

OECD PRODUCTIVITY GROWTH: MEDIUM-TERM TRENDS

A. Steven Englander and Andrew Gurney

TABLE OF CONTENTS

Introduction	112
I. Productivity performance over the medium term	113
A. Aggregate trend developments and cross-country differences ...	113
1. Basic data and results.	113
2. Assessing recent performance	118
3. Comparison of productivity levels	119
4. Qualifications to the basic data	122
5. Other measurement issues	123
B. Comparison with other studies	124
Bibliography	129

The authors were, respectively, Principal Administrator and Administrator in the Resource Allocation and Economic Prospects Divisions when this article was written. The authors would like to thank Peter Sturm, Jergen Elmeskov and Martine Durand for comments on earlier drafts of this note. They also thank Isabelle Wanner, Catherine Chapuis, Isabelle Duong, Lyn Louichaoui and Brenda Livsey-Coates for technical assistance in preparing this article.

INTRODUCTION

Productivity growth is the key mechanism by which average income and welfare are improved: over the medium term faster productivity growth is associated with more rapid growth in real wages per worker and real consumption per capita. In all OECD countries, the real income gains from productivity growth over time dwarf any possible gains from feasible re-distributions of a stationary income level. Accordingly, slower productivity growth has important implications for OECD countries: at its most basic, it sets a ceiling for the rate at which aggregate real incomes can improve, making it more tempting for owners of factor inputs to attempt to increase their returns by grappling over income shares.

The significant slowdown in productivity growth observed in the OECD area since the beginning of the 1970s has affected all OECD countries. The trend growth in labour productivity is now almost 3 percentage points **less** than in the pre-1973 period, and growth of total factor productivity (which relates output to the inputs of both labour and capital) **is** more than 2 percentage points lower. At best, there were muted signs of a modest recovery in the late 1980s.

Although most attention has been focused on comparing rates of productivity **growth** across countries and over time, relative productivity **levels** also provide important indications of economic performance. Comparisons of output per worker across countries reveal sizeable productivity differences between countries: adjusting these gaps for differences in factors such as capital intensity and education levels can provide indications of the underlying source of gaps. To the extent that such measurable factors cannot fully account for observed productivity differences, unmeasured factors such as competition, regulatory policy and openness to outside innovations may underlie the gaps.

This paper has three objectives. Firstly, it updates the data presented in Englander and Mittelstadt (1988) and examines whether there are any recent indications of a break in trend productivity growth. Secondly, it presents comparisons of business sector productivity levels as opposed to growth rates across OECD countries. Finally it compares the OECD business sector productivity data with the data used in other recent studies.

I. PRODUCTIVITY PERFORMANCE OVER THE MEDIUM TERM

Concepts and definitions. Both the levels and growth rates of total factor productivity (TFP) and labour productivity (LP) in the business sectors of OECD countries are discussed below. LP is defined as the ratio of business sector output to business sector employment, while TFP is defined as business sector output divided by a geometric average of business sector employment and capital stock, thus taking into account the output contribution of capital inputs as well. Labour productivity can be measured in absolute units – for example, output in physical units or constant prices per worker per year – but TFP is always measured as an index, either in relation to a base year or to another country. TFP level comparisons indicate how much more (or less) the same aggregate bundle of inputs would produce in another country, or at another time in the same country. The growth rate of TFP is defined as the difference between the output growth rate and a weighted average of input growth rates, while the growth rate of labour productivity is defined simply as the difference between output and employment growth rates.

Productivity “performance” can be gauged with respect to either levels or growth rates of productivity, but the interpretation and implications of these alternative performance measures are quite different. TFP growth can be interpreted as an indicator of how fast a particular country’s technology is improving, although other factors affect changes in TFP as well. The technology may either be developed domestically or acquired from abroad. When two countries are starting from similar levels of productivity and have access to common technology, the country with faster TFP growth is thought to be performing better than the country with slower TFP growth. For countries with access to similar technologies, persistent differences in TFP levels are indicative of differences in efficiency, which can come from many sources, including country-specific institutions, human capital endowments, infrastructure, geography and resource endowments, although the dramatic fall in transportation costs, and the shrinking relative size of resource sectors have reduced the importance of the latter two factors.’

A. Aggregate trend developments and cross-country differences

1. *Basic data and results*

The discussion of aggregate productivity trends that follows is based on data constructed so as to provide consistent measurements of business sector capital, labour input and output across all OECD countries.² In consequence, some deviation from concepts as defined by national administrations may occur. Business sector output is measured as real GDP (at market prices) less output originating in general government as measured in the national accounts.³ Business sector

employment is obtained by subtracting government employment from total employment. For most countries, the gross capital stock is obtained from national sources, accepting the differences in assumed service lives underlying the calculations. Where no official capital stock data exist, the perpetual inventory method has been used to construct estimates of the gross capital stock. A more detailed discussion of the construction of the data and the sources used is provided in Keese, Salou and Richardson (1991). Table 1 presents the basic data on OECD output and input growth from the 1960s to 1990.

There was a clear deceleration of output growth after 1973 for the OECD as a whole and for individual countries. Output growth patterns remained relatively stable as between the 1970s and 1980s. Overall employment growth has been relatively stable, although patterns have varied somewhat over time and, to a lesser extent, within countries. By contrast, capital stock growth fell in almost all OECD countries after 1973 and the deceleration continued in the 1980s. The (unweighted) standard deviations across countries of output and capital stock growth rates declined markedly as between the pre-1973 period and the 1980s, while that of employment growth declined to a lesser extent.

