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COMPETITION. PRODUCTIVITY AND EFFICIENCY

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INTRODUCTION

Productivity gains form the basis of improvements in real incomes and welfare. Slow productivity growth limits the rate at which real incomes can improve, and also increases the likelihood of conflicting demands concerning the distribution of income (Englander and Gurney, 1994). The slowdown of productivity growth in the OECD area over the past decade therefore has important ramifications. However, even though productivity growth has slowed down, productivity levels still differ substantially across the OECD area, possibly indicating an under-utilised potential for growth and catch-up with other countries.

Productivity growth is influenced by a range of factors, and most studies suggest that there is no simple way to boost it (Englander and Gurney, 1994*a*). Apart from some specific options, such as investment in education, R&D or infrastructure, policies to boost productivity often focus on the framework conditions for productivity growth. The degree of competition in a particular country or sector is often considered to be among the most important of such factors, since a lack of competition reduces the pressure on firms to incorporate better technology, remove organisational slack and improve productivity performance.

In analysing productivity growth across countries, a distinction can be made between three different processes. First, productivity growth can result from innovative activity. For the productivity leader in a particular industry, productivity growth is to a considerable extent conditional on the development of new products and processes. Over the first two or three decades of the post-war period, most innovative activity was concentrated in the United States, as both private firms and the public sector engaged in large R&D efforts At that time, much of the R&D efforts in other countries were directed at adapting and borrowing technology developed in the United States (Englander and Gurney, 1994*a*). However, as indicated below, productivity leadership in the OECD has become more diversified and innovation is currently more widespread across countries.

Second, productivity growth may also be due to reduced (technical) inefficiency.[1] An inefficient firm or industry uses more resources and factor inputs than required by a particular technology, thus tying resources to low-productivity activities and reducing the overall allocative efficiency of an economy. Exposure to a higher level of competition forces inefficient firms to restructure, freeing resources for other productive uses. This process of resource (re-)allocation, which includes the entry and exit of firms, provides an important contribution to the structural change of OECD economies (OECD, 1995).

A third process that can be distinguished is technological diffusion. Firms can improve productivity by adopting production processes and products developed elsewhere (imitation). This allows them to improve productivity in a relatively straightforward way, as they do not have to engage in, often costly, innovative activity. Diffusion differs conceptually from efficiency gains, as the latter relates to improvements made in using a given technology – even when this technology is outdated by international standards.

Across countries diffusion relates to the ability of countries with low productivity levels and/or a low level of technology to incorporate the stock of technology developed in more advanced economies (*i.e.* catch-up). Recent studies (Coe and Helpman, 1995; Eaton and Kortum, 1995*a*, 1995*b*; OECD, 1996) suggest that currently, even for the United States, technology developed abroad provides an important contribution to productivity growth.

Research suggests that all three processes (*i.e.* innovation, efficiency gains and diffusion) are influenced by competitive conditions. The diffusion of technology is promoted by openness to international competition, and competition forces firms to incorporate new production processes and technology. Efficiency is also closely linked to competition, as weak competition may result in management and workers appropriating rents in the form of organisational slack and overstaffing. The link between innovation and competition is less clear-cut, and has been quite controversial in the literature. Currently, most studies suggest that a low degree of competition, as expressed in high concentration rates, is not conducive to innovative activity [2]

This paper discusses the empirical evidence on cross-country productivity gaps and analyses the link between productivity and competition. It first reviews whether low productivity levels are common across the OECD area, and then tries to assess which factors, including competitive conditions, contribute to low productivity or inefficient behaviour. Next, the paper discusses whether the rate of productivity growth is affected by weak competition. The final section draws some conclusions

THE EVIDENCE ON PRODUCTIVITY GAPS

Productivity gaps in manufacturing

There is no obvious and simple way to measure productivity gaps, and each measure has some drawbacks. Three methods are commonly used. A first method (Van Ark and Pilat, 1993; Van Ark, forthcoming) relies on cross-country comparisons of productivity levels. An industry in a particular country may be relatively productive by national standards, but may have a low productivity level compared with best practice abroad.

The main problem for this type of international productivity comparisons is the lack of appropriate conversion factors for real output. Exchange rates are not suitable, since they are strongly influenced by monetary phenomena, and in general do not reflect real price differences between countries. In principle, industry-specific conversion factors (or purchasing power parities – PPPs) are required that reflect these differentials across countries. Recent studies have made such conversion factors available for a large range of OECD countries (Van Ark and Wagner, 1996; Van Ark, forthcoming).

Some evidence on the basis of these studies is presented in Table 1. It reports estimates of absolute levels of labour productivity (value added per person engaged and per hour worked) in the manufacturing sector over the period 1960-95. The average productivity performance of the United States continues to outrank that of the other major economies (Japan, Germany and France), although Japan in particular has made considerable productivity gains over the past decades. High labour productivity levels, in particular in terms of hours worked, are also estimated for Belgium, Finland, the Netherlands and Sweden.[3] The manufacturing sectors in these small OECD economies tend to be more specialised than those of the large countries and are, apart from Sweden, relatively capital-intensive (Pilat, 1996), contributing to a high level of labour productivity.

In the middle of the OECD productivity range are a number of follower countries (the United Kingdom, Canada, Australia and Spain) with somewhat lower productivity levels, although in particular the United Kingdom and Spain have made substantial progress over the past decades. Canada's manufacturing productivity level was relatively high during the 1970s and 1980s, but its level has fallen substantially over the past decade. The bottom range of productivity performance in Table 1 is made up by Mexico and Portugal, that are still quite far behind in productivity levels Evidence presented in the table also suggests that US productivity performance improved relative to many countries in the 1980s.[4]

More detailed estimates of labour productivity levels, for selected manufacturing industries, are presented in Table 2 On the basis of detailed data for value added, employment and hours worked, productivity levels were estimated for 36 industries in 9 countries (Pilat, 1996)[5] Table 2 shows benchmark estimates for 1987 and updated estimates for 1993. The countries included in the Table cover only a sample of manufacturing productivity performance within the OECD, but the relative productivity performance of these countries is relatively well documented in a range of country-specific studies [6]

Table 2 suggests that the United States remains the productivity leader for total manufacturing, but also indicates that the leadership in particular

Table 1. **Relative labour productivity levels in manufacturing**

1960-95, United States = 100

	1960		1973		1985		1995[1]	
	Value added per person engaged	Value added per hour worked	Value added per person engaged	Value added per hour worked	Value added per person engaged	Value added per hour worked	Value added per person engaged	Value added per hour worked
United States	100 0	100 0	100 0	100.0	100 0	100 0	100 0	100 0
Japan	25 1	19 2	55 4	48.5	78 2	68 8	74 8	72 8
Germany	60 6	56 0	72 5	76.1	75 6	86 4	63 1	81 4
France	47 5	45 9	66 0	70.0	72 3	85 8	70 1	85 1
United Kingdom	48 6	45 0	52 0	53.6	54 7	59 7	59 6	69 7
Canada	69 1	68 5	81 3	82.5	82 0	84 3	68 4	69 6
Australia	52 9	50 5	50 2	49.9	54 2	56 5	50 3	51 7
Belgium[2]	45 3	45 6	60 7	70.9	83 1	06 4	81 1	04 7
Finland[2]	49 2	45 9	54 4	58.3	63 9	71 9	82 8	00 8
Mexico[2]	26 6	24 7	34 2	32.4	34 3	31 4	n a	n a
The Netherlands	52 8	50 8	76 8	88.2	85 8	07 1	73 7	96 5
Portugal[2 3]	15 7	n a	25 3	n.a.	23 9	n a	26 7	n a
Spain[2 3]	15 4	20 4	29 2	37.8	48 8	79 8	40 1	67 6
Sweden	48 5	49 8	66 0	79.6	68 3	87 3	75 4	90 3

1 Or latest available year

2 The productivity estimates for these countries are directly derived from industry-of-origin studies and thus exclude PPPs from expenditure studies They are therefore not strictly comparable to the estimates for the other countries

3 Portugal/USA and Spain/USA are inferential estimates based on benchmark studies for Portugal/UK and Spain/UK that were linked to the other countries by the UK/USA comparison

Source Based on 1987 benchmark estimates from Table 2 updated with time series from Van Ark (forthcoming) and BLS (1995) Benchmark estimates for Finland/USA Belgium/USA and Mexico/USA are from Van Ark (forthcoming) Benchmark estimate for Portugal/UK based on Peres Lopes (1994) for Spain/USA from Van Ark (1995)

Table 2. **Manufacturing labour productivity levels in major OECD economies, 1987 and 1993**

Value added per hour worked, leader country = 100[1]

