduktivität von 14 OECD Ländern untersucht. Mit Hilfe der OECD International Sectoral Data Base (ISDB) wird die Entwicklung innerhalb von 12 Wirtschaftsbereichen während des Zeitraumes 1970 bis 1995 analysiert. Die Veränderung der Variationskoeffizienten weist einerseits auf eine starke Produktivitätskonvergenz der meisten Dienstleistungsbereiche hin, während sich andererseits für das *Verarbeitende Gewerbe* und für den Wirtschaftsbereich *Nachrichtenübermittlung* nur wenig Konvergenz zeigt. Diese empirischen Ergebnisse stimmen mit den meisten bisherigen Untersuchungen zur sektoralen Konvergenz überein. Aus den Ergebnissen wird geschlossen, dass die bestehenden unterschiedlichen Theorien zur Erklärung von Wachstum und Konvergenz (beziehungsweise Divergenz) von unterschiedlicher Bedeutung für die einzelnen Wirtschaftsbereiche sind. Während Modelle der *Neuen Wachstumstheorie* nützlich sind, um die Wachstumsmechanismen innerhalb des Verarbeitenden Gewerbes und des Wirtschaftsbereiches Nachrichtenübermittlung zu beschreiben, so scheinen traditionelle Modelle die anderen Bereiche besser zu erklären.

JEL-Classification: D24, F15, F43, O41, O57.

Contents

1. Introduction

Supply-side issues like innovations, transfer of technology, spillovers, knowledge, and human capital attract more and more attention. The issue of productivity or income convergence, for example, has motivated numerous researchers to analyze the mechanisms that eventually lead to convergence or divergence of productivity.

This paper tries to bridge the gap between the macroeconomic issue of productivity convergence on the aggregate level and the microeconomic issue of convergence on the industry level.

The impulse for this paper came from the fact that productivity levels following the reunification of East and West German differed quite significantly across sectors and industries. Overall, the productivity gap between East and West Germany in 1998 was about 40 percent. Yet, in some sectors, this gap has almost vanished, e.g. in *Banking and Insurance* or *Agriculture*, while in others the progress is rather disappointing, e.g. in *Transport* or *Other Services* with a productivity gap of around 60 percent. These sectoral differences suggest that it is worthwhile to analyze the causes of the productivity gap in more detail, and that sectoral specifics should be highlighted.

However, the East German case is a special one – large amounts of transfer payments went from West Germany to East Germany summing up to about 1 trillion Dollar for the last decade. These transfers certainly fueled the production of non-tradable goods. Hence, for more general conclusions about sectoral developments it seems useful to look at international developments.

The outline of this paper is as follows: The first part gives an overview on research already undertaken concerning the development of sectoral productivity levels across countries. One major finding of these analyses is that productivity convergence can be documented for some sectors while for other sectors the parameters signaling productivity convergence are not significant. Krugman (1987) suggests that the manufacturing sector, for instance, is better described by growth models based on the new growth theory, while other sectors can be well described by traditional growth models.

A weakness of the research done so far is that the sources for productivity growth and convergence have not been analyzed. Hence, the second part of this paper will give a short review on the mechanisms that might lead to convergence or divergence of productivity on the sectoral level. The third part subsequently uses the International Sectoral Data Base (ISDB) provided by the OECD to study the development of 12 different sectors in 14 different countries during the period 1970 – 1995.[1]

[1] The Intersectoral Database (ISDB) is described in detail in: MEYER-ZU-SCHLOCHTERN, F. J. M. (1988).

2. Sectoral convergence: What can be learned from the literature?

For the manufacturing sector, Dollar and Wolff analyzed international data provided by the UN Yearbook of Industry Statistics for the years 1963, 1979, 1982 and 1986 covering 13 OECD countries.[2] The authors aggregated 28 industries into four groups (heavy industries, medium industries, light industries, other industries). For the period from 1963 to 1982, convergence for overall manufacturing as well as for the four different groups was identified. Table 1 shows decreasing coefficients of variation until 1982 and also an increase of the average level of productivity relative to the USA. However, from 1982 to 1986 productivity across countries diverged slightly.

Table 1
Measures of productivity convergence covering 13 industrialized countries
- 1962-1986 -

	Coefficient of variation				Average productivity relative to USA			
	1963	1979	1982	1986	1963	1979	1982	1986
Heavy Industries	0,50	0,38	0,34	0,34	0,42	0,52	0,62	0,53
Light Industries	0,40	0,27	0,26	0,25	0,48	0,63	0,67	0,60
Medium Industries	0,33	0,24	0,25	0,20	0,59	0,75	0,79	0,66
All Manufacturing	0,36	0,24	0,23	0,24	0,47	0,62	0,66	0,60

Source: Dollar and Wolff (1988, 1993).

Dollar and Wolff argue that levels of productivity are more similar between industries than between the aggregate levels. Hence, increases of productivity are mainly fueled through shifts in employment structures towards capital and technology intensive industries. However, Dollar and Wolff could not identify a significant effect through shifts of employment, nor could they find an equalization of productivity levels on the industry level. In the end, they conclude that other factors such as the accumulation of capital and technological progress have to be considered to explain differences in productivity levels.

Likewise, Paci (1997) found convergence across regions not only for *Manufacturing* but also for *Services*. The analysis included 109 European regions and covered the period from 1980 to 1990. The speed of convergence was estimated at 1.7 percent annually for *Manufacturing*, while the estimate for *Services* was at 1.2 percent somewhat lower. Paci claims that most of the country dummies were significant. This means that the process of convergence is present at the overall European level as well as on the national level. In spite of this, no convergence was found for *Agriculture* or for the per capita income level.

[2] See DOLLAR, D.; E. N. WOLFF (1988, 1993) and DOLLAR, D.; E. N. WOLFF, BAUMOL, W. J. (1988).

Contrary to these findings various studies could not detect convergence concerning the productivity levels of the *Manufacturing sector* in different countries. Four of these studies will be presented in the remainder of this section.

Bernhard and Jones (1996) used the ISDB for their analysis. They tested the convergence hypothesis with the traditional approach suggested by Barro (1991). According to their results, the *Service sector* is an important engine for international convergence. Bernhard and Jones found a negative relationship between the initial level of productivity and the subsequent rates of productivity growth for the *Manufacturing sector*. However, the estimated parameter was not significant (see standard error SE in table 2). The results of their analysis of total factor productivity correspond to those of labor productivity.

Table 2
Results: convergence regression
- Sectoral labor productivity -

Sector	β	SE	t	γ[a]	R^2
Agriculture	0,0122	0,0078	1,57	0,0134	0,10
Mining	0,0290	0,0210	1,38	0,0364	0,07
Manufacturing	0,0262	0,0147	1,78	0,0326	0,14
Services	0,0244	0,0086	2,85	0,0283	0,56
Electricity, gas, water	0,0208	0,0095	2,20	0,0246	0,23
Construction	0,0227	0,0112	2,03	0,0274	0,19
Total industry	0,0298	0,0052	5,73	0,0385	0,71