Period averages of growth rates of TFP, LP and capital productivity are presented in Table 2. On the whole these data show no pronounced rebound of either LP or TFP growth rates during the 1980s from the low rates experienced during the 1970s. For the OECD as a whole TFP growth recovered slightly, while LP growth was unchanged. The countries which experienced some pick-up in TFP growth in the 1980s relative to the 1970s are the United States, Japan, the United Kingdom, Finland, Ireland, Norway, Portugal, Spain, Sweden, Switzerland and New Zealand. Germany, Italy, Canada, Greece, Iceland, the Netherlands and Australia showed a decline in TFP growth from the 1970s rates. Other countries remained within a ± 0.3 percentage point range of their 1973-79 performance. Over time there has been some tendency towards convergence of TFP and, especially, labour productivity growth rates (in addition to convergence in levels discussed below).

The countries with the fastest TFP growth in the 1980s (above 1.5 per cent per year) were Japan, France, the United Kingdom, Finland, Ireland and Spain. Average annual TFP growth in other OECD countries fell in a range of 0.5 to 1.5 per cent, with the exception of the United States, Canada, Greece and Norway where TFP growth was close to zero. Labour productivity growth followed a pattern similar to that of TFP. For most countries, labour productivity growth rates were about 1 percentage point higher than TFP growth rates. Capital productivity continued to decline in most OECD countries, although the rate of decline was much less marked than during the 1970s.

Average productivity growth rates did not differ greatly between the first and second half of the 1980s, although there was some acceleration in both LP and TFP in Germany, France, Italy and some smaller countries (Table 3). Capital productivity increased in the second half of the 1980s in a number of countries, contributing to a pick-up in TFP growth and reflecting slowing growth in the capital

Table 1. Business sector data on input and output growth
Average percentage change at annual rate

	Pre-1973'			1974-79			1980-90		
	Output	Employment	Capital	Output	Employment	Capital	Output	Employment	Capital
United States	3.8	1.7	3.7	2.5	2.5	3.8	2.4	1.8	3.1
Japan	9.3	1.3	12.1	3.4	0.6	6.9	4.2	1.3	5.6
Germany	4.3	-0.1	5.7	2.3	-0.7	3.3	2.2	0.6	2.7
France	5.7	0.5	4.9	2.9	0.0	4.0	2.4	0.0	2.6
Italy	5.5	-0.6	5.1	3.7	0.9	3.4	2.5	0.6	2.5
United Kingdom	3.5	-0.3	3.8	1.3	-0.1	3.0	2.6	0.5	2.2
Canada	5.0	2.2	4.5	4.4	2.9	4.8	2.8	1.6	4.6
Austria	5.0	-0.7	7.0	2.8	-0.4	5.9	2.2	0.3	3.8
Belgium	5.2	0.1	4.6	1.9	-0.8	3.8	2.3	0.0	3.0
Denmark	4.0	0.1	5.2	1.4	-1.0	4.0	1.8	0.0	3.0
Finland	4.6	-0.1	5.6	1.8	-1.4	4.1	3.4	0.2	3.3
Greece	7.7	-0.8	16.8	3.7	0.4	7.9	1.4	0.9	3.6
Iceland	-	-	-	5.7	1.7	1.7	3.0	1.6	1.9
Ireland	4.6	-0.2	5.4	4.0	0.6	5.8	3.8	-0.3	3.9
Netherlands	4.8	-0.1	3.9	2.5	0.0	2.9	2.1	0.5	1.9
Noway	3.8	0.2	3.9	1.4	1.2	3.9	1.5	0.0	3.2
Portugal	6.9	-0.3	7.5	2.6	2.1	5.2	2.6	1.0	3.3
Spain	6.5	0.7	10.2	2.1	-1.1	7.2	2.6	-0.2	3.5
Sweden	3.4	-0.6	4.2	1.1	-0.3	3.5	2.0	0.5	3.1
Switzerland	4.4	1.3	5.8	-6.5	-1.3	3.1	2.3	1.2	3.4
Australia	5.1	2.2	5.5	2.3	0.1	3.9	3.4	2.4	3.8
New Zealand	3.6	2.0	4.3	0.0	1.3	3.2	2.3	0.6	3.3
Weighted average	5.4	1.0	6.1	2.7	1.1	4.5	2.8	1.2	3.6
Unweighted average	5.1	0.4	6.2	2.4	0.3	4.3	2.5	0.7	3.3
Unweighted standard deviation	1.5	1.0	3.2	1.4	1.2	1.6	0.7	0.7	0.8

1. Data begin in 1961 for the United States, Germany, Italy, Austria, Denmark and Ireland; 1963 for Japan and New Zealand; 1964 for France and Portugal, Switzerland and Australia; 1965 for Spain; 1967 for Canada and Norway; 1971 for Belgium and the Netherlands and 1974 for Iceland.

Note: Output is measured at market prices. Weighted averages are based on 1990 GDP weights.

Source: OECD, Analytical Data Bank.