Industrial sectors	United States	Japan	Germany	France	United Kingdom	Canada	Australia	Netherlands	Sweden
					Panel A: 1987				
Food beverages and tobacco	100.0	32 3	75.3	65 3	46 1	596	459	95.4	57 3
Textiles, clothing and footwear	67 4	38 1	60.1	61 7	47 4	546	422	100.0	60 8
Wood products and furniture	69 5	15.6	50.2	52 4	38 1	638	327	100.0	64 1
Paper products and printing	97 2	47 5	61.2	65 0	64 7	81 4	532	62.7	100.0
Chemical products	80 8	52 9	60.1	58 0	59 5	680	449	100.0	72 4
Non-metallic mineral products	77 0	55 1	67.1	100.0	59 9	75 1	56 4	97.7	75 5
Basic metal products	94 4	100.0	80.3	77 0	74 2	893	57 1	80.3	93 3
Metal products	86 3	76 0	76.3	57 3	50 6	70 1	42 3	68.9	100.0
Machinery and equipment	99 0	85 6	73.8	100.0	65 4	642	61 1	59.1	66 5
Electrical machinery	00.0	82 7	67.6	90 0	51 3	664	358	93.7	75 6
Transport equipment	96 9	100.0	76.7	84 9	42 1	69 7	39 3	47.0	55 8
Other manufacturing	00.0	39 4	45.3	40 1	52 5	583	330	47.2	67 0
Total manufacturing	00.0	66 5	78.5	80 3	59 4	76.0	51.8	98.5	82 0
Coefficient of variation[2]	I6 9	41 4	20.5	31 0	26 1	22.7	28.0	28.4	29 2
					Panel B: 1993[3]				
Food, beverages and tobacco	100.0	356	826	87 0	41.7	643	51 1	96.6	72 8
Textiles, clothing and footwear	78.3	41 9	703	67 1	51.5	463	32 3	100.0	66 5
Wood products and furniture	56.0	17.6	506	55 3	28.1	526	27 1	100.0	71 9
Paper products and printing	85.0	497	566	64 3	76.4	676	537	64.5	100.0
Chemical products	66.9	526	509	56 9	79.7	526	398	100.0	89 4
Non-metallic mineral products	81.8	629	739	99 4	70.6	784	774	100.0	81 0
Basic metal products	76.8	78 3	780	63 3	61.4	879	568	70.4	100.0
Metal products	68.9	676	672	46 4	42.5	548	359	54.0	100.0
Machinery and equipment	160.0	674	587	67 3	47.9	55 5	464	34.6	45 2
Electrical machinery	80.3	890	540	78 9	48.2	51 9	280	82.2	100.0

Table 2. **Manufacturing labour productivity levels in major OECD economies, 1987 and 1993** *(cont.)*

Value added per hour worked, leader country = 100'

industrial sectors	United States	Japan	Germany	France	United Kingdom	Canada	Australia	Netherlands	Sweden
					Panel B: 1993[3]				
Transport equipment	884	**100.0**	82 6	85 0	47 8	71 9	455	41 8	49 5
Other manufacturing	**100.0**	41 4	396	31 4	43 5	335	22 1	27 0	47 4
Total manufacturing	**100.0**	76.6	81 3	84.2	64.1	71.3	52.0	95.6	91.8

i The procliictivity level of the leader country in each industry is indicated in bold

2 The coefhcient of variation is the standard deviation divided by the mean expressed as a percentage It is calculated over the 35 industries for which estimates are available (see Table A2)

3 Productivity levels for Germany are for 1992

Source Data for 1987 based on Table A2 1993 updated from 1987 benchmark using output and employment series from STAN data-base (OECD 1995*a*) Hours worked for 1993 are only available for total manufacturing (BLS 1995) Consequently the trend in hours worked at the sectoral level is assumed to be identical to the trend for total manufacturing

manufacturing industries has become more diversified.[7] In 1987, the United States was the productivity leader in food products and electrical machinery, the Netherlands in textiles and chemical products, Japan in basic metal products and Sweden in metal products. By 1993, some of these relative positions had changed, with Swedish productivity performance in particular improving substantially.

The productivity estimates in Table 2 cover only the 12 most important sectors. The more detailed estimates of productivity, for all 36 industries, suggest that in almost one-third of all industries, the United States remains the world productivity leader. In other industries, the leadership has passed to other countries, *e.g.* Japan in some heavy industries (iron and steel, shipbuilding), the Netherlands in some light and capital-intensive industries (textiles, industrial chemicals) and Canada and Sweden in some resource-related industries (non-ferrous metals and paper products, respectively).

Furthermore, there appears to be a shared leadership in several industries, *e.g.* in food products (United States and the Netherlands) and in motor vehicles (United States, Japan). Table 2 also shows that the inter-sectoral variation in productivity performance, as expressed in the coefficient of variation, is by far the largest in Japan. This indicates that whereas some industries in Japan are among the world productivity leaders, others are relatively far behind (McKinsey, 1993; Van Ark and Pilat, 1993). Consequently, the average productivity level of the Japanese manufacturing sector remains below that of the United States and several other OECD economies.

More evidence on productivity differences, although specific to individual countries, is available from a second approach to international comparisons, namely country-specific case studies. Two examples of such studies are those by the McKinsey Global Institute (McKinsey, 1993, 1994, 1995) and the National Institute of Economic and Social Research (Steedman and Wagner, 1989). Case studies have the advantage that products and firms can be carefully matched and several sources of bias at the aggregate level can be avoided. A problem with this method is that it is not always easy to generalise the results from case studies to a more aggregate level

Most case studies compared the productivity levels of two or more OECD countries for individual industries. In general, they found large differences in performance across the OECD area. Table 3 shows some of the evidence for selected manufacturing industries in seven OECD countries.[8] In food products, the United States is the undisputed productivity leader, with particularly Japan trailing far behind. In motor vehicles, Japan and the United States are the world productivity leaders, clearly outperforming the European countries In computer equipment, there appear to be only small differences between the three major OECD countries for which data are available

Table 3. **Productivity gaps in case studies, USA = 100**

	Manufacturing industries			Services		
	Food products,[1] 1990	Motor vehicles and equipment.2 1992	computers and parts,? 1990	Banking,[4] 1992	Retailing,[5] 1990	Construction,[6] 1990
United States	100 0	100 0	100 0	100.0	100.0	100 0
Japan	32 0	118.7	95 0	n a	44 0	66 0
Germany	70 0	58 5	89 0	55 0	89 0	91 0
France	n a	56 7	n a	50 0	87 0	93 0
Spain	n a	40 4	n a	n a	73 0	84 0
Italy	n a	39 8	n a	25 0	n a	91 0
Sweden	58 0	79 0	n a	66 0	84 0	77 0

1 Value added per hour worked at industry PPPs See McKinsey (1995)
2 Value added per employee at industry PPPs See McKinsey (1994) Productivity level for Sweden refers to passenger cars only
3 Value added per hour worked See Baily and Gersbach (1995)
4 Transactions per employee in payments and cash withdrawal See McKinsey (1995)
5 Value added per full-time equivalent employee in general merchandise retailing See McKinsey (1995) Productivity level for Japan refers to 1987 see McKinsey (1994)
6 Value added per employee See McKinsey (1994)
Source McKinsey Global Institute (1993, 1994, 1995); Baily and Gersbach (1995)

A third approach to productivity comparisons (Caves, 1992; Mayes *et al.*, 1994; Perelman, 1995) uses estimates of production frontiers and measures inefficiency as the gap between observed efficiency in a particular firm and the estimated efficiency frontier of the industry to which the firm belongs (see note 1)

This approach also provides some useful evidence, although it can mainly be used to analyse the existence of inefficiency *within* a country. Although some attempts have been made to derive estimates of international efficiency frontiers for manufacturing (Fecher and Perelman, 1992; Perelman, 1995), the data are often not particularly comparable across countries and the derived efficiency measures are of doubtful value. Five countries (Australia, Canada, Japan, the United Kingdom and the United States) have been covered by studies of domestic efficiency frontiers, and in each a significant level of inefficiency was found in many industries (Caves *et* al., 1992, Mayes *et* al., 1994)[9] In general, this is interpreted as each industry having a long "tail" of inefficient firms, i.e. firms that could produce substantially more output with existing inputs

The results of this latter approach are more difficult to interpret than the rather straightforward comparison of output per person or per hour worked. For instance, an industry in a particular country may be characterised by a high level of efficiency, implying that all (or most) firms are close to the estimated efficiency frontier for that industry and country. However, a high level of domestic efficiency does not exclude a low level of productivity compared to other countries, as firms in a country may be using outdated technology compared to firms in other countries.

Productivity gaps in services

There thus appears to be widespread evidence of large productivity differences in the manufacturing sector, both within countries and across countries. Given the low degree of international and domestic competition in several services, productivity might be expected to vary even more there.

Data constraints limit the scope of productivity analysis for the service sector and most of the available work on international productivity comparisons therefore pertains to the manufacturing sector. However, for some services, crude comparisons of productivity across countries are possible[10] Where productivity comparisons can be made, most of the available evidence points to a large variation in productivity in services across the OECD (Table 4).

In electricity, output per person differs widely between countries, with the United States, Japan, Canada and Norway having the highest productivity levels. Substantial differences in productivity performance also exist within the distribution sector, suggesting sizeable scope for productivity growth in several countries The highest productivity levels are estimated for the United States, France, Germany, Belgium and Luxembourg, whereas low productivity levels are estimated for Japan, the United Kingdom and some of the smaller OECD economies.