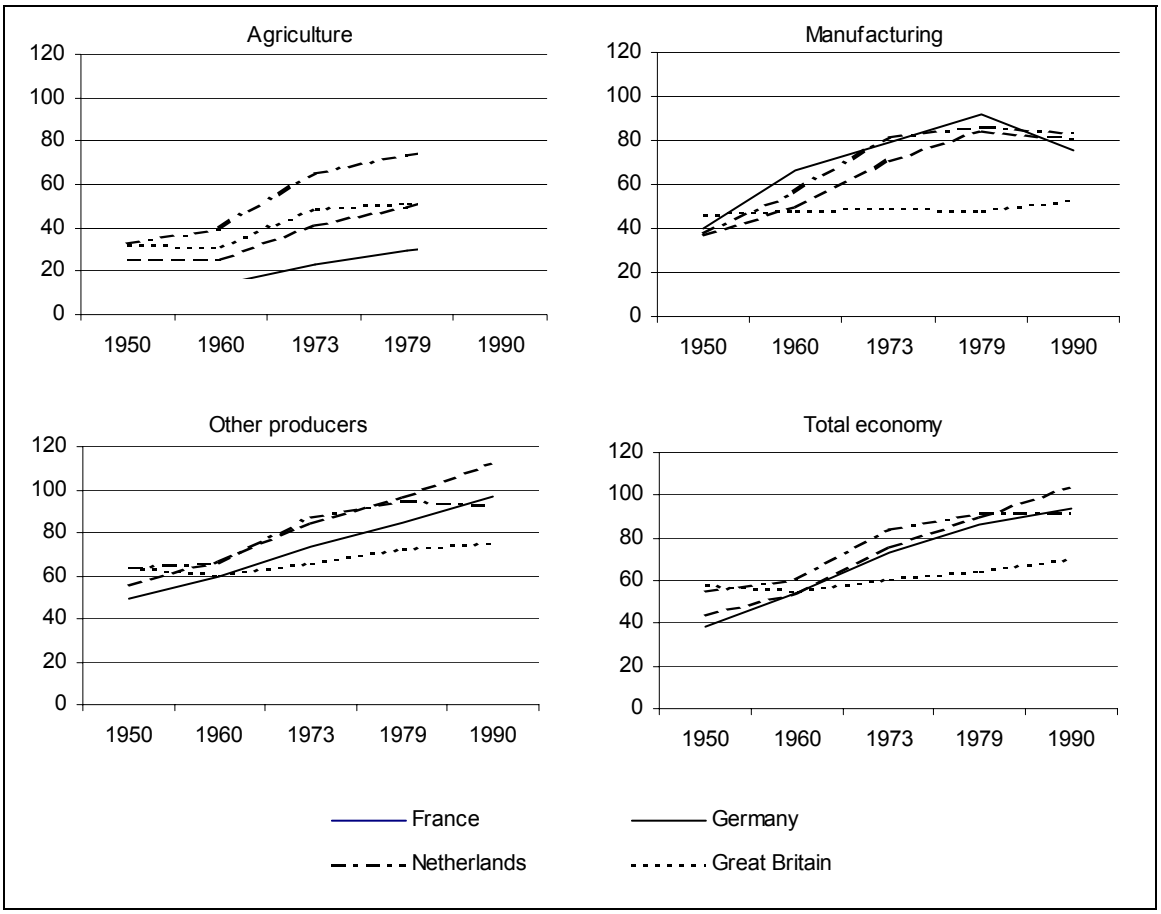
[a] Speed of convergence, calculated using β.

Source: BERNARD, A. B.; JONES, C. I (1996), S. 1226.

The same date base – the ISDB – is used by van Ark (1996). In his studies, van Ark is less interested in the question of convergence, he rather tries to identify periods of growth and stagnation. Using the method of "growth accounting", he estimates the importance of single components fueling the growth of productivity. Yet, his results concerning the convergence of productivity on the sectoral level are in line with the findings of Bernhard and Jones.

As figure 1 shows, the displayed countries (France, West Germany, Netherlands, Great Britain) could catch-up on the USA on the aggregate level. There is also a continuous process of convergence for the *Agricultural sector* and for the residual called *Other industries*, which contains mainly services. For *Manufacturing*, the process of convergence came to a halt during the nineteen eighties. Between the four European countries hardly any convergence was found.

Figure 1
Development of labor productivity of European countries relative to the USA
- USA=100 –



Source: van Ark (1996a), S.105.

Table 3
Various measurements of convergence, 13 OECD countries

	1970	1979	1987
Ratio between minimum and maximum			
Services	58,0	62,6	64,2
Manufacturing	54,8	55,0	49,2
Average efficiency			
Services	77,7	79,5	83,5
Manufacturing	72,0	71,7	67,4
Variation of efficiency levels			
Services	0,171	0,163	0,134
Manufacturing	0,213	0,224	0,248

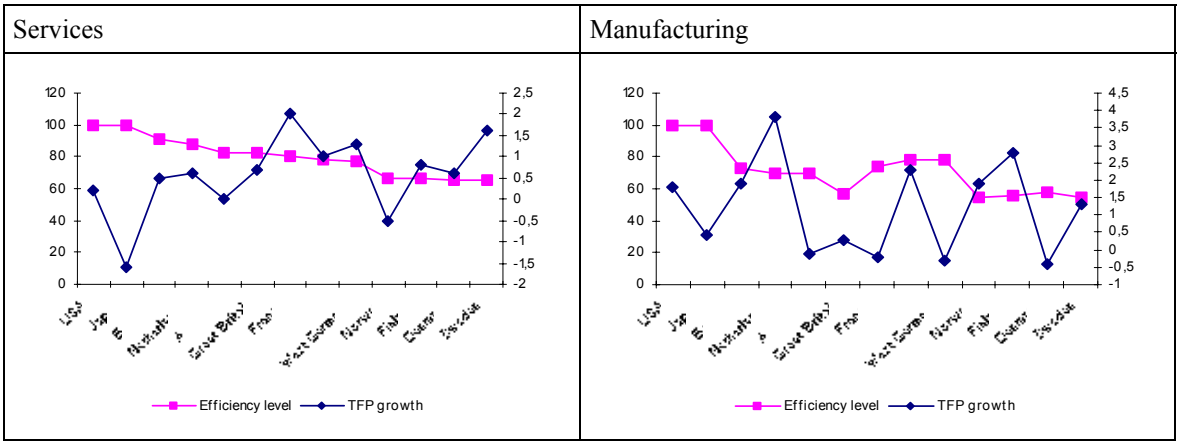
Source: Gouyette, C.; Perelman, S. (1997), S. 291.

Correspondingly, Gouyette and Perelman (1997) could identify a clear process of convergence concerning the *Service sector* while for *Manufacturing* they could not. Gouyette and Perelman likewise used the ISDB. Table 3 provides some measurements

calculated by them. All of these measurements suggest that there has been convergence of productivity in the service sector but not in the manufacturing sector.

Figure 2 shows that countries with a high level of productivity enjoy almost no increase in total factor productivity with regard to the service sector. This implies convergence across countries concerning the service sector. For manufacturing the picture is rather ambiguous. Countries with high efficiency levels can nevertheless experience high growth rates.

Figure 2
Efficiency level and TFP growth, Services and Manufacturing
- Average rates by country 1970-1987 –



Source: Gouyette, C.; Perelman, S. (1997), S. 289.

Broadberry (1993) already pointed out that, on the one hand, by looking at the USA, Great Britain, and Germany he could find no convergence for manufacturing within the period from 1870 to 1978. On the other hand, convergence for the whole economy was present. He concludes:

> „If, as I have argued in this article, the results for manufacturing are consistent with the results for the whole economy, the global convergence of GDP per Worker cannot be explained in terms of technology transfer in manufacturing. This in turn suggests the need for a more general view of the catching-up process. In addition to composition effects through structural change, productivity trends in sectors other than manufacturing have a role to play [...].“[3]

3. Theoretical background

The previous section raised the question if certain industries have a stronger tendency of convergence than others. The empirical section will deal with this question by looking at time series data presented in the all ready mentioned International Sectoral Data Base (ISDB) covering various countries, industries, and indicators.

[3] See BROADBERRY, S. N. (1993).

Still, prior to a meaningful interpretation of these time series, it is worthwhile to review the different theories explaining productivity convergence (or divergence):

- The traditional growth theory explains (conditional) productivity convergence via the accumulation of capital, which leads to decreasing factor returns and hence towards a slowdown of productivity growth.
- The traditional trade theory predicts an equalization of factor prices through international trade or factor movements. Eventually, the equalization of factor prices will bring about an equalization of factor productivity.

On the other hand, models of the new (or endogenous) growth theory or the new trade theory rooting in the traditional concepts come to different results. However, some of these models have room for convergence of productivity while others are helpful to explain divergence.

- Models including a catching-up effect caused by the absorption of foreign knowledge, for example, may very well explain convergence.
- Models that implicitly have a coefficient of productivity for the accumulated production factor of one (AK models) explain the absence of convergence.

All these different theories should be reflected in time series provided that they have explanatory power:

The *traditional growth theory*[4] predicts a catching-up process via the accumulation of capital if in one region the stock of capital is not optimal. In the Cass/Koopmans[5] model, this implies that the time preference rate is lower than the interest rate. When all the regions have reached their steady-state, the force promoting convergence will vanish. Productivity growth is subsequently determined only by technological progress. Hence, one would expect an initial convergence process driven by the convergence of the capital stock per employee.

