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DO GROWTH RATES DIFFER IN EUROPEAN MANUFACTURING INDUSTRIES?

This paper focuses on the determinants of industry growth in the EU. We review theoretical hypotheses, previous empirical literature, and present stylised facts on the growth process in European manufacturing over the past ten years. Summing up the most important results, we find significant decreasing geographical concentration, reflected by higher growth rates in the industries of those countries, whose shares of the respective industry were initially small, relative to country size. Industries in countries lagging behind in terms of productivity, grew significantly faster. Growth of industries is driven not only by demand, but also by the strong forces emanating from the globalisation process. In addition to the integration process, globalisation must be seen as the second most important factor shaping industrial structures within Europe.

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In contrast to theories explaining aggregate growth at the country level, theories on the growth of industries are rare[1]. Usually, they combine determinants from the demand side, which focus on income growth or demand for new varieties, with determinants from the supply side, which focus on cost shifts or new technologies. A third group of explanatory factors includes structural determinants such as market structure, and economic policy.

INDUSTRY GROWTH FROM A THEORETICAL POINT OF VIEW

In addition to improvements in technology, growth in factor endowments is also evident as a major source of overall growth (*Pugel,* 1992). The effects of a country's

[1] For macro growth see *Barro – Sala-i-Martin* (1995). For the industry level, growth accounting (explaining output by the inputs used) is a popular line, which will not be followed here; see *Oulton – O'Mahony* (1994).

growth in factor endowments are summarised in the Rybczynski magnification relationships, which predict faster growth for those industries which more intensively use the faster growing factor.

Investment in human capital increases the qualifications of the labour force and leads to higher productivity levels. Ceteris paribus, an industry will grow more quickly, the more it invests in human capital. Output growth follows from the productivity growth achieved by upgrading the skills and qualifications of the labour force. Note that investment in human capital is accompanied by investment in intangibles.

Technology can be tangible or intangible (know-how, skills). New technologies improve the production process, or inspire the creation of new products, and increase the competitive advantage of firms. Spill-overs extend these improvements to the industry level. New growth theory demonstrates that knowledge can generate endogenous growth in total factor productivity or enhance the quality or variety of products. The growth potential is shown to be higher for heterogeneous differentiated products than for homogeneous ones.

In the new growth theory, Ricardian-type models characterise different activities with different rates of productivity growth originating from differences in the availability of technological opportunities. Thus, industries specialising in activities with a higher potential for productivity growth are expected to achieve faster overall growth.

Firms differentiate their products, either through quality improvements (product upgrading) or through marketing efforts (e.g., the creation of brands), decreasing the possibility of substitution and thus the degree of price competition. Both strategies allow the producer to charge a mark-up over marginal costs to recover the funds for investments in new innovations and continued growth.

Industry growth is, ceteris paribus, higher, (i) the lower its price elasticity of demand, (ii) the lower the rate at which its relative price increases, (iii) the higher the income elasticity of demand, (iv) the faster the rate of income increases, and (v) the greater marketing efforts and the faster product invention are. One stylised fact is Engel's law: if income increases, the demand for basic goods decreases and the demand for sophisticated goods ("luxury goods", "non-necessities") increases. Rising incomes shift demand to industries producing goods with higher income elasticities. National demand preferences can establish a national lead-market, which can be the basis of international expansion (home market effect).

In a more competitive framework, the incentives to invest in new technologies and products, as well as to adapt new technologies earlier, may be stronger (*Aiginger – Pfaffermayr,* 1998) and fewer opportunities for inefficient behaviour may exist. On the other hand, endogenous growth theory assumes that imperfect competition is necessary for innovation and growth. The empirical evidence favours the former argument. *Baldwin* (1992, 1995) has shown that the "churning" of businesses within and between industries is an important determinant of growth in industries. Challenging the incumbents often spurns new ideas for products and processes of production. Entrants can be new firms or new lines of business for existing firms.

Public support can create additional demand or reduce costs. It is justified, if it eliminates market failures, as is the case with R&D subsidies or in the case of public goods that would otherwise be underprovided by the market. Modern growth theory stresses the role of public support in (knowledge) spill-overs and external effects, which are of special importance to R&D investments. Doubts as to whether real policy will succeed in providing sector-specific aid efficiently exist due to informational problems (*Neven – Vickers,* 1992). Strong cases in favour of intervention include limiting the strategies of incumbent firms to deter entry, functional aid (e.g., R&D), and regional subsidies to alleviate the asymmetric costs of economic shocks.

If structural convergence takes place, lagging industries grow systematically faster than the leaders. Country-specific economic policy could speed up convergence, for example, by enforcing knowledge spill-overs, fostering external economies and more generally creating a favourable business environment. Early specialisation likewise affects economic growth. During the process of integration, factor movements, restructuring, etc., reshape specialisation patterns and in this way lead to differences in growth rates during the period of transition to the new long-run equilibrium.

Neo-classical multisector growth models imply that differential growth in a particular industry cannot last forever. However, differential growth can be observed in the transitional dynamics to a new steady state, i.e., during the course of economic adjustment to the new long-run equilibrium.

PREVIOUS EMPIRICAL EVIDENCE ON INDUSTRY GROWTH

In an empirical study of industry growth, *Salter* (1960) identifies technological opportunities and the particular stage an industry has reached within its life cycle as the determinants of growth rates. Furthermore, fast growth may be self-enhancing, because faster growing industries

Table 1: Determinants of industry growth rates: 1963 to 1987

	Europe	USA	Japan
	Regression coefficients (*t* values in parentheses)		
Own R&D intensity	0.22	0.14	2.63
	(0.84)	*(0.52)*	*(5.54)*
Physical capital intensity	0.00	0.00	0.00
	(0.88)	*(0.81)*	*(0.03)*
Human capital intensity	1.07	1.69	1.56
	*(2.05)***	*(2.08)***	*(2.74)***
Constant	–10.82	–17.29	–16.98
	(1.82)	*(1.91)*	*(2.70)***
R^2	0.30	0.28	0.77

Source: *Pugel* (1992, p. 70, Table 3.8). Own R&D intensities . . . industry R&D-sales ratios, physical capital intensity . . . ratio of gross depreciable assets to the number of employees, human capital intensity . . . median years of education of the labour force, ** . . . significant at the 5 percent level.

often tend to install newer plants embodying the latest techniques ("best practice techniques"), which in turn lowers the average age of the capital stock[2].