In airlines, considerable differences in cost efficiency exist between countries. In this sector, the highest cost levels tend to be found in continental Europe (including Ireland), and the lowest in Australia, the United States, the United Kingdom, Finland and New Zealand Among the larger countries, the high costs levels of Japan and France stand out. In telecommunications, productivity is relatively low in the smaller European countries, but also in Germany. Productivity differences in postal services and railways also appear substantial, although this evidence has a somewhat historical character. Nevertheless, productivity differences appear quite large in these sectors as well.

Some evidence on productivity gaps in services can also be drawn from more detailed industry-specific comparisons across countries (Baily, 1993; McKinsey, 1992, 1994, 1995; Table 3). These studies cover the experience of selected service industries in the United States, Japan, Germany, France, Italy, the United Kingdom, Spain and Sweden. On the whole, they suggest the existence of considerable slack in services in many countries and considerable variation in performance across countries.

Table 4. **Productivity and efficiency in selected service industries**

	Electricity	Distribution		Airlines	Telecommunications		Postal Services	Railways
	Gigawatt-hour per person engaged, 1993	Distribution GDP per person engaged, 1990 (USA = 100)	Retail sales per employee, 1990 (USA = 100)	Operating expense per available tonne kilometre, 1993 (US$)	Revenue per employee, 1992 (USA = 100)	Mainlines per 100 inhabitants, 1992	Average technical efficiency, 1975-88[1]	Average technical efhciency 1986-88[2]
United States	8.2	100 0	100 0	0 45	100 0	56	n a	n a
Japan	6.3	60 3	70 7	0 84	80 6	46	0 797	n a
Germany	2.2	78 5	100 7	0 71	63 1	44	0 457	0 620
France	3.8	96 6	94 8	0 88	68 3	52	0 720	0 731
Italy	1.6	95 3	72 3	0 72	89 3	41	0 722	0 638
United Kingdom	2.2	59 5	77 6	0 43	68 9	45	0 850	0 746
Canada	5.5	58 4	n a	0 54	73 9	59	n a	n a
Australia	2.9	59 4	60 1	0 35	70 6	49	0 893	n a
Austria	1.8	86 8	73 4	1 08	77 9	44	n a	0 594
Belgium	3.2	105 0	94 1	1 04	58 6	43	0 600	0 630
Denmark	3.3	86 6	68 6	1 00	53 4	58	0 732	0 523
Finland	3.1	56 4	85 9	0 44	48 0	54	0 198	0 653
Greece	2.5	37 1	62 2	0 47	36 9	44	0 387	0 564
Iceland	n.a.	38 3	75 1	n a	39 6	54	n a	n a
Ireland	n.a.	68 7	60 3	1 46	52 7	31	0 355	0 731
Luxembourg	n.a.	101 3	130 1	n a	132 7	61	0 787	0 562
Netherlands	3.1	95 2	54 8	0 48	88 0	49	0 924	0 797
New Zealand	3.4	77 8	85 8	0 44	65 2	44	n a	n a
Norway	8.0	42 3	92 9	1 10	52 2	53	0 630	0 516
Portugal	1.2	45 4	52 8	0 83	58 9	31	n a	0 692
Spain	3.3	77 6	45 7	0 66	74 2	40	n a	0 647

Table 4. **Productivity and efficiency in selected service industries** *(cont.)*

	Electricity	Distribution		Airlines	Telecommunications		Postal Services	Railways
	Gigawatt-hour per person engaged, 1993	Distribution GDP per person engaged 1990 (USA = 100)	Retail sales per employee 1990 (USA = 100)	Operating expense per available tonne kilometre 1993 (US$)	Revenue per employee 1992 (USA = 100)	Mainlines per 100 inhabitants 1992	Average technical efficiency 1975-88[1]	Average technical efficiency 1986-88[2]
Sweden	5.6	66.4	86.9	1.01	50.4	68	0.755	0 662
Switzerland	n.a.	115.8	78.8	0.75	100.1	61	0.574	0.736
Turkey	n.a.	n.a.	n.a.	n.a.	27.4	16	n.a.	0.769

1. Defined as output relative to inputs, where output is the sum of the number of letters delivered and the financial operations performed, inputs include employees, number of motor vehicles and number of postal offices used [see Perelman and Pestieau (1994) for details].

2. See note 1. Output is the combination of gross hauled tonne-kilometres by freight trains and gross hauled tonne-kilometres by passenger trains The inputs are engines and railcars, employment, and electrified and non-electrified lines [see Pestieau (1993)].

Source: Electricity based on OECD/IEA (1995) and national sources for employment; Distribution GDP per person based on OECD National Accounts and national sources, converted with 1990 PPP for expenditure on goods from OECD (1993); Retail sales per employee based on EC (1993) and national sources, converted with same PPP; Airlines based on data provided by the Institute of Air Transport, Paris, for major airline companies; Telecommunications from OECD (1995*b*); Postal services from Perelman and Pestieau (1994); Railways from Pestieau (1993).

EXPLAINING PRODUCTIVITY LEVELS

The role of factor intensity

Part of the difference in manufacturing productivity between countries can be explained by differences in factor use, reflecting differences in factor endowments and relative factor prices (Salter, 1966). Firms in countries such as Mexico and Portugal are faced with relatively low labour costs and consequently choose relatively labour-intensive production techniques, leading to low levels of labour productivity (see Table 1). Best practice technologies from more advanced countries may be of little relevance to these firms, as such technologies are often based on a different set of factor prices.

Table 5 **Explanations of productivity gaps in manufacturing, 1989**

All levels relative to the United States

	Japan	Germany	France	United Kingdom	United States
Value added per hour worked	73 9	84 0	91 1	62 0	100 0
Relative capital intensity	76 5	102 2	132 2	75 6	100 0
Value added per unit of fixed capital	96 6	82 3	69 0	82 0	100 0
Total factor productivity (TFP)[1]	81 1	83 6	84 1	66 8	100 0
Relative level of workforce qualifications	97 7	98 5	95 9	95 2	100 0
TFP adlusted for labour force skills'	83 0	84 5	86 5	69 1	100 0
TFP adlusted for skills and industrial structure?	85 7	78 9	84 8	69 2	100 0

1 Value added per hour worked adjusted for capital per worker

2 TFP adlusted for educational qualihcations of the manufacturing workforce For Japan the adjustment only takes account of general qualihcations for the other countries the adjustment also incorporates vocational qualifications Workforce qualihcations are for 1987

3 TFP adlusted for the composition of manufacturing industrial composition based on 1987 data

Source Labour productivity levels are from Van Ark (1996) Adjustment factors are based on Van Ark and Pilat (1993) for japan and Germany relative to the United States and on Van Ark (1993) for France and the United Kingdom relative to the United States

To some extent, differences in factor prices also affect productivity differentials between countries with more similar factor endowments, such as those reported in Table 2. Thus, part of the difference in labour productivity across countries can be explained by differences in capital intensity and capital productivity For instance, Japan and the United Kingdom have relatively low levels of capital intensity in their manufacturing sector and relatively high levels of capital productivity (Table 5). For these countries, capital intensity explains a substantial part of the labour productivity gap with the United States, more than 25 per cent of the gap between Japan and the United States, and almost 13 per cent of the gap between the United Kingdom and the United States However, for France, Canada and the Netherlands, which have more capital-intensive manufacturing industries than the United States (Pilat, 1996), an adjustment for capital intensity does not help to explain the labour productivity gap with the United States. In general, this implies that capital productivity in the manufacturing sector of these countries is relatively low. However, the comparison of real capital stocks and capital productivity across countries is more difficult than the comparison of real output, implying that these numbers should be evaluated with care.'[1]

An adjustment for the average educational skills of the manufacturing work force explains only little of the productivity gap. Although the average level of schooling in the United States is among the highest in the OECD (Englander and Gurney, 1994*a*), the average skill level of its manufacturing work force – measured by the qualification levels of manufacturing workers – is not very different from that of other major OECD countries (Van Ark and Pilat, 1993; Table 5). In addition, the experience with transplant production suggests that companies are able to match the productivity of their parent company abroad by using local labour, suggesting that educational differences are not a binding constraint for the achievement of high productivity, as appropriate in-company training can reduce such differences (McKinsey, 1993; Baily and Gersbach, 1995).

Other explanations for productivity differences

Differences in labour productivity may also be the result of structural differences, i.e. differences in the composition of output within a particutar industry or sector. The McKinsey studies (McKinsey, 1993) suggests that this factor plays only a limited role in most industries. However, for some of the industries shown in Annex Table 2 this factor probably plays an important role For instance, Japan is one of the few countries in the OECD that produces supertankers, contributing to a high level of labour productivity in shipbuilding. In addition, the productivity leaders in the aircraft industry, the United States and France, are the main producers of large passenger aircraft. At the aggregate level, an adjustment for industrial structure does not contribute much to the overall explanation of productivity gaps, however (Table 5). In fact, an adjustment for industrial structure increases Germany's productivity gap with the United States, as the industrial structure of Germany is more geared towards industries with high absolute levels of labour productivity (Van Ark and Pilat, 1993).