Table 2. Business sector productivity growth

Average percentage change at annual rate

	Average labour share	Total factor productivity ¹			Labour productivity			Capital productivity		
		Pre-73	1974-79	1980-90	Pre-73	1974-79	1980-90	Pre-73	1974-79	1980-90
United States	0.68	1.5	-0.4	0.2	2.1	0.0	0.6	0.1	-1.3	-0.7
Japan	0.69	4.6	0.9	1.6	8.0	2.9	2.9	-3.0	-3.5	-1.4
Germany	0.67	2.5	1.7	1.0	4.4	3.0	1.7	-1.4	-1.0	-0.5
France	0.65	3.8	1.6	1.5	5.3	2.9	2.4	0.9	-1.0	-0.2
Italy	0.64	4.1	1.9	1.2	6.1	2.8	1.9	0.4	0.3	-0.1
United Kingdom	0.69	2.5	0.5	1.6	3.6	1.5	2.1	-0.3	-1.6	0.4
Canada	0.63	2.0	0.8	0.1	2.8	1.5	1.2	0.6	-0.5	-1.8
Austria	0.66	3.0	1.0	0.7	5.6	3.1	1.9	-2.1	-3.2	-1.5
Belgium	0.70	3.7	1.3	1.4	5.1	2.7	2.3	0.6	-1.9	-0.7
Denmark	0.69	2.3	0.8	0.9	3.9	2.3	1.8	-1.2	-2.6	-1.2
Finland	0.64	2.7	1.2	2.1	4.9	3.2	3.2	-0.1	-2.3	0.1
Greece	0.63	1.9	0.5	-0.5	8.5	3.3	0.5	-9.2	-4.3	-2.2
Iceland	0.66	-	4.7	1.3	-	4.0	1.5	-	4.6	1.1
Ireland	0.66	2.9	1.6	2.7	4.8	3.4	4.1	-0.8	-1.8	0.0
Netherlands	0.66	3.5	1.6	1.1	4.9	2.6	1.6	0.9	-0.3	0.1
Norway	0.66	2.4	-0.8	0.4	3.6	0.2	1.5	0.0	-2.6	-1.6
Portugal	0.58	3.9	-0.8	0.6	7.2	0.5	1.6	-0.6	-2.6	-0.7
Spain	0.65	2.5	0.3	1.5	5.8	3.2	2.8	-3.7	-5.1	-0.9
Sweden	0.70	2.5	0.3	0.7	4.0	1.4	1.5	-0.8	-2.3	-1.1
Switzerland	0.71	1.8	-0.5	0.5	3.2	0.8	1.1	-1.4	-3.6	-1.0
Australia	0.64	1.7	0.9	0.5	2.9	2.2	1.0	-0.4	-1.5	-0.4
New Zealand	0.65	0.8	-2.0	0.8	1.6	-1.3	1.7	-0.7	-3.3	-1.0
Weighted average		2.7	0.5	0.8	4.3	1.5	1.6	-0.8	-1.8	-0.8
Unweighted average		2.7	0.8	1.0	4.7	2.1	1.9	-1.1	-1.9	-0.7
Unweighted standard deviation		1.0	1.3	0.7	1.8	1.4	0.9	2.2	2.0	0.8

1. TFP growth is measured as the difference between output growth and a constant and are based on the shares of labour and capital in factor income. T of self-employed and family workers in agriculture.

ed average of employment and gross capital stock growth. The weights are share of labour is presented in the first column; it is adjusted for labour income

Source: OECD, Analytical Data Bank.

Table 3. Recent trends in business sector productivity

Average percentage change at annual rate

	Total factor productivity			Labour productivity			Capital productivity		
	1980-85	1986-90	1986-93	1980-85	1986-90	1986-93	1980-85	1986-90	1986-93
United States	0.1	0.3	0.6	0.7	0.5	0.9	-1.2	0.0	-0.1
Japan	1.4	1.8	0.8	2.8	3.1	2.2	-1.7	-1.1	-2.1
Germany	0.4	1.6	1.0	1.3	2.1	1.6	-1.6	0.8	-0.1
France	1.0	2.0	1.4	2.2	2.7	2.2	-1.1	0.8	-0.3
Italy	0.6	2.0	1.3	1.3	2.7	2.1	-0.7	0.6	-0.2
United Kingdom	1.5	1.6	1.5	2.4	1.7	1.9	-0.5	1.4	0.5
Canada	0.3	-0.1	-0.2	1.6	0.7	0.9	-2.0	-1.5	-2.1
Austria	0.3	1.3	0.5	1.6	2.2	1.5	-2.3	-0.6	-1.3
Belgium	1.3	1.4	0.9	2.5	2.0	1.7	-1.4	0.1	-0.9
Denmark	1.2	0.5	0.7	2.1	1.5	1.8	-0.7	-1.8	-1.7
Finland	1.8	2.5	1.5	2.7	3.8	3.5	0.1	0.0	-2.1
Greece	-1.3	0.4	0.8	0.1	1.0	1.3	-3.6	-0.6	-0.2
Ireland	2.0	3.6	3.3	4.2	4.0	3.9	-2.3	2.7	2.2
Netherlands	1.0	1.1	1.1	1.9	1.2	1.2	-0.5	1.0	0.2
Norway	1.5	-0.8	0.0	2.3	0.5	1.2	-0.2	-3.4	-2.3
Spain	1.8	1.1	1.0	3.7	1.7	2.2	-1.9	0.1	-1.1
Sweden	0.8	0.6	0.8	1.6	1.3	2.1	-1.2	-1.0	-2.1
Switzerland	0.2	0.8	0.5	0.6	1.7	1.6	-0.8	-1.3	-2.1
Australia	0.9	0.0	0.4	1.8	0.1	0.9	-0.7	-0.1	-0.3
Weighted average	0.7	1.1	0.8	1.6	1.6	1.5	-1.3	-0.1	-0.7
Unweighted average	0.8	1.2	1.0	2.0	1.8	1.8	-1.3	-0.2	-0.9
Standard deviation	0.8	1.0	0.7	1.0	1.1	0.8	0.9	1.4	1.2

