Labor Productivity in Western Europe 1975-1985: An Intercountry, Interindustry Analysis

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1. Introduction

The dynamics of productivity differentials across countries have attracted a lot of attention. Do productivity levels converge over time or not, and why or why not? The traditional Solow-Swan model (Solow, 1956, Swan, 1956) predicts that labor productivity levels will definitely converge, as technological opportunities are assumed to be identical across countries and the law of diminishing returns to capital is assumed to apply. In the Solow-Swan model, labor productivity differences are therefore caused by temporary capital-labor ratio differences only. More recent theories, however, argue that worldwide convergence is less likely. Examples that emphasize the role of different levels of investment (in physical capital as well as in knowledge and human capital) can be found in neoclassically oriented endogenous growth theory (Lucas, 1988, Romer, 1990, Grossman and Helpman, 1990), in evolutionary growth theory (Verspagen, 1991) and in Post-Keynesian growth theory (Dixon and Thirlwall, 1975, Fagerberg, 1988).

Empirical research on convergence has led to rather heterogeneous conclusions, mainly as a consequence of varying samples of countries. Well-known contributions are those by Baumol (1986), DeLong (1988), Dowrick and Nguyen (1989) and Barro and Sala-i-Martin (1992), all of whom examined the issue of convergence using a regression framework. Inspired by development economists who argue that economic development causes employment shifts from low-productivity agriculture to high-productivity manufacturing and services, some authors have taken a disaggregated view at productivity figures and calculated which part of aggregate productivity changes could be attributed to changes in the employment (or output) composition (e.g. Denison, 1967, Maddison, 1987, Jorgenson *et al.* 1987, Dollar and Wolff, 1993, and Bernard and Jones, 1996). In general, they found significant effects of what is often called ‘structural change’.

The fact, however, that industries are interdependent (both within and between countries) through input-output linkages seems to be largely overlooked. The present paper aims at an extension of the 'shift-share' analyses by Dollar and Wolff (1993) and Bernard and Jones (1996), explicitly taking into account these economic interdependencies. Therefore, it can be seen as an attempt to merge the convergence literature with the single-country input-output productivity decompositions by Wolff (1985, 1994), Galatin (1988), and Casler and Gallatin (1997).

Using two full-fledged intercountry input-output tables for six Western European countries[1] for 1975 (in 1985 prices) and 1985 and employment data for the same years, we decompose the aggregate labor productivity growth in six constituent parts. Two of these are related to changes in labor productivity levels for each industry in each country, two reflect changing industry output shares across the six countries (due to changing intermediate requirements and changing final demands) and the remaining two can be seen as the effects of changing trade relationships between the six countries.[2] Contrary to the bulk of input-output related structural change decomposition analyses, that apply an additive decomposition framework, we develop a multiplicative decomposition analysis.[3]

The methodology is discussed in the next section. Section 3 is devoted to a description of the data. In Sections 4 and 5, we will present the decomposition results. The results for the labor productivity change in the entire 'Euro-6 economy', country-specific effects and industry-specific effects are given in Section 4. A 'vertically integrated industry' viewpoint is adopted in Section 5, in order to see how changes in the input and trade structure have affected the ratio between the value added and the total labor as required to produce one unit of final demand. Further, the effects of structural change on convergence among comparable vertically integrated industries in each of the countries will be studied by means of regression analysis. The final section contains a brief summary and conclusions.

2. Methodology

In order to split changes in aggregate labor productivity into its determinants, we apply a multiplicative decomposition framework. We use the following definitions, in which N represents the number of industries per country and C the number of countries:

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[1] The countries are Belgium, Denmark, France, Germany, Italy and The Netherlands.

[2] Note that we do not investigate which factors affect an industry's labor productivity. This implies that we do *not* investigate the ways in which an industry's labor productivity level is affected by technological progress in other industries. For a study into the productivity effects of interindustry technology spillovers, see Los and Verspagen (1997). Verspagen (1997) also considers productivity effects of international spillovers. Los (1997) offers a survey of interindustry technology spillover measures.

[3] Classic contributions in the field of (additive) structural change decompositions are Chenery *et al.* (1962), Carter (1970), Wolff (1985), Feldman *et al.* (1987) and Skolka (1989). An extensive survey is presented by Rose and Casler (1996).

v: aggregate value added (scalar);
l: aggregate labor inputs (scalar);
π: aggregate labor productivity (v/l) (scalar);
A: matrix with input coefficients (NCxNC matrix), with typical element a_{ij}^{rs} denoting the input of product i from country r per unit of output in industry j in country s;
L: Leontief-inverse (NCxNC matrix), $L \equiv (I-A)^{-1}$;
F: matrix of final demands for each country of destination (NCx(C+1) matrix). The typical element f_i^{rs} denotes the final demand for product i produced in country r, by country s. s = 1, …, C, C+1 where C+1 denotes the aggregate of non-Euro 6 countries;
f: vector with elements f_i^r giving the final demand for output of industry i in country r (NCx1 vector). Note that $f = Fe$, where e is the (C+1)x1 summation vector consisting of ones;
λ: vector with elements λ_i^r giving the use of labor per unit of gross output in industry i in country r (NCx1 vector);
μ: vector with elements μ_i^r the value added per unit of gross output in industry i (NCx1 vector);

Using $v = \mu' L f$ and $l = \lambda' L f$ (primes indicating transposed vectors and matrices), we can write

$$\frac{\mu_1' L_1 f_1}{\mu_0' L_0 f_0} = \frac{\mu_1' L_1 f_1}{\mu_0' L_1 f_1} \cdot \frac{\mu_0' L_1 f_1}{\mu_0' L_0 f_1} \cdot \frac{\mu_0' L_0 f_1}{\mu_0' L_0 f_0} \quad \text{and}$$

$$\frac{\lambda_1' L_1 f_1}{\lambda_0' L_0 f_0} = \frac{\lambda_1' L_1 f_1}{\lambda_0' L_1 f_1} \cdot \frac{\lambda_0' L_1 f_1}{\lambda_0' L_0 f_1} \cdot \frac{\lambda_0' L_0 f_1}{\lambda_0' L_0 f_0} \ ,$$

in which indices are time indicators. For aggregate labor productivity change, this yields

$$\frac{\pi_1}{\pi_0} = \frac{v_1}{v_0} \cdot \frac{l_0}{l_1} = \left(\frac{\mu_1' L_1 f_1}{\mu_0' L_1 f_1} \right) \cdot \left(\frac{\lambda_0' L_1 f_1}{\lambda_1' L_1 f_1} \right) \cdot \left(\frac{\mu_0' L_1 f_1}{\mu_0' L_0 f_1} \cdot \frac{\lambda_0' L_0 f_1}{\lambda_0' L_1 f_1} \right) \cdot \left(\frac{\mu_0' L_0 f_1}{\mu_0' L_0 f_0} \cdot \frac{\lambda_0' L_0 f_0}{\lambda_0' L_0 f_1} \right) \quad \textbf{(1)}$$

where the first factor reflects productivity effects of changes in the value added coefficients, the second factor indicates the effects of changes in the direct labor requirements, the third factor describes the effects of changes in the production structure, and the last factor gives the effects of changes in the final demands.[4] The

[4] Note that Wolff (1994) recommends gross output divided by employment as the measure for labor productivity, partly because the change in μ_j equals the change in $\Sigma_i a_{ij}$. Hence changes in value added per unit of labor are contaminated by changes in the intermediate input coefficients. In our opinion, however, value added is a much better measure for output than gross output because it directly relates to the contribution of an industry to the economy's income. In addition, our database records imports from non-included EC countries and non-EC countries as primary cost categories. Therefore, changes in $\Sigma_i a_{ij}$ do

last two factors can be decomposed further in order to incorporate the distinction between effects of aggregate production structure changes and aggregate final demand changes on the one hand, and effects of changing international trade (with respect to both intermediate inputs and final demand deliveries) on the other. Using