Pugel (1992) focuses on structural change within the manufacturing sector in Europe (EU 12), the USA and Japan, and draws two major conclusions. First, the growth rates of manufacturing industries vary widely across industries, indicating substantial structural change, but are similar for the three areas. Secondly, growth in individual industries in Europe and in the USA is significantly related to the human-capital intensity of the industry, but is only weakly related to the R&D intensity of the industry. In Japan, on the other hand, both variables have positive and significant effects.

The literature on "technological gaps" (*Nelson – Wright,* 1992, *Abramovitz,* 1986) and on catching up as a source of different growth rates, which may be conditional with respect to educational efforts (see *Fagerberg,* 1994), usually restricts itself to the macro level, although it sometimes shifts to the question whether there is a difference between convergence in manufacturing and in services, or within the manufacturing sector.

Bernard – Jones (1996A, 1996B) claim that while aggregate productivity was converging for a group of 14 industrialised countries over the 1970 to 1987 period, individual sectors displayed quite disparate behaviour[3]. Similar results are presented by *Carree et al.* (1997) for 18 OECD countries and 28 manufacturing industries over the period 1972-1992. The authors claim that one reason for slow or lacking convergence in productivity is the existence of knowledge and capital barriers. In industries with high barriers, convergence to the level of the leading country may be slow, and the output and productivity growth rates in these industries could lag behind for quite a long time period.

In contrast, *Dollar – Wolff* (1988, 1994) find convergence in nearly every individual industry analysed. *Dollar – Wolff* (1988) conclude that the convergence of productivity within industries is the main cause of convergence in aggregate labour productivity. Convergence was strongest in heavy industries.

Selvanathan – Selvanathan (1993) estimate demand equations for ten commodity groups in 18 OECD countries. Preferences are heterogeneous across countries.

[2] *Arrow* (1962) and *Schmookler* (1966) emphasise endogenous technological progress. The rate of improvement will be highest if new problems keep appearing. Higher rates of investment and therefore output growth will induce faster technical progress.

[3] The countries are Australia, Belgium, Canada, Denmark, Finland, France, Italy, Japan, the Netherlands, Norway, Sweden, U.K., USA, and West Germany. The six sectors at the one-digit level are agriculture, mining, manufacturing, electricity – gas – water, construction and services. The data source is the OECD Intersectoral Database (ISDB).

Table 2: Income elasticities of ten commodity groups for 18 OECD countries

	Food	Beverages	Clothing	Housing	Durables	Medical care	Transport	Recreation	Education	Miscellaneous
Belgium	0.49	0.98	1.14	0.58	1.49	0.58	0.88	0.94	0.06	2.37
Denmark	0.36	0.69	1.63	0.38	1.59	0.49	2.25	1.24	–0.14	0.95
Germany	0.62	.	1.50	0.16	1.44	0.83	2.30	1.00	.	0.71
Spain	0.85	0.91	1.29	0.19	1.46	0.95	2.37	1.36	0.40	0.62
France	0.46	0.48	1.29	0.44	1.57	0.56	2.21	1.02	0.78	1.31
Italy	0.86	0.70	1.81	0.49	1.53	1.03	1.42	0.67	0.62	0.95
Ireland	0.45	0.74	1.34	–0.04	1.89	0.76	2.49	1.44	–0.01	1.72
The Netherlands	0.50	0.62	2.06	0.58	1.41	0.60	1.77	0.95	0.80	0.76
Austria	0.21	0.50	1.79	0.18	1.95	–0.73	3.11	0.80	–0.40	0.54
Finland	0.55	1.28	1.67	0.15	1.56	0.65	1.80	1.89	1.16	0.71
Sweden	0.55	1.10	1.45	0.16	1.87	0.05	2.01	1.59	0.58	1.03
U.K.	0.33	1.03	1.20	0.35	2.14	0.61	1.66	1.34	1.01	1.17
Norway	0.23	1.14	1.21	0.00	1.29	0.79	3.20	1.03	0.52	0.84
Switzerland	0.97	1.35	1.82	0.15	2.10	0.30	1.58	1.01	.	0.61
USA	0.61	0.28	1.33	0.41	1.74	0.37	2.31	1.22	0.82	0.70
Canada	0.96	0.59	0.82	0.03	1.57	2.45	1.56	1.86	1.05	0.93
Japan	0.62	.	1.88	0.22	2.08	0.78	1.35	1.15	.	1.49
Australia	0.26	0.83	1.29	0.63	2.22	0.70	1.49	2.25	2.82	0.54
Mean	0.55	0.83	1.47	0.28	1.72	0.65	1.99	1.26	0.67	1.00

Source: *Selvanathan – Selvanathan* (1993).

Half of the estimated income elasticities is smaller than 1 ("necessities"), the other half is larger than 1 ("luxuries"). In all countries, food and housing are necessities, confirming Engel's law. Medical care is a necessity in all countries except Canada and Italy, where it is a luxury good. Durable goods are luxuries in all countries, and clothing, transport and recreation are almost always luxury goods. The study proves that differences in income and price elasticities exist across commodity groups and across countries. These differences in elasticities can induce differential growth rates of industries.

Many empirical investigations of firm growth find that the evolution of firm size follows a random walk, and that mean reversion (i.e., that in the long run, the sizes of firms within an industry converge to a common mean), if it exists at all, is extremely slow (*Geroski,* 1998). For a sample of 77 large, quoted U.K. companies, observed over a 30-year period from 1955 to 1985, *Geroski – Urga – Walters* (1997) find that differences in growth between any two firms persisted typically for only about two years. No spells of superior relative growth performance lasted longer than seven years, and the sign of the difference between the growth rates of any two firms changed on average seven times. Thus, corporate growth rates appear to be random, even when observed over a 30-year period. The reason for this may be that firms are irregular and erratic innovators (see *Geroski – Van Reenen – Walters,* 1997B). If firms innovate erratically and innovations are major determinants of firm growth, then firm growth rates will evolve in an unpredictable fashion.