Note: TFP is calculated as output growth less a weighted average of employment and gross capital stock growth, with weights determined by average shares of labour and capital in factor income. The share of labour is presented in Table 2 and the share of capital equals one minus the share of labour. Shares are constant over sub-periods. Data for 1992 and 1993 are estimates for some countries

to labour ratio in some countries. When productivity growth rates are compared over 1986-93 rather than 1986-90, the negative effect of the cyclical downturn of the early 1990s emerges for most countries, particularly the larger European countries and Japan. The major exceptions are the United States, Norway and Australia, in which labour productivity growth is more than 0.4 percentage point higher over the longer period.

2. Assessing recent performance

Peak-to-peak averages give reasonable estimates of past trends in productivity growth, but developments beyond the most recent peak can be easily obscured by the high cyclical nature of productivity growth on a quarter-to-quarter or year-to-year basis. As structural policy changes are often aimed at improving the efficiency with which economies operate, a more contemporaneous measure of trend productivity would contribute to assessing the effectiveness of structural policy changes on a more timely basis. More generally, better trend productivity indicators would indicate whether the evolution of trend wages, prices and productivity was in line with medium-term macro-economic objectives.

More elaborate detrending methods, when applied to the current situation, do not point to any major break in recent productivity trends or any large deviation between actual and trend productivity growth in recent years (Table 4).⁴ The exceptions are the United Kingdom and Canada, which went into recession earlier than the other *G-7* countries, and whose estimates of trend productivity growth

Table 4. Estimates of trend labour productivity growth
Business sector

	Latest observation	1979-85		1986-93 ¹		Latest quarter trend estimate
		Average growth	Trend estimate	Average growth	Trend estimate	
United States	1993 Q4	0.5	0.4	0.9	0.7	1.0
Japan	1991 0 4	3.1	3.1	2.8	3.2	3.3
Germany ²	1992 Q4	1.4	1.7	1.8	1.9	2.0
France	1992 0 4	2.4	2.2	2.3	2.5	2.1
Italy	1991 0 4	1.6	2.2	2.2	2.4	2.2
United Kingdom	1992 0 4	2.6	2.3	1.8	2.2	1.9
Canada	1993 0 3	1.5	1.2	0.7	1.4	0.9

1. 1986-92 for Italy and Japan.

2. Western Germany.

Note: Period trend estimates are an average of estimates obtained using three trend estimation techniques:

a) Twenty-quarter moving average,

b) Discounted least squares,

c) Twenty-quarter change in trend productivity levels estimated using Beveridge-Nelson trend-cycle decomposition.

A description of these procedures is available on request from the authors.

since the mid-1980s were in excess of their actual productivity growth rates. Relative to the estimated trends for 1986-92, the most recent available data suggest that the United States may have experienced a moderate increase in labour productivity growth, while estimated trend productivity growth may have slowed somewhat in France and the United Kingdom. There is no clear evidence that any one detrending method is superior.

3. *Comparison of productivity levels*

Output per hour worked (or TFP defined in terms of labour hours rather than employee numbers) is a more appropriate indicator for comparing productivity across countries than output per worker. Average hours worked per year appear to have declined rapidly in the 1960s and continued to fall – though less rapidly – after the productivity growth slowdown in the 1970s. In most European countries, the reduction of hours worked has continued into the 1980s, although at a somewhat slower pace than in the past. However, the relative ranking of countries according to their productivity growth rates is not significantly changed by the hours adjustment, nor can the productivity growth slowdown (in terms of output per worker) be explained by observed behaviour of average hours worked (Table 5).

Estimates of labour productivity **levels** in a common currency are presented in Table 6. Business sector output is evaluated at purchasing power parities (PPPs) which adjust output in national currencies to a common set of relative prices and a common currency. In principle, a PPP dollar's worth of production in one country is comparable with a PPP dollar's worth of production elsewhere, but such calculations are always approximate. For example, it is impossible to guarantee that exactly the same products will be priced in all countries. Once PPP-based business sector productivity is calculated for 1990 (the most recent year for which PPPs are calculated), estimates are made for earlier years based on national rates of business sector productivity growth. Although this procedure is standard, differential changes in relative prices over time across countries may obviate the comparisons to some degree.

With respect to labour productivity levels, the process of “catch-up” continued through the 1980s.⁵ In PPP terms, the United States remains the leader in annual output per worker, but the (unweighted) average of other OECD countries' productivity levels (output per worker) relative to that of the United States increased from 45 per cent in 1966 to 55 per cent in 1973 and 75 per cent in 1990 (Table 6). The relatively slow productivity growth of the “leader” is not limited to the United States. Canada, Switzerland and New Zealand – high productivity countries in 1966 – have also experienced slow growth relative to countries with initially low productivity levels.