The combined adjustments for capital intensity, labour force qualifications and industrial structure explain more than 45 per cent of the Japan-US productivity gap, and almost 20 per cent of the UK-US productivity gap. For Germany and France, the combined adjustments fail to provide any explanation for the productivity gap with the United States, although the adjustment for educational skills reduces the productivity gap somewhat.

More evidence on explanatory factors for productivity differences, although somewhat specific to individual countries, is available from the country-specific studies mentioned above, and primarily from the McKinsey studies (McKinsey, 1993, 1994, 1995). These studies generally confirm that differences in capital and skill intensity do not explain much of the productivity gaps in manufacturing. They also suggest that access to technology is not a major explanatory factor for productivity differentials across OECD countries. Much technology is embodied in capital goods, which tend to be easily accessible in the world market. There are, however, major differences in the degree to which the latest technology is incorporated in the production process, suggesting that new technology is only slowly diffused across countries.

Economies of scale do appear to play some role, at least for some countries For Japan relative to the United States, Van Ark and Pilat (1993) found that the small size of establishments in many lapanese industries contributed substantially to the low level of average productivity. Similar evidence was presented by the McKinsey work (Baily and Gersbach, 1995). These studies found that sub-optimal scale and craft production processes still made up a substantial part of Japanese *(e.g.* in food manufacturing) and German industry *(e.g.* in beer production and in metalworking), contributing to low productivity levels in these industries.

Firms are increasingly looking across national borders to analyse the performance of their major competitors and of the productivity leaders in a particular industry. This is particularly the case in global markets, where firms are faced with a high degree of competition. This "benchmarking" allows them to look at best practice and sets standards for their own performance. In this context, the McKinsey studies found that much of the differences across countries with regards to productivity performance actually resulted from the "organisation of functions and tasks".[12] These differences are often the result of an accumulation of small improvements over a long period of time, regarding both workfloor organisation and the management of the firm (Baily and Gersbach, 1995).

If differences in productivity levels across countries are not just the result of differences in factor endowments or structural effects, then the gap in productivity levels between countries can partly be taken as the gap between best available (average) practice and average implemented practice in a particular country This would suggest the existence of considerable scope for catch-up In addition, the large variation in productivity performance in some countries indicates that the catch-up process with US productivity levels has not been uniform across industries, suggesting that productivity growth in some sectors may have suffered from structural rigidities, other than the availability of technoiogy (Englander and

Gurney, 1994a). The evidence on productivity differentials also indicates that even within the United States, catch-up possibilities may exist in some sectors.

Where services are concerned, country-specific factors appear to affect productivity levels to some degree For instance, in electricity, favourable resource endowments in some countries (*e.g.* Canada and Norway) allow a high share of hydropower in electricity production, contributing to high productivity levels in these countries. In distribution, a substantial part of the differences in productivity appears related to structural characteristics (population density, land prices, etc.). In airlines, specific factors such as higher fuel costs, shorter stage lengths and higher fly-over costs reduce the efficiency of European airlines relative to US-based carriers (Høj, Kato and Pilat, 1996)

The impact of competition

The impact of competition on productivity is not so easy to evaluate The degree of competition in a particular industry is difficult to measure and is determined by many different factors. Competition also does not affect productivity in a direct and easily measurable way, as tends to be the case with production factors such as capital or technology. Rather, it is an important determinant of the conditions under which productivity growth occurs and under which high productivity levels may emerge

A first look at the link between productivity levels and competition is provided in Table 6. It shows pooled correlations between a set of competition-related variables and labour productivity levels, for 9 countries and 36 industries The correlations distinguish between different types of industries, based on a typology by market structure (Oliveira Martins, Scarpetta and Pilat, 1997) This typology allows a distinction between different types of competitive behaviour. For instance, fragmented, homogeneous industries are most likely to be characterised by perfect competition. Firms in these industries are typically small and the goods produced by these industries are relatively homogeneous Examples of such industries include food products and textiles. On the other extreme, segmented, differentiated industries are mostly made up of large firms, producing highly sophisticated and differentiated goods. Examples of such industries include drugs and medicines, as well as electrical and computer equipment.

First, as expected, relative levels of capital intensity are positively and significantly related to labour productivity levels Concentration rates are not correlated to productivity levels in fragmented industries, but there appears to be a significant negative link for segmented industries, suggesting that high concentration is not conducive to productivity in these industries Entry rates have a positive impact on productivity levels, particularly in fragmented, homogeneous industries, where entry is easiest and firms are relatively small

Table 6 **Correlations between productivity levels and structural variables**[1]

T-statistics in parenthesis

Market structure groups[2]	Capital intensity level	Concentration rate	Entry rate	Trade Variables			
				Export intensity	Import penetration	MFN tariff rates	Rate of core NTBs
Fragmented, homogeneous	0.28 (2.85)	0.05 (0.36)	0.44 (3.97)	0 20 (2 05)	–0 09 (–085)	–0 19 (–1 95)	0 06 (0 57)
Fragmented, differentiated	0.48 (3.59)	0.16 (0.78)	0.31 (1.70)	–0 20 (–1 21)	–0 30 (–1 86)	–0 10 (–058)	0 41 (2 68)
Segmented, homogeneous	0.31 (2.96)	–0.35 (–2.51)	0.15 (1.19)	0 24 (2 17)	0 07 (0 59)	–0 18 (–1 57)	–0 05 (–040)
Segmented, differentiated	0.19 (1.59)	–0.31 (–2.12)	0.36 (2.90)	0 04 (0 40)	–0 15 (–1 44)	0 03 (0 32)	0 23 (2 18)

1. The Table shows correlations between structural variables and the pooled sample of labour productivity estimates For all 9 countries and 36 industries For which estimates could be derived. Concentration rates (see Van Ark and Monnikhof. 1996) are only available for the United States, Japan, Germany, France and the United Kingdom Entry rates are only available for the United States, Japan, Germany, the United Kingdom, Canada and the Netherlands.
2. Detail on the classification of industries by market structure is available in Oliveira Martins, Scarpetta and Pilat (1997).

Source. Calculations on the basis of labour productivity levels reported in Annex Table A2; capital intensity levels from Pilat (1996); concentration rates from Van Ark and Monnikhof (1996); entry rates from Schwalbach (1991), Management and Coordination Agency (1989/90 and 1993/94) and Kleijweg and Lever (1994); export intensity and import penetration from STAN database (OECD, 1995a); tariff barriers and NTBs from OECD (19960).

The trade variables also provide some interesting results. Export intensity and tariff barriers are only correlated with productivity levels in homogeneous industries, *i.e.* those industries where price competition is most important. Though not significant, the negative link between import intensity and productivity levels is more difficult to interpret, although it could indicate that import penetration increases if industries in a particular country can not match high productivity levels abroad. Non-tariff barriers (NTBs) appear positively linked to high productivity levels, but only in differentiated industries. This result is surprising and difficult to interpret, as NTBs are primarily used in declining industries, most of which tend to produce homogeneous goods.

The correlation analysis is somewhat elaborated in the regression analysis of Table 7. It appears that some of the variation in manufacturing labour productivity levels seems related to the exposure of sectors to international competition, as measured by tariff barriers and export intensity, while, as expected, a much larger part appears due to differences in capital intensity The regressions only explain about half of the variation in productivity levels, however. This is not surprising, as a complete model of productivity levels is difficult to test empirically. Many relevant variables, for instance work force qualifications or the degree of foreign direct investment by industry, are not available at a sufficient level of detail and are thus difficult to integrate in a regression analysis

In the McKinsey work, the degree to which firms implement modern technology was directly related to their exposure to competition A firm in a sheltered market has few incentives to choose an efficient technology and reduce resource use, but can spend the rents it earns on technical inefficiency and organisational slack. For Germany, Japan and the United States, Baily and Gersbach (1995) argued that differences in the use of modern technology were strongly correlated with the extent to which entire industries were exposed to competition with best-practice firms, either by international trade or by competition with transplant companies. In general, domestic competition by itself was insufficient to bring firms – and hence entire industries – up to global best practice productivity levels.