Traditional models of trade theory[6] exhibit a static character. Two situations of equilibrium can be compared, but descriptions of dynamic changes are hardly possible. Still, if a small labor abundant country is integrated into the global trade regime, the traditional trade theory would predict that this country has a comparative advantage in producing labor-intensive goods. Global demand will lead to an increase of the price for labor-intensive goods in the home country and consequently wages will increase, too. Therefore, time series should reflect a convergence of wages especially in those industries producing tradable goods. For the non-tradable goods producing industries, only the sectoral mobility of workers will result in wage equalization.

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4 See SOLOW, R. M. (1956), SWAN, T. W. (1956).

5 See CASS, D. (1965), KOOPMANS, T. C. (1965).

6 The traditional trade (or Heckscher-Ohlin) Theory goes back to HECKSCHER, E. (1919) and Ohlin, B. (1933).

Models with technological spillovers[7] assume that one country holds the technological leadership in a certain industry while those countries lagging behind are able to reduce the productivity gap by absorbing technological knowledge from the leading country. Time series should therefore show few changes in the leadership position. Yet, at the same time not only labor productivity but also total factor productivity should converge, as the countries lagging behind are catching-up.

The more important accumulative factors are for the production of goods, the weaker the tendency of convergence is. In extreme cases, *AK models of the new growth theory*[8] become relevant and the tendency of convergence disappears. This finding not only applies to the whole economy but also to single industries. Time series for industries where AK models are useful to explain the development of productivity should show no convergence and the technological leadership might alter between countries.

4. Some empirical findings based on the International Sectoral Data Base

For the research project we look at 15 different countries.[9] For every country the total economy is split up into 13 different industries.[10] Yet, for analytical purposes we would like to group these industries into homogenous groups. The first categorization criterion, which is quite obvious, is whether a certain industry shows convergence of labor productivity across countries. Therefore, the percentage change of the coefficient of variance for the period 1970 to 1990 is calculated. With the exception of *Producers of Government services* all industries showed convergence across the countries included in the sample. To distinguish between those industries that have a stronger tendency of convergence and those that only show little convergence, we defined those industries in which the coefficient of variance decreased by more than 20 percent as industries with a strong convergence of labor productivity.

The second categorization criterion used for grouping is the rate of growth across countries. Again all industries with the exception of *Restaurants and hotels* and *Real estate and business services* showed an increase in labor productivity. Therefore, we

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[7] Two early publications on this issue were written by GERSCHENKRON, A. (1962) and ABRAMOVITZ, M. (1979). For contemporary empirical results see VERSPAGEN, B. (1991).

[8] Represented by ROMER, P. (1986, 1990) and LUCAS, R. E. (1988).

[9] These are: USA, Japan, Belgium, The Netherlands, Australia, Great Britain, France, Canada, West Germany, Norway, Finland, Denmark, Sweden, Italy.

[10] These are: Agriculture, hunting, forestry and fishing; Electricity, gas and water; Wholesale and retail trade; Transport and storage; Construction; Financial institutions and insurance; Real estate and business services; Mining and quarrying; Manufacturing; Communication; Restaurants and hotels; Community, social and personal services; Producers of government services. Some of these industries could very well be labeled as sectors (e.g. manufacturing, agriculture). However, to avoid confusion we will stick to expression “industries”.

distinguished between the industries depending on whether their rate of average annual growth was above or below one percent.

Table 4
Industries and their characteristics with regard to labor productivity
- Years 1970-1990 -

Industry	Change of the coefficient of variance in percent[a]	Average annual growth[b]	Spearman-correlation coefficient[c]	Productivity leader
Agriculture, hunting, forestry and fishing	-27	4,0	0,705	no
Mining and quarrying	-17	4,5	0,133	yes
Manufacturing	-14	3,0	0,446	yes
Electricity, gas and water	-52	2,8	0,710	yes
Construction	-59	1,0	0,499	no
Wholesale and retail trade	-66	2,0	0,764	yes
Restaurants and hotels	-14	-0,5	0,382	no
Transport and storage	-36	1,9	0,976	no
Communication	-11	4,4	0,571	yes
Financial institutions and insurance	-27	0,3	0,733	no
Real estate and business services	-46	-1,0	0,771	yes
Community, social and personal services	-15	0,5	0,923	yes
Total industries	-51	2,3	0,688	yes
Producers of government services	2	0,4	0,921	no
Other producers		1,2		yes

[a] Grey, if the change of the coefficient of variance was smaller than –20 percent. [b] Grey, if the annual rate of growth was more than 1 percent. [c] Grey, if the Spearman correlation coefficient was smaller than 0,7.

Combining these categories, we get four groups of industries. Evidently, there are further categories of importance for our analysis. Table 4 shows – aside from the percentage change of the coefficient of variance and the average annual growth rate – i) the Spearman correlation coefficient and ii) if one country held the position of the productivity leader for a longer period of time. The Spearman correlation coefficient accounts for the fact that industries that do not show a substantial decline of the coefficient of variance (in other words no sigma-convergence is present) can nevertheless have beta-convergence.[11] However, prerequisite for this type of beta-convergence is that the ranking order across countries changes over time. The Spearman correlation coefficient is a simple indicator for changes in the ranking order. Finally,

[11] See BARRO, R. J.; SALA-I-MARTIN, X. (1995), pp. 382-387.

table 4 indicates if individual industries have productivity leaders. On the one hand, models including a catching-up effect generally assume the presence of a persistent productivity leader. If, on the other hand, the leadership position frequently changes, this would imply that other sources are more important for productivity growth than knowledge spillovers.

Table 5
Industries and their characteristics with regard to labor productivity
- cross tabulation -

	High growth of labor productivity	Low growth of labor productivity
Convergence of labor productivity	Agriculture, hunting, forestry and fishing ELECTRICITY, GAS AND WATER WHOLESALE AND RETAIL TRADE Transport and storage	*Construction* FINANCIAL INSTITUTIONS AND INSURANCE Real estate and business services
No convergence of labor productivity	*MINING AND QUARRYING* *MANUFACTURING* *COMMUNICATION*	*Restaurants and hotels* COMMUNITY, SOCIAL AND PERSONAL SERVICES Producers of government services

Italics: frequent rank changes between the countries over time (Spearman correlation coefficient smaller than 0.7 – see table 4) and therefore, possibly beta-convergence. Capital letters: There is a productivity leader.

Table 5 allocates industries according to the described categories. We will look at one representative industry for each of the four groups in more detail. For that reason, six indicators are used to illustrate the sectoral developments across countries:

Labor productivity

Labor productivity is calculated as value added at market prices[12], at 1990 prices and 1990 purchasing power parities (PPPs) given in US dollars divided by total employment. It should be noted that by this definition we can only compare *values* (produced per employee) across countries, although these values are deflated and made comparable across countries using PPPs. The problem is that value added per employee could be the same for two countries while the goods and services produced per employee differ quite significantly in quantities and quality. Various authors therefore have argued that the usage of PPPs is inadequate. Instead, the creation of unit value ratios (UVRs) is suggested with prices for goods and services (produced in the home country) collected on a very disaggregated level. Using this price information, aggregate price ratios can be calculated based on the industry structure present in the countries under investigation.[13] This concept, which comes close to a measurement of

[12] For some countries, value added is only available at factor values. See table in the appendix.

[13] See for example ARK, B. VAN (1996b).

productivity in a technical sense, might be feasible for *Manufacturing*. However, with respect to *Services* the two main problems are i) the definition of homogenous entities of produced services and ii) that national statistics usually do not collect information about e.g. number of haircuts. Therefore, we stick to the pure *value* concept reflected by PPPs.

Sectoral shares of total employment

Unfortunately, the definition of employment differs across countries. Basically, three concepts are used: some countries count the number of jobs (one person might hold more than one job), some countries count the number of employees (regardless of the number of hours actually worked) and some countries provide figures about the number of full-time equivalent employees. For an overview see table in the appendix.