*A**: matrix constructed by stacking C identical NxNC matrices of aggregate intermediate inputs per unit of gross output by industry by country (NCxNC matrix), $\forall r$: $[a^*]_{ij}^{rs} = \Sigma_{r=1}^{C} a_{ij}^{rs}$;

T^A: matrix of intermediate trade coefficients, representing the shares of each country in aggregate inputs, by input by industry by country (NCxNC matrix). $[t^A]_{ij}^{rs} = a_{ij}^{rs} / [a^*]_{ij}^{rs}$, note that $\Sigma_r [t^A]_{ij}^{rs} = 1$;

*F**: matrix constructed by stacking C identical Nx(C+1) matrices of final demand for product *i* by country *s* (NCx(C+1) matrix), $\forall r$: $[f^*]_i^{rs} = \Sigma_{r=1}^{C} f_i^{rs}$;

T^F: matrix of final demand trade coefficients, representing the shares of country *r* in aggregate final demand for product *i* in country *s* (NCx(C+1) matrix). $[t^F]_i^{rs} = f_i^{rs} / [f^*]_i^{rs}$, note that $\Sigma_r [t^F]_i^{rs} = 1$;

and *I* for the identity matrix we can write $L = \left(I - A^* \circ T^A\right)^{-1}$ and $f = (F^* \circ T^F)e$, $\circ$ denoting the Hadamard product (of elementwise multiplication).[5] Our final decomposition of aggregate labor productivity change can thus be written as

$$\frac{\pi_1}{\pi_0} = (2.1) \cdot (2.2) \cdot (2.3) \cdot (2.4) \cdot (2.5) \cdot (2.6), \text{ with} \qquad \mathbf{(2)}$$

$$(2.1) = \left(\frac{\mu_1 ' L_1 f_1}{\mu_0 ' L_1 f_1} \right), \quad (2.2) = \left(\frac{\lambda_0 ' L_1 f_1}{\lambda_1 ' L_1 f_1} \right),$$

$$(2.3) = \left(\frac{\mu_0 '[I - (A_1^* \circ T_1^A)]^{-1} f_1}{\mu_0 '[I - (A_0^* \circ T_1^A)]^{-1} f_1} \cdot \frac{\lambda_0 '[I - (A_0^* \circ T_0^A)]^{-1} f_1}{\lambda_0 '[I - (A_1^* \circ T_0^A)]^{-1} f_1} \right),$$

$$(2.4) = \left(\frac{\mu_0 '[I - (A_0^* \circ T_1^A)]^{-1} f_1}{\mu_0 '[I - (A_0^* \circ T_0^A)]^{-1} f_1} \cdot \frac{\lambda_0 '[I - (A_1^* \circ T_0^A)]^{-1} f_1}{\lambda_0 '[I - (A_1^* \circ T_1^A)]^{-1} f_1} \right),$$

$$(2.5) = \left(\frac{\mu_0 ' L_0 (F_1^* \circ T_1^F) e}{\mu_0 ' L_0 (F_0^* \circ T_1^F) e} \cdot \frac{\lambda_0 ' L_0 (F_0^* \circ T_0^F) e}{\lambda_0 ' L_0 (F_1^* \circ T_0^F) e} \right) \text{ and}$$

$$(2.6) = \left(\frac{\mu_0 ' L_0 (F_0^* \circ T_1^F) e}{\mu_0 ' L_0 (F_0^* \circ T_0^F) e} \cdot \frac{\lambda_0 ' L_0 (F_1^* \circ T_0^F) e}{\lambda_0 ' L_0 (F_1^* \circ T_1^F) e} \right).$$

Now, (2.1) represents the productivity effects of changes in the value added figures per unit of gross output by industry, (2.2) measures the effects of changed labor

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not necessarily imply a change in μ_j. This holds in particular in the case of import substitution.

[5] See Oosterhaven *et al.* (1995) and Oosterhaven and Van der Linden (1997) for a similar methodology concerning decompositions of value added growth.

requirements per unit of gross output by industry, (2.3) indicates the effects of changes in the interindustry structure (due to e.g. technological change, factor substitution, and changing output compositions within industries), (2.4) reflects productivity effects of changed trade structures with respect to commodities and services used as intermediate inputs, (2.5) represents the effects of final demand composition changes (due to e.g. substitution by consumers, investors or third countries following relative price changes, or changing preference structures) and, finally, (2.6) measures the aggregate labor productivity effects of changes in the trade structure as regards commodities and services used for final demand purposes.

As is well-known, structural change decompositions are not unique. Dietzenbacher and Los (1997, 1998) show that the sensitivity of (additive) decomposition results across different formulae may be very large. Therefore, we also report results obtained by a second decomposition, in which the weights are reversed compared to equation (2):

$$\frac{\pi_1}{\pi_0} = (3.1)\cdot(3.2)\cdot(3.3)\cdot(3.4)\cdot(3.5)\cdot(3.6) \text{ , with} \qquad \textbf{(3)}$$

$$(3.1) = \left(\frac{\mu_1' L_0 f_0}{\mu_0' L_0 f_0}\right), \quad (3.2) = \left(\frac{\lambda_0' L_0 f_0}{\lambda_1' L_0 f_0}\right),$$

$$(3.3) = \left(\frac{\mu_1'[I-(A_1^* \circ T_0^A)]^{-1} f_0}{\mu_1'[I-(A_0^* \circ T_0^A)]^{-1} f_0} \cdot \frac{\lambda_1'[I-(A_0^* \circ T_1^A)]^{-1} f_0}{\lambda_1'[I-(A_1^* \circ T_1^A)]^{-1} f_0}\right),$$

$$(3.4) = \left(\frac{\mu_1'[I-(A_1^* \circ T_1^A)]^{-1} f_0}{\mu_1'[I-(A_1^* \circ T_0^A)]^{-1} f_0} \cdot \frac{\lambda_1'[I-(A_0^* \circ T_0^A)]^{-1} f_0}{\lambda_1'[I-(A_0^* \circ T_1^A)]^{-1} f_0}\right),$$

$$(3.5) = \left(\frac{\mu_1' L_1 (F_1^* \circ T_0^F) e}{\mu_1' L_1 (F_0^* \circ T_0^F) e} \cdot \frac{\lambda_1' L_1 (F_0^* \circ T_1^F) e}{\lambda_1' L_1 (F_1^* \circ T_1^F) e}\right) \text{ and}$$

$$(3.6) = \left(\frac{\mu_1' L_1 (F_1^* \circ T_1^F) e}{\mu_1' L_1 (F_1^* \circ T_0^F) e} \cdot \frac{\lambda_1' L_1 (F_0^* \circ T_0^F) e}{\lambda_1' L_1 (F_0^* \circ T_1^F) e}\right).$$

Dietzenbacher and Los (1998) find that the results for the average of these two types of decompositions are generally very close to the average of all possible decomposition forms, at least in the additive case. The variance of the results, however, is generally much smaller when the two types of forms as in equations (2) and (3) are taken into account, then when all possible forms are used.

Equations (2) and (3) provide estimates of the various partial effects on labor productivity growth for the entire Euro-6 economy, aggregated over countries as well as over industries. In order to obtain estimates for single countries (aggregated over industries) and single industries (aggregated over countries), we replaced the vectors λ and μ in equations (2) and (3) by diagonal matrices with the same elements on the main diagonal and zeros elsewhere, and pre-multiplied all numerators and denominators with (1xNC) aggregation vectors, one for each country or industry.

