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Economic Growth in the OECD Area: Recent Trends at the Aggregate and Sectoral Level

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ECONOMIC GROWTH IN THE OECD AREA: RECENT TRENDS AT THE AGGREGATE AND SECTORAL LEVEL

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ABSTRACT/RÉSUMÉ

This paper discusses growth performance in the OECD countries over the past two decades. Special attention is given to developments in labour productivity, allowing for human capital accumulation, and multifactor productivity (MFP), allowing for changes in the composition and quality of physical capital. The paper suggests wide (and growing) disparities in GDP per capita growth, while differences in labour productivity have remained broadly stable. These patterns are explained by different employment growth rates across countries. In the most recent years, a rise in MFP growth in ICT-related industries has boosted aggregate growth in some countries (*e.g*. the United States).

JEL classification: N10, O47
Keywords: Economic growth, productivity, human capital, investment

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Cette étude examine les performances en matière de croissance dans les pays de l'OCDE durant les deux dernières décennies. Une attention est tout particulièrement donnée à la productivité du travail, en tenant compte de l'accroissement du capital humain, et de la productivité multifactorielle (PMF), en tenant compte des changements dans la composition et la qualité du capital physique. L'étude suggère des disparités importantes (et en augmentation) dans les taux de croissance du PIB par habitant, alors que les différences dans les taux de croissance de la productivité du travail sont demeurées généralement stables. Des taux d'accroissement de l'emploi très variés sont à la base de ces différences. Durant ces dernières années, une hausse du taux d'accroissement de la productivité multifactorielle dans les industries liées aux technologies de l'information et des communications a accru la croissance globale dans certains pays (ex. les États-Unis).

Classification JEL :N10, O47.
Mots-Clés : Croissance économique, productivité, capital humain, investissement.

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ECONOMIC GROWTH IN THE OECD AREA: RECENT TRENDS AT THE AGGREGATE AND SECTORAL LEVEL

Stefano Scarpetta, Andrea Bassanini, Dirk Pilat and Paul Schreyer[1]

SUMMARY AND CONCLUSIONS

1. The aim of this paper is to ascertain how OECD countries' growth performance has evolved in recent years, whether disparities are indeed widening, and which factors are immediately responsible. It describes which countries have done particularly well or badly in terms of output and productivity growth over recent years; which sectors in the economy are the main contributors to economic growth; and which factors support growth.

2. It should be stressed at the outset that, despite major efforts by national statistical offices and international organisations, data problems still limit the possibility of comparing growth performances across countries and sectors, as well as over time. Comparability problems have always affected international analyses of growth performances but are particularly relevant at present because of the different pace and comprehensiveness with which different countries have adopted new measurement techniques in their national accounts. In addition, the growing emphasis on growth in *quality* instead of growth in *quantity* and the large share of hard-to-measure services in total output are some of the factors adding to these measurement problems. For this reason, the paper is supported by a methodological annex (Annex 2) that discusses data comparability across the different dimensions, as well as the adjustments made to the original sources to improve the results of cross-country time-series analyses. In any event, actual growth rates may hide significant differences in the cyclical position of countries, especially in the 1990s. Thus, this paper largely relies on cyclically adjusted series.

3. Bearing these caveats in mind, the following conclusions can be drawn from the paper:

- In the OECD area as a whole, trend GDP growth was somewhat lower in the 1990s than in the previous decade. This general picture hides significant and widening differences across regions and individual countries.

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1. This paper reflects the joint work of the OECD Economics Department and the Directorate for Science, Technology and Industry. A previous version of this paper was presented at the spring 2000 meeting of Working Party No. 1 of the Economic Policy Committee and the November 1999 meeting of the Statistical Working Party of the Industry Committee. The authors are indebted to Thomas Andersson, Jørgen Elmeskov, Mike Feiner, Philip Hemmings, Nicholas Vanston, Ignazio Visco and Andrew Wickoff for helpful discussions and comments on previous drafts. The views expressed are those of the authors and do not necessarily reflect those of the OECD or its Member countries.

- Given generally modest demographic changes, widening disparities in trend GDP growth rates have also resulted in more diverse trend growth rates of GDP per capita, an (imperfect and partial) indicator of economic welfare. These differences can only partially be explained by the catching up of some countries (Ireland, Korea, Portugal, Turkey) to higher income levels. They are more the results of markedly higher growth rates in some relatively affluent countries, such as the United States, Australia, the Netherlands and Norway and lower growth rates in Continental Europe, Japan and Korea.

- Growing disparities in growth rates of per capita GDP have been accompanied by much smaller variations (over time and across countries) in labour productivity growth rates, especially when the latter are measured as output per hour worked.

- The proximate explanation of these seemingly conflicting developments is the diversity in the trends of labour utilisation. Countries with higher per capita growth rates maintained or even increased employment over the 1990s, while employment has stagnated or even fallen in those experiencing a GDP growth slow-down. Average hours worked have generally declined in the OECD countries. In this respect, part of the continued convergence of labour productivity levels was caused by labour shedding in countries with weak employment growth.

- Changes in labour productivity growth rates are in some cases (*e.g.* the United States, Australia, Denmark, Norway) related to significant technological changes as estimated by the growth rates of multifactor productivity (MFP). In some of the countries where high or rising labour productivity was associated with sluggish or falling employment, MFP growth did not show any significant improvement, or even fell in the 1990s as compared with the previous decade.

- Available data suggest a significant degree of convergence in the sectoral sources of aggregate productivity growth amongst the OECD countries, *i.e.* the same industries provide the strongest contributions to aggregate productivity growth, especially amongst the G7 economies. Productivity performance at the industry level tends to be associated with the effort to innovate (proxied by R&D intensity) as well as by up-skilling of the workforce. In the manufacturing sector of many Continental European countries, the latter process has been associated with employment losses amongst low-skilled workers. This has been partially compensated by employment growth in service sectors with relatively slow productivity growth, reinforcing the negative correlation between productivity growth and employment in the total economy.

- Reflecting the growth patterns described above, the United States began to pull away from most other countries in terms of GDP per capita levels over the 1990s. This happened despite some continued, albeit slight, convergence in levels of productivity. Differences in productivity levels at the industry level remain important. In manufacturing, the process of convergence of labour productivity to the US level which took place in previous decades but was reversed in the 1990s because of a speedup in US industries.

4. The growth performance of some OECD countries deserves a closer look. Thus, growth patterns in the United States, especially in the most recent years, include higher growth rates of GDP per capita, employment, labour and MFP as well as further capital deepening. These patterns are not uncommon amongst successfully catching-up countries, but unusual for a country that is already at the world productivity frontier in many industries. Some of these trends are likely to continue and tentatively suggest the move towards relatively high potential growth rates for some time to come. Productivity improvements

in the *information and communication technology* industry itself provided a strong contribution to the speed-up of aggregate labour productivity in the 1990s. Available estimates also suggest that the shift in capital composition due to the spread of information technology in other industries made a contribution to aggregate output and productivity growth, with a rising trend in the most recent years. Moreover, in some sectors increases in productivity may have gone unmeasured.

5. Differences in growth performance in the other countries can partly be related to different labour market conditions and policy reforms. Thus, the strong employment content of GDP growth in Australia, Canada, Ireland and the Netherlands went hand-in-hand with major structural reform efforts there,[2] and in Norway growth was related to persistently favourable labour market conditions over the 1990s. It is also interesting to note that significant growth in MFP has occurred in most of the countries with a record of reforms and a higher employment content of growth than in the past. In other words, structural changes seem to have led to higher utilisation of labour in a context of more productive use of factor inputs (or greater factor productivity if quality changes in factor inputs are taken into account). On the other side of the spectrum, stagnant employment conditions are often associated with insufficient structural reforms in countries with persistently high unemployment rates (*e.g*. several countries in Continental Europe) or with economic stagnation - and consequent labour shedding (*e.g*. Japan).

Introduction

6. This paper examines several concepts of economic growth: real GDP (the usual summary measure of economic activity); GDP per capita (an indicator of the average economic welfare of the population); labour and capital productivity; and multifactor productivity (a pointer to, among other things, technological progress). Productivity measures also attempt to account for changes in the quality of production factors as well as their quantities. Where relevant, trends by sector are examined, as well as economy-wide concepts. The paper also examines levels of these variables, where possible. Low levels of output per head may indicate opportunities for catch-up, and the breakdown into proximate causes may give hints as to the underlying factors behind below-average performance. Some of these may be susceptible to policy influence.

7. The first section examines cross-country patterns of growth of output and factor inputs across the OECD area, bearing in mind several key measurement issues that affect comparisons across countries and over time. The section also examines less-easily-measurable trends in the quality of inputs of labour and capital and their impact on productivity. The second section looks at the levels of GDP per capita and productivity across countries to shed light on relative positions of countries as well as to assess the role of economic convergence. The third section looks at sectoral performances and the role of structural shifts and productivity increases within sectors in explaining performance at the macro level.

2. These countries have all a high record of structural reforms as measured by follow-through of the recommendations of the Jobs Strategy (see OECD, 1999*a*). Moreover, they have all experienced significant improvements in labour market conditions over the 1990s.

1. Cross-country growth patterns

1.1 Measurement issues

8. It has to be emphasised at the outset that the coverage and depth of analysis in this paper is necessarily constrained by the availability, accuracy and international comparability of economic statistics. Economic statistics are regularly revised to reflect underlying shifts in the structures of economies, to incorporate improved methodologies to quantify economic developments and to take into account new sources. National authorities and international organisations have recently taken important steps to improve the quality of time series of outputs, inputs and productivity as well as to facilitate international comparability. Nevertheless, a number of measurement issues still arise at the aggregate and especially at the disaggregated levels. The three most pertinent issues in output measurement are: i) the independence of output from input measures; ii) the use of chain and fixed-weighted indices; and iii) the treatment of price indices of information technology products, in particular computers. For example, for industries that mainly comprise non-market producers (such as health or education), output volume series are often based on the extrapolation of input measures, which is likely to generate a downward bias within each country.[3] Moreover, annual chain-weighted indices are used in a small number of OECD countries instead of fixed base years for the construction of time series of outputs, inputs and productivity. Annual chain-weighted indices minimise the substitution bias implicit in fixed-weight price and volume indices that occurs in periods of rapid change of relative prices and quantities or over long time periods. Finally, the method to construct price indices of computers and peripheral equipment varies between OECD countries. The use of hedonic methods in the deflation of computers tends to produce much more rapid price declines than other methods. Hence, the growth rate of volume output of those countries that do not use hedonic methods will be lower, *ceteris paribus*, than those that do. Annex 2 provides a more comprehensive discussion of these points.

9. These measurement issues are particularly relevant at the time of writing because of the ongoing implementation of revised methodology and use of new statistical definitions for compiling national accounts (*i.e.* the implementation of the 1993 System of National Accounts, SNA). Given the large scale of the revision, its implementation has been gradual, with progress from the old to the new methods uneven across countries, across series within a country, and over different time horizons. This paper uses data provided by the national authorities and included in the Analytical Data Base (ADB) of the OECD which takes into account changes known to date to the new SNA. Adjustments were necessary to improve international comparability and details are given in Annex 2. Notwithstanding the efforts made, statements about relative growth performance, in particular at the sectoral level, have to be read with these caveats in mind, and results should be interpreted with the necessary care.

10. Another complication inherent in international comparisons of growth performance in the short to medium term is that cross-country differences in output growth rates and levels may reflect differences in cyclical positions as well as underlying differences in performance. This problem was particularly relevant in the 1990s when business cycles were largely unsynchronised across OECD countries.[4] In order to account for differences in the cyclical position of countries, the trend series reported in this paper were calculated using an extended version of the Hodrick-Prescott (HP) filter. Given the aim of this paper to

3. The extent of the underestimation is difficult to determine, although BLS suggests that the order of magnitude is unlikely to be very large (Dean, 1999).

4. OECD estimates suggest that most European countries experienced the trough of the business cycle in 1993. The United States and Australia bottomed out in 1991, Canada and New Zealand in 1992, Portugal in 1994, and Japan in 1995 (OECD, 1999*a*). However, since then the strength of recoveries has been very uneven across countries.

assess possible changes in output and productivity growth rates in the most recent years and the well-known end-of-sample problems related to HP filters, a detailed sensitivity analysis was conducted using different assumptions as well as a Multivariate Filter technique (see Box 1).[5]

Box 1. **Estimates of trend output: the extended Hodrick-Prescott and multivariate filter**

In this paper, trend series of output, employment and productivity have been estimated using an extended version of the Hodrick-Prescott filter (Hodrick and Prescott, 1997). Apart from the arbitrary choice of the smoothness parameter, the H-P filter may lead to "inaccurate" results if the temporary component of a series contains a great deal of persistence. The distinction between temporary and permanent components then becomes particularly difficult, especially at the end of the sample when the HP filter suffers from an in-sample phase shift problem. One extension of the traditional HP filter used in this paper tries to overcome this latter problem by prolonging actual data out of the sample by using the observed average growth rate of output over the 1980-98 period. However, if past growth rates are not reasonable proxies for future growth patterns, this extension may lead to a bias in the last observations of the HP filtered series. Hence, in an alternative extension of the HP filter, out-of-sample data based on average growth rates are replaced by the OECD projections included in the Medium Term Reference Scenario (MTRS). These projections normally assume that economies return to an equilibrium growth path after a five-year horizon (see OECD, 1999*g*).

A further step in the sensitivity analysis of trend series is made by considering a multivariate filter that relies on two well established macroeconomic relationships: i) a Phillips curve relating output and inflation; and ii) Okun-type relation that maps output gaps into employment gaps. To the extent that these two processes are well identified, data on inflation and employment help in the identification of trend output. Moreover, the combined estimate of trend output, the Phillips curve and Okun's relation guarantee consistent estimates of trend output, trend employment and, consequently, trend labour productivity.

The table below presents estimates of GDP growth rates based on the extended HP filters, using the two out-of-sample series as discussed above, and the multivariate filter. The multivariate filter and the extended HP filter based on out-of-sample average growth rates show only modest differences. However, in the case of Germany, France and Canada the use of OECD MTRS projections for the out-of-sample data yields a somewhat higher estimated growth rate over the 1990s; that is to say, the projections assume a higher growth rate over the 2000-2005 than that observed on average in the past. By contrast, MTRS projections assume a lower growth rate in output than observed in the past decades in Japan: their use as out-of-sample data thus somewhat lowers estimated GDP growth rates in the 1990s. Notwithstanding the relevance of the end-of-sample problem, the different results do not significantly affect the main message one can derive from the cross-country comparisons as well as comparisons for different time periods. More details on this issue are presented in Annex 2.

5. It should be stressed, however, that in countries affected by major macroeconomic shocks (*e.g.* Mexico, Korea), trend estimates of GDP or productivity growth are problematic and have to be considered with care.

Box 1. **Estimates of trend output: the extended Hodrick-Prescott and multivariate filter** (continued)

Table. **Comparing different estimates of trends in GDP in the G7 countries**
(Total economy, percentage changes at annual rates)

		1970-98	1970-79	1980-89	1990-98 [3]	1995-98
United States	Actual	3.1	3.5	3.1	3.1	4.2
	MV filter	3.0	3.0	2.9	3.1	3.5
	EHP filter[1]	2.9	2.9	2.9	3.1	3.5
	EHP filter[2]	2.9	2.9	2.9	3.1	3.5
Japan	Actual	3.4	4.6	3.9	1.3	1.2
	MV filter	3.5	4.3	3.9	1.9	1.4
	EHP filter[1]	3.6	4.9	3.8	1.9	1.4
	EHP filter[2]	3.6	4.9	3.9	1.8	1.2
Germany	Actual	2.6	2.9	1.9	1.2	1.5
	MV filter	2.6	2.6	2.0	1.1	1.4
	EHP filter[1]	2.6	2.8	2.1	1.3	1.4
	EHP filter[2]	2.6	2.8	2.1	1.4	1.6
France	Actual	2.4	3.5	2.3	1.4	2.2
	MV filter	..	..	2.2	1.7	1.8
	EHP filter[1]	2.4	3.4	2.1	1.6	1.7
	EHP filter[2]	2.5	3.4	2.2	1.8	2.0
Italy	Actual	2.4	3.6	2.2	1.3	1.2
	MV filter	2.5	3.7	2.4	1.4	1.3
	EHP filter[1]	2.5	3.6	2.4	1.4	1.4
	EHP filter[2]	2.5	3.6	2.4	1.5	1.5
United Kingdom	Actual	2.2	2.4	2.9	2.0	2.8
	MV filter	..	..	2.4	2.2	2.4
	EHP filter[1]	2.2	1.9	2.5	2.2	2.5
	EHP filter[2]	2.2	1.9	2.5	2.2	2.5
Canada	Actual	3.2	4.6	3.1	2.2	2.9
	MV filter	3.1	4.2	2.9	2.3	2.6
	EHP filter[1]	3.1	4.1	2.8	2.3	2.7
	EHP filter[2]	3.1	4.1	2.8	2.4	2.9

EHP : extended Hodrick-Prescott filter, MV:multivariate filter.
1. Hodrick-Prescott filter with out-of-sample growth rate restriction.
2. Hodrick-Prescott filter using OECD projections to extend time-series out of sample.
3. 1992-98 for Germany.

1.2 Trend growth in output[6]

11. Table 1 and Figure 1 suggest a slow-down in actual and trend GDP growth rate in the OECD-24 area (*i.e*. excluding the new OECD countries) over the 1990s as compared with the previous decade. This aggregate pattern hides persistent differences in trend GDP growth rates across OECD countries. Amongst the larger countries, only the United States reversed the slow-down in growth performance observed during the 1970s and 1980s, whereas several smaller OECD countries were able to do so (most notably Australia, Denmark, Ireland, the Netherlands, Norway).[7]

6. This section largely focuses on trends in total GDP, including the government sector. However, output trends in the business sector are also highlighted if they differ from those of the total economy. Moreover, the analysis of labour and multi-factor productivity focuses on the business sector, since output and input trends in this sector are determined primarily by the market process and productivity thus has a clearer interpretation. Government output remains more difficult to measure, although attempts are being made in several OECD economies (*e.g*. Fisk and Forte, 1997).