Total factor productivity

We calculated total factor productivity (TFP) by using the concept of a Cobb-Douglas type production function with factor weights of 0,3 for capital and 0,7 for employment.[14] The ISDB provides us with another variable called TFP. However, this variable represents the difference between output growth and the weighted growth of factor inputs, while we actually calculated levels of total factor productivity. Using logarithms, the level of total factor productivity is given by

$$(1) \qquad z^{TFP} = \alpha_1 \cdot l + \alpha_2 \cdot k - y$$

with α_1 and α_2 representing partial elasticities of substitution (or factor weights), while l and k represent the logarithms of the factor inputs labor and capital, y is logarithm of value added, and z^{TFP} the total factor productivity.

Capital intensity

For calculating capital intensity and total factor productivity the stock of capital is measured as gross capital stock, at 1990 prices and 1990 PPPs given in US dollars. National statistics are supplemented with OECD estimates. Some differences of capital intensity across countries might be due to different assumptions about average service lives. For Japan, service lives of equipment were assumed to be 11 years, while for Great Britain 26 years were assumed. For constructions, the variation of average service lives range from 29 year in the USA to 70 years in Sweden.

Deflators

For deflators, the ratio between value added at current prices (national currency) and value added at 1990 (US dollar PPPs) is computed, which of course is one for all industries in 1990.

[14] In some industries, the factor share of capital is well above average (e.g. Electricity, gas and water; Mining and quarrying; Real estate and business services), therefore the ISDB User's guide suggests to use weights for the capital share of 66 percent instead of 30 percent. Yet, for simplicity we kept these factor weights constant across industries and countries.

Wages

The compensation of employees comprises all payments by producers, such as wages in cash and contributions to social security and to private pension, casualty insurance, life insurance and similar schemes. Again, wages are given in PPPs (US dollars). However, wages should reflect purchasing power, therefore they are *not* deflated with industry specific deflators.

Now, we start analyzing the aggregate level of total industries before we turn to individual industries.

Total industries

Looking at the overall labor productivity – excluding *Government* and *Other producers*, it is evident that labor productivity converged while the leadership position of the USA was not challenged. The ranking between the other countries underwent some changes. Some countries continuously fell behind (e.g. Canada, Australia), while others could surpass several countries (e.g. West Germany). Only few countries switched between these two groups. All countries showed fluctuations around their long time growth trend.

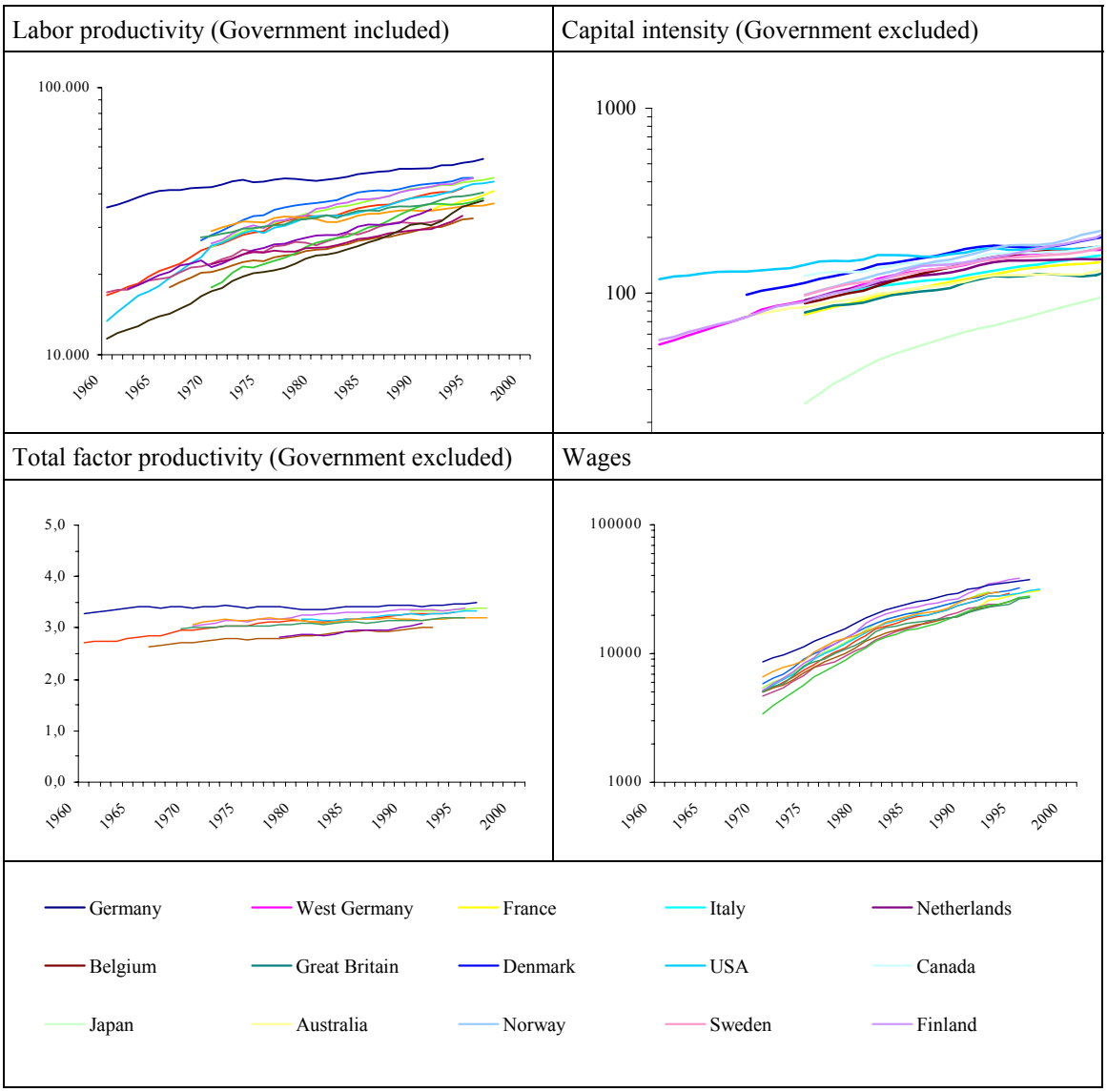
Total factor productivity displays a similar picture. Again, the USA holds an unchallenged leadership position for the period under review. Yet, the most recent data points show that Belgium and France are very close to US efficiency levels. The USA does not really show an increase in total factor productivity, which leads us to believe that increases in US labor productivity were exclusively driven by capital accumulation. However, the figures show that the USA lost its leadership position with regard to capital intensity. Japan experienced quite a dynamic catch-up process in terms of capital intensity. It seems that in 1970 capital intensity was inefficiently low and that the subsequent catch-up was driven by the mechanism described within the traditional growth model. Other countries might have experienced the same growth of capital intensity in the aftermath of World War II. However, figures for the period from 1960 to 1970 are available for very few countries.

Average wages increased more dynamically in the nineteen seventies than in the eighties and nineties. Time series show that wage levels across countries somewhat converged.

These empirical findings are suitable to support all of the cited theories about productivity convergence and divergence. Regarding traditional growth theory, the accumulation of capital has fueled the convergence of labor productivity. Consequently, the convergence of total factor productivity is less apparent than convergence of labor productivity. Regarding traditional trade theory, the development of wages across countries reveals convergence that can be explained by international trade and (or) factor movements. Furthermore, declining growth rates of wages in the eighties and nineties might be due to increased competition between countries for investments due to intensified trade, which is a sine qua no for the international mobility of capital.

Figures about the development of total factor productivity illustrate that all other countries included in the sample could catch-up with the USA. This could be explained by knowledge spillovers. However, when the USA is excluded from the sample, convergence of labor productivity is less apparent. The forces bringing about productivity convergence seemed to be fairly weak. Therefore, it is too early to put the AK-models of new growth theory aside. Especially, as the rates of productivity growth were barely decreasing during the period under investigation, which is a stylized fact better explained by new growth theory models than by traditional growth theory. One interesting question is, how this overall picture will change when individual industries are analyzed.

Figure 2
Total industries
- Various Indicators -



Source: ISDB.