3. Data Description

Our decompositions are implemented using data from Eurostat. The intercountry input-output tables for 1975 and 1985 were constructed at the University of Groningen on the basis of Eurostat harmonized national input-output tables (see Eurostat, 1979) and from harmonized international trade data (Eurostat, 1990).[6] The 1975 table has been constructed using 1985 prices in ecus. The conversion of values in national currencies into common ecu values was done using official exchange rates. This implies that we can not distinguish between real relative output fluctuations and output fluctuations because of exchange rate movements (see Maddison and Van Ark, 1989, for a survey of PPP-measurement methods at the industry level that attempt to circumvent this difficulty).

The tables contain all trade flows measured within and between six Western European economies (Belgium, Denmark, France, Germany, Italy, and The Netherlands), disaggregated into 25 industries. Because of incomplete employment data (see below) we had to merge three industries into one: "inland transportation services", "maritime transportation services" and "auxiliary transportation services" into "transportation services".

Final demand deliveries consist of "household consumption", "government consumption", "capital stock formation", and "inventory stock changes" to each of the Euro-6 countries as well as "exports to non-included EC countries" and "exports to third countries". In the present analysis we do not focus on differences between final demand categories, but on the countries of destination only. Hence, we lumped together the first four categories for each of the countries of destinations and added exports to both categories of non-Euro-6 countries into one group.

Finally, our measure of value added is "gross value added at market prices". Other primary input categories (like "imports from non-included EC countries") are not required for our analysis. Hence, each input-output table consists of a (6x23)x(6x23) intermediate deliveries part, as well as a (6x23)x7 final demand matrix and a 1x(6x23) value added vector.

With regard to the construction of the trade coefficient matrices T^A, we often encountered the problem that the use of an industry's output (summed over all countries-of-origin) by an industry is zero (that is, $\Sigma_{r=1}^{C} a_{ij}^{rs} = 0$). In that case trade coefficients could not be derived in a sensible way. Whenever this happened for both years, the trade coefficient could be assigned an arbitrary (but constant across years)

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[6] Details on the construction can be found in Van der Linden and Oosterhaven (1995) and Hoen (1998), earlier analyses making avail of these tables are Dietzenbacher *et al.* (1993), Oosterhaven *et al.* (1995), Dietzenbacher (1997), Dietzenbacher and Van der Linden (1997) and Oosterhaven and Van der Linden (1997).

value , which was chosen to be 0. However, in cases where the total use was zero in one year but positive in the other, it was necessary to replace the indefinable trade coefficients in the first year by some nonnegative value, the choice of which is likely to affect the results. In those cases we decided to assign this coefficient the same value as the corresponding trade coefficient for the other year, which implies that if all other values would have remained equal, all labor productivity effects would be ascribed to changes in the input structure and none to changes in the trade structure.

In order to compute labor productivity levels (value added per unit of labor input) by industry, we divided the value added elements from the intercountry IO-tables by the corresponding total employment figures in Eurostat (1986) and Eurostat (1991) for 1975 and 1985, respectively.[7] As is well-known, labor productivity levels are best measured when the labor input indicator reflects changes in working hours. Unfortunately, data on man years were available for The Netherlands only, so we had to use the total number of jobs. When interpreting the results, the downward bias for productivities in 1985 (compared to those for 1975), due to decreasing working hours per job in many industries and countries, should be borne in mind.

To obtain a common labor input indicator for all countries, we had to adapt the man year figures for The Netherlands. Assuming that employers had full-time jobs, we used ratios calculated from tables 1g and 1q (jobs per industry) and 4g and 4q (man years per industry) in Statistics Netherlands (1996) to correct for years worked by part-time and seasonal employees.[8] Especially in services industries the number of jobs appears to deviate strongly from the number of man years. Finally, in order to keep the level of aggregation as low as possible, we had to divide labor input totals for two groups of industries for Belgium 1975 and The Netherlands 1975 among their constituent individual industries according to their labor input compositions for 1978 documented in Eurostat (1988).

In Tables 1 and 2, some summary statistics on labor productivity are presented. Table 1 focuses on industry figures, Table 2 on country characteristics. Table 1 not only shows that labor productivity levels were very different for industries, but also that big differences existed between countries within an industry. ‘Euro-6’ industries with a relatively high labor productivity are “fuel and power products” (2), and, to a lesser extent, “chemical products” (5) and “other market services” (22). The highest standard deviations are found for “fuel and power products”, although Denmark’s apparent ‘catch-up’ in this industry reduced the dispersion significantly. In general, labor productivity levels within the

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7 Employment figures for a given industry in a given country in a given year often appear to vary across annual Eurostat publications. We used the most recent versions, except for Italy and The Netherlands in 1985. Data for The Netherlands and Italy were taken from Eurostat (1989), partly because this publication presents these data at a more appropriate level of aggregation than Eurostat (1991).

8 The industry classification in Statistics Netherlands (1996) is different from Eurostat’s NACE. For many industries reclassification was straightforward, but for some (notably “fuel and power products”, “other manufacturing”, “communication services”, “other market services”, and “non-market services”) the correction ratio may be relatively inexact.

Table 1

Euro-6 converged: standard deviations decreased in 14 out of 23 industries (coefficients of variation even in 19 industries). Moreover, the decreases were generally larger in size than the increases. With respect to the exceptions to the general convergence, the increased standard deviations in “agricultural, forestry and fishery products” (1) and in “office and data processing machines, precision and optical instruments” (8) are remarkable, especially when they are related to the low or moderate average levels in these industries.

The rightmost columns for both years show that there should be some room for labor productivity growth through increased international specialization, as in more than 50% of the industries the share of national employment turns out to be higher in the country with the lowest productivity than in the country with the highest. This holds in particular for tradable goods like manufacturing products where one would expect a more pronounced specialization pattern in Western Europe.[9] Apparently, labor productivity is not the main determinant for market share dynamics.

It should be noted, however, that industries and countries that appear in the ‘maximum’ columns should not automatically be interpreted as being the technologically most advanced, as labor productivities are also affected by capital-labor ratios that partly depend on (both industry- and country-specific) relative factor prices. An analysis of ‘total factor productivities’, TFP, (purely reflecting technological differences) would probably provide additional insights, but is not undertaken here due to a lack of reliable capital stock data.[10]

Table 2 presents summary statistics for the six countries under consideration, aggregated over industries. The countries are ordered according to their aggregate labor productivity levels in 1975. The figures in Table 2 also indicate that productivity convergence has occurred: the rates of productivity growth in the ‘low productivity’ countries Belgium and Italy were higher than in the other countries. France has overtaken The Netherlands, the same holds for Belgium vs. Denmark.

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9 The very low values for labor productivity in Dutch “other market services” (22) is remarkable. This is probably due to the Eurostat data on labor inputs. We do not think this will influence our analysis too much, as we investigate growth rates, not levels in our decomposition analyses.

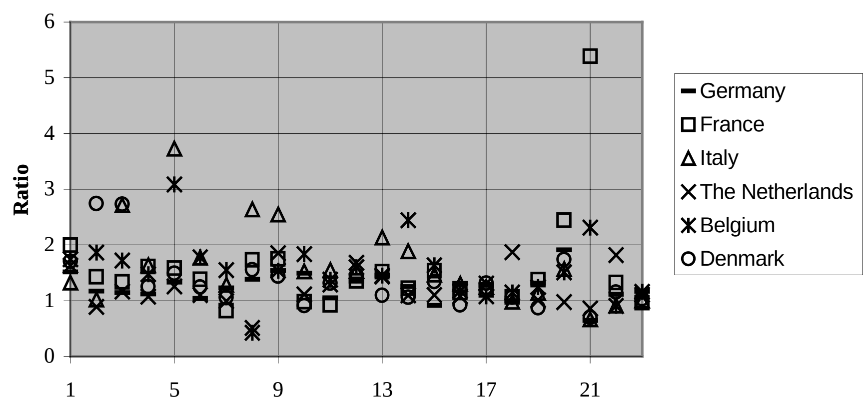
10 Contrary to labor productivity, the derivation of ideal TFP indices is not unambiguous, as it requires assumptions on the degree of substitutability of capital and labor and also depends on one’s view on capital as a produced input (see Wolff, 1985).