The data presented in Table 6 suggest that OECD countries can be grouped into three broad categories according to their average productivity levels relative to that of the United States. The high productivity countries, comprising those with annual output per worker of more than US\$39 000 in 1990, include the United

Table 5. Productivity growth adjusted for hours worked

Business sector, average percentage change at annual rate

	Output per worker			Output per worker-hour (BLS data) ¹			Output per worker-hour (OECD data) ²			Output per worker-hour (Maddison) ³		
	1960-73	1974-79	1980-w	1960-73	1974-79	1980-90	1960-73	1974-79	1980-90	1960-73	1974-79	1980-90
United States	2.2	0.0	0.6	2.2	0.4	0.4	--	0.6	0.7	2.5	1.1	0.6
Japan	8.0	2.9	2.9	9.0	3.2	3.1	--	3.4	3.3	8.8	3.1	3.2
Germany	4.4	3.0	1.7	5.5	3.9	2.9	--	4.0	2.4	5.5	3.8	2.4
France	5.3	2.9	2.4	5.8	3.9	3.2	--	3.7	3.2	5.9	3.9	3.4
Italy	6.1	2.8	1.9	6.9	4.0	1.4	--	3.7	--	8.0	3.2	2.3
United Kingdom	3.6	1.5	2.1	4.2	2.0	2.4	--	--	--	4.5	2.2	2.5
Canada	2.8	1.5	1.2	2.9	1.8	1.4	--	2.1	1.5	3.2	2.0	1.6
Austria	5.6	3.1	1.9	--	--	--	--	--	--	6.3	4.3	2.4
Belgium	5.1	2.7	2.3	6.1	3.8	2.7	--	--	--	6.2	3.8	3.2
Denmark	3.8	2.3	1.8	5.5	2.8	2.3	--	--	--	5.4	2.5	2.2
Finland	4.9	3.2	3.2	--	--	--	--	3.7	3.7	6.2	3.4	4.1
Greece	8.5	3.3	0.5	--	--	--	--	--	--	--	--	--
Netherlands	4.7	2.8	1.6	6.0	4.1	2.0	--	--	2.6	5.9	4.3	3.3
Spain	5.8	3.2	2.8	--	--	--	--	--	3.7	--	--	--
Sweden	4.0	1.4	1.5	5.3	3.0	0.8	--	2.6	1.3	5.1	2.8	1.4
Switzerland	3.2	0.8	1.1	--	--	--	--	--	--	3.7	1.2	1.7
Australia	-2.9	2.2	1.0	--	--	--	--	--	--	3.1	3.1	0.9
New Zealand	1.6	-1.3	1.7	--	--	--	--	--	--	--	--	--

1. Based on BLS manufacturing hours. *Monthly Labor Review*. Dec. 1991.2. From *OECD Employment Outlook 1992*; average hours actually worked, including part-time.

3. From Maddison (1991).

Table 6. Productivity levels in OECD countries
Based on 1990 PPPS, business sector output at market prices per worker

	Output per worker (000s of 1990 \$US)			Output per worker ¹			Output per worker-hour ¹					
							OECD Data ²			Maddison ³		
	1966	1975	1990	1966	1975	1990	1966	1975	1990	1966	1975	1990
United States	41 188	44 918	47 943	85.9	93.7	100.0	77.8	89.0	100.0	79.4	88.5	100.0
Japan	11 190	19 922	32 636	23.1	41.9	68.6	—	34.2	60.5	16.9	32.3	49.4
Germany	21 056	28 741	41 428	44.7	61.1	86.7	38.8	57.5	93.1	37.2	54.7	80.2
France	21 012	30 115	46 855	44.0	63.0	97.7	—	58.9	103.8	38.4	57.4	93.8
Italy	18 592	26 981	39 490	39.1	56.7	83.0	35.3	53.6	—	34.4	56.8	80.9
United Kingdom	19 295	25 737	35 308	40.8	54.1	74.2	—	—	—	36.6	51.7	76.9
Canada	29 167	35 455	44 191	61.5	74.7	92.6	55.8	71.4	95.2	54.1	67.4	88.6
Austria	17 346	26 440	39 374	36.4	55.1	82.1	—	—	—	31.6	50.3	75.8
Belgium	—	29 162	43 997	—	60.8	91.8	—	—	—	—	52.7	85.0
Denmark	19 992	26 141	36 675	41.7	54.5	76.5	—	—	—	35.0	50.8	69.0
Finland	13 832	20 267	35 039	28.9	42.3	73.1	25.1	39.3	74.1	25.0	40.2	63.6
Greece	7 838	13 963	17 939	16.3	29.1	37.4	—	—	—	—	—	—
Iceland	—	23 257	34 743	—	48.5	72.5	—	—	—	—	—	—
Ireland	11 945	18 280	35 199	24.9	38.1	73.4	—	—	—	—	—	—
Netherlands	—	31 863	44 722	—	66.5	93.3	—	—	110.3	—	61.6	103.0
Norway	19 878	25 624	30 528	41.5	53.4	63.7	—	—	—	36.2	50.4	66.3
Portugal	8 010	13 705	16 945	16.7	28.6	35.3	—	—	—	—	—	—
Spain	13 947	20 711	34 096	29.1	43.2	71.1	—	—	65.3	—	—	—
Sweden	21 104	27 852	35 776	44.0	58.1	74.6	45.2	66.5	89.8	42.1	60.0	80.6
Switzerland	26 732	33 421	39 481	55.8	69.7	82.3	—	—	—	45.3	58.6	70.2
Turkey	—	5 387	9 266	—	11.2	19.3	—	—	—	—	—	—
Australia	21 081	26 388	33 809	44.0	55.0	70.5	—	—	—	41.1	52.3	70.4
New Zealand	26 520	28 114	31 369	55.3	58.6	65.4	—	—	—	—	—	—
Weighted average	26 857	32 944	41 468	56.0	68.7	86.5	70.1	67.5	87.2	50.8	63.9	82.0
Unweighted average	19 464	25 324	35 079	40.6	52.8	73.2	47.7	58.8	87.3	39.5	55.3	78.3
Standard deviation	7 950	8 135	9 517	16.6	17.0	19.8	20.3	18.9	18.7	14.4	12.1	14.0
Catch-up ⁴	—	—	—	44.6	54.9	75.4	51.3	61.1	87.6	46.4	60.6	78.1