7. The actual GDP growth rates presented in Annex Table A.1 are broadly consistent with those based on trend series with a few exceptions. For Denmark and Norway, actual GDP series show a more rapid picking-up of GDP in the 1990s than suggested above, while for Finland, Iceland and Sweden the slow-down in GDP growth is more marked with actual series than with trend estimates. For the United States, actual series suggest an even stronger picking-up in GDP growth in the most recent years (1995-

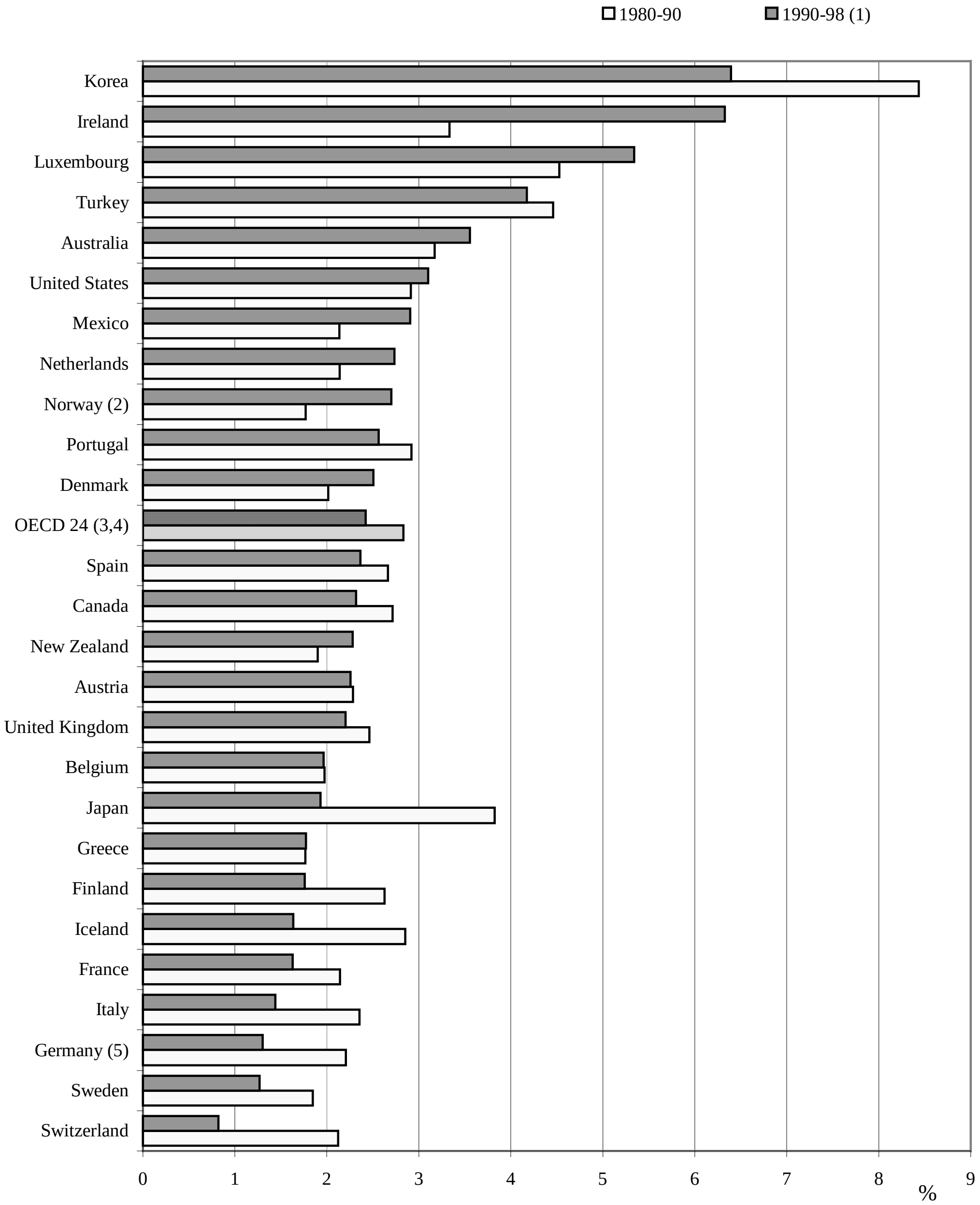
Table 1. **Growth performance in OECD countries, 1970-99**
Average annual rates of change

	Actual growth of GDP				Actual growth of GDP per capita				Trend growth of GDP per capita	
	1970-80	1980-90	1990[1]-98	1999	1970-80	1980-90	1990[1]-98	1999	1980-90	1990-98
United States	3.2	3.2	3.0	4.2	2.1	2.3	2.0	3.2	2.0	2.2
Japan	4.4	4.0	1.4	0.3	3.3	3.4	1.1	0.1	3.3	1.6
Germany	2.7	2.2	1.4	1.5	2.6	2.0	1.0	1.4	1.9	0.9
France	3.3	2.4	1.4	2.9	2.7	1.8	0.9	2.5	1.6	1.2
Italy	3.6	2.2	1.3	1.4	3.1	2.2	1.2	1.3	2.3	1.3
United Kingdom	1.9	2.7	2.0	2.1	1.8	2.5	1.7	1.7	2.2	1.8
Canada	4.3	2.8	2.2	4.2	2.8	1.6	1.1	3.4	1.5	1.2
Austria	3.7	2.3	1.9	2.2	3.5	2.1	1.3	2.1	2.1	1.7
Belgium	3.4	2.0	1.8	2.5	3.2	1.9	1.5	2.3	1.9	1.7
Denmark	2.2	1.9	2.3	1.6	1.8	1.9	1.9	1.2	2.0	2.1
Finland	3.4	3.1	1.5	3.5	3.1	2.6	1.0	3.2	2.2	1.3
Greece	4.7	1.6	2.0	3.2	3.7	1.1	1.4	2.9	1.3	1.3
Iceland	6.3	2.7	2.2	4.4	5.2	1.6	1.3	3.3	1.7	0.8
Ireland	4.7	3.6	6.3	8.7	3.3	3.3	5.5	7.4	3.0	5.6
Luxembourg	2.6	4.5	5.3	4.9	1.9	3.9	3.9	3.6	4.0	4.0
Netherlands	2.9	2.2	2.6	3.6	2.1	1.6	2.0	3.0	1.6	2.1
Norway[3]	4.2	1.5	3.1	0.8	3.6	1.1	2.6	0.2	1.4	2.2
Portugal	4.7	2.9	2.4	3.0	3.4	2.9	2.3	2.7	2.9	2.5
Spain	3.5	3.0	2.1	3.7	2.4	2.6	1.9	3.6	2.3	2.2
Sweden	1.9	2.1	1.1	3.8	1.6	1.8	0.6	3.7	1.5	0.9
Switzerland	1.9	2.1	0.5	1.7	1.7	1.5	-0.3	1.5	1.6	0.1
Turkey	4.1	5.2	4.2	-5.0	1.8	2.8	2.4	-6.6	2.0	2.3
Australia	3.3	3.3	3.5	4.4	1.9	1.7	2.3	3.1	1.6	2.4
New Zealand	1.6	2.4	2.2	3.9	0.5	1.7	0.7	3.4	1.2	0.8
Mexico	6.6	1.8	3.0	3.7	3.4	0.0	1.3	1.4	0.3	1.2
Korea	7.6	8.9	5.2	10.7	5.8	7.6	4.1	9.7	7.2	5.3
Hungary	..	..	-0.2	4.5	..	..	0.1	4.9	..	..
Poland	..	..	3.5	4.0	..	..	3.4	4.0	..	..
Czech Republic	..	..	0.4	-0.2	..	..	0.4	-0.1	..	..
Variability of growth rates [4] *:*										
EU15	0.9	0.7	1.5	1.8	0.7	0.7	1.3	1.5	0.7	1.2
OECD24[5]	1.1	0.9	1.3	2.4	1.0	0.7	1.2	2.4	0.7	1.1

1. 1991 for Czech Republic and Germany.
3. Mainland only.
4. As measured by the standard deviation of growth rate.
5. Excluding Czech Republic, Hungary, Korea, Mexico and Poland.
Source: Secretariat calculations mainly based on data for the OECD *Economic Outlook,* No 67, see Annex 2 for details.

98). This difference with the trend series can be largely explained by the fact that the HP filter technique or the multivariate filter use relatively prudent out-of-sample projections (based either on an extrapolation of past trends or the OECD projections). This may underestimate potential growth rates to the extent to which a new growth pattern has emerged in the most recent years.

Figure 1. **Trend GDP growth in the OECD area, 1980-90 and 1990-98**
(Total economy, percentage change at annual rate)



	1980-90	1990-98
Coefficient of variation OECD total [6]	0.47	0.54
Coefficient of variation EU15	0.28	0.58
Coefficient of variation OECD 24 [4]	0.28	0.51

1. 1990-97 for Iceland and Portugal, 1991-98 for Germany.
2. Mainland only.
3. Growth rate for OECD 24 is computed as a weighted average of country growth rates, using country GDP levels expressed in 1993 EKS PPPs as weights, see Annex 2.
4. Excluding Czech Republic, Hungary, Korea, Mexico and Poland.
5. Western Germany for 1980-90.
6. Excluding Czech Republic, Hungary and Poland.

Source: Secretariat calculations based on data for the OECD *Economic Outlook,* No 66, see Annexes 2 and 3 for details.

12. From a national living standard perspective, trends in per-capita GDP growth are more relevant than aggregate GDP growth.[8] These are presented in Figure 2. Since demographic changes are generally slow the same broad evolution is evident: only the United States registered a significant acceleration amongst the larger countries, whereas several of the smaller economies improved their performance in the 1990s as compared to the previous decade. In particular, Australia, Ireland, the Netherlands and Norway recorded markedly higher growth rates of GDP per capita in the 1990s than in the 1980s. Whereas disparities in overall GDP growth increased only marginally in the 1990s relative to the 1980s, those in GDP per capita increased markedly.[9] In particular, disparities in trend GDP per capita growth rates in the European Union have doubled in the past decade.

1.3 Labour utilisation and productivity

13. This sub-section explores how growth in per-capita output can be "explained" by changes in labour input and its productivity. Growth in GDP per capita can be decomposed into five elements:

- Changes in the ratio of persons of working-age (15–64 years) to the total population;
- Changes in the ratio of those in the labour force to the working-age population, *i.e.* the labour force participation rate;
- Changes in the ratio of those employed to the labour force, *i.e.* (1 - the unemployment rate);
- Changes in the number of working hours per person employed;
- Changes in GDP per hour worked.

14. With a different intensity, all these factors are affected by macroeconomic, structural, educational and immigration policies, either directly or indirectly given the close interactions between demographic trends, macroeconomic conditions and decisions affecting labour demand and labour supply. The first element in the breakdown reflects the age-structure of the population. It may have an important impact on GDP per-capita growth in the future since most OECD economies are about to undergo a rapid ageing of their population.[10] Changes in the next three ratios are more important in an economic and policy sense, since they reflect how an economy uses its potential workforce (those of working age). The final ratio reflects changes in labour productivity. Table 2 presents a breakdown of growth of GDP per capita in these five components for most OECD countries over the period 1990-98.

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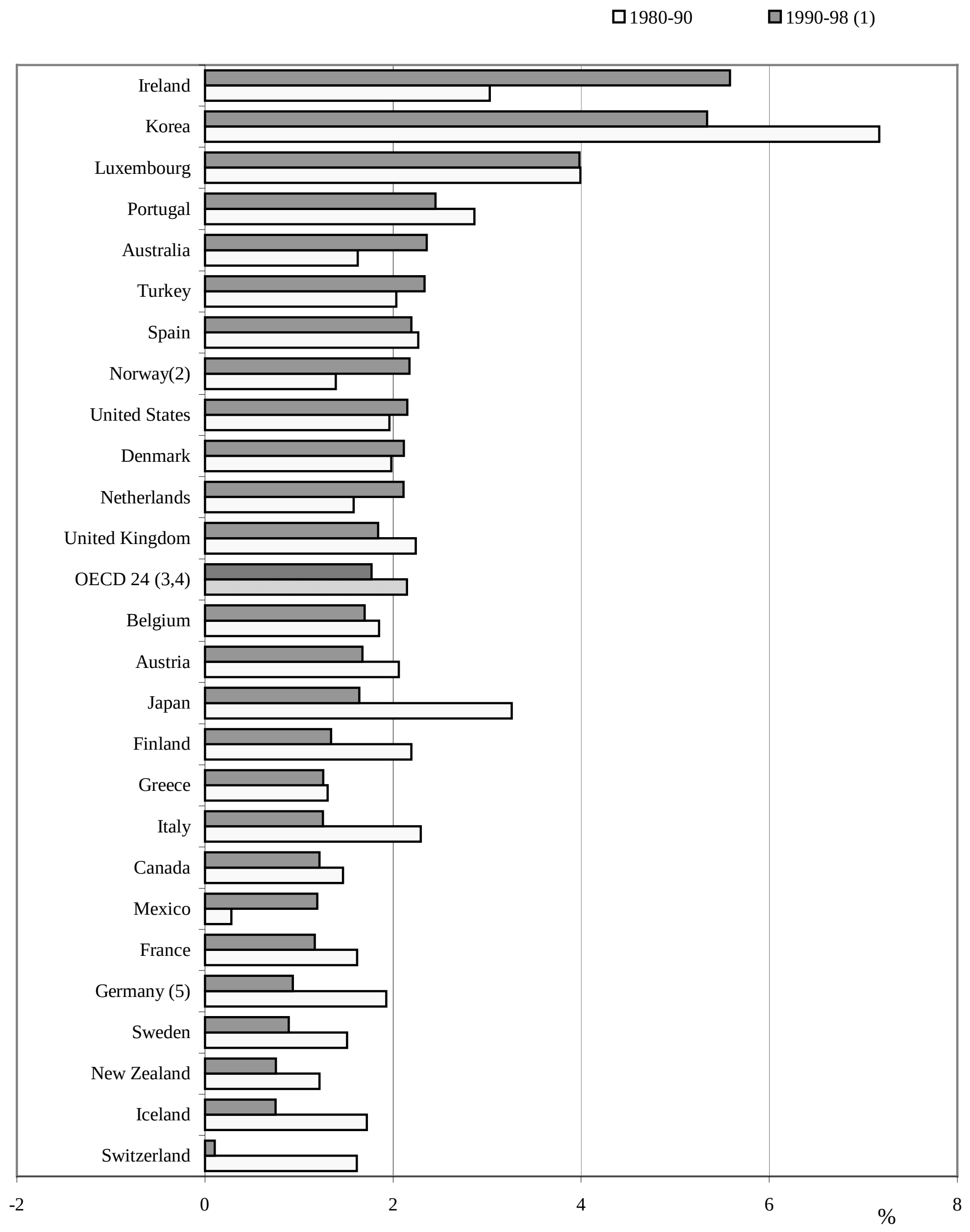
8. Strictly speaking, per capita GNP growth would be an even better measure, but in practice there is little difference between the two concepts in trend growth rates terms. There are, however, a few exceptions, including Switzerland and Ireland: for the former actual annual growth rate of GNP was 0.2 percentage points higher than the GDP growth rate (0.5 per cent); for Ireland, it was 0.6 percentage points lower than the GDP annual growth rate (6.3 per cent).

9. The variability of growth performance is generally expressed in this paper on the basis of the unweighted coefficient of variation: the standard deviation divided by the average.

10. The ageing process implies that the ratio of those of working-age to the total population will decline significantly in the next few decades. At current participation rates and productivity levels, this will inevitably have a depressing impact on growth of GDP per capita (OECD, 1998*b*).

Figure 2. **Trend growth of GDP per capita in the OECD area, 1980-90 and 1990-98**
(Total economy, percentage change at annual rate)



	1980-90	1990-98
Coefficient of variation OECD total [6]	0.56	0.66
Coefficient of variation EU15	0.31	0.61
Coefficient of variation OECD 24 [4]	0.32	0.61

1. 1990-97 for Iceland and Portugal, 1991-98 for Germany.
2. Mainland only.
3. Growth rate for OECD 24 is computed as a weighted average of country growth rates, using country GDP levels expressed in 1993 EKS PPPs as weights, see Annex 2.
4. Excluding Czech Republic, Hungary, Korea, Mexico and Poland.
5. Western Germany for 1980-90.
6. Excluding Czech Republic, Hungary and Poland.

Source: Secretariat calculations based on data for the OECD *Economic Outlook*, No 66, see Annexes 2 and 3 for details.

Table 2. **Growth in GDP per capita and its components, 1990-98**

	Working-age population/ total population (a)	Labour force participation rate (b)	Employment/ Labour force (c)	GDP per person employed (d)	Hours worked (e)	**GDP per capita (a)+(b)+(c)+(d)**	Total impact of labour utilisation (a)+(b)+(c)+(e)	GDP per hours worked (d)-(e)
United States	0.0	0.3	0.2	1.6	0.1	**2.1**	0.6	1.5
Japan	-0.2	0.7	-0.2	1.3	-1.1	**1.6**	-0.8	2.4
Germany[1]	-0.1	-0.3	-0.6	1.9	-0.7	**1.0**	-1.5	2.5
France	-0.1	0.2	-0.3	1.4	-0.4	**1.2**	-0.7	1.8
Italy	-0.1	-0.2	-0.3	1.9	-0.2	**1.2**	-0.8	2.0
United Kingdom	-0.1	-0.1	0.2	1.8	-0.1	**1.8**	-0.1	1.9
Canada	0.2	-0.2	0.1	1.1	-0.1	**1.2**	0.1	1.1
Australia	0.0	0.3	0.0	2.0	0.0	**2.3**	0.4	2.0
Austria	0.0	0.0	-0.2	1.8	..	**1.7**	..	..
Belgium	-0.2	0.5	-0.3	1.7	-0.4	**1.7**	-0.5	2.2
Denmark	-0.1	-0.5	0.3	2.3	0.0	**2.1**	-0.2	2.3
Finland	-0.1	-0.5	-0.8	2.8	-0.1	**1.3**	-1.6	2.9
Greece[2]	0.1	0.4	-0.4	1.0	0.1	**1.1**	0.2	0.9
Iceland[2]	0.1	-0.3	-0.3	1.2	-0.1	**0.7**	-0.5	1.3
Ireland	0.9	0.5	0.9	3.1	-0.6	**5.4**	1.7	3.8
Korea	1.9	-0.5	0.1	3.9	-0.8	**5.2**	0.6	4.7
Mexico	1.1	..	..	-0.2	0.8	**1.2**	..	-1.1
Netherlands	-0.2	1.2	0.2	0.8	-1.0	**2.1**	0.3	1.8
New Zealand	0.1	0.2	0.1	0.4	0.0	**0.8**	0.3	0.4
Norway[3]	-0.1	0.4	0.1	1.8	-0.3	**2.2**	0.1	2.1
Portugal[2]	0.3	-0.3	0.7	1.7	-0.6	**2.4**	0.2	2.2
Spain	0.2	0.5	-0.2	1.7	-0.1	**2.2**	0.4	1.8
Sweden	0.0	-0.9	-0.5	2.4	0.6	**0.9**	-0.9	1.7

1. 1991-98.
2. 1990-97.
3. Mainland only.

Source: Secretariat calculations based on: data for the OECD *Economic Outlook*, No 66; hours worked from various sources, see Annex 2 for details.

15. As the period considered is quite short, the impact of changes in demographic structure is limited. For most countries, the share of the working-age population in the total population changed only marginally over the 1990s. However, the slight decline in a number of old OECD countries reversed the post-war trend and mechanically reduced the growth of GDP per capita. Countries with significant changes are those with a rapidly evolving age structure due to strong population growth (Korea) and changes in migration flows (*e.g*. Ireland).

16. Participation rates for the OECD countries as a whole have been rather stable over the recent past, with rising prime-age female participation rates largely compensated by falling participation rates among older workers and youths. In a few countries, the rise in part-time work (most notably in the Netherlands) has been associated with increasing participation rates, especially, amongst women (see OECD, 1999*a*). In the other countries, participation rates made more modest contributions to growth or even fell in some of those with high levels (notably in most of the Nordic countries).

17. Changes in employment with respect to the labour force or, equivalently, in the unemployment rate have strongly influenced the evolution of GDP per capita. Amongst the major economies, the United States and the United Kingdom and Canada all recorded falls in trend unemployment over the 1990s, while the other G7 countries had either persistently high unemployment rates or significantly rising rates. A significant easing of labour market conditions was also observed in some smaller countries.[11]

18. Average hours worked vary considerably across the OECD countries (see next section) and there have been major differences in their evolution over time. Over the 1990s, hours worked fell in most countries, and particularly so in continental Europe, thus lowering the growth rate of GDP per capita. In part this reflects differing rates of decline in statutory (collectively agreed) working weeks, but in a number of countries (especially in Europe) it also reflects a substantial increase in part-time working.[12] The association between changes in hours worked and changes in participation rates across countries supports the view that the spread of part-time work has encouraged people to enter the labour force rather than oblige those who prefer to work full time to accept part-time jobs.[13]

19. The overall net effect of these changes in labour utilisation on GDP per capita can be considerable, and has provided a significant boost to annual growth in some countries (*e.g.* the United States, Ireland). Greater labour utilisation can thus make an important contribution to growth over the short and medium run, but its potential is not unlimited. Even so, there are large differences in the degree of labour utilisation and the potential for higher levels is far from exhausted, especially in Continental Europe where employment rates are low, especially amongst youths, prime-age women and older workers.[14] Moreover, policy may affect migration flows and thus the size of the working age population, especially in the context of the ageing of population in most OECD countries.

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11. More details on the evolution of trend unemployment rates are in OECD (1999*a*).

12. In the Netherlands almost half of the growth in employment in the 1993-97 period was in the form of part-time employment and almost two-third of women are currently employed part-time. In Germany, the increase in part-time employment partly compensated fall in full time employment. See OECD (1999*a*).

13. The 1999 Jobs Strategy report (OECD, 1999*a*) suggests that part-time is largely voluntary in most countries, although significant involuntary part-time was observed in the 1990s in countries with high and persistent unemployment where it was a second-best choice for a number of workers seeking employment in the absence of full time jobs.