Table 2: Labor productivity levels (in 1000s of ecus per worker) **and growth rates by country.**

	1975	1985	%growth
GER	23,90	29,96	25,36
NTH	23,66	28,24	19,36
FRA	23,61	29,47	24,82
DEN	22,44	26,33	17,34
BEL	21,25	26,99	27,01
ITA	18,30	23,40	27,87
Euro-6	22,20	27,64	24,50

So far we have mostly taken a static viewpoint with respect to industry productivity. Figure 1 offers insight into labor productivity growth rates between 1975 and 1985 for each of the 23 industries in each country. Most industries experienced 10-year growth rates between 0% and 100% (corresponding to ratios between 1.0 and 2.0), but there are some important exceptions. Italy's high aggregate productivity growth rate, for example, appears to be caused mainly by strong productivity increases in a few manufacturing industries ("chemical products" (5), "office machines and instruments" (8), and "electrical goods" (9)).

Fig.1: Labor Productivity Ratios by Industry, 1975-85



For Belgium, manufacturing industries also seem to be the most important sources of the productivity catch-up ("chemical products" (5) and "rubber and plastic products" (14)), although the "credit and insurance services" industry (21) also increased its productivity with more than 100%. France, on the contrary, seems to owe its aggregate productivity increase mainly to a couple of services industries.[11]

[11] It should be mentioned that this is not in line with the results of Maddison's (1987, table A6) detailed study and might be caused by our use of exchange rate-based value added data. Maddison reports annual average compound productivity growth rates for services industries of 1.1 (France), 1.7 (Germany) and 0.2 (The Netherlands), and much higher

With the exception of "lodging and catering services" (18) and "other market services" (22), The Netherlands appear to be on the bottom side for most industries. German industries do not show much variation, while most Danish industries seem to have performed just below average.
The issue of convergence can also be dealt with at the industry level. We estimated a simple linear equation that links the ten-year labor productivity growth rates by industry by country (the ratios depicted in Fig. 1 minus one, *gr*) to the logarithms of the corresponding 1975 labor productivity levels (*linit*) as well as industry dummies to correct for interindustry level effects. We carried out the analysis for three samples of industries: the total sample (n = 138), a sample of manufacturing industries (classification codes 3 to 15, n = 78) and a sample of services industries (classification codes 17 to 23, n = 42). Not reporting the estimates for the industry dummy coefficients that turned out to be insignificant for the large majority of industries, the results are (t-values between brackets):

Total sample: $$gr = \underset{(9.39)}{3.545} - \underset{(10.4)}{1.075}\,linit\,,\ R^2 = 0.58;$$

Manufacturing sample: $$gr = \underset{(12.8)}{4.319} - \underset{(12.6)}{1.432}\,linit\,,\ R^2 = 0.77;\qquad \textbf{(4)}$$

Services sample: $$gr = \underset{(4.43)}{3.310} - \underset{(4.60)}{1.002}\,linit\,,\ R^2 = 0.46;$$

The significantly negative estimates for the initial productivity coefficient clearly show that labor productivity convergence occurred between 1975 and 1985 in the Euro-6 industries.[12] Convergence was relatively strong within manufacturing, compared to the rest of the industries.

The general picture sketched in this section is that labor productivity changes have varied within rather broad ranges, across countries as well as across industries. Until now, however, we have only briefly touched upon the effects that are the main focus of this study, aggregate labor productivity changes that are due to shifts of production between different countries and different industries. The remainder of this paper is devoted to the decomposition analyses that give more insight into the magnitude of these effects.

4. Decomposition Results

The results of the application of decomposition equations (2) and (3) are documented in Tables 3 and 4. In Table 3, the focus is on the effects of the distinguished factors on

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productivity growth rates for French agriculture and manufacturing. His period of analysis is comparable to ours, 1973-84.

[12] F-tests led to rejection of the hypothesis that both the intercept and the convergence coefficient are zero at the 1% significance level.

labor productivity levels for the six countries (aggregated over industries), Table 4 emphasizes the effects on productivity levels for the 23 industries (aggregated over countries).

Table 3: Labor productivity decomposition results by country

Country	Total[a]	Factor 1[b]		Factor 2		Factor 3		Factor 4		Factor 5		Factor 6	
GER	1.253	0.912	0.918	1.366	1.360	1.017	0.989	0.990	1.014	0.999	1.005	0.999	0.996
FRA	1.248	0.978	0.976	1.303	1.284	0.987	0.991	0.995	0.998	0.998	1.003	1.000	1.004
ITA	1.279	0.975	0.983	1.327	1.312	0.990	0.983	1.001	1.001	1.000	1.003	0.997	1.004
NTH	1.193	0.889	0.895	1.508	1.455	0.908	0.998	1.042	0.959	0.962	0.966	0.978	0.991
BEL	1.270	0.947	0.956	1.366	1.301	0.994	1.009	0.999	1.000	0.982	1.003	1.008	1.008
DEN	1.174	0.965	0.962	1.208	1.196	1.010	1.031	1.005	0.992	0.974	1.000	1.018	0.997
Euro-6	1.245	0.946	0.950	1.343	1.324	0.994	0.992	0.999	1.002	0.989	0.996	0.998	1.000

[a] Ratio of labor productivity in 1985 to labor productivity in 1975.
[b] Left columns refer to results of Eq. (2), right columns to results of Eq. (3)

The last line of Table 3 shows that the labor productivity increase of 24.5% in the 'Euro- 6 economy' (already presented in Table 2) is almost exclusively caused by two of our six factors: the decreased labor input per unit of gross output would have increased productivity by about 33% if no other factor had changed, an effect that is partly offset by a productivity-decreasing effect of a smaller share of value added in total inputs (about -5%). The remaining four factors seem to have had a negligible influence, although both factor 3 (changing input structures) and factor 5 (changing final demand compositions with respect to commodities) may have had weak negative effects on productivity in the aggregate Euro-6 economy. Furthermore, it should be noted that these results are found using either of both polar decompositions: differences are small.

The results are roughly similar for each of the countries, except for The Netherlands. For this country, we find a much stronger positive effect of decreasing labor inputs (factor 2), which did not yield an extraordinary productivity increase because every factor except factor 4 seems to have had a compensating negative effect. In particular, the changing final demand compositions with respect to commodities (factor 5) seem to have resulted into a shift away from high-productivity activities in The Netherlands, accounting for about 4% productivity decrease.

The most interesting results in Table 3 for other countries are the relatively strong negative effect, about 8.5%, of decreasing value added per unit of gross output (factor 1) in Germany and the below-average positive effect of decreasing labor inputs in Denmark (only 20%). Further, only three countries (Italy, the Netherlands and, to a lesser extent, France) appear to be responsible for the weak negative effect of factor 3 for the Euro-6 economy, the other countries being unaffected by changes in input structures or even experiencing a slightly productivity-increasing effect (Denmark). Belgium and Denmark resembled The Netherlands in the sense that factor 5 had a significant negative impact on productivity, although the size of this effect was only about 1% in Belgium and about 2% in Denmark.