Manufacturing

The average rate of productivity growth in manufacturing across countries between 1970 and 1990 was 3 percent while at the aggregate level it was 2.3 percent. For the whole period, manufacturing shows larger variations of labor productivity between countries than the aggregate level shows. Without an analytical tool, convergence of labor productivity is not visible in figure 3. However, the productivity gap between the USA and all other countries continuously decreased during the seventies and eighties. Yet, since the early nineties the productivity concerning manufacturing has grown relatively dynamically in the USA. Within the sample the developments are rather disparate: Some countries show high rates of productivity growth for the sixties and seventies that subsequently slow down. West Germany, for example, has contiguously been falling back since the beginning of the eighties. Then again, other countries do not reveal declining grow rates. The new EU member countries Sweden and Finland have experienced high rates of productivity growth since the beginning of the nineties – high compared to other countries and also compared to their own recent history.

Total factor productivity does not reveal any convergence for the manufacturing sector. Nonetheless, growth rates seemed to move similarly across countries. For instance, the growth rates of total factor productivity decreased in many countries in the middle of the seventies while in the eighties many countries experienced a period of continuous total factor productivity growth. There might have been some convergence since 1992. Yet, for these recent years there is no information on those countries that previously deviated significantly from the average.

From the methodical point of view, the high degree of variation of capital intensity is problematic. For example, the figures show that capital intensity in Finland was with $150.000 twice as high as in West Germany with only $80.000. Different assumptions about service lives cannot explain the difference in capital intensity between Finland and West Germany. It is also remarkable that according to the figures in 1968 total factor productivity in the USA was as high as in several countries only in 1995 (e.g. West Germany, Italy, Canada, etc.). This is not really in line with the general notion of technological progress. It is hard to believe that advanced countries do not adopt new technologies within very few years. Still, the leadership of the USA in total factor productivity allows the hypothesis that this lead is not only based on capital accumulation. The difference between wages paid in the USA and those paid in the other countries of the sample decreased. Also, wages seemed to move uniformly across countries. We can identify two phases of relative high wage increases namely from 1972 to 1975 and from 1978 to 1981.

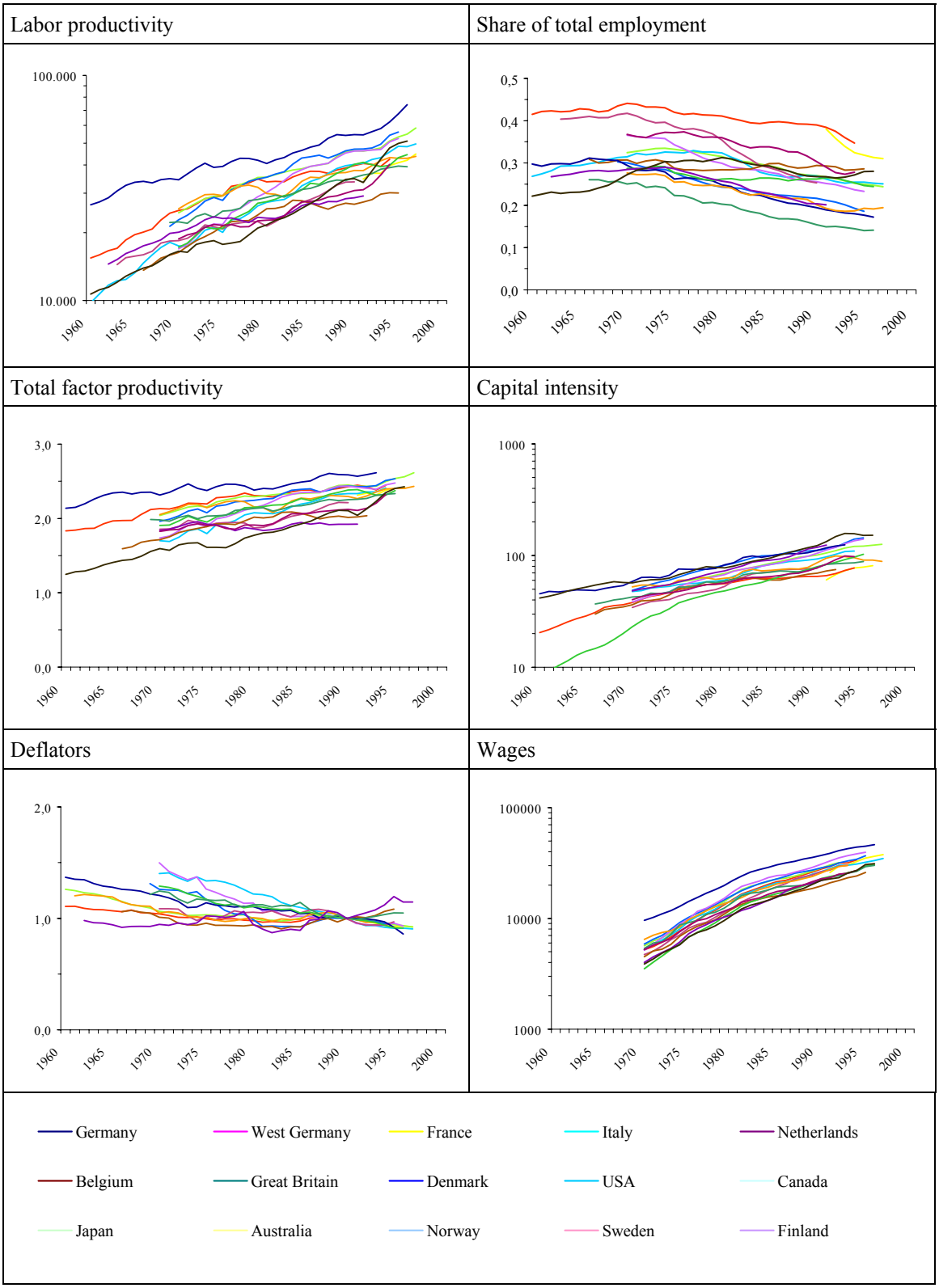
In most countries, the price level for manufactured products decreased in comparison to other products, which indicates that productivity gains were transmitted to other sectors via relative prices. Therefore, productivity gains in manufacturing raised income in all sectors (not only in the manufacturing sector itself).

All in all, manufacturing exhibits little convergence across countries. Estimated measurements for convergence presented earlier showed that convergence is detectable. However, traditional growth theory is not sufficient to explain the findings.

One factor that is stressed in many modern growth theory models is the accumulation of human capital. Unfortunately, no information on the accumulation of human capital is given in the ISDB. Therefore, we have to keep in mind that some of the differences across countries in labor and total factor productivity are certainly due to differences in the level of human capital employed.

Figure 3

Manufacturing
- Various Indicators -



Source: ISDB.

Wholesale and retail trade

On the one hand, *Manufacturing*, *Wholesale and retail trade* experienced relative high growth rates of labor productivity across countries compared to other industries. On the other hand, *Wholesale and retail trade* reveals a long-term trend of convergence. However, the ranking between countries does not change much and productivity differences are still quite large. Not surprisingly, countries known for large-scale shopping centers have above average labor productivity (e.g. Belgium, France, Great Britain). Wholesale and retail trade also show a convergence in total factor productivity. In most countries, capital intensity is continuously rising. (Only Canada shows declining capital intensity for a longer period.) Wages, too, are clearly converging. While in 1970 the wage level in the USA was by far the highest, in 1995 it was not higher than in Italy. Belgium shows an unusual picture with wages in *Wholesale and retail trade* greatly increasing since the middle of the seventies.

Surprisingly, the development of the deflators indicates that services of this industry became relatively cheaper. One would expect that this sector has only limited opportunities to increase productivity and hence to decrease relative prices. One fact that could explain decreasing prices is the tendency to employ less personnel in specialist shops and more un-trained personnel in giant stores.