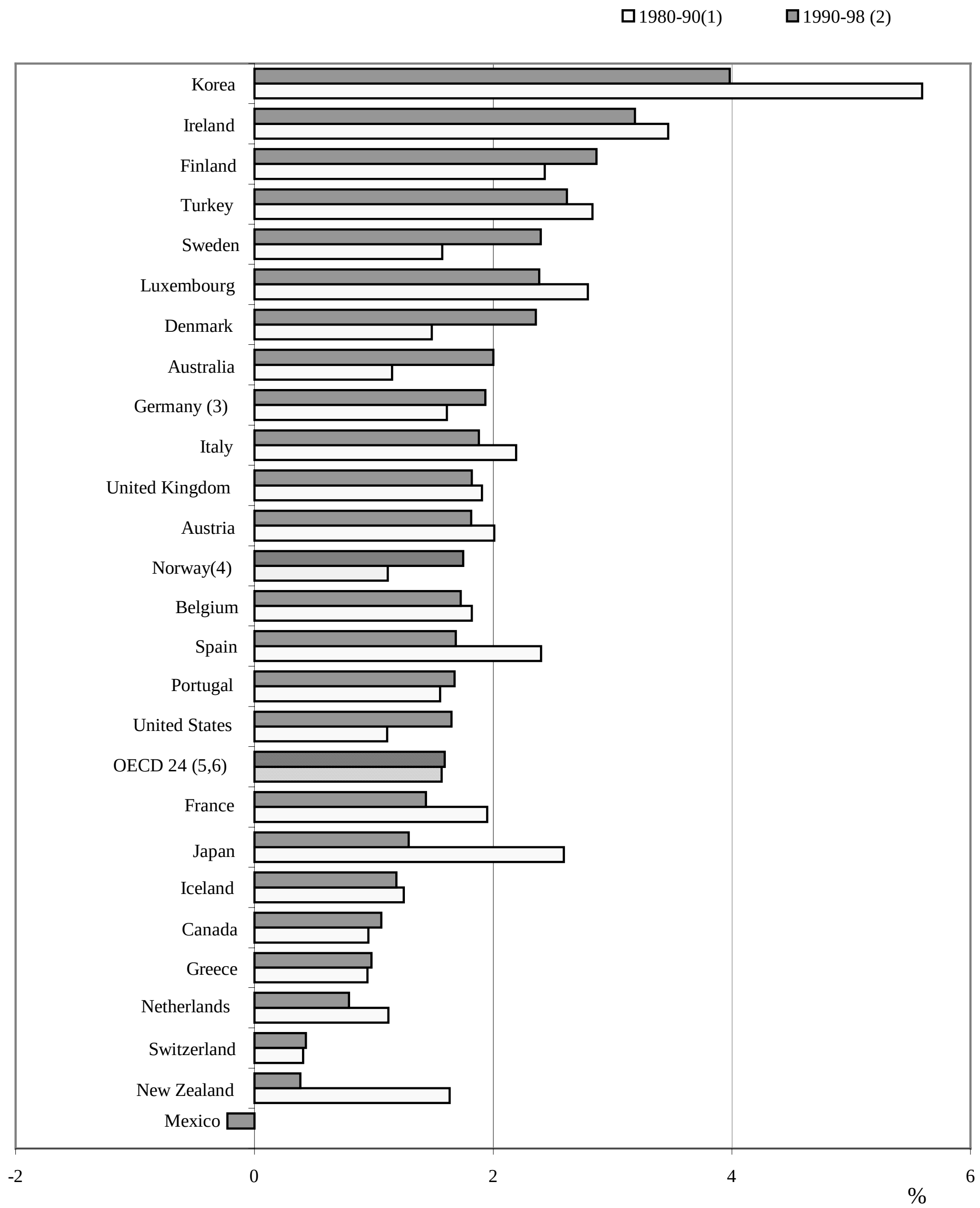
14. In 1998, employment rates range from about 50 per cent (*i.e.* one person of working age in two is employed) in Italy and Spain to more than 70 per cent in the United Kingdom, Sweden, the United States, Denmark and Norway (OECD, 1999*a*).

20. Over the longer term, the growth rate in labour productivity is the most important determinant of the growth of GDP per capita.[15] Labour productivity expressed as GDP per person employed in the 1990s picked up in a number of countries compared with the 1980s (Figure 3). However, this was associated with stable or rising employment in some of them (*e.g.* United States, Australia, Denmark, Norway, Portugal), but falling employment in others (*e.g.* Germany, Finland, Sweden). Given the decline in hours worked, growth rates in GDP on an hourly basis are generally higher than per employed in most countries over the recent period, Sweden and the United States being among the key exceptions (Figure 4).[16] As shown in the figure, the United States was among the few countries where growth of GDP per hour worked in the 1990s was markedly more rapid than in the 1980s (see also Box 2 for a discussion about US productivity performance). Notwithstanding the fact that some countries have shown significant change in the growth rate of labour productivity over the 1990s, the degree of dispersion of trend growth across the OECD and within the European Union did not vary markedly. However, it should be stressed that labour productivity growth accounts for at least half of GDP per capita growth in most OECD countries and considerably more than that in many of them (last column of Table 2).

15. Annex 3 compares trend labour productivity series, which imply estimating trends for GDP and employment separately, based on the extended Hodrick-Prescott filter (used throughout this paper) with those based on a multivariate filter in which price pressures and the employment-output relationship are taken into account in identifying trend series (Box 1 in the main text). The results from this latter approach broadly confirm the patterns based on the extended HP filter.

16. Data on hours worked used in this paper are drawn from various sources, and importantly from an ongoing project in the Directorate for Education, Employment, Labour and Social Affairs (DEELSA). Cross-country comparability has been improved as compared to the use of original national sources for some countries, but there remains a margin of uncertainty, especially for data referring to the early 1980s in some countries. See Annex 2 for more details.

Figure 3. **Trend growth of GDP per person employed, in the OECD area, 1980-90 and 1990-98**
(Total economy, percentage change at annual rate)

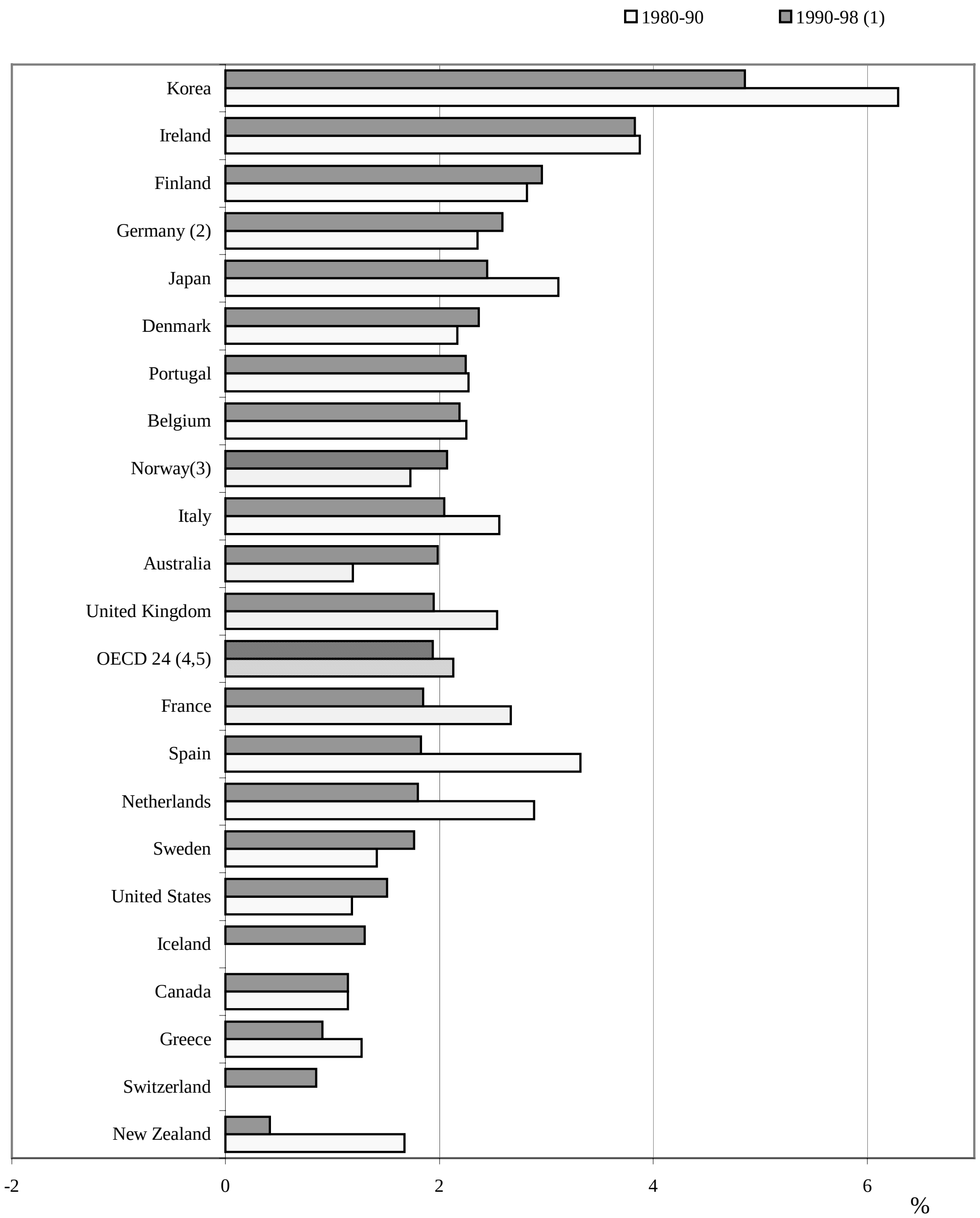


	1980-90	1990-98
Coefficient of variation EU15	0.33	0.33
Coefficient of variation OECD 24 [6]	0.40	0.41

1. 1983-90 for Mexico.
2. 1990-97 for Greece, Iceland, Korea and Portugal, 1991-98 for Germany.
3. Western Germany for 1980-90.
4. Mainland only.
5. Growth rate for OECD 24 is computed as a weighted average of country growth rates, using country GDP levels expressed in 1993 EKS PPPs as weights, see Annex 2.
6. Excluding Czech Republic, Hungary, Korea, Mexico and Poland.

Source: Secretariat calculations based on data for the OECD *Economic Outlook*, No 66, see Annexes 2 and 3 for details.

Figure 4. **Trend growth of GDP per hours worked, in the OECD area, 1980-90 and 1990-98**
(Total economy, percentage change at annual rate)



	1980-90	1990-98
Coefficient of variation EU15 [6]	0.28	0.32
Coefficient of variation OECD 24 [5]	0.35	0.40

1. 1990-97 for Greece, Iceland, Korea and Portugal, 1991-98 for Germany.
2. Western Germany for 1980-90.
3. Mainland only.
4. Growth rate for OECD 24 is computed as a weighted average of country growth rates, using country GDP levels expressed in 1993 EKS PPPs as weights, see Annex 2.
5. Excluding Austria, Czech Republic, Hungary, Korea, Luxembourg, Mexico, Poland and Turkey.
6. Excluding Austria and Luxembourg.

Source: Secretariat calculations based on data for the OECD *Economic Outlook,* No 66; hours worked from various sources, for details see Annexes 2 and 3.

Box 2. **US productivity performance: the contribution of information and communication technology**

The causes and implications of recent productivity performance in the US economy have been a source of heated debate over the past few years. The official productivity data, from the Bureau of Labor Statistics, suggest that labour productivity growth has been very strong in the past decade and especially in the most recent years. Output per hour in the private non-farm business sector grew at 2 per cent annually over the entire decade and at 2.9 per cent in the 1995-99 period, almost double the average growth rate of the period 1973-95.

The long expansion in the United States economy has been accompanied by a surge in investment in information and communication technology (ICT) assets. In particular, the acceleration of US output in the second half of the 1990s coincided with a rise in the growth rate of hardware and communication equipment and the question has been raised as to the role of the information and communication technology in the improved productivity performance at the macro level. There are at least three, complementary approaches to assess the role of ICT in output growth, and all three angles have been covered in different studies of the US economy:

ICT industries. One way to grasp the economic importance of ITCs is to look at the importance of ICT production in the economy. Although value-added shares of ICT industries are relatively modest when measured in current prices, the contribution to real output growth can be significant if ICT industries grow much faster than other parts of the economy.

ICT as a capital input. A second avenue by which ICT can affect output and labour productivity growth is via its role as a capital good. ICT investment takes place in all parts of the economy and thereby provides capital services. These are part of the overall contribution of ICT to output and labour productivity growth. Studies that assess the importance of ICT as a capital input include Oliner and Sichel (2000), Whelan (2000) and OECD (2000) (see below for an international comparison). These studies treat ICT capital goods like other types of capital goods – in particular, it is assumed that firms who own ICT assets are able to reap most or all benefits that accrue from using new technologies. Only in this case is it possible to observe market income accruing to ICT capital and make inferences about its overall growth contribution. If there are other, unobserved benefits or income, this contribution would be under-estimated. This leads to the point about ICT as a special input.

Spillovers from ICT usage. A final avenue by which to trace effects of ICT is based on the claim that ICTs produce benefits that go beyond those accruing to investors and owners, for example through network externalities. Where such spillovers exist, they would raise overall MFP growth. As such, they are similar to advances in knowledge as well as the appearance of new blueprints and formulae or organisational innovations that potentially benefit all market participants. Studies at the firm level (for example Brynjolfsson and Kemerer, 1996; Gandal, *et al.*, 1999) do indeed point to spillovers from ICT capital, but it is difficult to transpose these results to the aggregate level.

Notwithstanding measurement issues, there is growing consensus about a strong overall impact of ICT on observed output and productivity performance in the United States. Gordon (1999) finds that most of the rise in overall labour productivity growth is due to productivity advances in computer-producing industries (see also below for an international comparison). The result is obtained by combining the effects of capital deepening and MFP growth in the computer industry on labour productivity. The latest *Economic Report of the President* (2000) singles out the contribution of multifactor productivity in the computer sector to aggregate productivity and suggests that only a fraction of the post-1995 acceleration of labour productivity growth is accounted for by the acceleration of MFP in the computer sector. Two additional studies (Whelan, 2000; Oliner and Sichel, 2000) also relate the growing utilisation of computer hardware and software to faster aggregate productivity growth in the United States. Their estimates suggest an almost doubling in labour productivity growth in the 1996-99 period as compared with the first part of the decade: the use of information technology and the production of computers accounted for about two-thirds of this acceleration. More generally, it should also be stressed that the use of different deflators may affect the way in which the overall impact on productivity is split between the ICT-producing industry and the ICT using industries. For example, the rapid fall in the hedonic ICT deflator in the US tends to assign a stronger role to the ICT-producing industry (see footnote 58 below).

Growth in human capital and its impact on labour productivity

21. Workers differ significantly in their characteristics and this has an important bearing on workers' contribution to output, as implicitly shown by the variability in wage rates.[17] Accordingly, workers with different characteristics should ideally be treated as separate and distinct inputs in the measurement of output and productivity changes. This paper attempts to do this by calculating labour input as a weighted sum of different groups of workers with different levels of education, each weighted by their relative wage.[18] Moreover, since wage rates of men and women differ markedly, the decomposition is applied separately to each of them. To the extent wages are a reasonable proxy for differences in productivity[19], the measured labour input control for changes in the 'quality' of the workforce over time.[20] Compared with other proxies available in the literature (largely for the United States) this decomposition is rather crude, but it does shed some light on the role of compositional changes in labour input consistently for a range of OECD countries, thereby permitting cross-country comparisons.[21]

22. Table 3 decomposes changes in total labour input into a component that reflects unweighted changes in total hours and a second component reflecting the changing educational composition of labour, as well as changes in the relative wages earned by different workers. Given data availability, the decomposition covers only a selected number of OECD countries and the 1985-96 period.[22] The labour composition effect is positive in all but one country, implying that quality-adjusted hourly labour input

17. From the seminal contributions of Becker (1975) and Mincer (1974), a wealth of studies have focused on the effects of education and experience on earnings. For a survey, see Psacharopoulos (1994).

18. It is not suggested here that there is a perfect association between wage rates by education and relative productivity. Another OECD study (OECD, 1998*f*) looks at labour composition effects at the industry level using occupational data. At the aggregate level, however, the availability of data on employment by educational attainment offers a better grasp of compositional effects since education is often a prerequisite for entrance in an occupation and because education enhances performance in many occupations (see BLS, 1993 and especially Denison, 1985).

19. This is a strong assumption that is however common in the literature. It implies that firms operate under constant returns to scale in competitive input and product markets. Moreover, firms are assumed to maximise their profits by equating compensation with each worker's contribution to output. BLS (1993) discusses how deviations from these hypotheses affect the relationship between the contribution to output and compensation.

20. As stressed by Barro (1998), although groupings on the basis of education or occupations do not remove workers heterogeneity, any finer grouping than simple head-counts delivers a better measure of labour input and thus productivity.

21. A number of studies on growth accounting for the OECD and non-OECD countries use the Barro-Lee database on population of working age by levels of educational attainment (Barro and Lee, 1993, 1996). Labour input is obtained by weighting years of education with wages rates obtained by applying a constant rate of return to education. This latter hypothesis is quite restrictive and is removed in some recent studies on the US economy. A study by the Bureau of Labour Statistics (BLS, 1993) proxies skills by education and experience of men and women separately. Moreover, wage rates for each category are based on econometrically estimated hourly earnings functions instead of sample estimates of average hourly earnings. Jorgenson, Gollop and Fraumeni (1987) and Ho and Jorgenson (1999) estimated labour input using a very large number of categories of workers representing cross-classification of five characteristics [age, education, class of workers, occupation (not in Ho and Jorgenson) and gender]. The average shares obtained from cross-classified labour compensation data give the weights.

22. The period and countries covered reflect data availability on education and relative wages. Moreover, a somewhat longer time period was chosen with respect to most of the analysis in this paper (1985 onwards instead of 1990-98) to better grasp the contribution to labour input stemming from the increase in the educational attainment of the workforce.

grew faster than total hours.[23] In most European countries, sluggish employment growth and falling hours worked have been accompanied by a significant up-skilling of the workforce. This raises the suspicion that productivity gains have been achieved in part by dismissing or not employing low-productivity workers. In contrast, in the United States, Australia and the Netherlands, skill upgrading has played a relatively modest role in total labour input.[24] Improving labour market conditions and structural reforms have widened the employment base in these countries, especially in the 1990s, allowing low skilled workers to get a foothold into employment, but reducing the overall process of skill upgrading.[25]

Table 3. **Trends in labour input, total hours and labour composition, 1985-98**
(average annual percentage change)

	Total labour input (adjusted for compositional change)	**Total hours**	of which: Persons engaged	of which: Average hours per person	**Labour composition**	**Labour productivity[1]** With composition effect	**Labour productivity[1]** Without composition effect
United States	1.8	1.6	1.5	0.1	0.2	1.2	1.4
Germany	1.6	2.1	2.8	-0.7	-0.5	1.6	1.1
France	1.0	-0.2	0.2	-0.4	1.2	1.0	2.1
Italy	0.4	-0.5	-0.3	-0.2	0.9	1.5	2.3
United Kingdom	1.7	0.4	0.6	-0.2	1.4	0.6	2.0
Canada	1.9	1.3	1.3	-0.1	0.6	0.5	1.1
Australia	1.9	1.8	1.8	0.0	0.1	1.5	1.5
Denmark	0.1	-0.2	0.1	-0.3	0.3	2.0	2.3
Finland	-0.3	-1.3	-1.1	-0.2	1.0	1.9	2.9
Ireland	1.6	1.1	1.6	-0.5	0.5	3.4	3.9
Netherlands	0.4	0.4	1.8	-1.5	0.0	2.3	2.3
New Zealand	1.2	0.8	0.9	-0.1	0.4	0.6	1.0
Norway	0.7	0.1	0.5	-0.4	0.6	2.2	2.8
Portugal	3.5	0.7	1.2	-0.4	2.8	-0.5	2.3
Sweden	0.7	-0.2	-0.7	0.5	0.8	0.7	1.5

1. GDP per hour worked assuming unchanged and changed quality of the workforce.
Source: Secretariat calculations based on data for the OECD *Economic Outlook*, No 66; hours worked from various sources, see Annex 2 for details.

23. To shed further light on the role of skill upgrading on observed performances, Figure 5 plots the change in the share of employed persons with upper-secondary education or above against the change in the same share in the total working-age population. If the process of skill upgrading of the workforce occurred as a result of a generalised improvement in human capital in the working age population (*i.e.* related to education policy), then one would observe the countries located along the diagonal. By contrast, a position above the diagonal would suggest a skill-biased employment growth, in the sense that the shift to higher skill in employment was greater than the shift in the working age population would have suggested. While the increase in the quality of employment is largely associated with a generalised improvement in the educational level of the working-age population, there has been a general tendency

23. The result for Germany reflects the discrete fall in the average education level of the workforce in the aftermath of the unification with the Eastern Länder.