In our opinion, the rather general validity of the Euro-6 economy results for individual countries is not very surprising as the countries have roughly gone through the same stages of development and were all very stable in an institutional and political sense. It would have been very interesting to extend the present analysis to, say, 1995 in order to see how the reunification of Germany (with significantly lower productivity levels in the former GDR) had affected the results, but unfortunately Eurostat decided to stop the construction of harmonized input-output tables after 1985.

The results for separate 'Euro-6 industries' (presented in Table 4) show much more variability than the results by country, due the diversity of industries. This diversity is clearly reflected in the first column, showing that labor productivity increased between 1975 and 1985 by as much as 85% in "communication services" (industry 20), but even slightly decreased in "services of credit and insurance institutions" (industry 21). Again, the bulk of productivity increases is caused by factor 2, decreasing labor inputs per unit of gross output. For the majority of industries this effect appears to be larger than the total growth, which implies that the totals of the other five effects are often smaller than one.

Table 4: Labor productivity decomposition results by industry.

Industry		Total[a]	Factor 1[b]		Factor 2		Factor 3		Factor 4		Factor 5		Factor 6	
1	AGRI	1.600	0.967	0.968	1.619	1.595	1.011	1.008	1.007	1.017	1.005	1.012	0.999	0.999
2	FUEL	1.199	1.139	1.151	1.116	1.068	0.965	0.985	1.004	1.010	0.998	0.999	0.976	0.982
3	ORME	1.453	0.901	0.900	1.633	1.612	1.022	1.002	1.002	1.000	0.972	1.004	0.992	0.996
4	MINE	1.374	0.829	0.838	1.664	1.655	1.015	0.998	1.000	0.999	0.981	0.994	1.000	1.000
5	CHEM	1.663	1.007	0.997	1.771	1.674	0.983	0.996	0.992	1.005	0.976	0.998	0.980	0.998
6	METP	1.212	0.805	0.783	1.609	1.593	0.967	0.997	0.998	0.997	0.977	0.985	0.992	0.992
7	MACH	1.141	0.787	0.790	1.470	1.423	1.000	1.002	0.995	1.005	0.996	1.003	0.994	1.006
8	OFFM	1.564	0.958	0.960	1.774	1.606	0.997	1.015	1.005	1.006	0.966	0.987	0.950	1.007
9	ELEC	1.725	0.996	0.996	1.781	1.728	0.992	1.002	0.998	0.999	0.981	1.000	1.000	1.000
10	TREQ	1.322	1.032	1.011	1.295	1.284	0.992	0.999	1.000	1.002	0.994	0.993	1.004	1.024

The complex dynamics of factor substitution and technological progress summarized in factor 3 have had significant effects only in “fuel and power products” (-2.5%), “metal products” (-1.8%), “services of credit and insurance

Second, it is a well-known fact that quality differences are seldom fully reflected in prices. Deflation procedures may yield relatively low productivity measures for industries that produce 'high-quality varieties' of a good.[13] Keeping this in mind, it would not be that strange if an industry with a low productivity level or a low productivity growth rate (compared to its foreign competitors) would not lose market share.

A third potential cause, related to the interindustry nature of final demand good production is investigated in the next section.

5. Productivity Analysis of Vertically Integrated Industries

Labor productivity changes in an individual industry can be due to a number of 'real productivity factors', of which capital deepening and technological progress are the best recognized ones, but can also be caused by a changing underlying activity structure. A well-known example is the contracting out of accounting and/or cleaning activities by manufacturing firms to specialized firms: on the aggregate the same work may be done by an identical amount of employees, but the productivity figures of the manufacturing firm are likely to change. We can get rid of these effects by taking a different perspective, in which the ratio between value added and labor needed in the production of one unit of final demand output is the main variable.

The alternative approach does not consider industries in the usual sense, but investigates "vertically integrated industries" (Pasinetti, 1973) that consist of all industries that directly or indirectly contribute to the production of a final demand commodity, weighted by their respective contributions.[14] Such an approach might indicate a potential solution to the previous section's somewhat paradoxical result that final demand for tradable goods did not shift towards countries in which levels and growth rates of labor productivity in the industries concerned were relatively high. A hypothetical example might clarify the claim for a potential solution.

Suppose a situation in which labor productivity in the "food, beverages and tobacco" industry (in country A) is decreasing and productivity in its main supplier industry "agricultural, forestry and fishery products" (in the same country) is increasing, while labor productivity levels for these industries are constant in the other countries. Then, an increasing share of country A in final demand for "food, etc." might seem strange at first sight if one assumes that low labor productivity

[13] In fact, conventional price deflators "shift" productivity increases from the quality-increasing industry to the industries buying its product. For example, it may well be that part of the 85% labor productivity increase in "communication services" is due to productivity increases that should actually be accounted for in "office and data processing machinery" in the same or a second country (see, e.g. Los, 1997, for a discussion of these so-called "rent spillovers"). In this paper, however, we focus on 'conventionally measured' prices and productivity levels.

[14] So accounting and cleaning activities always turn up in the productivity of the vertically integrated industry that produces a certain manufactured good, no matter whether these activities are contracted out or not.

levels are reflected in high prices (wage rate differences, for instance, might disturb such relationships). In fact, however, labor is not the only input the use of which may be reflected in output prices: next to fixed capital goods, intermediate inputs are often required. Bearing this in mind, the relatively low price paid for "agricultural products, etc." might allow country A to set the price for its "food, etc." equal to or below that of foreign competitors, depending on the shares of "agricultural products, etc." in total inputs. Extending this reasoning, labor productivity changes in any of the upstream industries might well affect the final demand market shares of a country for a given output. The concept of vertically integrated industries accounts for this notion. Hence, labor productivity changes in vertically integrated industries are the central issue in this section.

Analogous to our earlier investigations in labor productivity by industry, we define labor productivity in vertically integrated industry *i* as the ratio of value added created in vertically integrated industry *i* and the number of jobs in vertically integrated industry *i*. In matrix notation (maintaining the symbols introduced in Section 2), the labor productivity of vertically integrated industry *i* can be expressed as

$$\pi_i^P = \mu' L\hat{f} e_i / \lambda' L\hat{f}\, e_i \,, \qquad \textbf{(5)}$$

a hat denoting the diagonalization of a vector and e_i representing an NCx1 vector of zeros and a one for element *i*. It should be noted that this approach does not take into account Pasinetti's notion that capital goods used in various phases of the production of a final demand commodity should also be included in the vertically integrated industry. The lack of matrices with interindustry capital goods flows prevents us from such an approach, which admittedly would be preferable from a theoretical perspective.

Fig. 2: Labor Productivity Ratios by Vertically Integrated Industry, 1975-85

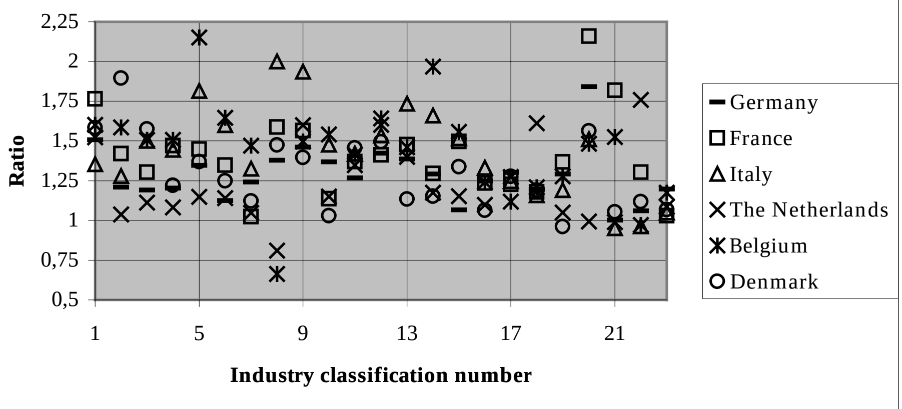

Figure 2 presents an overview of labor productivity developments in all 23 vertically integrated industries (each representing one final demand output) for each of the six countries.[15] In general, the results are similar to those plotted in Fig. 1. The magnitudes of the ratios, however, are far less dispersed, which does not come as a surprise as all ratios can be interpreted as weighted averages of those plotted in Fig. 1. The Netherlands did not perform well compared to other countries, except for the vertically integrated industries 18 ("final demand of lodging and catering services") and 22 ("final demand of other market services"). France did well in several final demand services, but in a vertically integrated industry context the main French winner is not "final demand of credit and insurance services" (21), but "final demand of communication services" (20). Italy is again strong in final demand of various manufactured commodities. Further, Belgian vertically integrated industries 5 ("final demand of chemical products") and 14 ("final demand of rubber and plastic products") managed to attain high scores, the latter not only because the Belgian rubber and plastic industry itself shows a high productivity growth, but also because a large share of total inputs was supplied by the Belgian chemical industry with an extremely strong productivity growth (see Fig. 1).