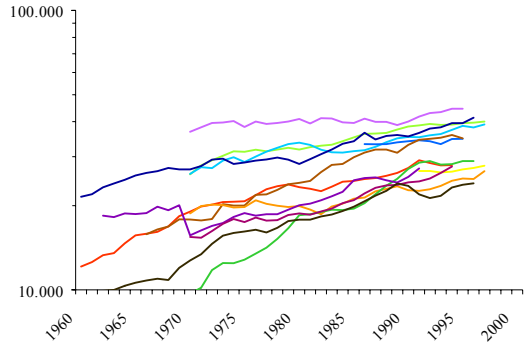
On the other hand, the continuous expansion of capital intensity and the constant share of total employment indicate that ever-larger shops produce ever growing turnover. In other words, with growing markets economies of scale allow amplified labor productivity and declining prices for services of the wholesale and retail trade industry.

Productivity growth is therefore driven by capital accumulation, and hence the traditional growth model is useful for describing cross sectional developments. Also, the slight increase of total factor productivity might be explained by technology spillovers as increasing capital intensity might be connected to more efficient techniques in terms of logistics, storage, etc.

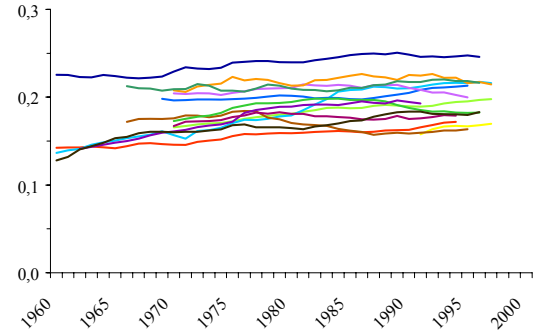
Figure 4

Wholesale and retail trade
- Various Indicators -

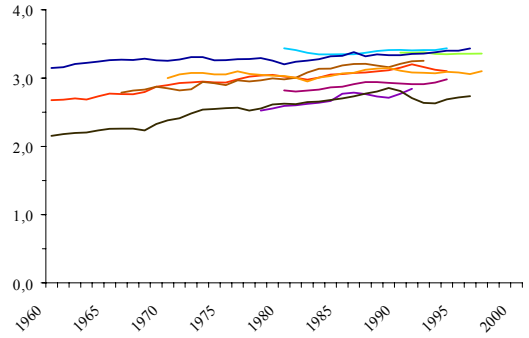
Labor productivity



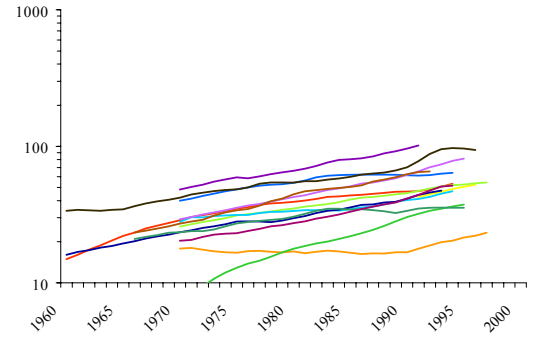
Share of total employment



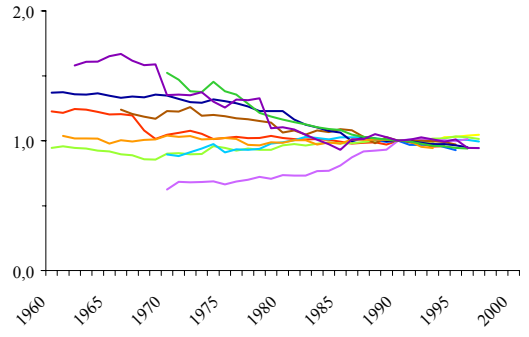
Total factor productivity



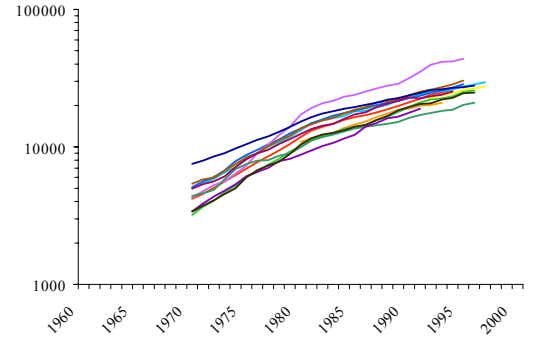
Capital intensity



Deflators



Wages



Germany, West Germany, France, Italy, Netherlands
Belgium, Great Britain, Denmark, USA, Canada
Japan, Australia, Norway, Sweden, Finland

Source: ISDB.

Restaurants and hotels

Neither convergence nor an increase of average productivity is present in the restaurant and hotel industry. Norway, Sweden and the USA even show declining real labor productivity. Total factor productivity stays constant over time for most countries while others experienced a decline of total factor productivity. Hence, there is no convergence in total factor productivity, either. Generally, it is extremely difficult to find measurements that reflect the "technical productivity" of an industry. What we have is a reflection of the value added per employee across countries (expressed in purchasing power parities for a certain base year). The problem is that value added per employee could be the same for two countries while the goods and services produced per employee differ quite significantly in quantities and quality. Certainly, this is a serious problem, which applies to all industries. However, it is more serious for those industries facing limited international competition.

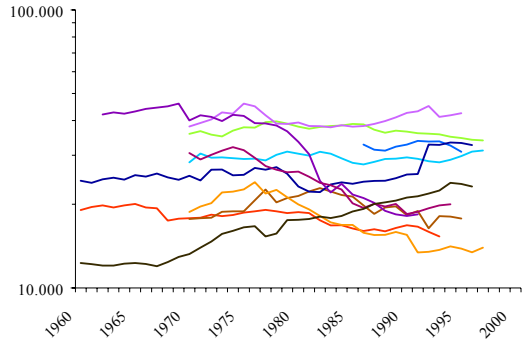
Capital intensities across countries are fairly dispersed in the restaurant and hotel industry. It is generally rather low and only Sweden and Finland have experienced a significant increase of capital intensity since 1970. Price levels of restaurant and hotel services usually increased more than the average price level for goods and services. One exception is the USA during the eighties.

This industry is a typical example for an industry that has no leverage for increasing real labor productivity. Also, there seemed to be no international linkage across countries concerning labor productivity. Labor productivity rather depends on national attributes e.g. consumer preferences. Moreover, differences are partly due to different data definitions, for example the number of employees. The Netherlands reports the number of full-time equivalent employees while Germany reports the number of employees. This might partly explain why the figures show labor productivity to be much higher in the Netherlands than in West Germany. As long as we cannot account for all these national disparities (which apparently have a strong effect concerning this industry), it is quite futile to explain developments of labor productivity across countries by any of the models mentioned before.