1. United States = 100 in 1990.

2. Annual hours based on OECD (1992).

3. Annual hours from Maddison (1982, 1989, and 1991). hours for 1966 are an average of 1960 and 1973 as estimated by Maddison; for 1990, they are extrapolated from 1980s' trends.

4. Unweighted average of non-US productivity relative to that of the United States.

Note: Output in all cases is based on OECD estimates of 1990 business sector output, measured at PPPs. Only the hours data come from different sources.

States, Germany, France, Italy, Canada, Austria, Belgium, the Netherlands, and Switzerland. The middling countries fall in the range of US\$30 000 to 37 000 and include Japan, the United Kingdom, Denmark, Finland, Ireland, Spain, Sweden, Australia and New Zealand. Below that are Greece, Portugal and Turkey. This latter group also shows the largest dispersion of output per worker within the group.

The data in Table 6 indicate that Japan has experienced remarkable gains in labour productivity over the last 30 years, but still remains well behind the United States and most other OECD countries in terms of aggregate business-sector productivity levels, despite its leadership in some manufacturing sectors. The large variation in relative sectoral productivity rates, discussed in Englander and Gurney (1994) and Van Ark and Pilat (1993) is behind this somewhat surprising result.

The relatively high productivity levels of Ireland and Spain are perhaps a little surprising, as are the relatively low levels in the Nordic countries. As discussed below, low employment rates among adults in Ireland and Spain may indicate that less productive workers have a much lower chance of working in these countries, thereby skewing the distribution towards those who are relatively more productive. The reverse is the case in Nordic countries, where employment to population ratios are very high and average hours worked per year are relatively low, reflecting the high share of part-time work. The low productivity level of Germany relative to European neighbours, such as France, Belgium and the Netherlands, may also come as a bit of a surprise. The inclusion of the eastern Lander will definitely have widened any such gaps.

When adjustments for hours per worker are made, catch-up with U.S. productivity levels is somewhat more pronounced on the whole, as average hours worked have declined more rapidly in Europe than in the United States. In fact, under some hours adjustment, hourly productivity in France and the Netherlands exceeds that of the United States in 1990. Hours worked in Japan are substantially higher than in other countries, so hourly productivity measures show substantially lower relative productivity levels.

4. Qualifications to the basic data

Even if productivity were measured correctly, there are factors which reduce the comparability of the data across countries. Low labour utilisation and the downside of the business cycle is often associated with poor productivity performance because firms may be hoarding labour, and plant may not be used at the optimum capacity. By contrast, the low employment to population ratios of many countries (even at cyclical peaks) and the concentration of unemployment among low-skilled workers suggests that over time the low end of the skill distribution may have been removed from the workforce in some countries. As compared to North America, Australia and Japan, the data may somewhat overstate "inherent" labour productivity in the low employment to population countries of Europe.

For example, the private sector employment to adult population ratio, at about 50 per cent in Europe, is about 10 percentage points lower on average than in the United States. If additional workers, whose productivity levels were about two thirds of the average, were added to the private sector so as to equalise the two employment ratios, average productivity in Europe would be 5 percentage points lower relative to the U.S. level; if they were only half as productive as the average, average productivity would be almost 8 percentage points lower.⁶ Although the extent of these effects are difficult to quantify accurately, it is striking that France and the Netherlands, where average hourly productivity is estimated to exceed that of the United States, both have lower business sector employment to population ratios.

Such effects from differential levels of productivity among different classes of workers are properly viewed as level effects; productivity growth rates are unlikely to be affected in the long run except to the extent that the biases of technological progress are also affected. In the short and medium term, however, **as** certain classes of workers become more or less represented in employment, there may be some transitional effects on productivity growth.

There are no data on hours of capital use that are comparable with those of labour hours. The limited data available indicate that there has been some increase in multi-shift and week-end work in Europe, although the average length of the work week of labour has declined; on the whole the work week of capital seems to have been fairly stable. The work week of manufacturing capital in the United States is longer than in Europe, both because of longer regular hours and a somewhat greater tendency for factories to employ two or more shifts. A very rough guess, based on recorded work week and shift work differences, might put U.S. factory utilisation some 10-20 per cent above European use. There are also indications of much more intensive capital utilisation (*e.g.* by multiple shifting) in services such as retailing, but much more careful analyses of intensity of capital use are needed.⁷