A natural conclusion seems to be that industry or economy-wide growth rates may also be random. However, even if the growth rates of existing corporations are random, systematic differences in industry growth rates may prevail, if there are systematic differences in entry and exit rates. Studies analysing the growth of small and/or new firms find much better support for convergence, indicating that the determination of random growth rates for larger firms can be subject to a selection bias. The growth of smaller or younger firms is driven much more by transitional dynamics, as these firms usually start out at a sub-optimal size. If the fraction of industry output produced by start-up businesses varies systematically across industries, and these young businesses indeed exhibit systematically different growth rates than established firms, it follows that industry growth rates vary systematically (if only during the transitional period).

Small firms are sources of considerable innovative activity, stimulating industry evolution and creating an important share of newly generated jobs (*Acs – Audretsch,* 1993). In a study of 13 OECD countries and 14 manufacturing industries covering the period 1990 to 1994, *Carree – Thurik* (1998) find that industries with a low presence of large and medium sized firms, relative to the same industries in other countries, perform better in terms of output growth. Small firms may be more flexible in adjusting their organisational structures and adapting to economic shocks.

The substantial long-run differences in industry-level growth rates, typically revealed by the data, are worth investigation, even when annual growth rates of firms may appear random. The forces of catching up, technological factors, and endowment growth (such as growth in human capital through education) are confirmed as supply side determinants; income and price elasticities are important demand side factors. Higher valued and, presumably, higher quality products, have income elasticities larger than 1. Industries producing these products exhibit, ceteris paribus, higher growth rates.

SOURCES OF VARIATION IN INDUSTRY GROWTH

The average rate of nominal growth[4] in a typical 3-digit industry amounted to 2.1 percent during the 9-year period 1989-1997. The standard deviation of 6.3 percentage points reveals high variation between EU countries and between industries, a picture confirmed not only by the very great extremes in the distribution, but also by the analysis of variance in Table 3. 47 percent of the variation can be explained by country, sector, and combined sector and country effects. The variation across countries is more pronounced than that across the sectors, indicating that

[4] Note that the span of the sample is two years shorter than that used for the previous chapters, due to a loss of one year at the beginning and one at the end (the data substitution process chosen would have influenced the variance and covariance properties). As before, we stick to the nominal figures for several reasons: first, previous experience shows that value added deflators are of poor quality and methods of measurements differ across EU countries. Secondly, in some industries, most prominently in the computer industry, dynamics is determined by quality improvements. Since quality adjustment is a very difficult task and beyond the scope of this contribution, it is better to rely solely on nominal figures rather than real figures. Thirdly, note that price increases were very moderate over the period 1989-1997, so the bias of overall inflation should be very slight. Additionally, we include country fixed effects in our econometric estimations, which control for nominal variations in aggregate inflation and exchange rates among other country specific latent influences.

Table 3: Country effect, industry effect, and combined country/industry effect on growth

Analysis of variance of industry growth 1989 to 1997

	Partial *SS*	*df*	*F* test
Model	18,370.3	214	3.3**
Intercept	3,124.1	1	118.9**
Country effect	5,705.3	11	19.7**
Industry effect	2,527.9	17	5.7**
Country-industry effect	8,796.5	186	1.8**
Residual	20,574.6	783	
Total	38,944.9	997	
Number of observations	998		
R^2	0.47		

Source: WIFO calculations using SBS (Eurostat Structural Business Statistics). *SS* . . . explained, unexplained variance, *df* . . . degrees of freedom, ** . . . significant at the 5 percent level.

the country-specific environment, economic policy and macro-economic development have a significant impact on industry growth. This picture is consistent with the view that European manufacturing is not yet fully integrated. However, as the regressions below illustrate, there is a strong tendency towards catching up and deeper integration. Most of the variation in average growth rates comes from combined country-industry effects, suggesting that country-specific environments combined with industry-specific determinants common throughout the entire EU – such as demand growth – are the ingredients of long-run performance.

The Irish manufacturing industries performed best, growing on average by 6.5 percent per year, combining a remarkable catching-up process with significant specialisation in fast-growing industries. With average growth at 5.8 percent, Portugal placed second, followed by Austria, which registered 4.0 percent average annual growth in a typical industry. Average growth in France, the U.K. and Spain was below the industry average. At the bottom end of the scale, Finland encountered a period of deep recession, induced by the large reduction in trade with countries formerly belonging to the USSR. The average percentage change of Finnish industries fell to –2.5 percent. Like Sweden, Finland was also faced with the devaluation of its currency during the early 1990s. Note that on average, employment has been decreasing in the industries of every country, with exception of Ireland and Denmark.

The analysis of variance highlights country and industry-specific contributions to the growth of industries. The country-specific effect reflects the average bonus or deficit attributable to location and is identical for all of a country's industries (Table 4 provides an overview). On the other hand, the industry-specific effects reflect the fact that in every country the average growth of certain industries is faster than the average growth of other industries (see Table 5). Industry-specific effects reflect differences in product differentiation, technology, market structure, etc. For example, differences in demand growth or different stages in the product cycle could be viable explanations.

The country growth pattern is consistent with the catching up process in some of the EU countries, in which per-capita income at the start of the 1990s was below average. Proceeding from a position of low average labour productivity in 1989, Ireland and Portugal managed to close much of the gap by 1997 (Table 4). However, not all lagging countries were equally successful. Most notably, Greek industries barely exceeded average growth performance (+2.3 percent), while Spain performed below average, with the average growth rate of its industries amounting to only 0.8 percent.