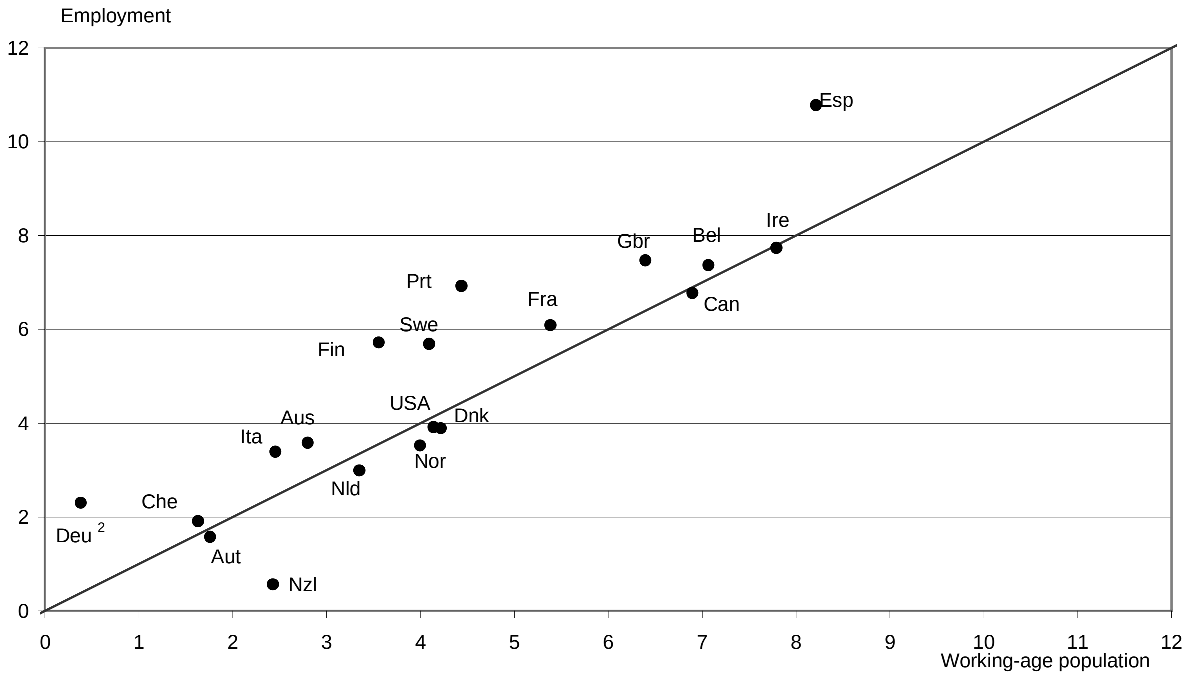
24. To assess the sensitivity of the estimation of labour input to the level of disaggregation used, the decomposition of labour input into employment, hours and composition was replicated for the United States using the BLS labour input index that, as stressed above, considers a finer breakdown of workers by education, experience and gender and weights them by econometrically estimated wage rates. As expected the finer decomposition yields a stronger composition effect (0.4 instead of 0.2) but does not radically change the basic message emerging from the comparison of the United States with the other countries.

25. As shown in OECD (1999*a*) in these countries (as well as in New Zealand, and Ireland) the unemployment rate of the low educated fell as much as the overall unemployment rate, while in most of the other countries the low educated experienced relatively smaller reductions or greater increases in unemployment than the average.

towards skill-biased employment growth. However, skill-biased employment performance is related to overall labour market conditions: most of the countries that have either maintained favourable labour market conditions or experienced significant improvements[26] have had a more balanced relative employment performance than those where unemployment has persisted at high levels or increased markedly.[27]

Figure 5. **Human capital growth in total working-age population and in employment, 1989-96**

(Share of individuals with higher educational levels[1] in total, percentage point change)



1. Higher education levels refer to ISCED codes 5, 6 and 7.

2. 1991-96.

Source: Secretariat calculations based on data from OECD, *Education at a Glance*, various issues.

24. To summarise, examination of recent trends in output and labour productivity indicates that there is substantial variety of experience. Disparities have tended to widen, and whereas hourly labour productivity has held up well in some countries, in Europe at least, this has been associated with low or falling employment levels. Amongst the major economies, the United States was an exception in the 1990s combining significantly higher labour productivity growth rates than in the previous decade with rising labour utilisation and more and more of low-skilled workers being drawn into jobs. In many Continental European economies there is evidence of a skill-biased employment performance with low-skilled workers been trapped into unemployment or inactivity. The next section examines how labour productivity may

26. Pomp (1998) discusses the slow-down in labour productivity in the Netherlands in the context of labour market reforms that have widened employment opportunities for the low paid/low skilled. He concludes that while changes in education, age, gender and full-time/part-time do not explain the decline in productivity after 1985, the increase in the share of low-paid workers has played an important role.

27. Portugal had a skill-biased employment performance, which, however, may reflect the fact that buoyant labour market conditions have benefited (better-educated) youths relatively more than older (less educated) workers. Indeed, Portugal is one of the few countries where the decline in youth unemployment rates has been stronger than the overall unemployment rate. See OECD (1999*a*).

have been influenced by changes in the quality of labour inputs, while Sections 1.4 and 1.5 look at trend growth of capital and multifactor productivity.

1.4 Capital deepening and capital productivity

25. Labour productivity growth provides only partial insights into overall economic efficiency. First of all, changes in labour productivity growth rates may occur because of changes in the capital/labour ratio, which in turn depends upon the rate of growth in fixed capital formation and/or changes in employment. Output growth also depends on the productivity of physical capital, which measures how physical capital is used in providing goods and services: changes therein indicate to what extent output growth can be achieved with lower welfare costs in the form of foregone consumption.

26. Yet, the accurate measurement of capital input is inherently difficult and comparisons across countries are particularly so. From the viewpoint of economic theory, the objective is to measure the flow of capital services, akin to the flow of effective hours worked (*i.e.* in equivalent quality terms, see above). Two important assumptions are often made in the empirical literature:

- The flow of capital services is often assumed to be a constant proportion of an estimated measure of the capital stock. This has the practical advantage that the assumed rate of change of capital services over time coincides with the rate of change of the capital stock as estimated by cumulating measurable investment according to assumptions about asset life-times, etc. However, this choice may lead to an over-estimation of the flow of capital services in times of low capital utilisation and vice versa.

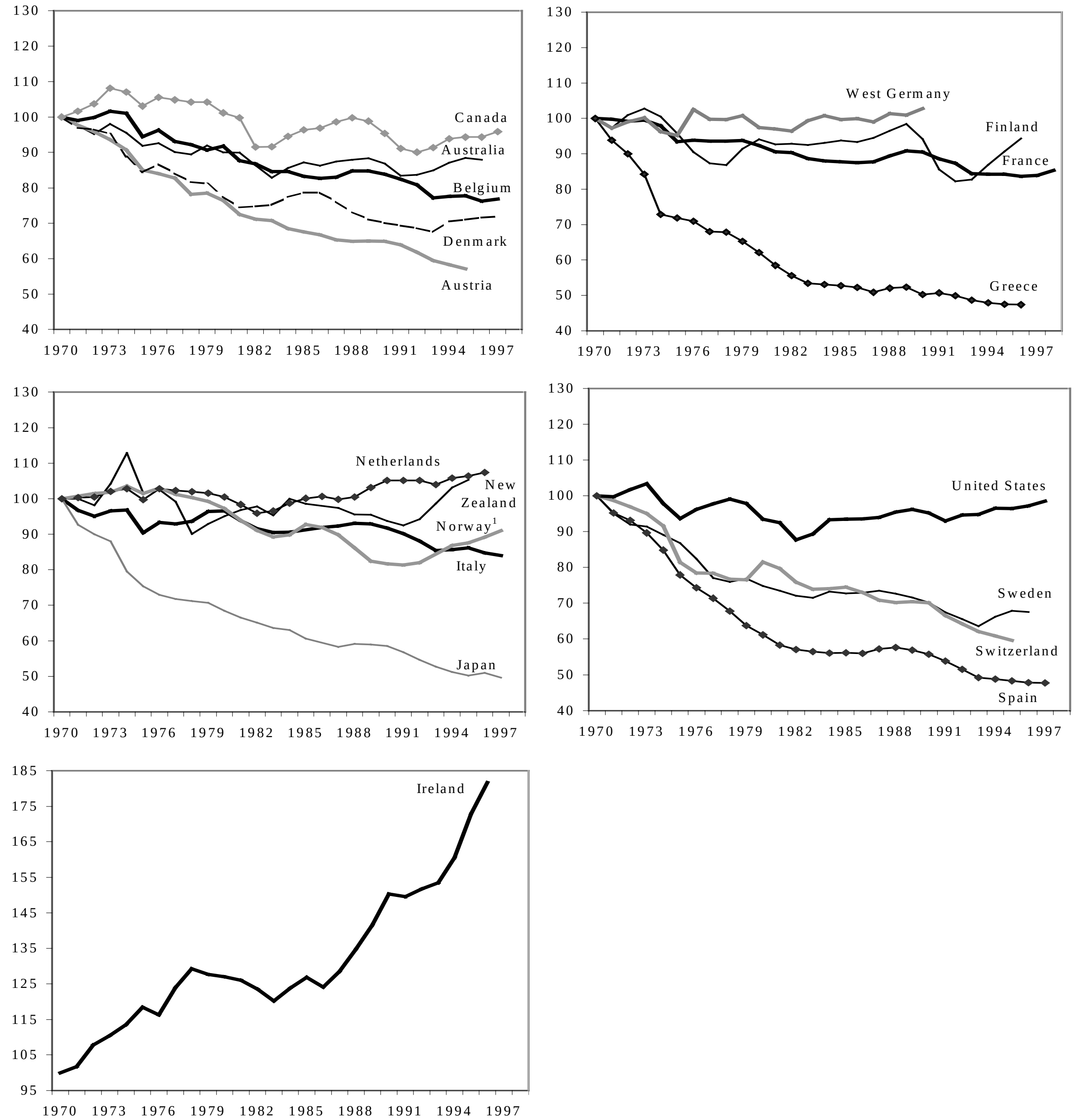
- A second and equally important assumption is that the aggregate capital stock is made up of one homogenous type of asset, or alternatively, that different assets generate the same marginal revenues in production. Stocks of individual assets can be computed, given information on investment flows, on the service life and on the profile of wear and tear of an asset. To obtain a measure of the service flow from *all* assets, the services from each asset would then have to be aggregated with user cost weights, designed to take into account the likely differences in the service flows of assets of different types (see OECD (1999*f*) for a detailed treatment of capital measurement).[28]

27. Figure 6 presents estimates of "unadjusted" capital productivity. It suggests that capital productivity rose in the United Kingdom and, particularly, in Ireland (although from relatively low levels

28. The construction of capital stock measures for the economy typically involves two distinct stages: first, a stock measure is constructed for each type of asset by adding up past investments in this asset, adjusted for the effects of wear and tear and retirement. Second, the resulting asset-specific stocks are aggregated to yield an overall measure of the capital stock. Because assets are heterogeneous, it would appear appropriate to associate each type of asset with a specific flow of capital services and to postulate proportionality between capital services and capital stocks at the level of individual assets. This ratio is not the same, however, for different kinds of assets, so that the aggregate stock and the flows covering different kinds of assets must diverge. A single measure cannot serve both purposes except when there is only one single homogenous capital good (Hill, 1999). In practice, then, using the rate of change of a single aggregate measure of the capital stock to approximate capital services will not appropriately reflect the compositional change of capital services and possibly lead to a biased assessment of the contribution of capital to economic growth.

especially in the latter), while it fell in the others since the 1970s. More recently though, some countries have registered an improvement in capital productivity.[29]

Figure 6. **Business sector capital productivity, 1970-98**
(1970=100)



1. Mainland only.

Source: Secretariat calculations mainly based on data for the OECD *Economic Outlook*, No 66 and national sources, see Annex 2 for details.

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29. Capital stock series for the other countries which may have experienced growth in capital productivity in the most recent years are not available. Moreover, the recent rise in capital productivity observed in the United States according to the OECD data is not fully confirmed by BLS estimates (BLS, 1999*a*). It should be stressed, however, that BLS' capital service measure tends to rise more rapidly than a simple measure of the capital stock. For a given rate of output growth, this implies a slower rate of capital productivity when based on the capital service measure.

28. Several factors lie behind observed growth rates in capital productivity (Parham, 1999), notably changes in the capital/labour ratio. Indeed, in a neoclassical framework, the increase in this ratio implies that each unit of capital has less labour to work with, contributing to diminishing returns. Over the past decade, the rate of growth of the capital/labour ratio fell in most countries (Table 4). There are a few notable exceptions to this pattern which, however, have to be seen in conjunction with employment patterns. In some continental European countries (*e.g.* Germany, Italy) the growth rate of capital intensity increased in the 1990s compared with the 1980s, but this was mainly driven by losses in employment rather than an acceleration of investment. A significant picking-up in the growth rate of capital was also observed in some other countries (*e.g*. the United States, Australia, Ireland the Netherlands, and Norway) in the second half of the 1990s, but this was in conjunction with strong employment growth.

Table 4. **Evolution of capital intensity and capital stock**
(Average annual growth rate)

		1980-90[1]	1990-98[2]	1995-98[3]
United States	Capital stock	3.0	2.6	3.3
	Capital/labour ratio	1.1	0.6	1.0
Japan	Capital stock	5.7	4.2	3.6
	Capital/labour ratio	4.9	4.7	4.4
Germany	Capital stock	2.6	2.6	2.3
	Capital/labour ratio	2.9	3.7	3.1
France	Capital stock	2.0	2.0	2.0
	Capital/labour ratio	2.3	2.3	2.3
Italy	Capital stock	2.8	2.7	2.7
	Capital/labour ratio	2.7	3.5	3.4
United Kingdom	Capital stock	1.8	1.6	1.6
	Capital/labour ratio	1.8	1.2	1.0
Canada	Capital stock	3.5	2.2	2.7
	Capital/labour ratio	1.8	0.9	1.4

Table 4. **Evolution of capital intensity and capital stock** (continued)
(Average annual growth rate)

		1980-90[1]	1990-98[2]	1995-98[3]
Australia	Capital stock	3.5	1.9	2.9
	Capital/labour ratio	1.5	0.1	0.9
Austria	Capital stock	3.9	4.3	4.0
	Capital/labour ratio	4.0	4.7	5.0
Belgium	Capital stock	2.9	3.0	2.9
	Capital/labour ratio	3.1	3.0	2.7
Denmark	Capital stock	2.9	2.9	3.3
	Capital/labour ratio	3.4	2.8	2.6
Finland	Capital stock	3.0	0.3	0.5
	Capital/labour ratio	4.1	2.8	1.2
Greece	Capital stock	3.5	2.5	2.5
	Capital/labour ratio	2.7	1.8	1.6
Iceland	Capital stock	3.0	..	..
	Capital/labour ratio	..	..	..
Ireland	Capital stock	2.6	2.3	3.3
	Capital/labour ratio	2.4	-0.1	-0.4
Netherlands	Capital stock	1.7	2.3	2.8
	Capital/labour ratio	2.7	1.6	1.6
New Zealand	Capital stock	1.9	0.9	..
	Capital/labour ratio	1.7	-1.1	..
Norway[4]	Capital stock	2.8	1.7	2.8
	Capital/labour ratio	3.4	1.6	1.7
Portugal	Capital stock	4.0	..	..
	Capital/labour ratio	2.9	..	..
Spain	Capital stock	3.7	4.0	3.7
	Capital/labour ratio	4.8	3.8	2.8
Sweden	Capital stock	3.0	1.8	2.4
	Capital/labour ratio	2.6	2.4	2.7
Switzerland	Capital stock	3.6	3.0	2.8
	Capital/labour ratio	..	3.5	..

Note: Capital /labour ratio is adjusted for hours worked.

1. Data for Germany refer to 1981-90 and cover only Western Germany, 1986-90 for Austria, Greece, New Zealand and Portugal, 1984-90 for Belgium and Denmark for capital/labour ratio.
2. 1990-97 for Australia, Belgium, Canada, Italy, Japan, Norway, Spain and United States, 1990-96 for Austria, Finland, Greece, Ireland, Sweden and United Kingdom, 1990-95 for New Zealand and Switzerland, 1991-98 for Germany.
3. 1995-97 for Australia, Belgium, Canada, Italy, Japan, Norway, Spain and United States, 1995-96 for Austria, Finland, Greece, Ireland, Sweden and United Kingdom.
4. Mainland only.

Source: Secretariat calculations based on data for the OECD *Economic Outlook* , No 66; national sources, see Annex 2 for details.

29. Technological change might be a counterbalancing factor to diminishing returns to capital, although apparently not sufficiently so in most countries.[30] Greater X-efficiency (defined as the distance of the observed production mix from the production possibility frontier), for instance in the form of better organisational and management practices, would result in higher growth of multi-factor productivity (see below), which would, in its turn, increase capital productivity.[31]

30. Changes in capital productivity may also arise from compositional shifts, for example if new investments are allocated towards more productive uses, or if the new investment is primarily geared towards more productive types of capital goods. To shed light on this issue, Table 5 presents estimates of the latter type of composition effects for the G-7 countries. These are based on comparing inputs of different types of capital weighted together either by acquisition prices or the relevant user costs. Several caveats are called for before interpreting these effects. First, the size of the composition effect depends on the level of detail at which aggregation with user costs or with acquisition prices is available. The present results are based on an aggregation across six types of capital goods - given the great heterogeneity of physical capital assets, this is still a fairly high level of aggregation[32] and so probably under-estimates the compositional effect. Second, a number of assumptions have to be made in the course of computing capital stocks by asset, in deriving user costs expressions and in aggregating across assets. Accordingly, the resulting time series of capital inputs and capital stocks may vary from those available from other sources, including national statistical offices. For example, in the study underlying Table 5, particular effort was made to derive a set of internationally harmonised price indices (based on hedonic adjustments) for investment in the asset type 'information and communication technology' (Schreyer, 2000).

31. Two main observations can be made regarding the results in Table 5:

- For all seven countries, and over both time periods shown, the compositional effect is positive, *i.e.* capital services grew at a more rapid pace than the capital stock.[33] The positive

30. For instance, the use of hedonic price indexes for investment in computer equipment implies the embodiment of technological change in measures of capital stock (see OECD, 1999*g*).

31. Simple algebra suggests that, in the presence of static constant returns to scale, capital productivity declines when the capital-labour ratio increases and improves when multifactor productivity increases.

32. As a matter of comparison, a similar study by Dean *et al*. (1996), starting at a much lower level of aggregation for the United States, yields a rate of change of capital services of 4.0 per cent over the period 1979-90 and of 2.0 per cent over the period 1990-94. The capital stock measure changes by 3.1 per cent and 1.6 per cent, respectively. This gives rise to a rate of compositional change of 0.9 per cent over the years 1979-90 and of 0.4 per cent over the years 1990-94. Ho *et al*. (1999), base their analysis for the United States on 69 different types of assets and derive a rate of compositional change of 0.31 per cent (the difference between the growth of capital services of 2.05 per cent and the growth of the capital stock of 1.74 per cent) over the period 1990-96. Such comparisons remain approximate, however, because these studies differ not only in their level of dis-aggregation of assets but also in other methodological aspects. For example, the work by Ho *et al*. (1999) uses a geometrically declining age-efficiency function which tends to produce slower rates of growth of the capital stock than the hyperbolic age-efficiency functions applied in the present study or by Dean *et al*.

33. This reflects a situation where the more rapidly growing assets command a higher share in total user costs than they do in the total capital stock, valued at acquisition prices. This happens when relative acquisition prices between assets are not equal to relative user costs. One important factor that drives a wedge between relative user costs and relative acquisition prices is depreciation: short-lived assets exhibit higher costs of depreciation and user costs than longer-lived assets. Thus, if investment in short-lived assets is more rapid than investment in other assets, an index based on relative user costs will attach more weight to these short-lived assets than an index based on acquisition prices. The higher user cost weights for short-lived assets are appropriate because they approximate more accurately the higher marginal productivity of short-lived assets.

composition effect observed here reflects the rapid investment in information and communication technology assets in G-7 countries - they are relatively short lived and, on the assumptions adopted, their marginal productivity in each of the few periods of their service life has to be high enough to finance depreciation and capital losses. Available evidence suggests that the capital composition effect in the United States is likely to have increased significantly in the past few years due to a marked boost in ICT investment (especially in hardware and communication equipment) (see Oliner and Sichel, 2000). This increase in ICT investment is linked to the rapid decline in ICT prices, which has led to a substitution of ICT goods for other capital goods.

– A positive composition effect implies that the measured contribution of capital to output growth is higher after controlling for quality changes in the capital stock (at the same time, measured multi-factor productivity growth will decline by the same amount, see below). In other words, the measurement of capital services shifts some of the growth effects from exogenous productivity growth to capital, or to a source of growth that is associated with return to private investors. The quantitative importance of this should not be exaggerated: the impact of the compositional change of the capital measure on the contribution of capital to output growth is the product of the overall cost share of capital times the compositional effect. As the overall cost share is about 0.3, the impact on the measured contribution to output growth amounts to about one third of the composition effect. For example, the changing composition of capital input contributed 0.1 percentage points (one third of 0.3) to US business-sector output growth in the period 1990-96.

Table 5. **Capital input and capital composition**[1]
Total private industries, percentage change at annual rates

	Capital services[2]	Capital stock[3]	Capital composition
		1980-96	
United States	3.3%	3.1%	0.2%
Japan	4.9%	4.7%	0.3%
Western Germany	2.8%	2.8%	0.1%
France	3.4%	3.0%	0.3%
Italy	2.2%	1.9%	0.3%
United Kingdom	2.7%	2.4%	0.3%
Canada	3.1%	2.7%	0.4%
		1980-90	
United States	3.7%	3.5%	0.2%
Japan	5.3%	5.0%	0.3%
Western Germany	3.0%	3.0%	0.1%
France	3.9%	3.4%	0.4%
Italy	2.4%	2.1%	0.3%
United Kingdom	2.8%	2.6%	0.2%
Canada	3.6%	3.2%	0.3%
		1990-96	
United States	2.7%	2.4%	0.3%
Japan	4.3%	4.1%	0.2%
Western Germany	2.5%	2.4%	0.1%
France	2.6%	2.4%	0.2%
Italy	1.8%	1.5%	0.3%
United Kingdom	2.5%	1.9%	0.6%
Canada	2.3%	1.9%	0.4%

1. The series presented are from Schreyer (2000), *The Contribution of Information and Communication Technologies to Output Growth*; STI Working Paper. For this study, capital stock and capital input measures were developed using the perpetual inventory method for six different types of assets. The data is not directly comparable to other capital stock series as it uses an internationally harmonised price index to deflate investment in information and communication technology. Furthermore, asset-specific capital stocks were based on a hyperbolic age-efficiency profile: in early years of an asset's service life, its productive capacity declines at a slow rate, in later years at a more rapid rate.
2. Törnqvist index with user cost weights. See Annex 3 for a derivation.
3. Törnqvist index with acquisition prices as weights See Annex 3 for a derivation.
4. The rate of compositional change is the difference between the rate of growth of capital services and the rate of growth of the capital stock.