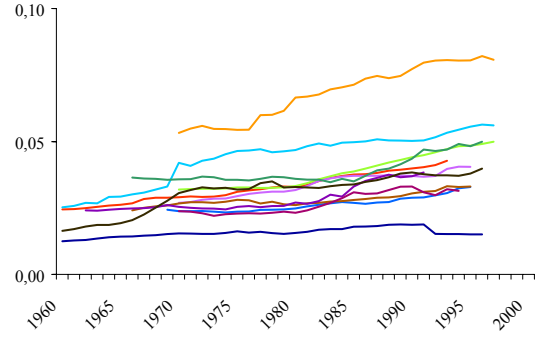
Figure 5

Restaurants and hotels
- Various Indicators -

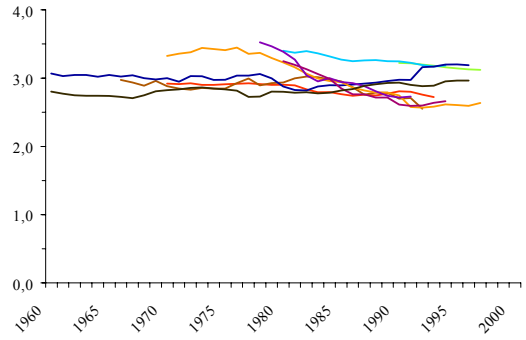
Labor productivity



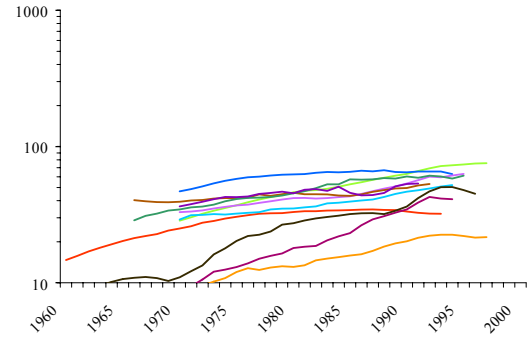
Share of total employment



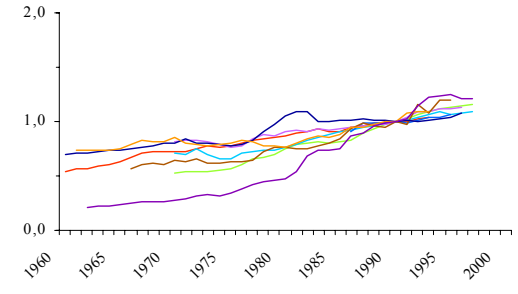
Total factor productivity



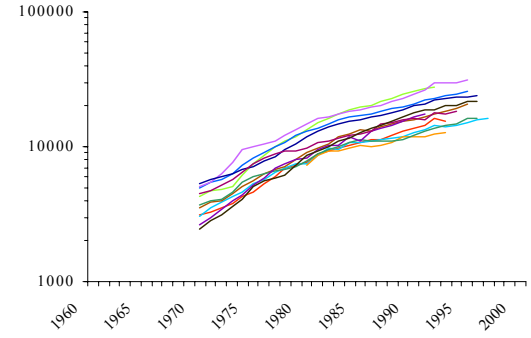
Capital intensity



Deflators



Wages



Germany, West Germany, France, Italy, Netherlands
Belgium, Great Britain, Denmark, USA, Canada
Japan, Australia, Norway, Sweden, Finland

Source: ISDB.

Financial institutions and insurances

Productivity leaders could barely increase their labor productivity, hence a convergence process occurred in the *Financial institutions and insurances* industry in so far as the less productive countries caught up. With the exceptions of Italy and Denmark whose productivity is well above, respectively below average, the cross section of countries shows some convergence. Average productivity was at $70.000 in 1997 (for total industries it was $39.000). West Germany, Belgium and Finland belong to the group of countries that managed to catch-up, while Norway and Denmark even showed a decrease of real productivity.

Looking at total factor productivity, the picture is quite diverse. While some countries (again West Germany, Belgium and Finland) showed an increase of total factor productivity, others (as Norway and the USA) experienced even a decline of total factor productivity. Overall, this lead to convergence, with Denmark being an exception as its total factor productivity is significantly below average. The picture is also rather diverse when looking at the development of the price level for services of this industry. For most countries, the figures reveal a relative increase in prices for services of this industry. However, in the nineteen eighties in Belgium and West Germany the price level of this industry increased less than the average price level. Similarly, the capital intensity is fairly diverse, too. In the USA it reaches $335.000 per worker while in Sweden the capital intensity was only $65.000 per worker (figures for 1993).

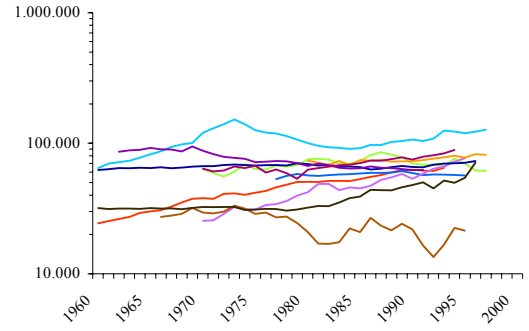
Italy has the highest wage level of all countries in this industry. Although the gap was reduced, in 1995 wages in Italy ($67.000) were still twice as high as in Denmark ($32.000). Again different definitions of employment might play a role: Italy reports full-time equivalents while Denmark reports all employees (even including unpaid family workers).

When Denmark and the USA are excluded from the picture (Denmark because its labor productivity is really low and the USA as its capital intensity is incomparably high) the figures show that all other countries could catch-up with Italy with respect to labor productivity and capital intensity. Thus, the mechanism for convergence can be explained by the traditional growth model. Moreover, the figures reveal no increase of total factor productivity. Nevertheless, this industry is of interest for explaining economic growth as its productivity is relatively high and its employment share grew in most countries. One may ask the question if labor productivity would show significantly higher growth rates if employment shares would have been constant.

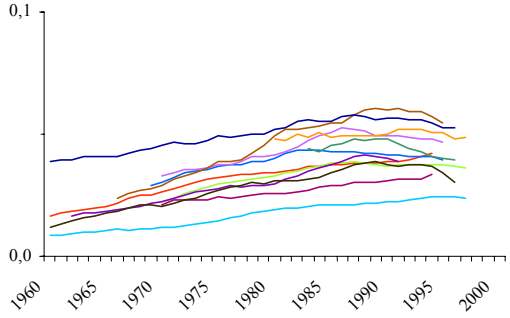
Figure 3

Financial institutions and insurance
- Various Indicators -

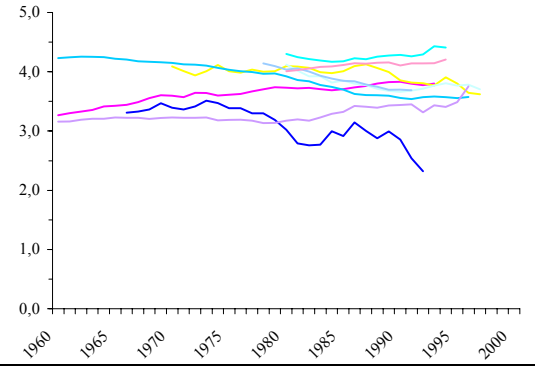
Labor productivity



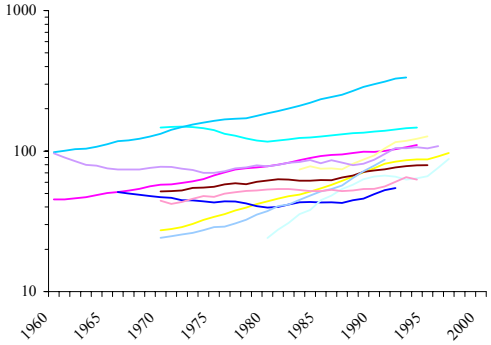
Share of total employment



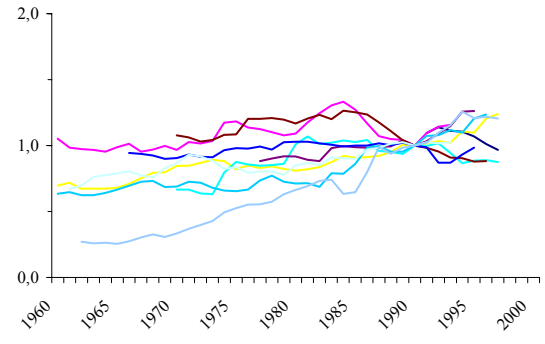
Total factor productivity



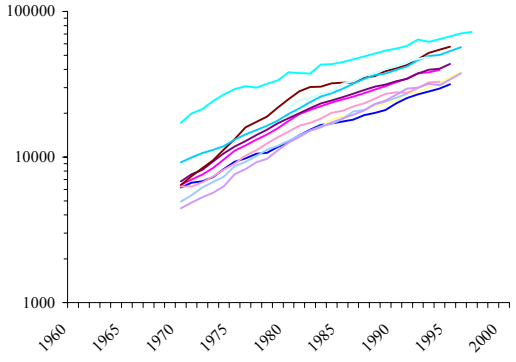
Capital intensity



Deflators



Wages



Source: ISDB.

5. Conclusion

The research project has so far been able to show that the dynamics on the sectoral level are very rich. Looking at individual sectors or industries is very informative when it comes to the questions about labor productivity convergence across countries.

Furthermore, the figures showed that some service sectors, contrary to conventional thinking, are fairly dynamic in terms of labor productivity growth. Hence, simple models splitting an economy into two sectors (the first one exhibiting growing labor productivity and producing tradable goods and the second one without advances in labor productivity and producing only non tradable goods) are insufficient to represent real economies.[15] Even so, we have to keep in mind that here only *values* expressed in purchasing powers were compared and not technical relationships. Hence, sectors that show productivity convergence in terms of value can nevertheless diverge in terms of technical productivity (and the other way round).