Table 4: Average industry growth by countries: 1989 to 1997

	Nominal value added		Employment		Nominal labour productivity		Level of nominal labour productivity 1989	
	Unweighted mean	*SD* of the mean	Unweighted mean	*SD* of the mean	Unweighted mean	*SD* of the mean	Unweighted mean	*SD* of the mean
	In percent						1,000 ECU	
Germany	2.1	0.5	–2.7	0.4	4.9	0.2	32.7	0.9
Denmark	3.9	0.4	1.4	0.3	2.4	0.3	40.7	1.6
Greece	2.3	0.9	–2.1	0.8	4.6	0.6	14.5	1.0
Spain	0.8	0.4	–1.3	0.4	2.2	0.4	27.1	1.3
France	1.8	0.3	–1.3	0.3	3.2	0.2	37.1	1.5
Italy	2.1	0.4	–0.9	0.4	3.2	0.3	38.5	1.1
Ireland	6.5	0.9	2.4	0.4	4.0	0.8	38.5	3.7
Austria	4.0	0.8	–2.2	0.6	6.3	0.5	32.5	1.3
Portugal	5.8	0.9	–1.3	0.7	7.3	0.7	12.8	1.1
Finland	–2.5	0.7	–1.7	0.7	–0.7	0.3	46.4	2.1
Sweden	–2.2	0.5	–2.5	0.6	0.2	0.3	52.4	1.9
U.K.	1.0	0.4	–2.6	0.2	3.7	0.3	33.0	1.9
Total	2.1	0.2	–1.3	0.2	3.4	0.1	34.1	0.6
Levene Statistic[1]	8.5**	(11, 986)	7.9**	(11, 977)	9.4**	(11, 977)	9.0**	(11, 985)
Kruskal-Wallis[1]	213.6**	(11)	163.7**	(11)	320.9**	(11)	453.4**	(11)

Source: WIFO calculations using SBS. A significant Levene test indicates that variances are not homogeneous across industries. In this case the usual *F* test on common group means cannot be applied. Instead the Kruskal-Wallis test on common group means is used. The growth rates refer to a typical industry and are therefore not weighted to account for size and composition effects. Thus they do not represent the growth of aggregate manufacturing. *SD* . . . standard deviation, ** . . . significant at the 5 percent level. – [1] Degrees of freedom in parentheses.

Table 5: Average industry growth by sectors: 1989 to 1997

	Nominal value added		Employment		Labour productivity	
	Unweighted mean	*SD* of the mean	Unweighted mean	*SD* of the mean	Unweighted mean	*SD* of the mean
Food products and beverages	2.0	0.5	–0.5	0.3	2.5	0.4
Textiles	–0.2	0.5	–4.0	0.4	3.9	0.3
Wearing apparel; dressing and dyeing of fur	–1.9	1.5	–5.4	1.0	3.7	1.4
Tanning and dressing of leather	–1.1	0.8	–4.1	0.7	3.0	0.6
Wood, products of wood and cork	1.9	0.7	–0.7	0.5	2.6	0.5
Pulp, paper and paper products	3.0	1.4	–1.3	0.6	4.4	1.6
Publishing, printing and reproduction	3.8	1.1	0.2	0.5	4.0	1.3
Chemical and chemical products	3.2	0.7	–0.5	0.6	3.7	0.4
Rubber and plastic products	2.0	1.6	–1.5	1.4	3.6	0.6
Other non-metallic mineral products	1.8	0.5	–1.4	0.3	3.4	0.4
Basic metals	–0.0	1.2	–2.8	0.5	2.9	1.1
Fabricated metal products	2.0	0.6	–0.6	0.5	2.7	0.5
Machinery and equipment n.e.c.	3.0	0.4	–0.2	0.4	3.3	0.4
Electrical machinery and apparatus n.e.c.	3.9	1.0	–0.1	0.7	4.1	0.7
Medical, precision and optical instruments, watches	4.5	0.8	0.2	0.8	4.3	0.6
Motor vehicles, trailers and semi-trailers	3.5	0.9	–0.1	0.7	3.7	0.9
Other transport equipment	1.1	1.1	–3.0	1.0	4.3	0.5
Furniture; manufacturing n.e.c.	4.0	0.9	0.5	0.6	3.6	0.6
Total manufacturing	2.1	0.2	–1.3	0.2	3.4	0.1
Levene Statistic[1]	2.1**	(17, 980)	3.5**	(17, 971)	1.9	(17, 971)
Kruskal-Wallis[1]	103.5**	(17)	115.6**	(17)	21.9	(17)

Source: WIFO calculations using SBS. A significant Levene test indicates that variances are not homogeneous across industries. In this case the usual *F* test on common group means cannot be applied. Instead the Kruskal-Wallis test on common group means is used. The growth rates refer to a typical industry and are therefore not weighted to account for size and composition effects. Thus they do not represent the growth of aggregate manufacturing. *SD* . . . standard deviation, ** . . . significant at the 5 percent level. – [1] Degrees of freedom in parentheses.

Across industries – at the 2-digit level – the average percentage change varies between –1.9 percent in the apparel industries and +4.5 percent in the medical, precision and optical instruments industries (Table 5). In particular, R&D-intensive industries performed above average (+4.2 percent; Table 6) and enjoyed rising employment (+0.4 percent), despite above-average labour productivity growth (+3.8 percent). The next in line are the mainstream industries (+2.3 percent), which are overwhelmingly skill-intensive, but do not rely on either labour or capital more intensively than total manufacturing. Labour and capital-intensive industries grew more slowly, at 1.5 percent and 1.4 percent, respectively. In addition, since average labour productivity growth did not deviate to a great extent from overall productivity growth, employment decreased significantly faster in these industries. The most important driving force behind this growth pattern can be found in the differences in average demand growth, which was only 1.6 percent in both labour and capital-intensive industries, but amounted to 3.3 percent in R&D-intensive industries and 2.2 percent in mainstream industries.