The work on efficiency frontier measurement also provides some links between competition variables and inefficient behaviour (Caves, *et al.*, 1992). Of particular interest are two types of explanations:

- Competitive conditions. In most countries efficiency within an industry declines beyond a certain level of concentration, suggesting that high levels of concentration are detrimental to efficiency. In Japan and Canada, export-oriented industries were found to be more efficient than import-competing industries, whereas import competition favourably affected efficiency in the United States and the United Kingdom Furthermore, tariff protection (in Japan and in Australia) and entry-restricting regulations (in japan) were found to have a negative impact on efficiency. This suggests that

Table 7. **Regressions explaining labour productivity levels in manufacturing, 1987**

Dependent variable is real value added per hour worked (in logs), t-statistics in parenthesis[1]

	Constant	Capital intensity level (in logs)	Export intensity (in logs)	Tariff measures (in logs)	Import penetration (in logs)	R^2 (adj)	Nob	Standard errors of regression
Equation 1	3 414 17 84)	0 189 (4 80)				0 477	301	0 267
Equation 2	3 773 1831)	0 154 (3 92)	0 091 (4 06)			0 504	300	0 260
Equation 3	3 866 18 53)	0 145 (3 69)	0 086 (3 84)	–0 065 (–2 14)		0 510	297	0 258
Equation 4	3 829 (18 85)	0 162 (4 20)	0 103 (4 63)		–0 250 (–3 24)	0 522	300	0 255
Equation 5	3 916 (1902)	0 154 (3 98)	0 098 (4 39)	–0 056 (–1 88)	–0 238 (–309)	0 526	297	0 254

1 The equations include fixed country effects and sectoral effects They are based on the pooled sample of productivity estimates for 9 countries and 36 industries (see Annex)

Source See source note to Table 6

competition reduces the spread in performance within an industry, probably by removing the most inefficient firms and by boosting performance in other firms. In general, domestic competition appears to play a larger role than international competition in promoting efficiency (*i.e.* eliminating intra-sector efficiency differences) within a given sector in an individual country.

- Organisational and managerial influences. Although difficult to measure, the ultimate source of inefficiency is often related to the management of a particular firm. Only some aspects of this factor have been analysed, however. For instance, Caves and Burton (1992) found that many US firms had diversified their activities too much in the 1970s, leading to a decline in efficiency.

Apart from these competition-related reasons, other explanations for inefficiency in these studies of efficiency frontiers were provided by industrial dynamics (fast-growing industries are likely to show a larger variation in performance), spatial disparities (efficiency is likely to differ in a geographically diversified market) and heterogeneity of products (which implies that the calculated efficiency frontier may not be appropriate for the industry as a whole)

For services, the link between competition and productivity can often only be made in a rather descriptive way, as few hard indicators of competition are available Within private services, the profit motive provides incentives for managers to enhance productivity, although regulations can limit the impact of competition. Regulations may also prevent firms from using business practices developed in other countries (OECD, 1995*c*). For sectors controlled by public enterprises, profit-maximising behaviour is likely to play a more limited role in managers' decision-making.

Across different sectors, there are some indications that competition matters. In electricity, the variation in productivity tends to be large even for countries with a similar composition of supply, suggesting that pure efficiency differences may play some role. For instance, productivity levels in the United States are substantially higher than in many other countries, even though the bulk of US electricity production is based on combustible fuels

In distribution, part of the variation in productivity seems due to a high degree of regulation in some countries, principally limitations on large-scale establishments and restrictive zoning laws (Høj *et al.*, 1996) In airlines, the evidence suggests that deregulated markets (primarily the United States, the United Kingdom, Canada, Australia and New Zealand) have much lower costs and are much more efficient than regulated markets (mainly those of many countries in continental Europe)

Within public enterprises and in particular in sectors that were, until recently, generally considered to be natural monopolies (*e.g* telecommunications, railways, postal services), the link between efficiency and competition is probably stronger The lack of competition in these sectors and the high degree of public ownership have reduced incentives for cost-minimisation and efficiency improvements and have often led to a substantial degree of overstaffing (Pera, *1989).* Furthermore, public enterprises tend to have lower internal efficiency than private enterprises (OECD, *1994).*

In telecommunications, technological improvements and the rationalisation of activities, partly due to increased out-sourcing, have substantially increased productivity. This trend, and the ensuing fall in costs and prices have been strongest in countries with competitive telecommunications markets (OECD, 1995*b*) For European railways, the evidence (Pestieau, *1993)* suggests that some of the efficiency differences between companies (Table *4)* are related to the degree of autonomy under which railways operate. Research on postal services within Europe (Perelman and Pestieau, *1994;* Table *4)* also suggests a link between efficiency and the degree of regulation and managerial autonomy of postal service companies

Case studies of service productivity also often relate the existence of slack to a lack of competition (Baily, *1993)* For instance, case studies of the banking industry suggested that this sector was characterised by considerable inefficiency, and few incentives to adopt new technology and available innovations before competitive pressures increased. Similar conclusions were drawn from case studies on airlines, construction and telecommunications.

THE DETERMINANTS OF PRODUCTIVITY GROWTH

Capital accumulation, RID and technological diffusion

The analysis of productivity *levels* generates useful insights in cross-country productivity differences and the links with competition The analysis of productivity *growth* is a more standard tool of economic analysis and may also provide useful views on the impact of competition Most research suggests that capital accumulation, RGD expenditure and human capital accumulation are the prime drivers of productivity growth (Englander and Gurney, 1994*a*; OECD, *1996).*

Unfortunately, human capital is difficult to integrate in detailed sectoral productivity analysis, due to data constraints. However, a regression analysis of manufacturing productivity growth at the sectoral level suggests that labour productivity growth is indeed positively affected by the growth of capital intensity, and also by the growth of the available RCD stock (RGD expenditure, accumulated over 5 years) per person engaged (Table 8)

In recent years, much attention has focused on the role of technological diffusion Recent studies (Coe and Helpman, *1995;* OECD, *1995;* Eaton and Kortum, 1995*a*, 1995*b*) suggest an important role of foreign R&D in productivity growth,

Table 8. **Estimates of labour productivity growth for manufacturing industries, 1981-90**

Dependent variable is real growth of value added per person employed, t-statistics in parenthesis

	Growth of capital intensity	Growth of RGD stock per person	Competition variables			1974 Labour productivity level (in logs)	R2 (adj)	Standard error of equation	Nob[1]
			Tariff measures (in logs)	Export intensity (in logs)	Entry rate (in logs)				
Equation 1[2]	0.370 (5.69)	0 196 (7 37)		0 664 (3 29)			0 536	2 23	315
Equation 2[2]	0.330 (4.93)	0 200 (7 48)	–0 262 (–1 02)	0 623 (3 02)			0 529	2 22	311
Equation 3[3]	0.361 (4.89)	0 287 (7 64)	–0 761 (–308)		1058 (2 13)		0 491	2 32	192
Equation 4[2]	0.481 (6.17)			0 889 (3.61)		– 1363 (–329)	0 513	2 29	251
Equation 5[2]	0.315 (4.01)	0 256 (7 00)				–0 759 (–1 92)	0 566	2 13	242

1 There are some differences in the coverage of the equations, due to availability of the basic data. Data on RGD stocks are not available for Australia, Belgiuin and Norway, while entry rates are only available for the United States, Japan, Germany, the United Kingdom, Canada, Belgium, the Netherlands and Norway, 1974 productivity levels could not be derived for Australia

2 Equations include fixed country and fixed sectoral effects

3 Equation includes only fixed country effects Fixed sectoral effects were not significant

Source Calculations are based on STAN data-base, R&D stocks are calculated on the basis of RCD flows from OECD's ANBERD data-base (OECD. 1995*d*), other variables are derived from sources quoted in Table 6 attesting to the importance of diffusion. A recent OECD study (OECD, 1996) concluded that: technology diffusion often accounted for more than half of total factor productivity growth; that its contribution was typically larger than that of direct R&D; and that the role of technological diffusion increased from the 1970s to the 1980s. Not surprisingly, this study also found that technological diffusion was particularly important for smaller countries.

Productivity growth also depends on the starting point, with low initial levels permitting faster growth This catch-up factor has given rise to a substantial literature, which tends to conclude that countries can catch-up with the productivity level of the leader country, providing that they have a sufficient stock of education and basic knowledge to absorb technology from abroad (Abramovitz, 1989). Among OECD countries, catch-up and convergence of income and productivity levels has been observed at the macro-economic level. Table 8 (equations 4 and 5) confirms that some element of catch-up is also at work at the industry level in the manufacturing sector, with low initial productivity contributing to more rapid productivity growth.

The impact of competition

As indicated before, the impact of competition on productivity growth is likely to be more indirect. By allowing inefficiencies to persist, weak competition may affect productivity growth. A lack of competition may also put insufficient pressure on management to improve productivity performance and incorporate new technology, and thus contribute to a productivity gap with best practice

The regression analysis reported in Table 8 appears to confirm that the degree of competition has some impact on productivity growth. Tariff measures appear to have a negative effect on labour productivity growth, whereas export intensity affects productivity growth positively. These results support the view that exposure to international competition promotes productivity growth. There are a number of alternative interpretations of the link between exports and productivity performance, however (Englander and Gurney, 1994*a*). For instance, competition on the international market can contribute to cost minimisation, but exports may also allow specialisation and economies of scale

It also appears that a dynamic product market, as measured by entry rates, provides a positive contribution to productivity growth. High entry (and exit) rates could ensure that only the best (and most productive) firms survive the competitive process, thus promoting productivity growth in an industry (Nickell, 1996)

The impact of competition on productivity growth is confirmed by a number of other studies, many based on industry- or firm-level panel data for individual countries (*e.g.* Haskel, 1991). These studies found that high degrees of market concentration and market share have an adverse effect on the level of total factor productivity. A more recent study for the United Kingdom (Nickell, 1996) confirmed this result, but also found that competition, measured by an increase in the number of competitors or lower levels of rents, is associated with higher total factor productivity growth.