1.5 Multi-factor productivity

32. By contrast with partial productivity measures where output is related to one input of production, multi-factor productivity measures describe the relation between output and a wide set of inputs. In its simplest form, the growth rate of MFP (also referred to as Total Factor Productivity, or TFP) is measured as the difference in the growth rate of output and a weighted average of the rate of change of inputs. Thus, MFP growth, if properly estimated, measures the growth rate of output that is not explained by changes in the quantity and quality of production factors (see Box 3).

33. The analysis of multi-factor productivity trends presented in this section proceeds from the simplest approach, covering most OECD countries, to a more refined method that is more data demanding. The section focuses on the business sector, because of the inherent difficulties in measuring output and

capital stock for the government sector, and on trend series to avoid picking up idiosyncratic movements in output and inputs.

34. Table 6 reports MFP growth rates in the business sector in a large sample of countries computed using employment and gross capital stock as factor inputs (*i.e.* neither adjusted for hours worked nor for changes in the quality and composition of labour and capital inputs). This is the broadest measure of productivity growth that incorporates the effects of progress in human capital as well as embodied (in physical capital) and disembodied technological progress.[34] For partial output elasticities, three different approaches are compared: average factor shares, time-varying factor shares and econometrically estimated output elasticities with a production function expressed in levels (see Annex 3 for the method of estimation). As it can be seen, only minor differences arise between the three methods.[35] These findings, which appear to be robust across a large number of countries, imply that the results from the use of more sophisticated measures of factor inputs will not be vitiated by using the comparatively simple "factor share" measures of partial output elasticities, reported in the next paragraphs.

34. For countries that use hedonic (or similar) price indices for certain investment goods (*e.g.* ICT), this measure of MFP growth rate does not incorporate technological progress embodied in them (as the capital stock is augmented by the improvements in quality of ICT goods). Bassanini *et al.* (2000) try to identify this component of broad MFP growth by considering the differences in growth rates of hedonic and non-hedonic price indexes of ICT. For the United States, the embodied part of MFP growth would be about 0.2 percentage point in the 1980-90 period and about 0.3 percentage point in the 1990-96 period.

35. See also Annex Tables A3.1 and A3.2.

Table 6. **Different estimates of Multi-Factor Productivity, growth rates 1970-98**
Average annual growth rates
(based on trend series)

	Method of estimation	1970-98[1]	1980-90	1990[2]-98[1]	1995-98[1]
United States	Average factor shares	0.7	0.8	1.1	1.1
	Time-varying factor shares	0.7	0.8	1.1	1.1
	Estimated factor elasticities	0.8	0.9	1.2	1.3
Japan	Average factor shares	1.6	1.6	0.8	0.9
	Time-varying factor shares	1.6	1.6	0.7	0.8
	Estimated factor elasticities	1.3	1.3	0.6	0.7
Germany [3]	Average factor shares	1.2	1.1	1.0	1.2
	Time-varying factor shares	1.3	1.1	1.0	1.1
	Estimated factor elasticities	1.5	1.2	1.2	1.3
France	Average factor shares	1.5	1.5	0.9	0.9
	Time-varying factor shares	1.6	1.6	0.9	0.8
	Estimated factor elasticities	1.8	1.7	1.2	1.1
Italy	Average factor shares	1.4	1.2	1.2	1.1
	Time-varying factor shares	1.5	1.2	1.1	0.9
	Estimated factor elasticities	1.3	1.1	1.1	1.0
United Kingdom	Average factor shares	1.7	2.0	1.2	1.3
	Time-varying factor shares	..	..	1.2	1.3
	Estimated factor elasticities	1.6	1.9	1.1	1.2
Canada	Average factor shares	0.6	0.3	0.7	0.7
	Time-varying factor shares	0.5	0.3	0.7	0.7
	Estimated factor elasticities	0.8	0.6	0.9	1.0

Table 6. **Different estimates of Multi-Factor Productivity, growth rates 1970-98** (continued)
Average annual growth rates
(based on trend series)

	Method of estimation	1970-98[1]	1980-90	1990-98[1]	1995-98[1]
Australia	Average factor shares	..	0.8	2.1	2.1
	Time-varying factor shares	..	0.8	2.1	2.1
	Estimated factor elasticities	..	0.9	2.1	2.2
Austria	Average factor shares	1.0	1.0	0.6	0.7
	Time-varying factor shares	1.0	1.0	0.6	0.6
	Estimated factor elasticities	1.0	1.0	0.6	0.7
Belgium	Average factor shares	1.3	1.1	0.7	0.6
	Time-varying factor shares	1.3	1.2	0.7	0.6
	Estimated factor elasticities	1.4	1.2	0.8	0.7
Denmark	Average factor shares	1.1	0.8	1.9	1.8
	Time-varying factor shares	1.2	0.8	1.8	1.7
	Estimated factor elasticities	1.4	1.0	2.1	2.1
Finland	Average factor shares	2.2	2.1	3.1	3.6
	Time-varying factor shares	2.3	2.2	3.1	3.5
	Estimated factor elasticities	2.5	2.4	3.3	3.6
Greece	Average factor shares	0.4	0.0	0.4	0.6
	Time-varying factor shares	0.4	0.0	0.3	0.6
	Estimated factor elasticities	..	..	..	..
Iceland	Average factor shares	..	..	0.4	..
	Time-varying factor shares	..	..	0.4	..
	Estimated factor elasticities	..	..	0.1	..
Ireland	Average factor shares	3.5	3.3	3.5	3.1
	Time-varying factor shares	3.7	3.4	3.5	3.2
	Estimated factor elasticities	3.8	3.7	3.4	3.0

Table 6. **Different estimates of Multi-Factor Productivity, growth rates 1970-98** (continued)
Average annual growth rates
(based on trend series)

	Method of estimation	1970-98[1]	1980-90	1990-98[1]	1995-98[1]
Netherlands	Average factor shares	1.4	1.1	1.1	0.8
	Time-varying factor shares	1.4	1.1	1.0	0.8
	Estimated factor elasticities	1.4	1.1	1.1	0.9
New Zealand	Average factor shares	0.5	0.6	1.0	..
	Time-varying factor shares	..	0.6	1.1	..
	Estimated factor elasticities	0.6	0.9	0.9	..
Norway[4]	Average factor shares	1.4	0.6	1.8	1.5
	Time-varying factor shares	1.5	0.7	1.9	1.6
	Estimated factor elasticities	1.2	0.4	1.7	1.4
Portugal	Average factor shares	0.9	0.9	1.9	..
	Time-varying factor shares	..	1.0	1.8	..
	Estimated factor elasticities	..	..	..	..
Spain	Average factor shares	1.1	1.4	0.7	0.6
	Time-varying factor shares	1.4	1.6	0.6	0.4
	Estimated factor elasticities	1.3	1.6	0.9	0.7
Sweden	Average factor shares	0.9	0.9	1.7	1.9
	Time-varying factor shares	1.0	0.9	1.7	1.7
	Estimated factor elasticities	..	..	..	..
Switzerland	Average factor shares	..	0.1	-0.1	..
	Time-varying factor shares	..	0.1	-0.1	..
	Estimated factor elasticities	..	0.0	-0.2	..

1. 1997 for Australia, Belgium, Canada, Italy, Japan, Norway, Spain and United States, 1996 for Austria, Finland, Greece, Ireland, Sweden and United Kingdom, 1995 for New Zealand and Switzerland, 1992 for Iceland and Portugal.
2. 1991 for Germany.
3. Western Germany before 1991.
4. Mainland only.

Source: Secretariat calculations based on data for the OECD *Economic Outllook* , No 66; national data, see Annex 2 for details.

Box 3. **Measures of multi-factor productivity (MFP)**

To calculate MFP it is necessary to have suitable measures of output and factor inputs as well as measures of partial output elasticities.[36] However, the latter are not directly observable and a standard choice in the literature is to assume them to be equal to income shares, given that the labour share can be easily computed from national accounts. This corresponds to making a few assumptions, most importantly that the product and input markets are perfectly competitive. Furthermore, it is often assumed that elasticities are constant across the whole period of observation (implicitly making the assumption of unit elasticity of substitution between factors) and equal to the observed average. Alternatively it can be recognised that elasticities can vary significantly for reasons different from measurement errors and use, as a discrete time approximation, the simple average of factor shares for each couple of subsequent years. An alternative for the measurement of partial output elasticity is to estimate them econometrically. This avoids assuming a relationship between partial output elasticities and income shares. However direct estimation raises a number of econometric issues that put into question the robustness of the results.

Measurement issues related to inputs and outputs are also important. Concerning the labour input, what counts for productivity analysis is not the number of workers but the number of effectively worked hours. Moreover, both labour and capital inputs tend to increase their quality over time and the use of quality adjusted indices makes the interpretation of resulting MFP estimates more straightforward. In the case of labour, the labour composition in terms of skills or educational attainment needs to be explicitly taken into account (see above in the main text). In the case of capital, quantities and prices should be adjusted for changes in quality, for example trough hedonic price methods in cases where both quality and volumes are changing rapidly. Measures of both levels and growth rates of MFP can be sensitive to aggregation methods. This may be the case particularly when quantities and user costs of some disaggregated inputs evolve along different patterns from those of the corresponding aggregate input, for example, when quality improvements in some particular capital inputs (such as ICT) are faster than those in others (see above).

Although the growth accounting methodology for the computation of MFP growth rate originated from the standard growth theory framework (Solow, 1957), it can encompass most of the endogenous growth models, provided that care is taken in the interpretation of the residual. As shown by Barro (1998) among others, when computed using non-adjusted factor inputs, MFP growth gives an estimate of both embodied and disembodied technological change that can be subsequently decomposed econometrically into its components[37]. The comparison of simple measures and quality-adjusted measures can provide an estimate of the impact of improvements in capital input that is compatible both with quality-ladder models of endogenous growth (as in Greenwood *et al.*, 1997, and Krusell, 1998) or standard vintage models (as in Hercowitz, 1998, and Gort *et al.*, 1999).

35. Moving forward another step, Table 7 reports four different measures of MFP (at most three for non-G7 countries and Japan) computed using time-varying factor shares and different measures of inputs. For each country, the first line reports the unadjusted MFP growth rate obtained with no adjustment for hours or quality changes in inputs as already displayed in Table 6. The second line reports the same measure with adjustment for changes in hours worked. The third measure corrects for the general rise in education levels by using a quality-adjusted measure of labour input. Finally, the fourth measure of the residual also takes into account changes in the “quality” and composition of the capital stock input (obtained aggregating over six types of assets). This measure can be considered as a proxy for the truly

36. For a more detailed methodological discussion of MFP measurement, see the OECD “Productivity Manual” (OECD, 1999f).

37. Notice that in most endogenous growth models final markets are perfectly competitive, allowing the use of factor shares to calculate MFP. Conversely, direct econometric methods may fail to give consistent estimates if the assumed externality is related to physical capital (such as in Romer, 1986)

disembodied technological progress, although the decomposition of capital assets is still very limited and thus does not capture shifts occurring at a finer level of disaggregation.[38]

Table 7. **Estimates of Multi-Factor Productivity growth rates**
with adjustment for hours worked and input quality changes, 1980-98
Average annual growth rates
(based on trend series time varying factor shares)

	Method of estimation	1980[1]-90	1990[2]-98[3]	1995-98[3]	1990-96[3]
United States	no adjustment	0.8	1.1	1.1	1.1
	hours adjusted	0.8	1.0	1.0	1.0
	labour input	0.8	0.8	1.0	0.9
	labour and capital input	0.6	..	..	0.8
Japan	no adjustment	1.6	0.7	0.8	0.7
	hours adjusted	2.0	1.6	1.6	1.5
	labour input	..	..	..	..
	labour and capital input	..	..	..	..
Germany [4]	no adjustment	1.1	1.0	1.1	0.9
	hours adjusted	1.6	1.4	1.5	1.4
	labour input	1.6	1.9	1.3	2.0
	labour and capital input	1.5	..	..	..
France	no adjustment	1.6	0.9	0.8	0.9
	hours adjusted	2.1	1.1	1.1	1.1
	labour input	1.9	0.7	1.0	0.5
	labour and capital input	1.5	..	..	0.4
Italy	no adjustment	1.2	1.1	0.9	1.1
	hours adjusted	1.5	1.2	1.0	1.2
	labour input	1.4	0.6	0.7	0.5
	labour and capital input	1.3	..	..	0.4
United Kingdom	no adjustment	..	1.2	1.3	1.2
	hours adjusted	..	1.3	1.4	1.3
	labour input	..	0.5	1.2	0.5
	labour and capital input	..	..	..	0.3
Canada	no adjustment	0.3	0.7	0.7	0.8
	hours adjusted	0.4	0.8	0.8	0.8
	labour input	0.4	0.8	0.8	0.8
	labour and capital input	0.2	..	..	0.4

38. A number of assumptions were also made in computing capital stocks by asset, in deriving user costs expressions and in aggregating across assets. For example, particular effort was made to derive a set of internationally harmonised price indices (based on hedonic adjustments) for investment in the asset type 'information and communication technology' (see Schreyer, 2000 for more details).

Table 7. **Estimates of Multi-Factor Productivity growth rates with adjustment for hours worked and input quality changes, 1980-98** (continued)

Average annual growth rates

(based on trend series time varying factor shares)

	Method of estimation	1980[1]-90	1990-98[3]	1995-98[3]
Australia	no adjustment	0.8	2.1	2.1
	hours adjusted	0.9	2.1	2.1
	labour input	0.9	2.0	2.0
	labour and capital input	..	..	..
Austria	no adjustment	1.0	0.6	0.6
	hours adjusted	..	..	..
	labour input	..	..	..
	labour and capital input	..	..	..
Belgium	no adjustment	1.1	0.7	0.6
	hours adjusted	1.4	1.0	0.8
	labour input	..	..	..
	labour and capital input	..	..	..
Denmark	no adjustment	0.6	1.8	1.7
	hours adjusted	1.0	1.8	1.7
	labour input	0.9	1.9	1.6
	labour and capital input	..	..	..
Finland	no adjustment	2.2	3.1	3.5
	hours adjusted	2.4	3.2	3.5
	labour input	2.2	2.8	3.1
	labour and capital input	..	..	..
Greece	no adjustment	0.6	0.3	0.6
	hours adjusted	0.6	0.3	0.6
	labour input	..	..	..
	labour and capital input	..	..	..
Iceland	no adjustment	-0.5	0.4	..
	hours adjusted	..	0.4	..
	labour input	..	..	..
	labour and capital input	..	..	..
Ireland	no adjustment	3.4	3.5	3.2
	hours adjusted	3.9	3.9	3.6
	labour input	3.8	3.6	2.7
	labour and capital input	..	..	..

Table 7. **Estimates of Multi-Factor Productivity growth rates with adjustment for hours worked and input quality changes, 1980-98** (continued)

Average annual growth rates

(based on trend series time varying factor shares)

	Method of estimation	1980[1]-90	1990-98[3]	1995-98[3]
Netherlands	no adjustment	1.1	1.0	0.8
	hours adjusted	2.2	1.7	1.2
	labour input	2.2	1.7	1.2
	labour and capital input	..	..	..
New Zealand	no adjustment	0.6	1.1	..
	hours adjusted	0.7	1.1	..
	labour input	0.6	1.2	..
	labour and capital input	..	..	..
Norway[5]	no adjustment	0.7	1.9	1.6
	hours adjusted	1.1	2.1	1.8
	labour input	0.9	1.9	2.1
	labour and capital input	..	..	..
Portugal	no adjustment	1.7	1.8	..
	hours adjusted	1.9	2.2	..
	labour input	1.9	..	..
	labour and capital input	..	..	..
Spain	no adjustment	1.6	0.6	0.4
	hours adjusted	2.2	0.6	0.4
	labour input	..	..	..
	labour and capital input	..	..	..
Sweden	no adjustment	0.9	1.7	1.7
	hours adjusted	0.8	1.3	1.3
	labour input	0.6	1.0	1.2
	labour and capital input	..	..	..
Switzerland	no adjustment	0.1	-0.1	-0.1
	hours adjusted	..	0.2	0.2
	labour input	..	0.2	-1.4
	labour and capital input	..	..	..

1. 1984 for Denmark, 1986 for New Zealand and Portugal.
2. 1991 for Germany.
3. 1997 for Australia, Belgium, Italy, Norway, Spain and United States, 1996 for Austria, Finland, Greece, Ireland, New Zealand , Sweden and United Kingdom, 1995 for Switzerland, 1992 for Iceland and Portugal.
4. Western Germany before 1991.
5. Mainland only.

Source: Secretariat calculations based on data for the OECD *Economic Outlook* , No 66; national sources, see Annex 2 for details.

36. As can be seen from Table 7 differences attributable to changes in methods of input measurement are significant. The comparison between the second and the third line of Table 7 (the hours adjusted measure of MFP and the human-capital adjusted measure of MFP) shows the effect of changes in the educational composition of employment on the growth residual (shift in the production function). The difference between the two is approximately the contribution of human capital to broadly defined "technological change".[39] A similar argument applies to the comparison between the third and the fourth

39. This is just an approximation because it would be valid strictu sensu only if the contribution of human capital were additively separable. Furthermore, identifying the growth residual with technological progress is legitimate only when all factor inputs are correctly accounted for, and all sectors are operating at maximum efficiency in fully competitive conditions (Solow's assumptions). Under Solow's assumptions "the productivity residual is uncorrelated with any variable that is a driving force for output, provided that

line of Table 7 with respect to the adjustment for changes in the composition of the capital stock (see also Hercowitz, 1998).

37. Comparisons of the different MFP estimates in Table 7 indicate significant variation amongst the G-7 countries. The United States and Canada recorded a recovery in MFP growth that reversed a longstanding downward trend.[40] Conversely, all measures of MFP growth rates decreased significantly in France and Italy. The correction for changes in the composition of labour and capital inputs tends to reduce measured MFP insofar as part of the productivity growth is assigned to improvements in the quality of factors used in the production process (*i.e*. embodied in inputs). Only in a few smaller countries did MFP growth unambiguously and significantly increase in the 1990s compared with the previous decade. Thus, Australia, Denmark, Finland, New Zealand, Norway and Sweden all experienced increases in average growth rates of MFP of at least 0.5 percentage point (in most cases from relatively low rates in the 1980s).

38. It should be stressed that trend series as estimated in this chapter could underestimate the potential pick-up in output and productivity that might have occurred in the most recent years. According to a very recent study (Jorgenson and Stiroh, 2000), the acceleration of MFP in the ICT industry in the second half of the 1990s was sufficiently strong to positively affect the economy-wide MFP growth rate in the United States. Two additional studies (Whelan, 2000; Oliner and Sichel, 2000) also relate the growing utilisation of computer hardware and software to faster aggregate MFP growth in the United States.