At this descriptive level, in addition to weak demand growth, two other hypotheses on the sluggish growth in labour and capital-intensive industries seem to find support: labour-intensive industries are losing ground in European manufacturing due to the forces of intensified globalisation, whereby labour-intensive production tends to be re-located to low-wage countries outside Europe. Capital-intensive industries seem to substitute labour to a greater degree through increased rationalisation. The first hypothesis is supported by the fact that highly globalised industries, which are to a large extent labour intensive, expanded at a slightly below-average rate of 1.8 percent. The latter hypothesis is confirmed by the below-average

Table 6: Average growth by type of industry (WIFO typology): 1988 to 1997

	Nominal value added		Employment		Labour productivity		Apparent Consumption	
	Unweighted mean	*SD* of the mean	Unweighted mean	SD of the mean	Unweighted mean	*SD* of the mean	Unweighted mean	SD of the mean
Mainstream industries	2.3	0.4	–1.3	0.3	3.6	0.3	2.2	0.1
Labour-intensive industries	1.5	0.4	–1.9	0.3	3.5	0.3	1.6	0.2
Capital-intensive industries	1.4	0.7	–2.0	0.4	3.4	0.5	1.6	0.2
Advertising-intensive industries	2.1	0.4	–0.8	0.3	3.0	0.3	2.4	0.1
Research-intensive industries	4.2	0.6	0.4	0.5	3.8	0.4	3.3	0.2
Total	2.1	0.2	–1.3	0.2	3.4	0.1	2.1	0.1
Levene Statistic[1]	0.3	(4, 993)	1.2	(4, 984)	0.1	(4, 984)	13.4**	(4, 993)
F test[1]	3.6**	(4, 993)	5.2**	(4, 984)	0.8	(4, 984)		
Kruskal-Wallis[1]	27.4**	(4)	22.6**	(4)	2.7	(4)	98.3**	(4)

Source: WIFO calculations using SBS. A significant Levene test indicates that variances are not homogeneous across industries. In this case the usual *F* test on common group means cannot be applied. Instead the Kruskal-Wallis test on common group means is used. The growth rates refer to a typical industry and are therefore not weighted to account for size and composition effects. Thus they do not represent the growth of aggregate manufacturing. *SD* . . . standard deviation, ** . . . significant at the 5 percent level. – [1] Degrees of freedom in parentheses.

Growth Performance of European Manufacturing Industries – An Econometric Investigation

There are many potential determinants of industry growth. In our explanation of growth performance, we concentrate on country and industry characteristics inherited from the past. In particular, we examine productivity, specialisation and regional concentration[1], and skill endowments as they were at the beginning of the estimation period. We control for demand growth, spill-overs generated by trade, and measures of globalisation. Finally, we introduce policy variables.

A significant factor in determining growth performance is the starting position. The starting position is measured according to the level of labour productivity at the beginning of the estimation period (1989)[2], as well as by industry specialisation, which is also measured according to two indicators representative of 1989. The specialisation term is defined for each country as the share in value added of a specific industry in total manufacturing (at the beginning of the estimation period). Secondly, we use the combined intra- and extra-EU trade balance as a measure of revealed comparative advantage. As both indicators are uncorrelated (0.08), their introduction is justified. The low correlation is consistent with the notion of an ongoing home bias, since having a large share of an industry in a particular country does not necessarily imply a trade surplus.

The indicator of geographical concentration is calculated as a country's industry share of value added in total EU valued added for the industry. This indicator is related to the specialisation indicator, particularly if it is taken relative to country size. From the perspective of new economic geography, this indicator can loosely be interpreted as a measure of geographical concentration, if we take countries rather than regions as a first very imperfect approximation of the unit of locational choice. This index is correlated positively to the other two, although it is not very high (0.13 and 0.15, respectively).

Motivated by the new growth theory, we include growth in intra- and extra-EU imports in the basic specification. *Helpman* (1992), for example, has shown that in a model of endogenous growth, trade is an important channel for knowledge spill-overs from one country to another, thereby inducing endogenous growth.

[1] Recall that regional concentration is defined at the country level, providing just a rough estimate; it should be emphasised that these measures ought to be interpreted relative to country size, which is implicitly done in the regression below. – [2] Note that the specification is not exactly comparable to the growth equations of the convergence literature (*Barro,* 1998), which would introduce lagged value added to measure the speed of catching up.

Table 7: Explaining industry growth I: fixed effects regressions

Dependent variable: Growth of nominal valued added 1989 to 1997 in percent

	Specification I		Specification II	
	Coefficient	*t* value	Coefficient	*t* value
Level of labour productivity 1989	– 5.2	–12.2**	– 3.5	– 6.1**
Interaction: productivity and skills	–	–	– 6.4	– 3.8**
Specialisation	18.2	1.1	19.8	1.2
Concentration	– 4.8	– 2.0**	– 5.2	– 2.2**
Trade balance	0.0	0.5	0.0	0.6
Growth of extra-EU imports	0.6	2.8**	0.8	3.5**
Growth of intra-EU imports	0.2	0.7	0.3	1.0
Denmark	4.4	6.4**	4.3	6.4**
Germany	2.6	2.9**	2.6	3.0**
Greece	– 3.0	– 3.3**	– 2.3	– 2.6**
Spain	– 0.1	– 0.6	– 0.3	– 0.5**
France	2.7	3.9**	2.7	4.0**
Italy	3.3	4.7**	3.3	4.8**
Ireland	4.9	4.1**	4.9	7.3**
Austria	2.4	3.5**	2.4	3.6**
Portugal	– 1.1	– 1.2	– 0.8	– 0.9
Finland	– 0.1	– 0.2	– 1.6	– 0.3
U.K.	1.0	1.4	1.1	1.5
Constant	–18.0	–12.9**	–17.1	–12.4**
Number of observations	980		980	
R^2	0.37		0.38	
SD	4.0		4.0	
Fixed industry effects	3.6	F (85, 877)**	3.1	F (85, 876)**
Fixed country effects	21.0	F (11, 877)**	19.6	F (11, 647)**
Fixed vs. random industry effects	83.2	χ^2 (17)**	70.7	χ^2 (18)**

Source: WIFO calculations using SBS. Sweden as the country with the highest labour productivity in 1989 is the basis category for the fixed country effects. 16 outliers are skipped. *SD* . . . standard deviation, ** . . . significant at the 5 percent level.

growth (1.7 percent) of mainly capital-intensive high-wage industries, which faced the biggest reductions in employment.