5. *Other measurement issues*

Productivity calculations are subject to some uncertainty, both due to errors of measurement and due to differences in national income accounting conventions, so individual country results and comparisons across countries should be treated cautiously.⁸ Potential adjustments include alternative weighting patterns of capital and labour over time (*e.g.* through Divisia-Tornquist indices); incorporating quality indices for computers (as is already done in some, but not all, countries), other products and labour; differentiating between the service flows from different categories of fixed capital as in the work of Jorgenson and his collaborators (*e.g.* Jorgenson, 1990 and the references therein); explicit incorporation of infrastructure capital through regression or growth accounting methods; treating intangible private-sector investment in a manner parallel to physical capital; and removing agriculture and other resource-intensive sectors from the business sector. Despite the desirability of such adjustments and the need for better indicators

of quality improvement and productivity growth outside manufacturing, such adjustments do not reverse the broad ordering of countries according to either productivity growth or levels, nor do they significantly affect the pattern of productivity slowdown observed in virtually all OECD countries since 1973.⁹

B. Comparison with other studies

A number of recent studies have discussed post-war trends in aggregate productivity. Most of these studies commence with standard data on real GDP, and transform national productivity measures into internationally comparable indicators via PPPs. Although the sector coverage as well as the productivity concept chosen differ across studies, there is a striking correspondence in terms of the overall assessment of aggregate productivity performance across countries.

Results of different comparisons of productivity levels relative to those in the United States are presented in Table 7. This paper, McKinsey (1992) and Maddison (1991) measure respectively business sector output per man-hour, market economy product per man-hour and GDP per man-hour.¹⁰ The three studies provide very similar results with respect to the relative positions of the United States, Japan, France, and Canada. German productivity is a little lower relative to that of France in the Maddison study.¹¹

Dougherty (1991) also obtains broadly similar results, although he adds the implied service flow from consumer durables to business sector GDP and the estimated amount of consumer durables to the capital stock.¹² By his calculations,

Table 7. Alternative measures of productivity

United States = 100

	Englander-Gurney ¹	Boskin-Lau ²	Dougherty ³	McKinsey ⁴	Maddison ⁵
United States	100	100	100	100	100
Japan	61	65	—	61	61
Germany	93	81	82	92	80
France	104	68	93	98	94
United Kingdom	—	55	77	77	80
Italy	—	—	84	—	79
Canada	95	—	104	—	92

1. Business sector output per hour worked in 1990 from Table 6.

2. Relative productive efficiency 1985 (corresponds closely to TFP) from Boskin and Lau (1990).

3. Business sector output (including imputed services from consumer durables) per hour in 1989 from Dougherty (1991).

4. Market economy output (GDP less general government, health and education) per hour in 1989 from McKinsey (1992).

5. GDP per man-hour in 1987 from Maddison (1991).

Table 8. Share of output growth attributable to various factors
1960s-1980s, per cent

	Growth of physical capital	Growth of employment	Growth of human capital	Growth of total factor productivity
United States				
Englander-Gurney	37	42	—	20
Boskin-Lau	22	30	11	38
Dougherty	47 (10)	15	18	21
Maddison	46 (14)	31	11	12 (25)
Japan				
Englander-Gurney	44	11	—	45
Boskin-Lau	41	5	11	43
Dougherty	60 (21)	-1	7	34
Maddison	52 (9)	6	8	35 (46)
Germany				
Englander-Gurney	45	0	—	55
Boskin-Lau	33	-10	27	49
Dougherty	54 (7)	-27	9	57
Maddison	67 (21)	-19	5	46 (66)
France				
Englander-Gurney	33	4	—	63
Boskin-Lau	28	-4	19	58
Dougherty	65 (-3)	-28	14	52
Maddison	58 (19)	-8	8	44 (64)
Italy				
Englander-Gurney	32	2	—	65
Dougherty	39 (12)	-9	3	55
United Kingdom				
Englander-Gurney	38	0	—	61
Boskin-Lau	34	-4	24	46
Dougherty	50 (4)	-24	11	60
Maddison	68 (26)	-18	6	45 (67)
Canada				
Englander-Gurney	40	39	—	21
Dougherty	61 (7)	10	13	17

Note: Startling and ending points of comparisons differ slightly across countries.

Source: Englander-Gurney: OECD, Analytical Data Bank, business sector output.

Boskin-Lau: Boskin and Lau (1992).

Dougherty: Dougherty (1991), business sector output. Contribution from growth in capital quality in parentheses. Contribution from human capital includes demographic factors as well as education levels. Without the adjustment for capital quality TFP growth would be higher by the amount in parentheses.

Maddison: Maddison (1991), whole economy output. Figures in parentheses show contribution from growth in capital quality, and for TFP include Maddison's correction for residential capital.

Canadian labour productivity levels are slightly above those of the United States. The relative productivity levels calculated in Boskin and Lau (1990) are very close to that of this paper (excepting France), although they proxy economy-wide hours (outside of the United States) by manufacturing hours. The authors use a regres-

sion-based methodology which provides measures of relative efficiency; the relative efficiency levels indicate what production levels in each of the countries included in the sample would be if all used identical primary inputs in production. They are not equivalent to comparative TFP measures that weight different quantities of inputs by a common or similar set of weights, and are highly dependent on the estimated production function parameters. For example, the United States might appear much less efficient at the German input bundle than at the U.S. bundle, if input choice is determined by relative prices. German efficiency by this measure is greater than that of France, and the United Kingdom falls below Japan.