2. Income and productivity levels: what is the scope for further catch-up?

2.1 The evolution of income and productivity levels over time

39. From a policy point of view, differences in income levels between countries are also of interest as markedly high or low levels of GDP per capita (and especially productivity) give some indication of how much - or little - extra output can be generated via reforms and policies that lead countries (or sectors) towards "best practice". Put it in another way, comparing output and productivity levels is related to studying the "catch-up" or "convergence" phenomenon, whereby countries with low GDP per capita can be expected to grow faster than high per capita ones, *ceteris paribus*. At least amongst the "old" OECD countries, inter-country differences in GDP per-capita levels are not very large at present relative to

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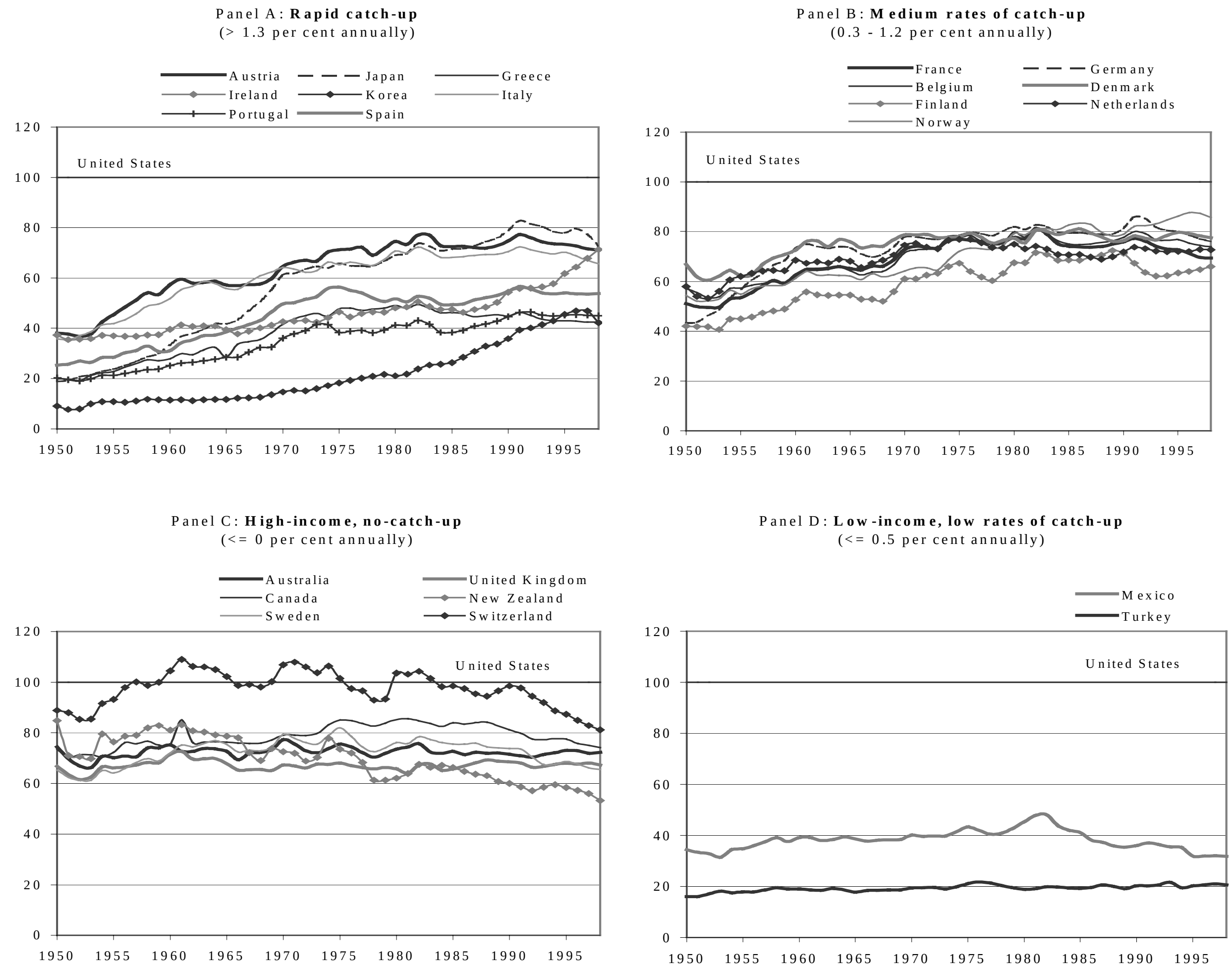
the variable is not one that shifts the production function" (Hall, 1990). However, at least at the industry level the invariance property fails to hold. Hall offers three main explanations for this: 1) monopolistic competition; 2) measurement errors (*e.g.* lack of account for changes in work effort over the cycle); and 3) thick market externalities in expansions. There is not clear-cut evidence on the impact of these factors for the estimates of MFP (*e.g.* Morrison, 1992). In the case of mark-ups of prices over marginal costs, Oliveira Martins and Scarpetta (1999) suggest that the presence of positive and counter-cyclical price margins has only a marginal impact on estimates of MFP growth rates. Another - perhaps more important - reason of failure of the invariance property consists in aggregation biases: from a fully rigorous perspective, the possibility of estimating an aggregate production function is conditional to the fact that the structure of the economy does not change over time (see *e.g.* Pasinetti, 1993). The analysis in Section 3 shows that this assumption fails to hold. However, little economic research has been conducted to understand the direction and size of aggregation biases, let aside how to overcome them (see *e.g.* Forni and Lippi, 1997).

40. Germany also had somewhat higher MFP growth rates based on labour quality adjusted measures in the 1990s compared with the 1980s, although reversion to the mean can be observed in the most recent years. It should be stressed, however, that quality adjusted measures for Germany are somewhat less reliable because reunification implied a slump in input quality at the beginning of the 1990s that was subsequently recovered, without changes of equal magnitude on output.

differences with new Member countries and, especially, with non-OECD countries. Given that OECD countries are open to trade, investment, technology transfer etc., it would be surprising if very large GDP per-capita differentials persisted. Indeed, cross-country differences in GDP per capita and labour productivity across the OECD have eroded considerably since the 1950s (Figure 7 and Table 8). In the 1950s and 1960s, many OECD countries were able to grow rapidly towards the much higher US income levels as they were able to use imported US technologies and knowledge to upgrade their economies (Maddison, 1995). However, the process of convergence in per-capita income slowed down and, as stressed above, the strong GDP performance of the United States in the 1990s meant that in most countries per capita income with respect to the United States was lower in 1998 than in 1985. The convergence of levels of GDP per hour worked shows a slightly different pattern. Out of the 22 OECD countries shown in the table, only two - Mexico and Switzerland - have not had an almost continuous process of catch-up to the US level of productivity over the post-war period. Several European countries are now at par with the United States in terms of average labour productivity and some have even surpassed that level.[41]

Figure 7. **Levels of GDP per Capita, 1950-98, United States=100**



Source: OECD estimates, partly based on Maddison (1995).

41. The table suggests that OECD labour productivity growth is characterised by both β-convergence (the less productive countries grow faster than the most productive country) and σ-convergence (the dispersion of productivity levels across the OECD has declined). See Barro and Sala-i-Martin (1995).

Table 8. **Productivity levels in OECD countries, 1950-98**
(GDP per man-hour relative to the United States)

	1950	1960	1973	1987	1992	1998
United States	100	100	100	100	100	100
Japan	15	20	45	60	67	68
West Germany	34	52	73	91	100	106
Germany	-	-	-	-	87	90
France	42	51	74	99	101	102
Italy	38	46	78	96	97	100
United Kingdom	58	57	68	81	79	82
Canada	68	72	75	83	82	80
Australia	66	68	69	77	75	78
Belgium	50	53	76	102	108	109
Denmark	54	58	79	85	85	89
Finland	32	37	59	69	74	82
Greece	19	n.a.	43	55	54	54
Ireland	32	n.a.	46	66	77	86
Korea	11	n.a.	15	25	32	36
Mexico	35	n.a.	47	n.a.	41	34
Netherlands	49	57	82	98	107	98
Norway	51	n.a.	71	96	104	109
Portugal	20	n.a.	42	44	48	50
Spain	24	n.a.	53	79	80	79
Sweden	50	55	78	84	82	84
Switzerland	70	74	84	85	87	85
Coeff. of variation[1]	50	n.a.	30	26	25	24

1. Excluding Mexico and Germany.

Source: OECD estimates. 1950, 1960 and 1973 extrapolated from Maddison (1991 and 1995).

2.2 Current disparities in income and productivity levels

40. There remains considerable diversity in real per-capita GDP levels across the OECD countries in 1998 (Table 9).[42] The United States is at the top of the OECD income distribution, followed by Norway and Switzerland that have levels of GDP per capita between 80 and 90 per cent of the US level.[43] The bulk of the OECD, including all the other major economies, has income levels that are between 65 and 75 per cent of the US level. Following this group are a number of lower-income economies, including Greece, Korea, Portugal, Spain and New Zealand, some of which have experienced very high growth over the recent period. Turkey, Mexico and two of the former centrally-planned economies (Hungary and Poland) are at the bottom of the OECD income distribution.

41. Differences in income per capita can be attributed to differences in labour utilisation and in GDP per person employed. Table 9 suggests that there are smaller differences in GDP per person employed, and

42. Estimates of labour productivity levels are based on OECD National Accounts data, Labour Force Statistics, estimates of hours worked (see Annex 2) and the 1993 Purchasing Power Parities (PPPs).

43. Table 8 suggests that Luxembourg also has a very high level of income per capita. This is partly due to the large share of frontier workers in total employment (56 000 out of 226 000 in 1997). These contribute to GDP and employment, but are not included in the working-age and total population.

especially per hours worked, across countries than in GDP per capita. This is due to large disparities in participation rates and unemployment rates, while differences in the age composition of the population have a minor role. A number of countries (*e.g.* the Nordic countries, the United States, Japan, Australia, Canada, Portugal, the United Kingdom) have high levels of participation in the labour market amongst those in the working age. By contrast, the low participation rates in others (*e.g.* Belgium, France, Greece, Ireland, Italy and Spain) can by themselves explain more than 10 percentage points gap in their income per capita with respect to the United States. However, the contribution of lower labour utilisation to GDP per capita should not be overemphasised: non-employed people of working age in these countries have generally lower education levels - and thus potential productivity - than those in employment and thus the gap shown in Table 9 is an upper limit to the potential effects of converging to the US level of labour utilisation.[44] Notwithstanding this point, even if labour utilisation in these countries were to increase at half the prevailing productivity level, GDP per capita would still increase substantially.

44. As an illustration, by considering the differences in the education structure of those in employment and those unemployed and the wage structure by education, one can get a first approximation of the potential increase in the GDP per capita by reducing unemployment to 5 per cent of the labour force in all countries. The simulation suggests that GDP per capita could have been from 6 to 7 per cent higher than observed in France, Italy and Ireland in 1995 and between 3 to 4 per cent higher than observed in Germany, Australia and Canada. This is an upper-biased approximation insofar as it does not consider second-order general equilibrium effects stemming from the reaction of productivity and wages to the increase in employment.

Table 9 . **Breakdown of GDP per capita in its components, 1985 and 1998**

	GDP per capita (as % of US)		Total effect of labour utilisation		Effect of working age population (15-64 years) to total population		Effect of participation rate		Effect of unemployment		Effect of working hours		**GDP per hour worked** (as % of US)		**GDP per person employed** (as % of US)	
	(1)		(2) [(3) + (4) + (5) + (6)]		(3)		(4)		(5)		(6)		(7) [(1) - (2)]		(8) [(1) - (3) - (4) - (5)]	
	1985	1998	1985	1998	1985	1998	1985	1998	1985	1998	1985	1998	1985	1998	1985	1998
United States	100	100	0	0	0	0	0	0	0	0	0	0	100	100	100	100
Japan	71	72	13	4	2	3	-2	0	5	1	9	0	58	68	67	69
West Germany	79	76	-11	-30	4	2	-7	-11	-1	-6	-7	-16	90	106	84	90
Germany	-	68	0	-21	-	2	-	-7	-	-4	-	-12	-	90	-	77
France	74	69	-22	-33	-1	-1	-10	-12	-3	-8	-8	-13	96	102	88	89
Italy	68	66	-24	-35	3	3	-16	-18	-3	-9	-8	-10	92	100	84	90
United Kingdom	66	67	-13	-15	-1	-1	0	-2	-3	-1	-9	-11	79	82	69	71
Canada	84	74	-1	-6	2	2	0	-3	-2	-3	-2	-3	85	80	83	77
Australia	73	72	-6	-6	0	1	-4	-3	0	-2	-1	-1	78	78	77	77
Austria	72	71	-4	-21	1	2	-9	-7	4	0	-	-16	-	92	76	76
Belgium	75	74	-25	-35	1	0	-15	-15	-6	-7	-5	-12	100	109	95	97
Czech Republic	-	52	0	2	-	2	-	-3	-	-1	-	5	-	50	-	54
Denmark	80	78	-6	-11	0	1	7	3	0	0	-13	-15	86	89	73	74
Finland	69	66	2	-16	2	1	3	-3	2	-7	-4	-7	66	82	62	75
Greece	46	42	-8	-12	-1	1	-11	-13	1	-3	4	3	54	54	57	57
Hungary	-	40	0	-16	-	1	-	-14	-	-2	-	-1	-	56	-	55
Iceland	79	72	8	2	-3	-1	5	5	6	1	-	-3	-	70	71	67
Ireland	48	71	-18	-14	-5	1	-10	-12	-6	-2	3	-2	66	86	69	84
Korea	26	42	4	7	0	3	-7	-7	2	1	10	9	22	36	32	45
Luxembourg	87	117	-8	0	4	1	-13	8	7	3	-6	-12	96	117	90	105
Mexico	20	17	..	..	-9	-3	..	..	..	..	-	3	-	18	26	21
Netherlands	71	73	-30	-26	2	3	-18	-5	-4	1	-10	-25	101	98	91	73
New Zealand	66	53	-8	-8	-1	0	-9	-4	3	-2	-1	-2	75	61	73	59
Norway	83	86	-14	-23	-3	-2	4	4	4	1	-19	-26	96	109	78	83
Poland	-	34	0	-8	-	1	-	-6	-	-3	-	-	-	-	-	42
Portugal	38	45	-4	-5	-1	1	-3	-1	-1	-2	0	-3	42	50	43	47
Spain	49	54	-29	-25	-1	2	-16	-14	-13	-12	1	-1	79	79	80	78
Sweden	76	66	-7	-19	-2	-3	7	-2	4	-1	-17	-13	82	84	66	71
Switzerland	99	81	12	-4	3	1	2	4	8	2	-	-12	-	85	86	74
Turkey	19	21	-7	-10	-3	-1	-4	-9	0	-1	-	-	-	-	26	31
G7	83	82	-2	-8	1	1	-4	-4	0	-2	0	-4	86	90	86	86
European Union	68	66	-18	-23	1	1	-9	-9	-3	-5	-7	-10	85	89	79	78
Euro area	68	66	-20	-26	1	2	-12	-11	-4	-6	-6	-11	88	92	82	81

Sources : Secretariat calculations based on data for the OECD *Economic Outlook* No 66, *Labour Force Statistics* , hours worked from Annex 2.

Summing up findings from the analysis of aggregate data

42. The analysis of aggregate indicators of economic growth suggest rising disparities across the OECD countries in the 1990s compared with the previous decade as well as persistent differences in per-capita GDP levels. Table 10 focuses on growth dynamics. Amongst the major countries, the United States experienced improving growth performances in the 1990s, in a context of continuously favourable product and labour market conditions. Especially in the most recent years, a combination of positive trends characterises the US economy, including higher growth rates of GDP per capita, employment, labour and, to some extent, multi-factor productivity as well as further capital deepening. These patterns are not uncommon amongst successfully catching-up countries, but unusual for a country that is already at the world productivity frontier in many sectors (see below). Although it is perhaps too early to fully assess structural shifts in growth patterns, these trends may suggest the move towards higher potential growth rates. Box 4 discusses some of the policy factors behind US growth performance.

Box 4. **Features of US growth performance in the 1990s**

An important reason in OECD countries for the renewed interest in economic growth and policies to sustain it, has been the recent growth record of the United States. GDP growth there has exceeded that in the European Union in all but three of the last twenty years, and in Japan in all but three of the last ten years. As a result, U.S. per capita income is now moving even further above that in other OECD countries. The upswing is the longest (although not the strongest) since records began in 1850, and has been accompanied by low inflation rates, falling unemployment, and improving public finances. With the benefit of hindsight, it is clear that the innovation and the extensive spread of new technologies in the fields of information and communication have been a key factor in giving the upswing a new lease of life in recent years, and possibly moving the economy to a new higher potential growth path. These developments are discussed in another box above. But other factors may also have played a role in permitting output and employment to rise smoothly in a sustained fashion for nearly a decade.

Upswings generally peter out, or go into reverse, when the economy comes up against capacity limits, or when investment proves to have been based on too-optimistic demand projections. Thus it was not expected that the US economy would be able to generate substantial increases in employment every year since 1992 without putting strong upward pressure on wages, real and nominal. In the event, employment growth has averaged around 2 per cent annually, similar to the growth in earlier upswings despite slower population growth, since more people were drawn into the labour market (thanks, in part, to welfare reform). Moreover, unemployment has fallen below levels which most analysts would argue are consistent with stable inflation in the medium term. And in fact both nominal and real wages have accelerated in the past few years, but labour productivity has recently accelerated even more, bringing an improvement in profitability and allowing core inflation to remain in a range consistent with price stability objectives, helped by favourable movements in import prices.

Box 4. **Features of US growth performance in the 1990s** (cont.)

This combination of elastic supply response and stable macro conditions raises the question as to what sorts of policies and framework conditions have contributed to bringing it about, and whether strains are building up. Among the factors to consider are the relative importance and roles of:

- strong work incentives in contributing to the rising mobilisation of labour;
- high job-market flexibility in accommodating the considerable changes in the structure of demand for labour, which have not provoked major shortages;
- leaving resource allocation issues in product and financial markets to be handled by the private sector, subject to policies that reduce distortions and spur competition in these markets;
- a legal framework for bankruptcy, competition and securities markets, and low effective marginal tax rates on corporate earnings, in encouraging a strong entrepreneurial tradition;
- monetary and fiscal policies that have allowed the private sector to operate at high capacity, without strains, while maintaining confidence that macro conditions were likely to remain stable.

The challenge for policy currently is to engineer a transition to a more sustainable rate of growth that ensures inflation remains under control while avoiding recession. The continuing large external deficits and build-up of external debt, combined with low household (though not national) savings rates will complicate this task.

43. In some other OECD countries (including Australia, Ireland and the Netherlands and Norway, as well as Canada in most recent years) growth rates of trend GDP per capita, employment and multi-factor productivity have generally accelerated in the 1990s as compared with the previous decade. It is noticeable that these are also the countries that made substantial reforms in their labour and product markets over the past two decades.[45]

45. These countries have all a high record of structural reforms as measured by follow-through of the recommendations of the Jobs Strategy (see OECD, 1999*g*). Moreover, they have all experienced significant improvements in labour market conditions over the 1990s.