A reduction in technical inefficiency within countries may also contribute to TFP growth. Although few studies have covered this aspect, the available evidence (Perelman, 1995), suggests that technical efficiency in the manufacturing sector of most OECD countries has actually declined over the period 1970-87 (*i.e.* the spread in productivity performance within industries has increased). According to this study, the main exceptions to this were Belgium and Japan, where improvements in technical efficiency provided a sizeable contribution to TFP growth over this period. For services, the available evidence suggests a positive contribution of efficiency improvements to TFP growth in most OECD countries over the period 1971-86 (Fecher-and Perelman, 1992).

The determinants of productivity growth may also differ according to market structure type (Table 9). It appears that the growth of capital intensity contributes to productivity growth in segmented, homogeneous industries, *i.e.* industries with high sunk costs, but has no significant effect in the other sectors. The growth of R&D stocks contributes to productivity growth throughout all sectors, but its effect is by far the strongest in segmented, differentiated industries, although it is also substantial in fragmented, differentiated industries. The negative contribution of tariff measures to productivity growth is strongest in homogeneous industries, where price competition is likely to be most intense High entry rates provide a positive, and significant contribution to productivity growth, except in segmented, differentiated industries which are most likely to be characterised by oligopolistic market structures.

The link between competition and productivity growth is perhaps most clearly demonstrated by the experiences with service sector deregulation in many OECD countries (Winston, 1993; Høj, Kato and Pilat, 1996). For instance, the deregulation of the US airline market since 1978 and that of the United Kingdom over the 1980s led to a sharp restructuring of the industry and a large increase in productivity. The deregulation of road freight transport in many OECD countries {OECD, 1990) and of the telecommunications industry in the United States, the United Kingdom and Japan (Harris, *et al.*, 1995) led to similar experiences

CONCLUDING REMARKS

Although the evidence is scattered and incomplete, a number of conclusions emerge from the discussion above. First, it appears that inefficiency and low productivity levels are widespread in both manufacturing and services, and throughout the OECD area, suggesting a substantial potential for further productivity growth in

Table 9 **Estimates of labour productivity growth for manufacturing, by market structure, 1981-90**[1]

Dependent variable is real growth of value added per person employed, t-statistics in parenthesis

	Constant	Growth of capital intensity	Growth of R&D stock per person	competition variables: Tariff measures (in logs)	competition variables: Entry rates (in logs)	R2 (adj)	Nob
All industries[2]	7.176	0.409	0.216	–0.616	1.862	0 386	192
	(6.28)	(5.72)	(5.67)	(2.51)	(5.25)		
Fragmented, homogeneous	6.283	0.136	0.037	–0.863	0.976	0.096	63
	(4.30)	(1.28)	(0.75)	(2.29)	(2.26)		
Fragmented, differentiated	11.471	0.207	0.352	–0.030	3.635	0 398	22
	(2.04)	(0.62)	(2.94)	(0.02)	(2.60)		
Segmented, homogeneous	7.234	0.502	0.198	–0.324	1.911	0.353	66
	(3.52)	(4.12)	(2.34)	(0.84)	(2.85)		
Segmented, differentiated	2.518	0.210	0.399	–0.653	0.633	0.573	41
	(0.71)	(1.36)	(5.65)	(1.11)	(0.60)		

1. Equations are based on pooled data for the United States, Japan. Germany, the United Kingdom, Canada and the Netherlands.
2. This equation is similar to equation 3 reported in Table 8, but excludes fixed country effects.

Source. Calculations based on STAN database (OECD. 1995*a*).

many countries. The great variation in the speed of catch-up across industries may indicate that structural factors inhibit productivity growth in some sectors.

Second, the variation in productivity levels and growth rates across countries appears to some extent related to the degree of competition facing industries and sectors in different countries. International competition, both in the form of trade and of direct foreign investment, appears to be an important element in achieving high levels of efficiency, while case studies suggest that the highest levels of efficiency are achieved by industries competing with best (global) practice. Productivity growth in manufacturing appears positively affected by open borders, a high export intensity and favourable entry conditions Openness also allows firms to learn from and benchmark their performance against that of their international competitors

There are also some signs that high entry rates are conducive to productivity and that a high degree of concentration is not Furthermore, sectors with a rapid growth of R&D stocks enjoy more rapid productivity growth. Industry-specific catch-up appears to play a role in explaining productivity growth, indicating the importance of technological diffusion and openness. In service sectors, government-imposed regulations are often an important restriction on competition, preventing entry and reducing the benefits of competition. Regulatory reform in many service sectors has led to an increase in competition and almost invariably to higher productivity growth.

Finally, the evidence from studies on efficiency frontiers suggests that a low degree of competition within a country, as indicated by low entry rates or a high degree of concentration, is likely to lead to a high variation in efficiency and productive performance and consequently to sub-optimal average productivity. However, if inefficient behaviour results from a lack of competition within a market or a high degree of regulation, the policy implications are more obvious than if inefficiencies result from other factors such as differences in the product mix or a geographically diversified market

Annex

COMPARING PRODUCTIVITY LEVELS: MEASUREMENT ISSUES

This annex briefly describes the methodology and data that were used to compute the labour productivity levels for manufacturing presented in the main text of the paper.[13] Productivity estimates were calculated for 9 countries, with industry-detail for 36 sectors. Two main problems had to be solved. The first relates to the conversion of value added in national currencies to a common currency. The second problem concerns the basic sources on value added, employment and hours worked.

In principle, the appropriate conversion factors for productivity comparisons need to be derived from a comparison of producer prices for specific goods. Such prices are sampled for most countries for the construction of the overall producer price index, but these data are often not available for outside analysis and may be difficult to compare across countries Another source of producer price information –at least for manufactured products – is the census of manufacturing industries. Most countries publish such a census, which shows production values and output quantities for a range of products, in principle allowing the comparison of producer prices and the derivation of appropriate conversion factors. This approach, the "industry-of-origin" approach, has been used in a range of studies, starting with some early work at OEEC (Paige and Bombach, 1959). Recently, most efforts in this area have been made by a group of researchers at the University of Groningen (Van Ark and Pilat, 1993; Van Ark and Wagner, 1996; Van Ark, forthcoming).

The results of this approach have been scrutinised in a number of studies The results of a comparison for Germany, Japan and the United States (Van Ark and Pilat, 1993) were carefully checked by work at McKinsey (McKinsey, 1993; Baily and Gersbach, 1995; Gersbach and Van Ark, 1995). The McKinsey work profited from detailed knowledge by industry experts and price information at the firm level. Substantial changes were made to some price comparisons (mainly for investment goods), but price comparisons for more homogeneous products (iron and steel, beer) were hardly affected. The overall perspective on Japanese and German productivity performance changed little, however.

There are a number of problems involved in using the industry-of-origin approach:

- The "prices" derived from the manufacturing census relate to average prices or "unit values" (*i.e.* values divided by quantities). If a country is producing a wide range of qualities and varieties of a particular good, the "price" is rather crude for comparative purposes. In a cross-country context, quality differences between countries may not be properly accounted for. This issue is less likely to be a problem for industries producing relatively homogeneous goods
- Unit values are available only for a sample of goods, and can be compared among countries for an even smaller sample, partly because of confidentiality problems. In addition, the production structure of countries tends to be far less comparable than the expenditure structure. Both problems imply that the unit values only cover part of the manufacturing sector, and that an aggregation procedure is required to cover manufacturing as a whole.
- The third major problem is double deflation Comparisons of labour productivity or total factor productivity are generally based on value added by industry, which implies, in principle, that conversion measures for both output and intermediate input are required In practice, conversion factors for intermediate input are very difficult to derive in a cross-country context Most studies have therefore tended to apply the conversion factors at the producer level directly to value added (*i.e.* single deflation, see Van Ark, forthcoming)

Although the production approach is theoretically the correct approach to sectoral productivity comparisons, it is therefore not without some measurement problems. Some authors have therefore used the more widely available price information (purchasing power parities or PPPs) on the expenditure side (Jorgenson and Kuroda, 1992; Kuroda, 1996). This type of information is available for almost all OECD Member countries at a fairly dis-aggregated level and new comparisons of this type are made on a regular basis. Extensive data sets are available for 1985 (OECD, 1987), 1990 (OECD, 1993) and 1993 (OECD, 1996*a*). The 1990 price comparisons covered about 2500 goods and services, and detailed comparisons are available for about 220 "basic headings". The price comparisons are based on detailed product descriptions, which generally ensures a rather high quality of the price comparisons.