Like for industries in the more usual sense, we carried out some regressions to see whether convergence at the level of vertically integrated industries occurred between 1975 and 1985. Labor productivity increases (*grp*) were again linked to the logarithms of productivity levels in 1975 (*linitp*) and a series of industry dummies. The regressions were run for the total sample, the sample of vertically integrated industries producing manufacturing goods and the sample of vertically integrated industries producing services.

$$\text{Total sample:} \quad grp = \underset{(4.55)}{0.828} - \underset{(4.23)}{0.228}\, linitp\,, \; R^2 = 0.41;$$

$$\text{Manufacturing sample:} \quad grp = \underset{(3.51)}{0.783} - \underset{(3.00)}{0.206}\, linitp\,, \; R^2 = 0.43; \qquad \mathbf{(6)}$$

$$\text{Services sample:} \quad grp = \underset{(2.64)}{1.049} - \underset{(2.32)}{0.303}\, linitp\,, \; R^2 = 0.34;$$

Again the null hypothesis of zero convergence is rejected at usual levels of significance.[16] Nevertheless, the differences with the regression results obtained for industries in the usual sense are clear. First, the estimated convergence rates are

15 Note that our intercountry framework implies that labor productivity growth for vertically integrated industries in a given country may also be affected by labor productivity changes in one or more of the other countries included in the analysis.

16 With respect to the total sample as well as the manufacturing sample, not only *t*-values lead to rejection. *F*-tests on the simultaneous significance of the constant and the convergence coefficient yield values that correspond to *p*-values well below 0.01 and 0.025, respectively. For services, the null of a zero constant and a zero convergence coefficient could only be rejected at a 10% significance level, so convergence may be absent within this subsample.

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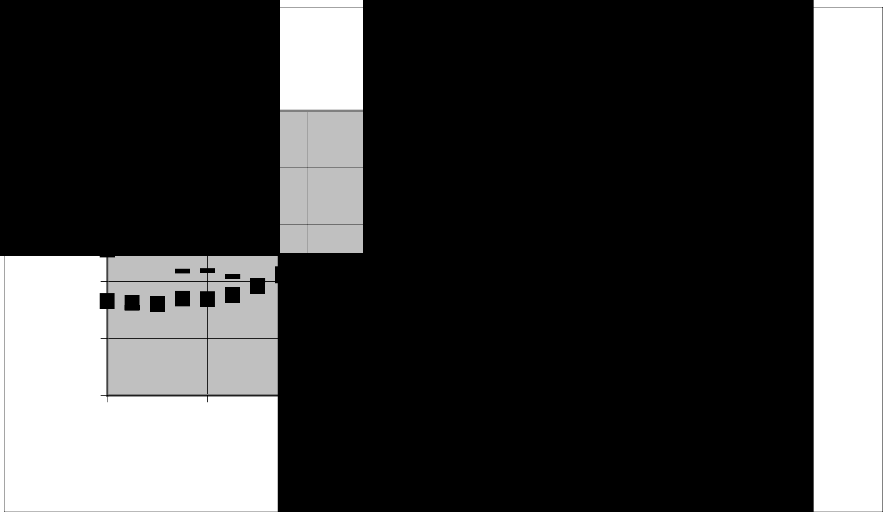

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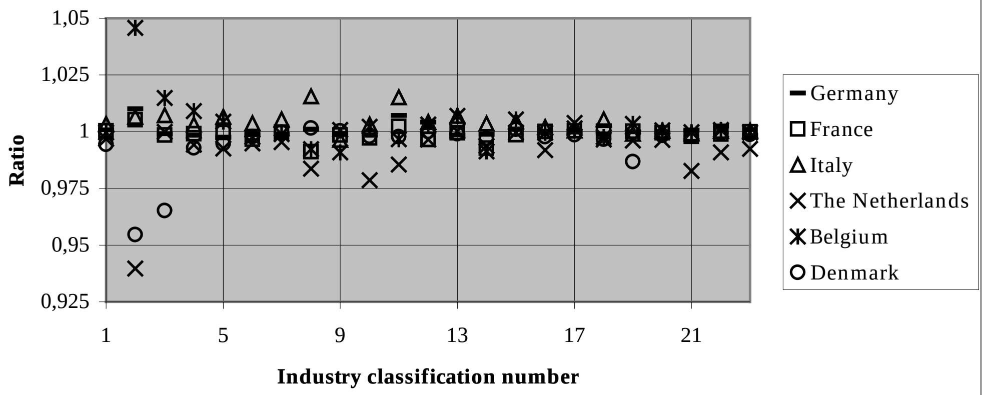
precision instruments" (8) and "final demand food and beverages" (11) are the exceptions.

Fig. 4: Trade Structure Effect Ratios by Vertically Integrated Industry, 1975-85



Finally, we investigated whether structural change effects (that mostly appeared small from Figs. 3 and 4) affected the convergence process. To that end, we estimated equations in which the dependent variable is the labor productivity growth rate that vertically integrated industries would have experienced if both input structures and trade structures with respect to intermediate inputs had not changed (grp^*). The right-hand side of the estimated equations is identical to the one in equations (6), including the non-reported dummy coefficients.

Total sample: $grp^* = \underset{(3.22)}{0.623} - \underset{(3.04)}{0.174}\, linitp\,,\ R^2 = 0.37$

Manufacturing sample: $grp^* = \underset{(2.90)}{0.704} - \underset{(2.19)}{0.164}\, linitp\,,\ R^2 = 0.39$ **(7)**

Services sample: $grp^* = \underset{(1.77)}{0.737} - \underset{(1.55)}{0.213}\, linitp\,,\ R^2 = 0.31$

When the estimation results in equations (7) are compared with those in equations (6) some important differences are found. For the total sample, the estimated convergence coefficient is much lower (0.174 versus 0.228). The weaker convergence is also reflected in the *t*-value and especially the *F*-statistic on the constant and the convergence coefficient: without structural change, the null hypothesis of zero convergence can not be rejected at the 1% significance level (at 2.5% it can). For both subsamples, these tendencies are even more visible: on the basis of similar *F*-tests, convergence can only be assessed at significance levels well over 5%. Apparently, the relatively small structural effects depicted in Figs. 3 and 4 had together a convergence-enhancing effect with respect to labor productivity levels in vertically integrated industries.

All in all, the analysis of labor productivity from a vertically integrated industry viewpoint does not alter our previous conclusion that neither input structure changes nor trade structure changes significantly contributed to the growth of labor productivity in the Euro-6 economy. Convergence of productivity levels, however, was enhanced by these structural effects.