Table 10. **Decomposition of growth performance, 1980-98**

(percentage change at annual rate, trend series)

Panel A. **Summary of GDP per capita growth and its components**

	GDP per capita			**Employment**			**Labour productivity** [1]		
	1980-90	1990-98 [2]	1995-98[2]	1980-90	1990-98[3]	1995-98[3]	1980-90	1990-98[3]	1995-98[3]
United States	2.0	2.2	2.7	1.8	1.4	1.6	1.1	1.7	1.9
Japan	3.3	1.6	1.1	1.2	0.6	0.3	2.6	1.3	1.1
Germany[4]	1.9	0.9	1.2	0.6	-0.6	-0.5	1.6	1.9	1.9
France	1.6	1.2	1.3	0.2	0.2	0.3	1.9	1.4	1.4
Italy	2.3	1.3	1.2	0.2	-0.4	-0.2	2.2	1.9	1.6
United Kingdom	2.2	1.8	2.2	0.5	0.4	0.7	1.9	1.8	1.9
Canada	1.5	1.2	2.0	1.7	1.2	1.6	1.0	1.1	1.1
Australia	1.6	2.4	2.7	2.0	1.5	1.7	1.2	2.0	2.3
Austria	2.1	1.7	2.0	0.3	0.4	0.1	2.0	1.8	2.0
Belgium	1.9	1.7	1.9	0.2	0.2	0.3	1.8	1.7	1.7
Denmark	2.0	2.1	2.4	0.5	0.1	0.7	1.5	2.4	2.2
Finland	2.2	1.3	2.7	0.2	-1.1	0.2	2.4	2.9	2.8
Greece	1.3	1.3	1.9	0.8	0.7	0.8	0.9	1.0	1.2
Ireland	3.0	5.6	6.3	-0.1	3.0	4.0	3.5	3.2	3.2
Luxembourg	4.0	4.0	3.8	1.7	2.9	2.9	2.8	2.4	2.0
Netherlands	1.6	2.1	2.3	1.0	1.9	2.0	1.1	0.8	0.8
New Zealand	1.2	0.8	1.4	0.3	1.9	2.3	1.6	0.4	0.3
Norway[5]	1.4	2.2	2.7	0.6	0.9	1.7	1.1	1.7	1.5
Portugal	2.9	2.5	2.3	1.3	0.9	1.0	1.6	1.7	1.5
Spain	2.3	2.2	2.4	0.3	0.7	1.1	2.4	1.7	1.4
Sweden	1.5	0.9	1.7	0.3	-1.1	-0.7	1.6	2.4	2.4
Switzerland	1.6	0.1	0.5	1.7	0.4	0.2	0.4	0.4	0.6
Variability of growth rates [6] *:*									
EU15	0.7	1.2	1.3	0.5	1.2	1.3	0.6	0.6	0.6
OECD24[7]	0.7	1.1	1.2	0.7	1.1	1.1	0.7	0.7	0.7

Table 10. **Decomposition of growth performance, 1980-98** (continued)

(percentage change at annual rate, trend series)

Panel B. **Summary of business sector GDP growth and its components**

	GDP			Employment			Labour productivity [1]			Capital deepening [8]			MFP		
	1980-90	1990-98[9]	1995-98[10]	1980-90	1990-98[9]	1995-98[10]	1980-90	1990-98[9]	1995-98[10]	1980-90	1990-98[11]	1995-98[12]	1980-90	1990-98[11]	1995-98[12]
United States	3.1	3.3	3.8	2.0	1.9	2.2	1.1	1.4	1.6	1.1	0.6	1.0	0.8	1.1	1.1
Japan	4.0	2.5	2.2	1.3	0.6	0.3	2.7	1.8	1.9	4.9	4.7	4.4	1.6	0.7	0.8
Germany[4]	2.3	1.6	1.7	0.5	-0.5	-0.3	1.8	2.1	2.0	2.9	3.7	3.1	1.1	1.0	1.1
France	2.3	1.7	1.8	-0.2	0.0	0.2	2.4	1.7	1.6	2.3	2.3	2.3	1.6	0.9	0.8
Italy	2.5	1.7	1.7	0.5	-0.6	-0.6	2.0	2.3	2.3	2.7	3.5	3.4	1.2	1.1	0.9
United Kingdom	3.0	2.1	2.3	0.6	0.6	0.7	2.3	1.5	1.6	1.8	1.2	1.0	..	1.2	1.3
Canada	2.8	2.5	3.1	1.7	1.4	2.0	1.1	1.1	1.1	1.8	0.9	1.4	0.3	0.7	0.7
Australia	3.5	4.1	4.6	2.1	1.8	2.1	1.4	2.2	2.5	1.5	0.1	0.9	0.8	2.1	2.1
Austria	2.3	2.4	2.2	0.0	0.4	0.1	2.4	2.0	2.1	4.0	4.7	5.0	1.0	0.6	0.6
Belgium	2.1	2.0	1.9	0.0	0.4	0.5	2.1	1.5	1.4	3.1	3.0	2.7	1.1	0.7	0.6
Denmark	2.0	2.9	3.4	0.3	0.0	0.6	1.7	2.9	2.8	3.4	2.8	2.6	0.6	1.8	1.7
Finland	2.6	2.1	3.6	-0.7	-1.9	-0.4	3.4	4.0	3.9	4.1	2.8	1.2	2.2	3.1	3.5
Greece	1.6	1.8	2.2	0.5	0.7	0.8	1.1	1.1	1.4	2.7	1.8	1.6	0.6	0.3	0.6
Ireland	4.0	6.6	7.4	-0.1	3.4	4.5	4.2	3.2	2.8	2.4	-0.1	-0.4	3.4	3.5	3.2
Netherlands	2.2	3.0	3.0	0.7	1.7	1.8	1.4	1.3	1.2	2.7	1.6	1.6	1.1	1.0	0.8
New Zealand	1.6	3.0	3.6	0.4	2.3	2.8	1.2	0.6	0.7	1.7	-1.1	..	0.6	1.1	..
Norway[5]	1.4	2.6	3.4	0.0	0.4	1.5	1.4	2.2	1.9	3.4	1.6	1.7	0.7	1.9	1.6
Portugal	2.7	2.4	..	0.8	0.2	..	1.9	2.2	..	2.9	..	..	1.7	1.8	..
Spain	2.4	2.3	2.5	-0.3	0.5	1.1	2.7	1.8	1.4	4.8	3.8	2.8	1.6	0.6	0.4
Sweden	2.0	1.6	2.0	0.2	-1.2	..	1.8	2.8	3.0	2.6	2.4	2.7	0.9	1.7	1.7
Switzerland	2.2	0.8	..	1.3	-0.1	..	0.9	0.9	..	..	3.5	..	0.1	-0.1	-0.1
Variability of growth rates [6] *:*															
EU15[13]	0.6	1.3	1.5	0.4	1.3	1.4	0.8	0.8	0.8	0.8	1.3	1.3	0.8	1.0	1.0
OECD24[14]	0.7	1.2	1.4	0.8	1.2	1.3	0.8	0.8	0.8	1.1	1.6	1.3	0.7	0.9	0.9

1. GDP per employee.
2. 1991-97 for Portugal, 1991-98 for Germany.
3. 1991-97 for Greece and Portugal, 1991-98 for Germany.
4. Western Germany for 1980-90.
5. Mainland only.
6. As measured by the standard deviation.
7. Excluding Czech Republic, Hungary, Iceland, Korea, Mexico, Poland and Turkey.
8. Growth of capital/labour ratio, adjusted for hours worked.
9. 1990-97 for Austria, Belgium, Ireland, Italy, Japan, New Zealand and Sweden, 1990-95 for Portugal and Switzerland, 1990-96 for United Kingdom, 1991-98 for Germany.
10. 1995-97 for Austria, Belgium, Greece, Ireland, Italy, Japan, New Zealand and Sweden, 1995-96 for United Kingdom.
11. 1990-97 for Australia, Belgium, Canada, Italy, Japan, Norway, Spain and United States, 1990-96 for Austria, Finland, Greece, Ireland, Sweden and United Kingdom, 1990-95 for New Zealand and Switzerland, 1990-92 for Portugal, 1991-98 for Germany.
12. 1995-97 for Australia, Belgium, Canada, Italy, Japan, Norway, Spain and United States, 1995-96 for Austria, Finland, Greece, Ireland, Sweden and United Kingdom.
13. Excluding Luxembourg.
14. Excluding Czech Republic, Hungary, Iceland, Korea, Luxembourg, Mexico, Poland and Turkey.

Source: Secretariat calculations based on data for the OECD *Economic Outlook*, No 66; national sources, see Annex 2 for details.

44. In the other countries, growth performance did not change significantly in the 1990s, and in some cases deteriorated. Amongst those with low per-capita income levels, Portugal and Turkey continued to grow at relatively high (and stable) rates and Greece maintained relatively low growth rates. In most Continental Europe, growth rates of per-capita GDP did not improve either because of clear slow down in productivity or, more often, because of sluggish employment developments. In these countries, the up-skilling of the workforce has accounted for most of the changes in labour input and thus for most of the contribution of labour to output growth, while the skill upgrading has gone hand in hand with growth in employment in other countries. The significant slow-down in the growth rate of GDP per capita in Japan has been accompanied by relatively smaller employment adjustments leading to declines in labour productivity growth rates.

3. Growth performance at the sectoral level

45. The aggregate analysis of growth performance may hide significant differences in growth trends across sectors and firms (see, amongst others, Bernard and Jones, 1996*a*, 1996*b*). The investigation of sectoral trends helps to throw further light on the growth process and the factors that drive it, and may also be important in the assessment of policies that can support growth (amongst others, see Haltiwanger, 1997). In particular, it allows assessing whether differences in the link between GDP growth, labour productivity and employment across countries are the result of aggregation of different sectoral patterns within each country or rather similar patterns across sectors. Differences in growth patterns at the sector level may also point to variations in the extent to which countries are benefiting from broader economic changes or the potential offered by technological change (Stoneman and Diederen, 1994). For example, technological change has enabled rapid productivity growth in telecommunications over recent years, but there are considerable variations in the degree to which countries have benefited from this potential. Detailed information on differences in sectoral productivity performances across countries also helps understanding the role of competition policies and privatisation in a variety of industries (*e.g.* telecommunication, airline, electricity, etc.) (see OECD, 1997).

46. The analysis of sectoral performances and their contribution to aggregate growth patterns is organised as follows. After a brief discussion of growth patterns across broad sectors of the economy, this section analyses within-industry productivity performance to shed light on the driving forces of recent growth patterns at the aggregate levels. This is followed by the assessment of structural shifts and their role to overall productivity patterns. Although significant changes have occurred both *within* and *between* industries over the past decade, aggregate performances are also affected by persistent differences across countries in industry productivity levels. These are discussed in the final part of this section.

3.1 The breakdown of growth and labour productivity change by sector

47. Productivity measurement at the sector level is constrained by the degree of detail and by measurement problems, in particular in services.[46] The productivity analysis below focuses on the *non-farm business sector* (*i.e.* excluding agriculture and community, social and personal services). Moreover, the sectoral decomposition of productivity does not take into account sectoral interactions due to the role that goods and services of some sectors play in the production process of other sectors and *vice versa*. Bearing these caveats in mind, a sectoral decomposition of labour productivity growth indicates that

46. As stressed in Annex 2, industry data used in this paper are from the OECD International Sectoral Data Base (ISDB) and the OECD STAN Database for Industrial Analysis. Industry disaggregation is available for the service sector at 2 digits (or even 1 digit for some services in some countries) which significantly affect the analysis of structural changes.

the manufacturing sector plays a more important role than services in terms of productivity growth, because output growth has been associated with stagnant or falling employment (Table 11). Indeed, around half of productivity growth over 1990-97 in the non-farm business sectors of several countries, including most of the major economies, was due to the manufacturing sector.[47]

Table 11. **Industry contributions to labour productivity growth in the non-farm business sector**
Percentage changes, 1979-90 and 1990-98

	Australia		Canada		Finland		France	
Industry (ISIC Rev.2)	1979-90	1990-98	1979-90	1990-98	1979-90	1990-98	1979-90	1990-98
2000 Mining and quarrying	0.2	0.2	0.0	0.3	0.0	0.0	0.0	0.0
3000 Total manufacturing industry	0.4	0.4	0.5	0.4	1.5	2.1	0.9	1.0
4000 Electricity, gas, water	0.2	0.2	0.1	0.1	0.1	0.2	0.1	0.1
5000 Construction	0.1	0.1	0.1	0.0	0.2	0.3	0.3	0.1
6000 Wholesale and retail trade, restaurants and hotels	-0.2	0.2	-0.2	0.1	0.4	0.4	0.2	0.1
6120 Wholesale and retail trade	-	-	0.0	0.3	0.3	0.3	0.3	0.1
6300 Restaurants and hotels	-	-	-0.2	-0.1	0.0	0.1	0.0	0.0
7000 Transports, storage, and communications	0.3	0.6	0.3	0.2	0.3	0.5	0.3	0.2
7100 Transport and storage	0.1	0.2	-	0.0	0.2	0.3	0.1	0.1
7200 Communication services	0.2	0.3	-	0.2	0.1	0.2	0.2	0.1
8000 Finance,insurance,real estate, & business services	0.5	0.5	0.4	0.3	0.6	0.7	0.5	0.2
8120 Financial institutions and insurance	-	-	-	0.2	0.2	0.3	0.0	-0.1
8300 Real Estate and business services	-	-	-	0.1	0.3	0.4	0.5	0.3
Non-farm business sector excl. non-market services	**1.4**	**2.2**	**1.2**	**1.4**	**3.1**	**4.1**	**2.2**	**1.7**

	Italy		Japan		United States		Western Germany	
Industry (ISIC Rev.2)	1979-90	1990-98	1979-90	1990-98	1979-90	1990-98	1979-90	1990-98
2000 Mining and quarrying	-	-	0.0	0.0	0.1	0.1	0.0	0.0
3000 Total manufacturing industry	1.4	0.9	1.3	0.6	0.8	0.8	0.6	1.1
4000 Electricity, gas, water	0.0	0.2	0.1	0.1	0.1	0.1	0.1	0.0
5000 Construction	0.1	0.0	0.3	-0.2	-0.1	0.0	0.1	0.0
6000 Wholesale and retail trade, restaurants and hotels	0.0	0.4	0.7	0.1	0.0	0.5	0.0	-0.1
6120 Wholesale and retail trade	0.1	0.3	-	-	0.0	0.5	0.1	-
6300 Restaurants and hotels	0.0	0.0	-	-	0.0	0.1	-0.1	-
7000 Transports, storage, and communications	0.1	0.4	0.3	0.0	0.1	0.2	0.2	0.3
7100 Transport and storage	0.1	0.2	-	-	0.0	0.1	0.1	0.1
7200 Communication services	0.1	0.3	-	-	0.1	0.1	0.1	0.2
8000 Finance,insurance,real estate, & business services	0.1	0.2	0.9	0.3	0.2	0.3	0.5	0.6
8120 Financial institutions and insurance	-	-	-	-	0.0	0.1	-	-
8300 Real Estate and business services	-	-	-	-	0.2	0.1	-	-
Non-farm business sector excl. non-market services	**1.8**	**2.1**	**3.6**	**0.6**	**1.2**	**1.7**	**1.5**	**2.1**

Sources: ISDB and STAN databases.

48. While certain services sectors made important contributions in some countries, the overall contribution of market services to labour productivity growth remains quite limited in many countries.

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47. Within manufacturing, non-electrical machinery (which includes computers in some countries) and electrical machinery (which includes telecommunications equipment and semiconductors) have been an important source of productivity growth, especially in the United States as well as Finland and Sweden. Previous OECD work suggested that these productivity patterns were linked to the industrial specialisation of OECD countries in certain fields (OECD, 1998*d*). It should be noted that the large contribution of electrical and non-electrical machinery in some countries is partly linked to the use of hedonic price indices for computer equipment and for semiconductors (see below). Moreover, the gap between manufacturing and service productivity performance may - to a limited extent - be due to an increase in outsourcing (Fixler and Siegel, 1999). This may have temporarily increased the demand for certain services, thus leading to a decline in productivity performance.

However, slow productivity growth in services masks a wide variety of experiences and is also influenced by measurement problems. In some services, such as distribution, telecommunications, and parts of the financial services industry, technological change has enabled significant improvements in productivity, although this is not always reflected in the official productivity statistics.[48]

3.2 The determinants of labour productivity growth

49. Industry level data allow a finer analysis of growth determinants over the past decade along two complementary dimensions. First, the contribution of each industry to overall productivity growth rate is assessed and compared across countries. This analysis addresses the question as to whether the driving forces of growth manifest themselves in the same way across countries. Second, within each country, it is important to identify how productivity performances have been obtained. In particular, are disparities in labour productivity growth rates across industries related to disparities in R&D intensity, differences in employment growth and upskilling?

50. Table 12 suggests that, in spite of differences in the economic structure of OECD countries, there is a relatively high (rank) correlation in the industry contribution of aggregate labour productivity growth rates, that is to say, across countries the same industries provided the major direct contributions to overall growth.[49] The rank correlations of industry contributions are somewhat stronger amongst the G7 countries than amongst small economies.[50] There is also only moderate sign of a fall in the strength of cross-country correlations of industry contributions from the 1980s to the 1990s. Similar conclusions could be drawn by looking at industry contributions within the manufacturing sector (Table 13), with some important qualifications: in particular, the bivariate correlations of industry contributions in Germany and Italy with those of the other G7 countries have declined over the past decade as compared to the 1980s. While for Germany this could be partially explained by the significant change in the industry composition of manufacturing sector in the aftermath of the reunification, the explanation for Italy is less clear-cut.

48. For several sectors, measurement problems obscure a substantial part of the productivity gains (Gullickson and Harper, 1999). Fixler and Zieschang (1999), for example, derive new output measures for the US financial services industry (*i.e*. depository institutions). They introduce quality adjustments to capture the effects of improved service characteristics, such as easier and more convenient transactions and intermediation. The output index calculated in this study grew by 7.4 per cent a year between 1977 and 1994, well above the GDP measure for this sector that grew only by 1.3 per cent a year on average. The recent revisions of GDP growth by the US Department of Commerce incorporate improved estimates of the real value of unpriced banking services, thus better capturing productivity growth in this industry (Moulton, Parker and Seskin, 1999; BEA, 1999).

49. The industry’s contribution to aggregate labour productivity growth rate is the difference between its contribution to aggregate output growth and its contribution to aggregate growth of labour input. The contribution to the growth of output is measured as the industry's output growth multiplied with the industry's share in overall output. Similarly, an industry's contribution to aggregate labour input growth is measured as the growth of labour input in a particular industry times that industry's share in overall labour input. The table reports Spearman rank correlations.

50. In the G7 countries, some manufacturing industries such as fabricated metals, electrical machinery, radio, TV and communications, accounted for a large fraction of the total increase in productivity over the 1990s. In the service sector, finance, insurance and business services as well as wholesale and retail trade played a major role in measured productivity increases.

Table 12. **Cross-country rank correlations of industry contributions to labour productivity growth**

non-farm business sector.

1979-98	United States	Japan	Germany	France	Italy	Canada	Australia	Finland
United States	1.00							
Japan	0.42 **	1.00						
Germany	0.55 **	0.48 **	1.00					
France	0.52 **	0.60 **	0.78 ***	1.00				
Italy	0.59 **	0.29	0.72 ***	0.82 ***	1.00			
Canada	0.55 **	0.16	0.58 **	0.70 ***	0.68 ***	1.00		
Australia	0.23	0.13	0.46 **	0.55 **	0.54 **	0.61 **	1.00	
Finland	0.46 **	0.37 *	0.54 **	0.61 ***	0.60 **	0.32	0.42 **	1.00

1990-98	United States	Japan	Germany	France	Italy	Canada	Australia	Finland	Netherlands
United States	1.00								
Japan	0.69 ***	1.00							
Germany	0.62 ***	0.59 **	1.00						
France	0.37 **	0.23	0.37 *	1.00					
Italy	0.45 **	0.33	0.48 **	0.56 **	1.00				
Canada	0.66 ***	0.45 **	0.48 **	0.39 **	0.52 **	1.00			
Australia	0.27	-0.22	0.18	0.50 **	0.44 **	0.47 **	1.00		
Finland	0.45 **	0.03	0.15	0.56 **	0.45 **	0.24	0.64 ***	1.00	
Netherlands	0.24	0.21	0.22	0.35 *	0.28	0.38 **	0.33	0.13	1.00

* Correlation is significant at the 10% level.

** Correlation is significant at the 5% level.

*** Correlation is significant at the 1% level.

Sources : Secretariat calculations based on ISDB and STAN databases.

Table 13. **Cross-country rank correlations of industry contributions to labour productivity growth manufacturing.**

1979-98	United States	Japan	Germany	France	Italy	United Kingdom	Canada	Australia	Finland	Netherlands	Norway	Sweden
United States	1.00											
Japan	0.54 **	1.00										
Germany	0.70 ***	0.42 *	1.00									
France	0.62 **	0.50 **	0.77 ***	1.00								
Italy	0.37	0.36	0.72 ***	0.87 ***	1.00							
United Kingdom	0.43 *	0.33	0.62 **	0.82 ***	0.60 **	1.00						
Canada	0.51 **	0.15	0.72 ***	0.66 **	0.55 **	0.57 **	1.00					
Australia	0.04	0.02	0.38 *	0.36	0.49 **	0.50 **	0.40 *	1.00				
Finland	0.43 **	0.28	0.44 **	0.61 **	0.59 **	0.41 *	0.26	0.30	1.00			
Netherlands	0.24	-0.15	0.25	0.38 *	0.47 **	0.39 *	0.32	0.24	0.53 **	1.00		
Norway	0.33	0.13	0.41 *	0.45 **	0.35	0.28	0.30	0.17	0.69 ***	0.51 **	1.00	
Sweden	0.52 **	0.44 *	0.65 **	0.80 ***	0.76 ***	0.63 **	0.54 **	0.48 **	0.80 ***	0.45 **	0.56 **	1.00

1990-98	United States	Japan	Germany	France	Italy	United Kingdom	Canada	Australia	Finland	Netherlands	Norway	Sweden
United States	1.00											
Japan	0.71 ***	1.00										
Germany	0.61 **	0.62 **	1.00									
France	0.46 **	0.33	0.39 *	1.00								
Italy	0.12	0.13	0.32	0.50 **	1.00							
United Kingdom	0.46 **	0.38 *	0.21	0.65 **	0.29	1.00						
Canada	0.48 **	0.46 **	0.39 *	0.42 *	0.26	0.63 **	1.00					
Australia	0.01	-0.21	0.06	0.34	0.30	0.23	0.38 *	1.00				
Finland	0.32	0.06	0.14	0.51 **	0.48 **	0.20	0.14	0.59 **	1.00			
Netherlands	0.29	0.13	0.03	0.35	0.20	0.59 **	0.39 *	0.16	0.29	1.00		
Norway	0.23	0.23	0.14	0.50 **	0.21	0.22	0.11	0.20	0.49 **	0.03	1.00	
Sweden	0.48 **	0.25	0.45 **	0.73 ***	0.36	0.48 **	0.37 *	0.62 **	0.73 ***	0.23	0.48 **	1.00

* Correlation is significant at the 10% level.
** Correlation is significant at the 5% level.
*** Correlation is significant at the 1% level.
Sources : Secretariat calculations based on ISDB and STAN databases.