Where productivity measurement is concerned, these price comparisons are rather problematic, however There are five problems in using expenditure PPPs for sectoral productivity comparisons:

- Distribution and transport margins. PPPs on the expenditure side are based on comparisons of prices at the retail (for consumer goods) or wholesale (for investment goods) level This implies that distribution and transport margins are added to the producer price, and that cross-country differences in the size of these margins affect the estimated price level
- Indirect taxes less subsidies. Prices at the expenditure level include indirect taxes less subsidies, implying that differences in VAT and other indirect taxes (duties) across countries affect the measurement of the relative price level
- International trade. International productivity comparisons should be based on the output produced in a country. However, part of this output is exported and not counted in comparisons of expenditure prices, while imported goods are taken into account in expenditure comparisons, but should be excluded for producer price comparisons
- Intermediate goods. Expenditure comparisons only cover goods entering final expenditure (see above). Intermediate goods, that form the bulk of output in many sectors of the economy, are not covered.
- Double deflation. Even after "peeling off" distribution margins and net indirect taxes, and after adjusting for international trade, the prices derived still refer to output only. No information is available on prices of intermediate goods that would allow double deflation

Providing data are available on the distribution margins by country (and preferably by sector), it is fairly simple to adjust for distribution margins (Hooper and Vrankovich, 1995). It is also fairly simple to adjust for taxes and subsidies Adjusting for international trade is not so easy (Hooper and Vrankovich, 1995), as information on the price levels of exports, imports and domestic production is required. Although some simplifying assumptions can be made, no simple solution is available and many expenditure studies (Jorgenson and Kuroda, 1992) have not addressed this problem. The fourth problem, that of intermediate goods, can not be addressed if only expenditure PPPs are used Most studies of this type use price ratios of other goods to fill these gaps. The fifth problem, that of double deflation, is inherent to international comparisons on the production side and no satisfactory solution is available

There therefore appear to be advantages and disadvantages to both the production and expenditure approaches The production approach has the merit of basing its price information directly on the producer price concept This is in contrast to the expenditure approach, where a number of adjustments are required, potentially introducing substantial measurement errors. The production approach is also the only approach that allows the derivation of price information for intermediate goods. However, for investment goods the production approach tends to offer less information.

In principle, detailed productivity comparisons might benefit from a mix of the two approaches. Therefore, this paper uses a mix of industry-of-origin and expenditure PPPs for the conversion of value added to a common currency. Table AI shows the conversion factors that were used by industry. Industry-of-origin price comparisons for the nine countries (see source note to Table A2) were used where possible, and could be applied in more than 65 per cent of all cases These price ratios are all based on binary price comparisons between the United States and one other country [14] Conversion factors from the McKinsey studies were used for Japan and Germany for those industries where these estimates were available (Gersbach and Van Ark, 1995) Expenditure PPPs, adjusted for net indirect tax rates and industry-specific distribution margins, were used for the other cases.[15] Nevertheless, for about 20 cases no suitable PPP was available from either the production or expenditure side, or the basic data were inadequate, impiying that no productivity level could be estimated

Table A1 indicates that for both the European countries and Japan, 1987 manufacturing price levels were on average substantially above US price levels. The relative price levels of Canada and Australia were – on average – almost identical to those in the United States. The variation in price levels across industries is considerable, however, particularly in Japan,and to a lesser degree also in France and the Netherlands.

Following the derivation of the PPPs, the main problem for the estimation of productivity levels is the availability of a suitable and comparable data-base. The starting point for data collection was OECD's STAN database {OECD,1995*a*), and the industry detail presented in that database. However, these data are closely linked to the national accounts of each country, which often implies that output and employment information are not derived from consistent data sources (Van Ark, forthcoming). In addition, since STAN is an estimated data-base, some of the industry data appeared to be implausible when compared across countries. For most countries, detailed information was therefore derived from national production censuses These sources have the advantage that output and employment information are based on a single source.[16] Furthermore, the industry detail available in production censuses often allows the reclassification of industries to achieve cross-country comparability. An adjustment for hours worked was based on the estimates of hours worked in the country-specific studies (see note to Table A2).

Relative labour productivity was subsequently calculated on the basis of the conversion factors of Table A1, and the value added, employment and hours worked information from the production censuses and national studies. As shown in Table A2, the results indicate a wide range in labour productivity levels.

Table A1. **Relative price levels for manufacturing industries, major OECD economies, 1987**

Industry-specific Purchasing Power Parity divided by the Exchange Rate, United States = 100

Industrial sectors (STAN classification)	Japan	Germany	France	United Kingdom	Canada	Australia	Netherlands	Sweden
Food Products	184.0	115.1	123.1	130.1	112.8	93.4	120.4	153.8
Beverages	153.1	132.4	145.4	96.1	134.1	85.5	108.1	152.8
Tobacco	78.3	67.2	**94.4**	77.8	74.7	47.6	64.2	67.2
Textiles	125.6	145.0	118.0	11.9	106.5	119.0	14.5	166.1
Clothing	123.9	161.7	169.2	13.2	105.7	110.5	24.4	153.3
Leather products	144.4	123.6	111.6	94.1	91.6	127.3	96.2	132.3
Footwear	144.4	156.1	111.6	94.1	92.2	90.9	96.2	132.3
Wood products	326.0	149.4	107.8	50.5	106.0	144.7	36.7	160.1
Furniture	**390.3**	**188.4**	**197.0**	**54.4**	**92.8**	**115.4**	**198.1**	**131.7**
Paper products	130.0	125.6	124.1	171.1	101.3	126.1	113.0	112.9
Printing, publishing	**171.7**	**235.6**	**161.9**	**105.7**	**124.1**	**94.0**	**250.2**	**188.5**
Industrial chemicals	184.7	142.4	139.9	103.6	97.3	93.1	101.7	122.4
Drugs and medicines	145.2	122.4	139.9	103.6	97.3	93.1	101.7	122.4
Chemical products, nec	145.2	122.4	139.9	103.6	97.3	93.1	101.7	122.4
Petroleum refineries	73.9	09.4	120.1	105.4	101.4	**92.4**	111.1	128.2
Petroleum and coal products	73.9	09.4	n.a.	105.4	101.4	n.a.	111.1	128.2
Rubber products	86.6	28.9	97.5	89.9	92.9	87.8	101.7	103.0
Plastic products	84.7	42.4	139.9	89.9	97.3	93.1	101.7	122.4
Pottery, china, etc	30.9	10.6	95.0	106.2	99.0	103.8	91.3	135.3
Glass products	30.9	35.9	95.0	106.2	99.0	103.8	91.3	135.3
Non-metallic mineral products	30.9	10.6	95.0	106.2	99.0	103.8	91.3	135.3
Iron and steel	00.7	04.4	125.1	103.9	97.1	104.9	142.6	111.2
Non-ferrous metals	60.8	22.7	n.a.	121.7	108.1	119.6	n.a.	130.0
Metal products	96.8	26.7	**144.5**	109.3	98.7	110.1	**139.8**	112.5
Office and computing machinery	06.0	27.2	118.6	99.8	**105.1**	**75.8**	**163.2**	**142.9**
Machinery and equipment, nec	01.7	36.7	118.6	99.8	**105.1**	**75.8**	**163.2**	**142.9**
Radio, TV and comm equipment	96.0	162.8	136.4	120.9	124.5	131.5	**126.0**	138.2
Electrical apparatus, nec	102.7	148.3	**159.0**	120.9	**120.6**	142.7	**139.3**	134.1
Shipbuilding and repair	**109.5**	**149.4**	**197.2**	**123.6**	**95.4**	**149.1**	**166.4**	**210.6**
Railroad equipment	**106.7**	**221.8**	**255.0**	**132.0**	**243.5**	**141.0**	n.a.	**266.0**
Motor vehicles	82.9	112.8	89.0	100.0	92.1	79.7	112.8	122.4
Motorcycles and bicycles	**212.2**	**187.6**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Aircraft	**226.5**	**167.9**	**162.9**	**191.9**	**121.9**	**125.5**	**179.7**	**227.8**

Table A1. **Relative price levels for manufacturing industries, major OECD economies, 1987** *(cont.)*

Industry-specific Purchasing Power Parity divided by the Exchange Rate, United States = 100

Industrial sectors (STAN classification)	Japan	Germany	France	United Kingdom	Canada	Australia	Netherlands	Sweden
Transport equipment, nec	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Professional goods	102.7	**171.3**	**209.0**	**78.1**	n.a.	**130.2**	**181.4**	**149.5**
Other manufacturing	**183.1**	**186.6**	**217.3**	**133.5**	**99.0**	**114.0**	**162.0**	**201.0**
Total manufacturing	121.9	128.4	125.5	113.1	104.7	100.7	122.3	134.2
Exchange Rate (national currency/US$)	144.6	1.80	6.01	0.61	1.33	1.43	2.03	6.34
Coefficient of variation[1]	43.1	24.0	29.0	21.6	25.3	21.6	30.1	26.2

1. The coefficient of variation is the standard deviation divided by the mean, expressed as a percentage.

Source: Figures in normal font are based on industry-of-origin studies as documented in Van Ark (forthcoming) or on the McKinsey studies as documented in Gersbach and Van Ark (1995); figures in bold font are based on expenditure PPPs for 1985 from OECD (1987). These expenditure PPPs were updated to 1987 with sector-specific deflators from the STAN data-base (OECD, 1995*a*) and subsequently adjusted for industry-specific distribution margins, inclusive of net indirect taxes. See Pilat (1996) for more detail.