6. Summary and Conclusions

The application of a new aggregate labor productivity growth decomposition framework on two full intercountry input-output tables in constant prices for six Western European countries has shown that productivity effects of input structure changes and of trade structure effects are rather small compared to those of growing labor productivity levels in individual industries. Although *convergence* in vertically integrated industries was enhanced by structural change, most of the relatively few significant structure effects on *growth* are even negative, which implies that labor productivity growth would have been higher if no structure changes had occurred (at least if one is willing to maintain the assumption common to growth accounting and structural change decomposition studies that the constituent parts of aggregate growth are independent). This is somewhat surprising, as our summary statistics on productivity levels indicate that aggregate Euro-6 productivity allows for a significant growth, by a mere increase in international specialization.

A number of potential explanations for this result can be formulated. The probably most important of them was argued to be the imperfect reflection of productivity differentials in prices. We mention four additional candidates that might explain the results above, the first two being related to our methodology and the latter two dealing with the time period and economies we investigated. First, our input-output tables were constructed using exchange rate-conversions of values in national currencies, instead of more appropriate PPP-conversions. Second, we were not able to decompose growth rate *differences* between two periods of time, as we had only two input-output tables available. Wolff (1985) provides some evidence that structural change effects (at least within a country) are more important in that kind of decompositions. Third, our period under investigation (10 years) may not be long enough to find significant positive effects, for example because structures do not adapt very quickly to changing technological or economic changes. Finally, our sample of countries may not be heterogeneous enough (despite the reported productivity differences) to cause important shifts of (labor) resources across industries, bearing in mind that transaction costs as well as transportation costs must be compensated for by price differentials before a firm might be tempted to buy its inputs abroad.

Following the argument of a lack of heterogeneity in our sample, we think that it would be a promising avenue of research to apply our decomposition formulae to a set of intercountry input-output tables for e.g. the U.S. (or even their individual states) and Mexico, to see how input structure and trade structure changes following NAFTA affected labor productivity in both countries or their states. Another interesting case might emerge if former Eastern Block countries enter the European Union. The construction of the required tables would not be without difficulties, however, in particular if one would try to use more appropriate currency converters. Nevertheless, we think that studies like the present one contribute to the merits of such tables.

References

Barro, R.J. and X. Sala-i-Martin (1992), “Convergence”, *Journal of Political Economy*, vol. 100, pp. 223-251.

Baumol, W.J. (1986), “Productivity Growth, Convergence, and Welfare: What the Long Run Data Show”, *American Economic Review*, vol. 76, pp. 1072-1085.

Bernard, A.W. and C.I. Jones (1996), “Productivity across Industries and Countries: Time Series Theory and Evidence”, *Review of Economics and Statistics*, vol. 78, pp. 135-146.

Carter, A.P. (1970), *Structural Change in the American Economy*, Harvard University Press, Cambridge MA.

Casler, S.D. and M.S. Gallatin (1997), “Sectoral Contributions to Total Factor Productivity: Another Perspective on the Growth Slowdown”, *Journal of Macroeconomics*, vol. 19, pp. 381-393.

Chenery, H.B., S. Shishido and T. Watanabe (1962), “The Pattern of Japanese Growth, 1914-1954”, *Econometrica*, vol. 30, pp. 98-139.

De Long, D.B. (1988), “Productivity Growth, Convergence and Welfare: Comment”, *American Economic Review*, vol. 78, pp. 1138-1154.

Denison, E.F. (1967), *Why Growth Rates Differ*, Brookings Institution, Washington DC.

Dietzenbacher, E. (1997), “An Intercountry Decomposition of Output Growth in EC Countries”, paper presented at the 44th North-American Meeting of the Regional Science Association, November 6-9, Buffalo NY.

Dietzenbacher, E., J.A. Van der Linden and A.E. Steenge (1993), “The Regional Extraction Method: Applications to the European Community”, *Economic Systems Research*, vol. 5, pp. 185-206.

Dietzenbacher, E. and J.A. Van der Linden (1997), “Sectoral and Spatial Linkages in the EC Production Structure”, *Journal of Regional Science*, vol. 37, pp. 235-257.

Dietzenbacher, E. and B. Los (1997), “Analyzing Decomposition Analyses”, in: A. Simonovits and A.E. Steenge (eds.), *Prices, Growth and Cycles*, Macmillan, London, pp. 108-131.

Dietzenbacher, E. and B. Los (1998), “Structural Decomposition Techniques: Sense and Sensitivity”, *Economic Systems Research*, vol. 10, forthcoming.

Dixon, R.J. and A.P. Thirlwall (1975), “A Model of Regional Growth Rate Differences on Kaldorian Lines”, *Oxford Economic Papers*, vol. 11, pp. 201-214.

Dollar, D. and E.N. Wolff (1993), *Competitiveness, Convergence, and International Specialization*, MIT Press, Cambridge MA.

Dowrick, S. and D.T. Nguyen (1989), “OECD Comparative Economic Growth 1950-85: Catch-Up and Convergence”, *American Economic Review*, vol. 79, pp. 1010-1030.

Eurostat (1979), *European System of Integrated Economic Accounts, ESA*, 2nd edition, Luxembourg.

Eurostat (1986), *National Accounts ESA: Detailed Tables by Branch, 1986*, Luxembourg.

Eurostat (1988), *National Accounts ESA: Detailed Tables by Branch, 1988*, Luxembourg.

Eurostat (1989), *National Accounts ESA: Detailed Tables by Branch, 1989*, Luxembourg.

Eurostat (1990), *External Trade Statistics: User’s Guide*, Luxembourg.

Eurostat (1991), *National Accounts ESA: Detailed Tables by Branch, 1980-1988*, Luxembourg.

Fagerberg, J. (1988), “International Competitiveness”, *Economic Journal*, vol. 98, pp. 355-374.

Feldman, S.J., D. McClain and K. Palmer (1987), “Sources of Structural Change in the United States”, *Review of Economics and Statistics*, vol. 69, pp. 503-510.

Galatin, M. (1988), “Technical Change and the Measurement of Productivity in an Input-Output Model”, *Journal of Macroeconomics*, vol. 10, pp. 613-632.

Grossman, G.M. and E. Helpman (1990), “Comparative Advantage and Long Run Growth”, *American Economic Review*, vol. 80, pp. 796-815.

Hoen, A.R. (1998), Ph.D. Thesis, University of Groningen, forthcoming.

Jorgenson, D.W., F.M. Gollop and B.M. Fraumeni (1987), *Productivity and U.S. Economic Growth*, Harvard University Press, Cambridge MA.

Los, B. (1997), “A Review of Interindustry Technology Spillover Measurement Methods”, Working Paper, University of Twente.

Los, B. and B. Verspagen (1997), “R&D Spillovers and Productivity: Evidence from U.S. Manufacturing Microdata”, MERIT Research Memorandum 96/007, University of Maastricht.

Lucas, R.E. (1988), “On the Mechanisms of Economic Development”, *Journal of Monetary Economics*, vol. 22, pp. 3-42.

Maddison, A. (1987), “Growth and Slowdown in Advanced Capitalist Economies: Techniques of Quantitative Assessment”, *Journal of Economic Literature*, vol. 25, pp. 649-698.

Maddison, A. and B. van Ark (1989), “International Comparison of Purchasing Power, Real Output and Labour Productivity: A Case Study of Brazilian, Mexican and US Manufacturing, 1975”, *Review of Income and Wealth*, vol. 35, pp. 31-55.

Oosterhaven, J., A.R. Hoen and J.A. Van der Linden (1995), “Technology, Trade and Real Value Added Growth of EC Countries, 1975-1985”, paper presented at the XIth International Conference in Input-Output Techniques, 27 november-1 december, New Delhi, India.