In this paper, industries were assigned to four different categories. Table 6 repeats these categories and adds theories suitable to explain industry specific dynamics.

Table 6
Theories about convergence of labor productivity and their relevance
- cross tabulation -

	High growth of labor productivity	Low growth of labor productivity
Convergence of labor productivity	Traditional growth theory with technological progress. Traditional trade theory. Models of new growth theory including knowledge spillovers.	Traditional growth theory with *no* technological progress.
No convergence of labor productivity	New growth theory: - AK models, - Models including human capital.	Persistent country specific differences (partly due to data insufficiencies).

Apparently, *Manufacturing* but also *Communication* are important engines for productivity growth. There is no evidence that convergence of capital intensity will result in a convergence of labor productivity. Growth rates do not seem to decline over time. Thus, it is very difficult to forecast future developments.

Other engines of productivity growth were *Agriculture*, *Wholesale and retail trade*, and *Transport and storage*. In these industries, capital intensity across countries converged.

[15] BALASSA, B. (1964). It is worth notifying that Balassa argued that exchange rates between countries with different productivity levels should not equalize purchasing power parities as services are cheaper in less developed countries (due to lower productivity). Turning the argument around would imply that by using purchasing power parities for comparison, we tend to overvalue manufactured goods and to undervalue services in less productive countries (compared to exchange rates reflecting costs of tradable goods).

Also the convergence of total factor productivity has had a positive - but less important - effect on labor productivity convergence.

Low rates of labor productivity growth but nevertheless some convergence were demonstrated by industries like *Construction*, *Financial institutions and insurance*, and *Real estate and business services*. Here we could detect the same mechanism causing convergence as for the previous category. However, productivity growth was much lower.

There was only limited productivity growth and no convergence in the *Restaurant and hotel* industry as well as in *Community services*, and *Government services*. For obvious reasons, it is difficult to quantify productivity levels of these sectors.

Still, even if history shows low levels of productivity growth for the last two categories, it is open to discussion how strong the influence of modern communication and information technologies will be on these industries. Considerable potential for increasing productivity could be discovered.

6. Future research agenda

Hitherto, no sophisticated empirical tools were used to identify and to quantify causal relationships. Yet, modern econometrics provide a wide rang of valuable empirical methods. Especially the theory of co-integrated time series will be useful for further analyses. If, for example, in some industries knowledge spillovers play an important role then time series reflecting the labor productivity of the productivity leader and the country absorbing spillovers should be co-integrated. Moreover, time series of wages should be co-integrated across countries if the theorems of traditional trade theory are correct – and so on.

Then again, for the application of econometric methods an appropriate economic model is needed. On the one hand, the model has to integrates a number of features: at least two factors of production, many goods, international trade containing tradable and non-tradable goods, technological progress, knowledge spillovers across countries. On the other hand, a mega model that could not produce clear-cut results does not make sense.

So far, purchasing power parities were used for comparing productivity levels as unit value rations for this extensive set of countries and industries were not on hand. Nevertheless, information about unit value rations should be used to improve future results of this research project.

Finally, our set of OECD countries barely contains positive examples of countries that were integrated into the European Union like e.g. Greece, Ireland, Spain or Portugal and that subsequently caught up with the advanced economies. The integration of Eastern European countries into the European Union will be an economically challenging project. Therefore, broad information about the fate of their predecessors would definitely be valuable.

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Appendix

Table A1: Definitions of various variables by county

	Gross Value Added	Employment	Base Year (national Source)	Industry coverage
Germany	Value added is given at market prices.	Total employment includes all persons pursuing one or several activities regardless of the number of hours actually worked. It includes soldiers or persons performing basic military service. It excludes persons in their capacity as owners of real estate, houses, dwellings or as holders of securities and similar assets.	1991	MID ex Quarrying Quarrying in MNM Structural Steal erection in MEQ Publishing in SOC Business services and real estate in SOC
West Germany	GDP is given at market prices.	Total employment includes all persons pursuing one or several activities regardless of the number of hours actually worked. It includes soldiers or persons performing basic military service. It excludes persons in their capacity as owners of real estate, houses, dwellings or as holders of securities and similar assets.	1991	MID ex Quarrying Quarrying in MNM Structural Steal erection in MEQ Publishing in SOC Business services and real estate in SOC
France	GDP is given at market prices.	Employment figures include all persons, resident or non resident, working in a resident unit of production. Estimates are annual averages where each person counts as one unit in his/her main activity. All types of employment are taken into account including interim, and fixed term jobs.	1980	
Italy	Series are provided at market prices.	Total employment includes all resident and non-resident workers who perform an activity for resident production units. Employment estimates are expressed in labor units. A person in employment is equal to one unit of labor if he/she works full-time in one job, to a fraction of a unit if he/she works part-time in a single job, and to one unit plus a fraction of a unit of he/she has more than one job, one of which is full-time and one part-time. Employment data are mid-year estimates. They include family workers and armed force.	1990	Industries are broken down according to the NACE classification. EGW corresponds to item Fuel and Power products. RES are included in Community and Social Services (SOC)
Netherlands	Value added is given at market prices.	Total employment is expressed in man-years or full time equivalent when one man-year equals the average contractual working hours of a full-time position on a yearly basis. Persons who do not have full-time employment for a whole year are only counted for the time they have actually worked in the year.	1990	
Belgium	Before 1975, Value added has been estimated by using gross of VAT data. From 1975 onwards. Data are net of VAT. Only a small part of indirect taxes is taken into account for the breakdown by economic activity.	Total employment covers employees, the self-employed, unpaid family workers and the armed force. Each person counts as one unit irrespective of the number of jobs he or she occupies.	1990	Data are given according to the NACE / CLIO classification.

Continuation

	Gross Value Added	Employment	Base Year (national Source)	Industry coverage
Great Britain	Gross Value added is given at factor values. All indirect taxes are excluded.		1990	Gross value added is based on the UK industry classification (SIC 92). Employment is still based on the previous industrial classification.
Denmark	Gross Value added is given at factor values. All indirect taxes are excluded.	Total employment covers employees, the self-employed, unpaid family workers and the armed force. Each person counts as one unit irrespective of the number of jobs he or she occupies. 12-month average.	1980	Gross fixed capital formation data (IT, ITV) are based on a different industrial classification. SOC includes HOT, RES except dwellings and OPR.
USA	Data are given at market prices. All indirect taxes are included in GDP. GDP data are the result of a major revision of the US national accounts.	Total employment covers "persons engaged in production" in domestic industries. It includes full-time equivalent employees and the number of self-employed persons and excludes unpaid family workers.	1992	Data are derived from the SIC87 used by the Bureau of Economic Analysis.
Canada	Gross value added is given at factor cost. All indirect taxes are excluded from GDP.		1992	
Japan	Data are given at market prices. All indirect taxes are included in GDP.	Total employment includes employees, self-employed persons and unpaid family workers working for resident units of production. Employees with more than one job are counted more than once.	1990	Hotels included in SOC. Wood industries included in MOT.
Australia	Data are given at market prices. All indirect taxes are included in gross value added.		1989 - 1990	National accounts data are classified to the ANZIC (Australian and New Zealand industrial classification).
Norway		Employment figures represent the annual average number of persons engaged in productive activities within the Norwegian territory. Total employment includes employees, self employed and unpaid family workers, part-time workers and persons temporarily absent from work. Persons with jobs in different industries are classified in the industry of their main employment.	1992	Industry coverage is different between the former and the new System of National Accounts.
Sweden		Employment estimates correspond to the annual average number of persons in employment.	1980[a]	
Finland	At basic values. Only a small part of indirect taxes is taken into account for the breakdown by economic activity.	Total employment covers employees, the self-employed, unpaid family workers and the armed force. Each person counts as one unit irrespective of the number of jobs he or she occupies.	1990	

[a] The data at 1990 constant prices are derived from the series of constant prices based on 1980 (before 1985), 1985 (for the period 1985 – 1990) and 1991 (for the period 1991 – 1995).

Source: ISDB 98, User's guide, OECD.