Table A2 **Manufacturing labour productivity levels in major OECD economies, 1987**

Value added per hour worked, leader country = 100[1]

Industrial sectors (STAN classification)	United States	Japan	Germany	France	United Kingdom	Canada	Australia	Netherlands	Sweden
Food products	100.0	31 7	66 3	66 8	43 6	62 7	47 7	83 3	62 2
Beverages	100.0	47 6	54 6	53 5	64 6	44 0	49 0	76 5	58 3
Tobacco	75 0	38 I	65 3	100.0	45 I	65 6	42 2	63 4	68 7
Textiles	64 0	41 0	61 6	69 4	52 3	64 2	44 0	**100.0**	62 I
Clothing	90 I	41 5	68 4	61 5	51 0	63 5	47 7	**100.0**	64 6
Leather products	74 9	37 3	71 9	63 8	52 6	55 I	48 5	**100.0**	78 I
Footwear	70 7	51 8	55 0	68 6	61 3	62 2	51 2	**100.0**	62 I
Wood products	59 6	14 I	49 4	60 0	33 7	58 9	27 2	**100.0**	54 4
Furniture	88 I	18 9	57 0	46 3	47 4	67 4	43 5	**100.0**	80 4
Paper products	87 8	42 3	57 I	56 0	30 0	82 3	41 7	85 9	100.0
Printing, publishing	100.0	47 5	53 4	67 3	87 6	60 3	59 5	51 0	70 I
Industrial chemicals	86 4	56 6	54 5	60 8	61 2	90 I	57 8	**100.0**	65 7
Drugs and medicines	**100.0**	83 0	61 2	52 3	59 8	73 5	38 9	72 7	75 3
Chemical products, nec	100.0	66 I	58 5	54 4	58 7	65 2	47 I	89 8	52 9
Petroleum refineries	57 7	62 9	61 2	30 6	73 8	44 0	24 5	86 6	**100.0**
Petroleum and coal products	77 3	41 8	54 2	n a	46 6	**100.0**	n a	76 0	89 8
Rubber products	88 4	96 7	78 4	86 5	72 7	77 4	57 5	100.0	86 6
Plastic products	75 0	42 I	61 2	60 9	69 7	67 2	54 5	100.0	75 5
Pottery, china, etc.	69 7	39 7	66 7	71 I	43 6	97 5	45 5	**100.0**	58 9
Glass products	79 4	81 5	57 4	93 9	51 6	63 8	68 2	100.0	80 0
Non-metallic mineral products	67 4	48 5	66 5	100.0	65 4	68 0	47 8	86 9	69 6
Iron and steel	83 9	100.0	69 3	54 6	68 5	72 4	40 8	59 6	80 3
Non-ferrous metals	94 5	60 I	79 5	n a	61 0	100.8	74 9	n a	93 5
Metal products	98 2	86 5	86 8	65 3	57 6	79 8	48 I	78 4	**100.0**
Office and computing machinery	75 8	52 9	62 6	**100.0**	71 6	42 I	33 9	35 8	40 7
Machinery and equipment, nec	**100.0**	92 6	78 7	93 5	67 9	70 2	67 I	65 7	74 I
Radio, TV and comm. equipment	100.0	84 8	79 5	86 7	53 5	71 4	46 6	91 4	78 4
Electrical apparatus, nec	100.0	80 2	59 4	64 5	50 6	61 2	36 8	87 7	72 3
Shipbuilding and repair	74 2	**100.0**	60 9	28 6	36 4	49 I	32 3	51 7	39 0
Railroad equipment	90 7	52 5	33 5	**100.0**	27 5	42 9	23 3	n a	20 8
Motor vehicles	**100.0**	95 I	71 5	83 5	51 5	69 7	44 7	53 2	66 6
Motorcycles and bicycles	100.0	52 8	42 5	n a	n a	n a	n a	n a	n a
Aircraft	**100.0**	41 7	57 6	78 3	29 6	56 2	33 5	33 7	38 8

Table A2. **Manufacturing labour productivity levels in major OECD economies, 1987** *(cont.)*

Value added per hour worked, leader country = 100[1]

Industrial sectors (STAN classification)	United States	Japan	Germany	France	United Kingdom	Canada	Australia	Netherlands	Sweden
Professional goods	56.7	31.7	24.1	21.5	28.1	n.a.	19.3	23.9	**100.0**
Other manufacturing	**100.0**	42.9	56.1	53.4	[illegible]3.9	81.6	42.4	67.9	27.6
Total manufacturing	**100.0**	06.5	78.5	80.3	59.4	76.0	51.8	98.5	82.0
Coefficient of variation[2]	16.9	41.4	20.5	21.0	26.1	22.7	28.0	28.4	29.2

1. Productivity estimate for leader country is in bold font.
2. The coefficient of variation is the standard deviation divided by the mean, expressed as a percentage.

Source: Based on industry-specific conversion factors from Table A1. Value added, employment and hours worked from Pilat (1996). See Pilat (1996) for further details.

NOTES

1. Efficiency and productivity are related, but not identical concepts (Sharpe, 1995). A firm or industry is considered to be inefficient if it could produce more output with existing inputs, *i.e.* the firm is not on the production possibility curve, but within it. Productivity relates the quantity of output produced to one or more inputs used in its production, irrespective of the efficiency of their use.
2. The paper by Symeonides (*1997*) provides an extensive discussion of the link between competition and innovation.
3. Finland's rapid productivity gains over the past decade are closely related to the significant restructuring of its manufacturing sector over the period *199*1-1994.
4. Table 1 shows only estimates of labour productivity. However, the high share of labour compensation in total value added implies that labour productivity levels tend to be a reasonable approximation of TFP levels. TFP levels are more difficult to calculate as the measurement of real capital stocks across countries poses several methodological difficulties (Blades, 1993; Maddison, 1993). Table 5 below presents some estimates of TFP levels for total manufacturing, based on standardised estimates of capital stocks for these countries (see Van Ark, forthcoming).
5. To convert value added to a common currency, PPPs from available industry-of-origin studies were applied where possible, whereas (adjusted) expenditure PPPs were applied in the other cases (see Annex for methodological details). For a few industries no suitable PPP could be estimated, or the basis data were inadequate, and consequently no productivity estimate could be derived.
6. The productivity estimates in Table *2* differ somewhat from those in the country-specific studies because of two main methodological differences. First, the country-specific studies do not estimate conversion factors for all industries, but sometimes apply the PPP of one industry to another industry. In most cases, the current study applies expenditure-based PPPs to industries for which no industry-of-origin estimate is available. Second, the industry breakdown in the current study is more detailed than that of the country-specific studies, which affects the estimated productivity level for total manufacturing. The Annex and Pilat (*1996*) provide more details on the estimation procedure.
7. Table *2* presents results only for the largest sectors. More detailed estimates, for ***35*** manufacturing industries in ***9*** countries, are available in the Annex.

8. The productivity estimates in Table 3 differ somewhat from those in Table *2* and Table **A2,** primarily due to differences in the basic data, related to the precise definition of an industry. However, the main thrust of the results tends to be the same.

9. A disadvantage of these studies is their rather historical character, as most of them cover inefficiency in the *1970s.*

10. In some services (e.g. electricity and transport), physical measures are a relatively sound basis to measure real output, thus reducing problems with the conversion of output to a common currency. For some other services (e.g. distribution, construction) comparisons of expenditure price levels provide a reasonable basis to convert real output (e.g. Baily, **1993),** as prices of these services tend to be influenced only little by trade and transport margins or international trade (see Annex).

11. Average levels of capital productivity and capital intensity may also conceal a large variation in capital intensity and capital productivity across countries. For instance, the low level of capital intensity in Japanese manufacturing obscures large differences among industries (Pilat, **1996),** with the iron and steel industry, shipbuilding and motor vehicles in Japan having very high levels of capital intensity compared to these industries in other OECD countries.

12. This factor is related to X-inefficiency (Leibenstein, **1966),** which are efficiency differences resulting from organisational, effort and skill-related factors.

13. A more extensive description of data and methodology is available in Pilat (I *996).*

14. Most industry-of-origin studies have taken the United States as the reference basis for productivity comparisons, partly because the United States is generally considered to be the productivity leader in manufacturing, and partly because the quality of its data. There are also studies (O'Mahony, **1992;** Freudenberg and Unal-Kesenci, **1994)** that have taken a European country as the basis, e.g. Germany or the United Kingdom. The results from these various studies are generally not transitive, *i.e.* a comparison between two countries may not be consistent with a comparison through a third country. This issue is not addressed here, although recent studies have shown how transitive results can be derived (Pilat and Prasada Rao, *1996).*

15. The shaded figures in Table A I are based on (adjusted) expenditure PPPs. More detail on the adjustment factors, including the detailed distribution margins by industry, is available in Pilat (*1996).*

16. The production census data are discussed in more detail in Van Ark (forthcoming) and in the country-specific studies quoted in that study.

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