The growth determinants we consider (see Box "Growth Performance of European Manufacturing Industries – An Econometric Investigation") are either country or industry specific, lacking variation in one of their dimensions. For this reason, they cannot be included in the fixed effects regressions. Therefore, in a second step, we regress the combined sum of industry effects and the error term on European-wide determinants of industry growth. These include a measure of market growth (defined as growth of apparent consumption in the triad, i.e., production plus imports minus exports), the degree of globalisation (measured by the exports and imports of the triad in relation to apparent consumption), non-tariff trade barriers (*Buigues – Ilzkovitz – Lebrun,* 1990) – often also referred to as sensitivity, with respect to the Single Market Programme –, a measure of skill and R&D intensity, as well as a differentiation by type of industry (see *European Commission,* 1998, and *Peneder,* 1998).

RESULTS OF THE PANEL ESTIMATIONS

The panel regressions in Table 7 reveal that the structure of specialisation and geographical concentration have a

Table 8: Explaining industry differences II

Dependent variable: industry effects plus error of regression from Table 7, specification I

	Coefficient	*t* value
Market growth	0.3	3.1**
Globalisation	–0.02	–2.7**
Sensitivity to single market (dummy for level 3 and 4)	8.8	1.1
Skill intensity	5.2	3.1**
Labour-intensive industry (dummy)	–0.7	–1.1
Capital-intensive industry (dummy)	0.8	1.0
Advertising-intensive industry (dummy)	0.8	1.3
Research-intensive industry (dummy)	2.5	3.3**
Constant	–1.5	–2.5**
N	86	
R^2	0.54	
Industry groups (WIFO typology)	5.0 F (4, 77)	

Source: Results of fixed effects regression in Table 7. Between regression (*Baltagi,* 1995, p. 118), ** . . . significant at the 5 percent level.

Table 9: Lowest and highest industry effects

	Average year-to-year percentage changes 1988-1997
5 fastest shrinking industries	
Leather clothes	–8.47
Dressing and dyeing of fur; articles of fur	–6.52
Other wearing apparel and accessories	–6.04
Knitted and crocheted articles	–5.55
Footwear	–4.58
5 fastest growing industries	
Railway locomotives and rolling stock	3.10
Parts and accessories for motor vehicles	3.48
Pesticides, and other agro-chemical products	4.33
Pharmaceuticals	4.55
Medical equipment	5.05

Source: Results of fixed effects regression in Table 7.

significant impact on growth[5]. A robust result is that geographical concentration in 1989 was significantly negatively associated with subsequent average industry growth. This implies that the industries of those countries already holding a comparatively large share of value added relative to their size (remember we control for fixed country effects) grew significantly more slowly. Geographical concentration is decreasing and industry structure is becoming more equally distributed across countries. Specialisation has little effect on growth; on the contrary, estimates are insignificant and there is no evidence that specialisation matters much as far as growth is concerned. These findings, however, do not imply the absence of strong agglomeration effects, which could lead to the regional agglomeration of production in more narrowly defined regions within countries or groups of countries.

There is significant catching-up, which means that industries in countries with low labour productivity in 1989 grew considerably faster. Comparative advantages based on productivity differences levelled off. Although the direct measure of specialisation does not show any impact, the findings on productivity support such an interpretation. The process of convergence proceeds hand in hand with a decreasing degree of specialisation in the industrial structures of European countries. Inter-industry trade shifts more and more to intra-industry trade, which is determined by economies of scale, product differentiation and imperfect competition. As argued above, empirical evidence shows that not all countries have succeeded in catching up[6].

The regression shows that extra-EU imports are growth enhancing, whereas intra-EU imports are insignificant. Import growth which influences production is often interpreted as a spill-over variable, transferring knowledge and stimulating further growth. This might be true for technology-intensive imports from the USA or Japan. Otherwise, the variable could proxy dynamic industries in which imports and production both increase, due to rapidly rising demand. Growth in intra-EU imports mainly captures two effects: first, intensifying integration through the removal of trade barriers leads to gains in efficiency, more competition, and subsequently lower prices. For a given demand schedule, this should also be reflected by higher growth rates, at least during an intermediate period. Since imports are measured in nominal terms, these effects cannot be disentangled. Secondly, trade with neighbouring countries may serve as an important channel for the transfer of knowledge, thus speeding up innovation and growth. However, this hypothesis does not find support, most probably because our proxy of spill-overs is rather imperfect.

Finally, although we control for several growth determinants, significant country and industry effects remain. Given the control variables, the fixed industry effects cover all latent, exogenous industry-specific growth determinants, which are equal for all countries. They exhibit a clear pattern: labour-intensive industries (textiles, apparel and footwear) reveal the lowest values, whereas skill and R&D-intensive industries (parts for motor vehicles, pharmaceuticals, pesticides and medical equipment) achieved the highest European-wide growth rates.

[5] For a more detailed analysis of convergence in structure and productivity in European manufacturing, see *Gugler – Pfaffermayr* (2000).

[6] We can't calculate the speed of catching up with the present specification. Estimating a simple specification to measure conditional β convergence for value added growth (see *Barro,* 1995) shows that – taking the regressions literally – it requires generations to close the gap to the steady-state growth path by 50 percent. Although we don't want to overemphasise the econometric estimations, we can conclude that industries in countries which are far from their (individual) steady-state growth paths grow faster on average. The growth effect is not very large and the speed of structural change is rather slow, amounting to several decades for the closure of the gap by 50 percent.