There are also broad similarities across the studies quoted in terms of the identification of sources of overall output growth (Table 8). In Canada and the United States, where employment has increased the most, standard inputs account for the greatest shares of overall growth between the 1960s and late 1980s. For other countries TFP growth generally accounts for about one-half to two-thirds of output growth. Neither changes in capital quality nor increases in the stock of human capital account for very large shares of overall growth according to these calculations. These analyses differ greatly from some of the “new growth” literature in the way that education and human capital in general are treated. The studies reported in Table 8 estimate the contributions of education either by growth accounting methods, which take into account relative wages of workers of different qualifications, or regression methods that look at the evolution of productivity both within and across countries as the stock of human capital varies. Studies, such as Levine and Renelt (1992), that find a far greater impact of education on growth, are generally based on the observed partial correlation of education and productivity growth in cross-section studies using data sets from a large number of countries.

NOTES

1. Under the assumption of competitive markets, an upper bound for resource rents in OECD countries can be estimated as the sum of profits and royalties in mining, petroleum extraction, agriculture and fishing. With the exception of countries such as the United Kingdom and Norway in the mid-1980s, where it approached 10 per cent of GDP, the number is of the order of 5 per cent or less, even in resource-rich countries like Canada and Australia.
2. The data base used is the OECD Analytical Data Base (ADB). Both the complete ADB and a **sub-set** containing the data used in calculating the aggregate productivity measures discussed in this paper are available commercially from the OECD on diskette.
3. Market prices are used rather than factor costs because the PPPs that are used to compare real output internationally are calculated at market prices. The effects on growth rates of using market rather than factor prices are relatively small unless there are large changes in indirect taxes and/or subsidies. In estimating factor shares for TFP calculations, input growth is weighted by factor cost shares with total output measured at factor cost.
4. A more detailed discussion of several approaches to determining productivity levels and trends is available on request.
5. Catching-up refers to the process of productivity levels in low productivity countries gradually approaching that of the leading country. Convergence refers to the process by which countries' productivity levels approach each other, even if they do not necessarily approach that of the leading country.
6. Minimum wages (including non-wage labour costs) are about $\frac{1}{2}$ to $\frac{2}{3}$ of the average wage in Europe as compared to about 40 per cent in the United States, so as a rough approximation, it seems reasonable to assume that the productivity of many of the workers to be added would fall in this range.
7. See the papers presented in *Économie et Société* (1991), as part of a symposium on the use of multiple shifting and the average length of work week of capital.
8. In particular, countries follow different conventions with respect to output measurement. For example, the United States shows virtually no productivity growth in construction, financial services and personal services, while France shows substantial productivity growth in all these sectors. To the extent that such conventions affect estimates of expenditures on final goods, aggregate productivity growth comparisons may be misleading. However, benchmark comparisons, such as are made when PPPs are being constructed need not be affected.
9. A note discussing and quantifying some of these effects is available on request.

10. McKinsey (1992) defines the market economy as GDP minus value added generated in general government and the health and education sectors.
11. This may be related to the use of 1985 PPPs by Maddison, as the relative price level in Germany is higher in 1985 than in 1990.
12. In doing so, he achieves consistency in his treatment of consumer durables and other forms of capital, at the cost of greatly reducing comparability of his results with those of other studies which do not embody a similar adjustment. This, however, is the tradition of the school of thought that has emerged from the work of Dale Jorgenson and his collaborators, e.g. Jorgenson (1990). See also Baily and Schultze (1990) and Jorgenson's comment on their work.

BIBLIOGRAPHY

- Baily, Martin Neil and Schultze, Charles L, "The productivity of capital in a period of slower growth", *Brookings Papers on Economic Activity*, Washington, D.C., 1990.
- Boskin, M.J. and Lau, L.J., "Post-war economic growth of the Group-of-Five countries: a new analysis", Technical Paper No. 217, Stanford, CA: Center for Economic Policy Research, Stanford University, 1990.
- Dougherty, Christopher, "A comparison of productivity and economic growth in G-7 countries", Ph.D. dissertation, Harvard University, 1991.
- Economies et Societe, Serie: Économie du travail, AB No. 17, September-October 1991.
- Englander, A. Steven and Mittelstädt, Axel, "Total factor productivity: macroeconomic and structural aspects of the slowdown", *OECD Economic Studies*, No. 10, Spring 1988.
- Englander, A. Steven and Gurney, Andrew, "Medium-term determinants of OECD productivity growth", *OECD Economic Studies*, No. 22, Spring 1994.
- Jorgenson, Dale W., "Productivity and economic growth", *Harvard Institute of Economic Research Discussion Paper*, No. 1487, Harvard University, June 1990.
- Keese, M., Salou, G. and Richardson, P., "The measurement of output and factors of production for the business sector in OECD countries", *OECD Economics Department Working Papers*, No. 99, 1991.
- Levine, Ross and Renelt, David, "A sensitivity analysis of cross-country growth regressions", *American Economic Review*, Vol. 82, No. 4, September 1992.
- Maddison, Angus, *Phases of Capitalist Development*, Oxford University Press, 1992.
- Maddison, Angus, *The World Economy in the 20th Century*, OECD Development Centre Studies, 1989.
- Maddison, Angus, *Dynamic Forces in Capitalist Development*, Oxford University Press, 1991.
- McKinsey Global Institute, "Service sector productivity", Washington, D.C., October 1992.
- OECD, *Employment Outlook*, Paris 1992.
- Van Ark, Bart and Pilat, Dirk, "Cross country productivity levels: differences and causes", paper presented at the MICRO-BPEA meeting, Brookings Institution, Washington, D.C., 10-11 June 1993.