Oosterhaven, J. and J.A. van der Linden (1997), “European Technology, Trade and Income Changes for 1975-85: An Intercountry Input-Output Decomposition”, *Economic Systems Research*, vol. 9, pp. 393-412.

Pasinetti, L.L. (1973), “The Notion of Vertical Integration in Economic Analysis”, *Metroeconomica*, vol. 25, pp. 1-29.

Romer, P.M. (1990), “Endogenous Technological Change”, *Journal of Political Economy*, vol. 98, pp. S71-S102.

Rose, A. and S. Casler (1996), “Input-Output Structural Decomposition Analysis: A Critical Appraisal”, *Economic Systems Research*, vol. 8, pp. 33-62.

Skolka, J. (1989), “Input-Output Structural Decomposition Analysis for Austria”, *Journal of Policy Modeling*, vol. 11, pp. 45-66.

Solow, R.M. (1956), “A Contribution to the Theory of Economic Growth”, *Quarterly Journal of Economics*, vol. 70, pp. 65-94.

Statistics Netherlands (1996), *Time Series Labor Accounts 1969-1993*, Heerlen / Voorburg.

Swan, T.W. (1956), “Economic Growth and Capital Accumulation”, *Economic Record*, vol. 32, pp. 334-361.

Van der Linden, J.A. and J. Oosterhaven (1995), “EC Intercountry Input-Output Relations: Construction Method and Main Results for 1965-1985, *Economic Systems Research*, vol. 7, pp. 249-270.

Verspagen, B. (1991), “A New Empirical Approach to Catching Up or Falling Behind”, *Structural Change and Economic Dynamics*, vol. 2, pp. 359-380.

Verspagen, B. (1997), “Estimating International Technology Spillovers Using Technology Flow Matrices”, *Weltwirtschaftliches Archiv*, vol. 133, pp. 226-248.

Wolff, E.N. (1985), “Industrial Composition, Interindustry Effects, and the U.S. Productivity Slowdown”, *Review of Economics and Statistics*, vol. 67, pp. 268-277.

Wolff, E.N. (1994), “Productivity Measurement within an Input-Output Framework”, *Regional Science and Urban Economics*, vol. 24, pp. 75-92.

Appendix: Industry classification

nr.	abbreviation	NACE-CLIO R6/R25	description
1	AGRI	01	agricultural, forestry and fishery products
2	FUEL	06	fuel and power products
3	ORME	13	ferrous and non-ferrous ores and metals, other than radioactive
4	MINE	15	non-metallic minerals and mineral products
5	CHEM	17	chemical products
6	METP	19	metal products, except machinery and transport equipment
7	MACH	21	agricultural and industrial machinery
8	OFFM	23	office and data processing machines, precision and optical instruments
9	ELEC	25	electrical goods
10	TREQ	28	transport equipment
11	FOOD	36	food, beverages, tobacco
12	TEXT	42	textiles and clothing, leather and footwear
13	PAPE	47	paper and printing products
14	RUBP	49	rubber and plastic products
15	OTHM	48	other manufacturing products
16	BUIL	53	building and construction
17	TRAD	56	recovery and repair services, wholesale and retail trade services
18	LODG	59	lodging and catering serices
19	TRAN	61+63+65	transport services
20	COMM	67	communication services
21	CRED	69A	services of credit and insurance institutions
22	OTMS	74	other market services
23	NMAS	86	non-market services

Table 1: Summary Statistics on Labor Productivity by Industry (in 1000's of 1985 Ecus per worker).

		1975									1985								
Industry		Mean	SD	Max	Country[a]	Share[b]	Min	Country	Share	Mean	SD	Max	Country	Share	Min	Country	Share
1	AGRI	10.33	2.90	14.38	NTH	5.9	6.89	GER	6.8	17.22	5.46	23.4	NTH	5.3	9.72	ITA	11.4
2	FUEL	119.73	98.00	330.14	NTH	1.1	48.15	DEN	0.7	143.74	69.59	293.99	NTH	1.2	84.5	GER	1.9
3	ORME	21.40	8.87	35.66	NTH	0.7	10.24	DEN	0.2	32.98	4.29	41.44	NTH	0.6	27.98	DEN	0.1
4	MINE	23.02	4.70	30.49	NTH	0.9	16.85	ITA	2.0	30.37	2.64	34.54	FRA	0.9	27.13	BEL	1.1
5	CHEM	26.03	10.79	42.60	NTH	1.8	11.23	ITA	1.5	44.7	4.43	53.54	NTH	1.6	39.76	DEN	1.1
6	METP	19.40	4.81	24.76	GER	3.8	13.15	BEL	2.3	25.67	3.83	34.05	FRA	2	23.36	ITA	2.5
7	MACH	24.31	4.20	30.11	NTH	1.5	17.80	BEL	2.1	27.28	3.06	30.24	ITA	2	22.66	DEN	3.3
8	OFFM	24.03	9.83	42.60	BEL	0.1	12.79	ITA	0.4	28.5	13.36	52.89	FRA	0.6	10.1	NTH	0.3
9	ELEC	16.68	2.60	19.16	GER	4.3	11.64	ITA	2.0	28.99	4.14	35.31	NTH	1.9	22.36	DEN	1.5
10	TREQ	20.96	3.59	24.75	FRA	3.2	15.07	BEL	2.4	26.63	5.19	36.82	GER	3.2	21.19	DEN	1.2
11	FOOD	28.85	6.12	38.89	FRA	2.7	20.87	NTH	3.9	34.96	3.66	37.64	DEN	3.8	26.9	NTH	3.2
12	TEXT	12.80	1.74	15.86	FRA	3.7	10.69	BEL	4.7	18.95	1.51	21.5	FRA	2.5	17.09	BEL	2.9
13	PAPE	19.32	4.13	24.57	DEN	2.1	14.03	ITA	1.3	28.39	4.3	35.34	GER	1.9	21.77	NTH	2.8
14	RUBP	19.87	4.63	26.25	NTH	0.6	12.98	BEL	0.7	27.52	2.78	31.7	BEL	0.8	22.49	DEN	0.7
15	OTHM	16.63	3.94	22.84	GER	2.0	12.73	ITA	2.8	21.2	1.48	23.41	NTH	1.1	18.7	ITA	2.1
16	BUIL	20.58	2.80	24.81	DEN	8.2	16.34	ITA	8.7	23.46	1.53	26.45	BEL	6.1	21.31	ITA	7.3
17	TRAD	20.68	2.95	24.54	DEN	15.1	16.61	NTH	17.0	25.45	3.54	32.19	DEN	12.5	21.68	NTH	16.5
18	LODG	17.94	4.48	23.30	BEL	2.8	11.21	NTH	1.9	20.49	4.3	26.69	BEL	2.9	18.14	DEN	1.9
19	TRAN	26.05	5.10	33.62	DEN	5.0	18.08	ITA	4.5	29.79	5.62	38.56	BEL	4.7	20.65	ITA	4.8
20	COMM	19.43	6.99	34.59	NTH	1.5	14.46	FRA	1.9	30.52	5.13	37.3	GER	1.9	23.59	BEL	2
21	CRED	7.38	4.96	13.90	ITA	1.3	1.47	FRA	2.3	7.73	3.21	11.9	BEL	3.9	1.28	DEN	3.8
22	OTMS	31.19	12.54	52.50	GER	6.7	9.97	NTH	17.0	35.2	13.21	58.49	GER	8.7	18.14	NTH	21.5
23	NMAS	25.62	4.16	32.62	NTH	16.4	21.31	DEN	25.0	27.41	4.55	36.07	NTH	18.9	21.98	DEN	30.7

[a] Country codes are as follows: BEL: Belgium, DEN: Denmark, FRA: France, GER: (Western) Germany, ITA: Italy, NTH: The Netherlands.

[b] Shares of total national employment