Table 10: Economic policy and growth performance

	Value added		OECD Regulation Index		Labour market			Education	State aid[1]		Tele-communication	Ratio R&D expenditure to GDP[2]
		Model evaluated at mean[3]	Overall product market regulation[4]	Overall regulatory environment[4]	Part-time employment[5]	Maximum working hours per week[6]	Active labour market policy expenditures[7]	Educational expenditures[8]	R&D aid	Aid to SMEs	Employees in mobile communications[9]	
	Year-to-year percentage changes 1988-1997				Percentage share		As a percentage of GDP	As a percentage of GDP	Percentage changes 1986-1996		Percentage share	Percent
Belgium	.	.	.	.	17.1	50.0	1.5	.	+ 2.8	– 0.9	7.0	1.6[10]
Luxembourg	.	.	.	.	10.7	48.0	0.3	.	+ 4.6	+ 3.5	.	.
Denmark	+3.9	+5.2	1.9	1.6	17.0	48.0	1.9	8.5	+ 6.5	+30.4	9.9	1.8
Germany	+2.1	+3.9	2.1	1.9	15.0	60.0	1.5	6.0	– 1.2	+ 4.3	8.9	2.3
Greece	+2.3	–3.1	2.9	.	8.5	48.0	0.3	3.7	–18.2	–13.1	4.8	0.5[10]
Spain	+0.8	+0.2	2.1	1.9	7.2	47.0	0.7	5.8	– 1.2	+21.5	12.3	0.8
France	+1.8	+3.6	2.4	2.1	14.8	48.0	1.3	6.6	+ 8.5	– 3.4	4.9	2.3
Italy	+2.2	+4.2	2.6	2.3	11.6	60.0	1.1	4.7	– 6.3	– 4.0	11.1	1.1
Ireland	+6.5	+5.6	1.7	1.3	15.7	60.0	1.7	5.7	– 4.4	+ 4.9	8.3	1.4
The Netherlands	.	.	.	.	29.4	60.0	1.4	5.4	– 6.4	–19.2	7.4	2.0[10]
Austria	+4.0	+3.4	2.2	2.1	10.7	50.0	0.4	5.5	.	–	11.1	1.5
Portugal	+5.8	–1.2	2.5	2.9	7.6	54.0	1.0	5.5	+ 5.7	–33.0	7.5	0.6
Finland	–2.5	–0.6	2.4	1.9	8.0	45.0	1.7	7.3	.	–	8.1	2.3
Sweden	–2.2	+0.7	2.2	1.9	14.8	50.0	2.4	7.9	.	–	.	3.0
U.K.	+1.0	+1.8	0.9	1.4	23.2	.	0.4	.	– 7.3	–14.6	8.7	2.1
Unweighted average	+2.1	+2.0	2.2	2.0	13.8	52.2	1.1	5.8	+ 0.5	+ 8.1	8.4	1.6

[1] Nominal; source: Berichte über staatliche Beihilfen (EU). – [2] As of 1995. Source: Science, Technology and Industry. Scoreboard of Indicators, OECD, 1997. – [3] Calculated from Tables 7 and 8. – [4] Source: *OECD* (1998). – [5] Source: Employment Outlook 1998. Part-time employment as a percentage of total employment as of 1996. – [6] Source: Employment Outlook 1998. – [7] 1996; source: Employment Outlook 1998. – [8] Source: OECD Education Database. Total expenditure from public, private and international sources for educational institutions plus public subsidies to households as of 1995. – [9] Source: Communications Outlook 1999. As a percentage of PTO employees as of 1997. – [10] 1993.

The second-step (between-) regression provides further results on the determinants of European-wide industry growth. As expected, overall market growth, defined as the growth of apparent consumption in the triad, plays an important role in fostering industry growth. Furthermore, globalisation, measured as the ratio of exports plus imports over apparent consumption in the triad, has a negative impact. This reflects the effect of global competition on structural change, whereby the more exposed industries grow, on average, slower.

The fixed country effects capture a variety of influences; among them are differences in macro-economic performance, economic policy and institutional settings. Significant country effects imply that during the period under investigation, differences in growth would have arisen, even if the countries in question had exhibited similar structures with respect to productivity, and geographical concentration, etc. They demonstrate that full integration is still yet to be achieved, although more recent data indicates that weaker effects can soon be expected. Compared to those of Sweden, the country effects for Ireland, Denmark, Italy, France, Germany and Austria are significantly larger, whereas all others are insignificant, some of them negatively. Formally, the estimation results are consistent with convergence in structure, but represent different country-specific steady states (conditional convergence). For a robust conclusion, the time period analysed is too short. The fixed country effects may stem from differences in macro-economic performance (e.g., devaluation as mentioned above in the case of Sweden), but may also be due to differences in industrial policy. In particular, the cases of Ireland and Italy illustrate that successful structural change results in higher growth potential over the long run, whereas for other fast growing countries which have been closing the gap (such as Portugal), this has not yet held true.

In the present setting, it is impossible to include these policy variables in our regressions. Instead, we make an informal comparison of growth performance and policy measures. Table 10 provides an overview.

POLICY VARIABLES BEHIND THE SYSTEMATIC COUNTRY DIFFERENCES IN GROWTH PERFORMANCE

Looking at the five fastest growing countries – Ireland, Portugal, Austria, Denmark and Greece – reveals important differences. First, observe that these are among the smaller EU countries. Secondly, evaluating the growth regressions at their average value (i.e., assuming counterfactually the same structure and the same productivity level) creates a different picture. Whereas average industry growth in Denmark, Austria, and Ireland is still above the EU average. Values are negative for Portugal and Greece indicating that growth is primarily part of the catching-up process. If this force levels off, structural change and active policy will be required for further growth.

Indices of liberalisation (*OECD,* 1998) measuring the impact of the regulatory environment provide no clear picture: the index on the degree of overall market regulation is above average in the fast growing countries of Ireland, Denmark and Austria. In Greece and Portugal, on the other hand, it is below average. A similar picture emerges when we examine the index of the overall regulatory environment. Note, however, that there are also counter examples. The U.K. has the most liberalised regulatory regime, but performed below average.

Labour market regulation, a second field of policy concern, differs widely across European countries. For example, the share of part-time workers varies between 29.4 percent in the Netherlands and 7.2 percent in Denmark. The maximum number of hours people are permitted to work per week varies between 45 hours in Finland and 60 hours in Germany, Ireland and Italy. In the U.K., there are no restrictions at all. Here, we find no clear trend, but some indication that labour market flexibility and especially, more part-time work, go hand in hand with higher long-run growth.

Spending on education is normally seen as a prerequisite to and the most important investment in long-run growth. The regression estimates have shown that industries using skilled employees more intensively grow faster over the long run. Also, the process of catching up is more rapid in those countries where productivity is below average. The case of Denmark illustrates that public spending on education can speed up growth. Similarly, Ireland – the country performing best in terms of growth – meanwhile has relatively high expenditures on education. The effect of investments on growth depends on the efficiency of the education sector, interaction with other policy instruments and the regulatory framework. Sweden, Finland and France likewise spend more than the EU average on education, but due to the above mentioned macro-economic developments in the former two countries, the long-run effects on growth are likely to be compensated.

With respect to state aid, we focus on (i) functional subsidies for R&D and (ii) aid to small and medium-sized enterprises. Various issues included in the Survey of State Aid in the European Union, made by the DG IV[7], serve as our sources. The greatest increases in innovation subsidies over the period 1989 to 1996 were received by firms in France, Denmark and Portugal. Thus, looking at the latter two EU countries, a case can be made for the promotion of growth by innovation subsidies. This is underlined by the programs for small and medium sized enterprises, which have increased most in Denmark, Spain, and Ireland.

This informal analysis shows that with the exception of innovation and education, there is no single policy measure, which can simply explain growth differences. The effects of innovation and education can be captured by the shares of skill and research-intensive industries. In other important areas, success seems to depend on the policy mix chosen. The best mix depends not only on national conditions, but also on whether growth is still in the catching-up phase.

CONCLUSION

Industry growth rates exhibit a large variance, including important country differences, which are determined by the starting positions measured according to structure and income per capita, but which may also indicate policy differences.

We find that there is significant decreasing geographical concentration. This is reflected by higher growth rates in the industries of those countries, which hold only small shares of an industry relative to their size.

The strongest robust result concerns convergence: industries in countries lagging behind in terms of their productivity level in 1989 grew significantly faster. This process is directly related to de-specialisation according to the old patterns, and perhaps even the newly emerging ones, as well. Such an observation implies that comparative advantages based on productivity advantages are diminishing and the degree of specialisation is tending to decrease. This process is expected to deepen integration.

Industry growth is also driven by demand, as well as by the strong forces of the globalisation process. The industries most exposed to the process of globalisation, mainly the labour intensive ones, show significantly lower rates of growth performance. In addition to the integration process, globalisation must be seen as the second most important factor shaping industrial structures in Europe.

Our analysis additionally provides evidence that growth is faster in industries in which intangible assets are important (i.e., skill and R&D-intensive industries), even considering the fact that demand in these industries is more dynamic. Our analysis strongly suggests that economic policies which enhance the skills of the workforce and support research will foster growth. The remaining fixed country effects suggest that other policies, which could not be tested econometrically, play an important role. The best policy

[7] Some regressions indicated the positive influence of functional subsidies. But they are not robust and a final assessment would require data with more variation in time or across industries.

mix may differ from one country to another, with income per capita playing a major role. Denmark and Ireland, which have above average growth performance, may be benchmarks of successful policy mixes.

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Do Growth Rates Differ in European Manufacturing Industries – Summary

The determinants of industry growth are of significant relevance to industrial policy. On the one hand, manufacturing growth can be viewed as part of the overall growth process. More important, however, differential growth across countries or industries contributes to the shaping of Europe's entire industrial structure.

According to the theoretical literature, growth at the industry level is either determined by demand side factors (e.g., income growth or demand for new varieties), by supply side factors (e.g., cost shifts or new technologies) or by structural factors (e.g., market structure or economic policy). Empirically confirmed factors responsible for substantial long-run differences in industry level growth rates are, from the supply side, the forces of catching up, technological factors, and endowment growth (such as growth in human capital through education); on the demand side, these factors include income and price elasticities.

On the NACE 3-digit level, the average rate of nominal growth in a typical industry amounted to 2.1 percent during the 9-year period 1989-1997. The standard deviation of 6.3 percentage points reveals the high level of variation between EU countries and between industries. 47 percent of the variation can be explained by country, sector, and combined sector and country effects. The variation across countries is more pronounced than the sector effects, indicating that the country-specific environment, economic policy and macro-economic development have a significant impact on industry growth. This picture is consistent with the view that European manufacturing is not yet fully integrated. However, as the regressions below illustrate, there is a strong tendency towards catching up and deeper integration. Most of the variation in average growth rates can be attributed to combined country-industry effects, suggesting that country-specific environments combined with industry-specific determinants common throughout the entire EU – such as demand growth – are the ingredients of long-run performance.

Furthermore, we find that specialisation and geographical concentration have a significant impact on growth. Geographical concentration is significantly negatively associated with subsequent average industry growth. This implies that the industries of those countries already holding a relatively large share of value added compared to their size grow considerably more slowly. Geographical concentration is decreasing and industry structure is becoming more equally distributed across countries. In general, specialisation has no effect on growth, with the notable exception of agglomerations.

Significant catching up has been taking place in the European manufacturing industry, with the result that industries in countries with low labour productivity have grown markedly faster. Comparative advantages based on productivity differences have levelled off. Although the direct measure of specialisation has not shown that there has been any impact, the findings on productivity can still be interpreted in this way. Convergence goes hand in hand with a decreasing degree of specialisation and thereby a more equal dispersion of industrial structures across European countries. This process is expected to deepen integration. Empirical evidence, however, shows that not all countries have managed to catch up.

Besides these forces, overall market growth, defined as the growth of apparent consumption in the triad, plays an important role in fostering industry growth. Furthermore, there is the negative impact of globalisation, measured as the ratio of exports plus imports over apparent consumption in the triad. This reflects the impact of global competition on structural change, with the more exposed industries growing on average more slowly.

Additional empirical evidence suggests that industries in which intangible assets are important (i.e., skill and R&D-intensive industries) grow faster, even after accounting for the fact that demand in these industries is more dynamic. Economic policies enhancing the skills of the workforce and research will foster growth. The remaining fixed country effects suggest that other policies, which could not be tested econometrically, will play an important role. An informal analysis suggests that liberal market regimes, flexible labour markets, and programs for small firms seem to be the most effective ingredients for promoting growth, but the best policy mix may differ from country to country and depend on its income per capita. Denmark and Ireland, which have above-average growth performance, may provide benchmark examples of successful policy mixes.

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