51. The high correlation in industry contribution (especially in manufacturing) seems to point to some communality in the sources of growth amongst the OECD countries. The somewhat weaker correlations amongst small economies reflect their narrower specialisation, especially in manufacturing (Pilat, 1996). However, rank correlations of industry contributions to labour productivity growth in different countries may hide significant differences in the dynamics of specific industries.[51] This seems to be the case for the *information and communication technology industry*. For example the aggregate industry comprising the *office and computing machinery* industry (ISIC 3825) plus the *Radio, TV & communication equipment* industry (ISIC 3823)[52] enjoyed a productivity growth above 10 per cent on average in the United States in 1990-97 period (as compared with 2.3 per cent on average in the manufacturing sector) and accounted for about 40 per cent of total manufacturing productivity growth. International comparisons of the contribution of ICT industry to manufacturing productivity growth is somewhat limited by the fact that some countries, including the United States, use hedonic price deflators for computers and others do not and this is likely to have a significant impact on measured productivity in

51. In particular, the variability of labour productivity growth rates across industries has increased markedly in the United States, driven by sharp increase in productivity in the ICT industry, but remained fairly constant in most other OECD countries, and even fell in some countries, including Japan, Italy and the United Kingdom. See below for further detail.

52. The OECD definition of the ICT industry includes “those industries which facilitate, by electronic means, the processing, transmission and display of information. See http://www.oecd.org/dsti/sti/it/stats/defin.htm.

the industry.[53] Available data suggest that, although generally higher than the manufacturing average, labour productivity growth rates of ICT industry have been smaller in most of the other OECD countries as compared with the United States, and particularly so in some of the countries with low productivity growth in the whole manufacturing sector, such as Italy.

52. Within each country, there is evidence that labour productivity growth rates have been associated with various experiences concerning labour utilisation, changes in quality of inputs, capital deepening and the growth rate of technological change (see above). At the industry level, three indicators are available to shed further light on productivity differences within countries; i) R&D intensity (expressed as the ratio of R&D expenditure to output); ii) employment adjustments; and iii) skill up-grading. These three factors are closely related. R&D intensity in manufacturing provides an - albeit limited - indicator of the capacity of firms to discover and implement new ideas and production technologies as well as of their effort towards technological improvement[54], while employment and up-skilling characterise changes in labour input.

53. Table 14 presents weighted correlation coefficients of changes in labour productivity growth rates with these three factors, in turn.[55] It points to a generally positive correlation between R&D intensity and labour productivity growth at the industry level in almost all OECD countries. This relationship has a limited statistical significance for contemporaneous R&D intensity, but it is more significant when a lagged indicator of R&D intensity is used.[56] This is suggestive of an impact from R&D in particular, and technological change in general, on labour productivity growth as would be expected.

53. The use of hedonic price deflators tends to boost the contribution of the ICT industry in two ways: i) it raises its value added compared with that of other industries; and ii) lowers the value added in industries which use ICT products (*e.g.* semiconductors) as intermediate inputs. As a thought experiment, real value added in the US computer-producing industry (Office and computing machineries; ISIC 3825) was re-calculated using conventional “matched model” deflators approximated by means of a price index for Germany that does not employ hedonic techniques. This provides only a very rough indication of the effects of hedonic techniques for two main reasons: 1) the product composition of the computer industry can be quite different between the United States and Germany; and 2) the true price can differ, because of differences in market structures and other factors. Bearing in mind these limitations, the results of the simulation suggest a significantly smaller contribution of the computer-producing industry to manufacturing value added and labour productivity when quality changes (as measured by the hedonic method) in computers and semiconductors are not taken into account.

54. Many studies find that research and development expenditures provide a positive contribution to productivity growth. However, technology diffusion from other industries is also a major source of productivity gains (these two components are mutually interdependent and, in practice, their independent contribution cannot be fully disentangled, see Cohen and Levinthal, 1989; Cockburn and Henderson, 1998; Mowery and Oxley, 1995). Likewise, importing modern technologies from abroad is increasingly driving productivity growth. See, amongst others, OECD (1996*c*).

55. As compared with simple correlations, weighted correlations allow to consider differences in industry size and thus provide information that is representative of aggregate phenomena. Employment shares were used as weights.

56. The rationale of using lagged indicators of R&D intensity is that most R&D expenditure represents a long-run investment deemed to produce results in the far future in terms of productivity changes.

Table 14. **Labour productivity, employment, up-skilling and R&D intensity at the industry level**
Non-farm business sector and manufacturing

	Weighted correlation[1] of industry labour productivity growth with:											
	R&D intensity, manufacturing, 1990-97				**Employment growth, 1990-97**				**Skill-upgrading, 1981-95 [2]**			
	Lagged R&D[3]		**Contemporaneous R&D[3]**		**Non-farm business sector[4]**		**Manufacturing**		**Non-farm business sector[4]**		**Manufacturing**	
	Correlation	t-statistics	Correlation	t-statistics	Correlation	t-statistics	Correlation	t-statistics	Correlation	t-statistics	Correlation	t-statistics
United States	0.54	2.67 ***	0.28	1.18	-0.29	-1.65 *	0.16	0.71	0.34	1.87 *	0.32	1.43
Japan	0.82	6.13 ***	0.72	4.44 ***	-0.23	-1.22	-0.06	-0.26	0.02	0.09	0.25	1.03
West Germany	0.21	0.93	0.18	0.76	-0.54	-3.36 ***	-0.44	-2.16 **	0.33	1.60	0.51	2.21 **
France	0.44	2.07 **	0.43	2.04 **	-0.42	-2.52 **	0.10	0.45	0.42	2.43 **	0.61	3.27 ***
Italy	0.17	0.73	0.16	0.67	-0.59	-3.77 ***	-0.39	-1.89 *	0.36	1.86 *	0.46	2.22 **
United Kingdom	0.60	3.18 ***	0.60	3.19 ***	..	..	-0.22	-1.02	..	..	0.06	0.25
Canada	0.48	2.31 **	0.46	2.20 **	-0.35	-2.03 **	-0.15	-0.68	..	..	..	..
Australia	0.42	1.97 **	0.36	1.65 *	-0.53	-3.29 ***	-0.45	-2.25 **	0.71	4.89 ***	0.30	1.26
Austria	..	..	..	..	-0.59	-3.54 ***	-0.02	-0.06	..	..	..	..
Belgium	..	..	..	..	-0.47	-2.52 **	-0.31	-1.24	..	..	..	..
Denmark	0.11	0.43	0.12	0.45	-0.32	-1.81 *	-0.23	-1.02	..	..	..	..
Finland	0.16	0.68	0.17	0.71	-0.04	-0.20	-0.04	-0.18	0.28	1.52	0.66	3.77 ***
Mexico	..	..	..	..	-0.78	-6.45 ***	-0.62	-3.48 ***	..	..	..	..
Netherlands	-0.10	-0.40	-0.04	-0.16	-0.79	-6.87 ***	-0.77	-5.48 ***	..	..	..	..
Norway	-0.01	-0.03	0.15	0.66	..	..	-0.74	-4.85 ***	..	..	..	..
Portugal	..	..	..	..	-0.47	-2.51 **	-0.11	-0.46	..	..	..	..
Spain	0.56	2.88 ***	0.28	1.22	-0.39	-2.22 **	-0.06	-0.25	..	..	..	..
Sweden	0.36	1.66 *	0.33	1.50	-0.23	-1.25	-0.34	-1.61	..	..	..	..
Switzerland[5]	..	..	..	..	-0.08	-0.24	0.54	1.68	..	..	..	..
Turkey	..	..	..	..	-0.76	-2.63 ***	..	..	..	..	..	..

* Correlation is significant at the 10% level.
** Correlation is significant at the 5% level.
*** Correlation is significant at the 1% level.

1. Weighted with industry's share in total employment.
2. See notes to figure 9 for details about differences in period covered.
3. Lagged R&D refers to average R&D intensity in the 1980-89 period; contemporaneous R&D refers to average R&D intensity in the 1990-97 period.
4. 1990-94 only in the service sector for Spain, Sweden and Turkey, 1990-93 only in the service sector for Portugal.
5. Non-farm business sector for Switzerland does not consider Transport, storage, and communications, Wholesale & retail trade, restaurants and hotels, and Finance,insurance, real estate & business services.

Source: Secretariat calculations, based on ISDB and STAN databases.

54. Table 14 also shows a generally positive correlation between skill-upgrading[57] and labour productivity growth across OECD countries, both in manufacturing and in the non-farm business sector as a whole. However the correlations are not strong across the economy as a whole and even in manufacturing, outside Continental Europe. The correlations between changes in labour productivity and employment changes are negative and strongly significant, especially across the whole non-farm business sector. Labour productivity growth across sectors have been mainly driven by employment adjustments, with some high productivity-growth industries reducing employment and some low productivity-growth industries, especially in the service sector, increasing it. Within manufacturing, the relationship between labour productivity and employment is relatively weaker because the quality of labour input is more important, *i.e.* skill-biased employment adjustment has been at work in firms recording comparatively strong productivity increases. These patterns are more clearly identified in Continental Europe where, as stressed before, aggregate employment trends have been sluggish, and skill-biased employment adjustments strong. In the United States and to some extent in Japan amongst the major economies, labour productivity improvements have not been necessarily driven by (selective) dismissals but, especially within

57. Given data availability at the industry level, the skill-upgrading is defined as the increase in the proportion of high-skilled white-collar workers in total employment. Data on occupation (ISCO88) are aggregated in the following way: A) White-collar high-skill: Legislators, senior officials and managers (Group 1), Professionals (Group 2), Technicians and associate professionals (Group 3). B) White-collar low-skill: Clerks, service workers (Group 4), shop & sales workers (Group 5). C) Blue-collar high-skill: Skilled agricultural and fishery workers (Group 6), Craft & related trade workers (Group 7). D) Blue-collar low-skill: Plant & machine operators and assemblers (Group 8), Elementary occupations (Group 9). For more details see Colecchia, Papaconstantinou (1996) and OECD (1998*g*).

manufacturing, by strong technological innovation and have sometimes been accompanied by positive employment changes.

3.3 Structural changes and labour productivity growth

55. Aggregate productivity growth patterns depend on within industry productivity performance as well as shifts of resources across industries. Historically, structural shifts were an important factor, as resources moved from a low-productive agricultural sector to a more productive manufacturing sector. More recently, the evidence from aggregate data seems to suggest that a large contribution to overall productivity growth patterns comes from productivity changes within industries rather than as a result of significant shifts of employment across industries (van Ark, 1996). Evidence from firm-level data partly confirm this finding of a strong *within-firm* effect, but also point to churning (entry and exit of firms) as an important component of productivity growth at the industry and possibly at the aggregate level (for a survey, see Foster *et al.*, 1998).[58] For the purpose of an international comparison, Figure 8 presents a decomposition of labour productivity growth in the business sector in three factors using the maximum industry decomposition available in ISDB-STAN (2-digit ISIC for services and a 3-4 digit ISIC for manufacturing):[59]

- An “intra-sectoral effect”, that measures productivity growth within industries;
- A “net-shift effect”, that measures the impact on productivity of the shift in employment between industries;
- And a residual third effect, the “interaction effect”. This effect is positive when sectors with growing productivity have a growing employment share or when industries with falling relative productivity decline in size. It is negative when industries with growing relative productivity decline in size or when industries with falling productivity grow in size.

58. Evidence from firm-level data also suggests that changes in market shares of individual firms within a given industry and other competitive effects can make an important contribution to growth at the industry level (OECD, 1998*a*). For US manufacturing, such competitive effects explained over 40 per cent of total factor productivity growth between 1977 and 1987 (Haltiwanger, 1997). A future paper in the OECD work on economic growth will look specifically at firm-level patterns. This will build on previous work on longitudinal databases (OECD, 1998*a*).

59. The shift-share analysis presented has limitations other than the lack of detail for services (Timmer and Szirmai, 1999). First, it focuses on labour productivity, and not on multi-factor productivity. Second, it assumes that marginal productivity of factor inputs moving in or out an industry is the same as average productivity. Finally, if output growth is positively related to productivity growth (the Verdoorn effect), the impact of structural change may be underestimated, since part of the shift to rapid-growth sectors will be counted in the within-effect.

Figure 8. **Breakdown of compound growth rate of labour productivity into intrasectoral productivity growth and intersectoral employment shifts**
Panel A. **Non-farm business sector**

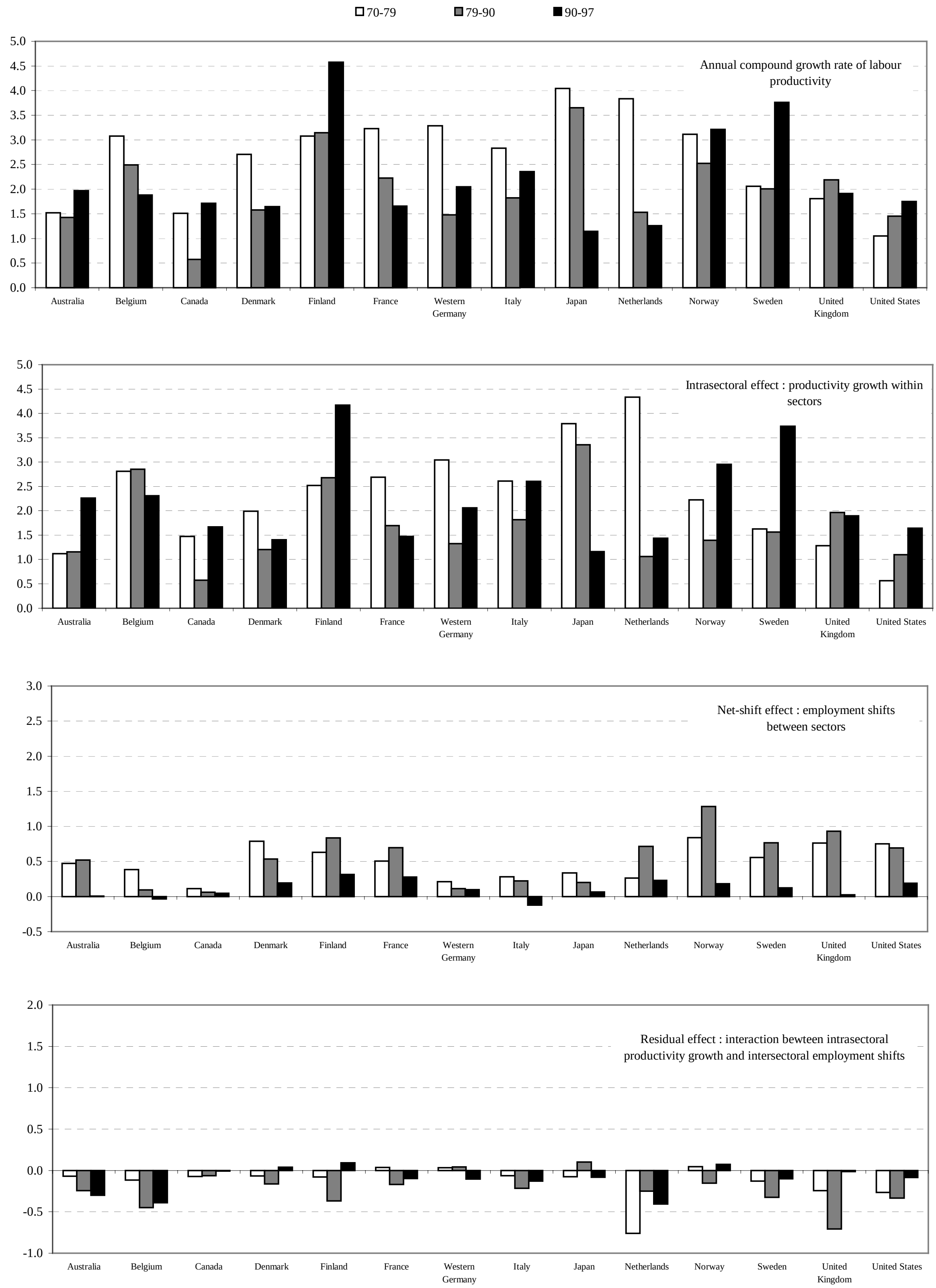
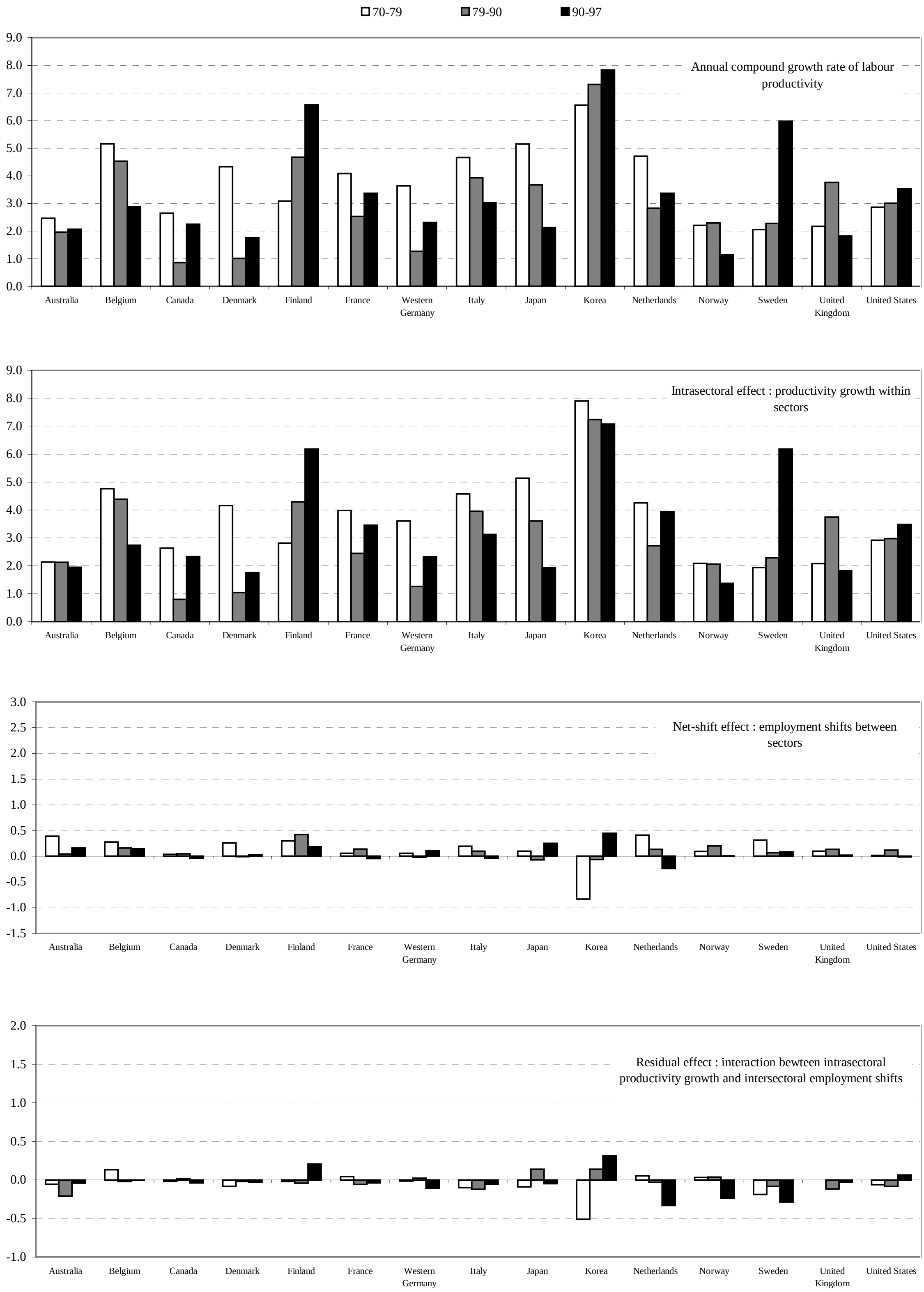


Figure 8. **Breakdown of compound growth rate of labour productivity into intrasectoral productivity growth and intersectoral employment shifts**
Panel B. **Manufacturing**



Source: Secretariat calculations based on ISDB and STAN databases.

56. Bearing in mind the limits of a decomposition based on rather broad industries, the results of these calculations show that the intra-industry effect is the most important contributor to productivity growth in the non-farm business sector (Panel A of in Figure 8).[60] The net-shift effect also makes an important contribution, but primarily during the 1970-79 and 1979-90 periods. Most of this impact can be allocated to the increased size of the business services sector. The interaction effect tends to be negative for most countries. It was particularly important in the United Kingdom in the 1980s, where it was linked to the decline of mining and manufacturing. These results are confirmed by looking at manufacturing only (Panel B of Figure 8). Employment shifts across manufacturing industries played a very modest role in most countries.

57. The evidence that productivity growth is more than ever a matter of performance improvement within industries is perhaps not surprising for the countries examined in Figure 8, as around 70 per cent of value added in these countries is already in services. However, other OECD economies, including Ireland and Japan as well as some low-income countries have much smaller service sectors, suggesting that there may be further scope for structural change. In addition, there is likely to be scope for further structural change and improved resource allocation within the industries considered in Figure 8. Indeed, in reading the figure, it should be stressed that the disaggregation of the service sector is limited, and it is possible that considerable structural changes are occurring within some broadly-defined industries (*e.g.* business services).[61]

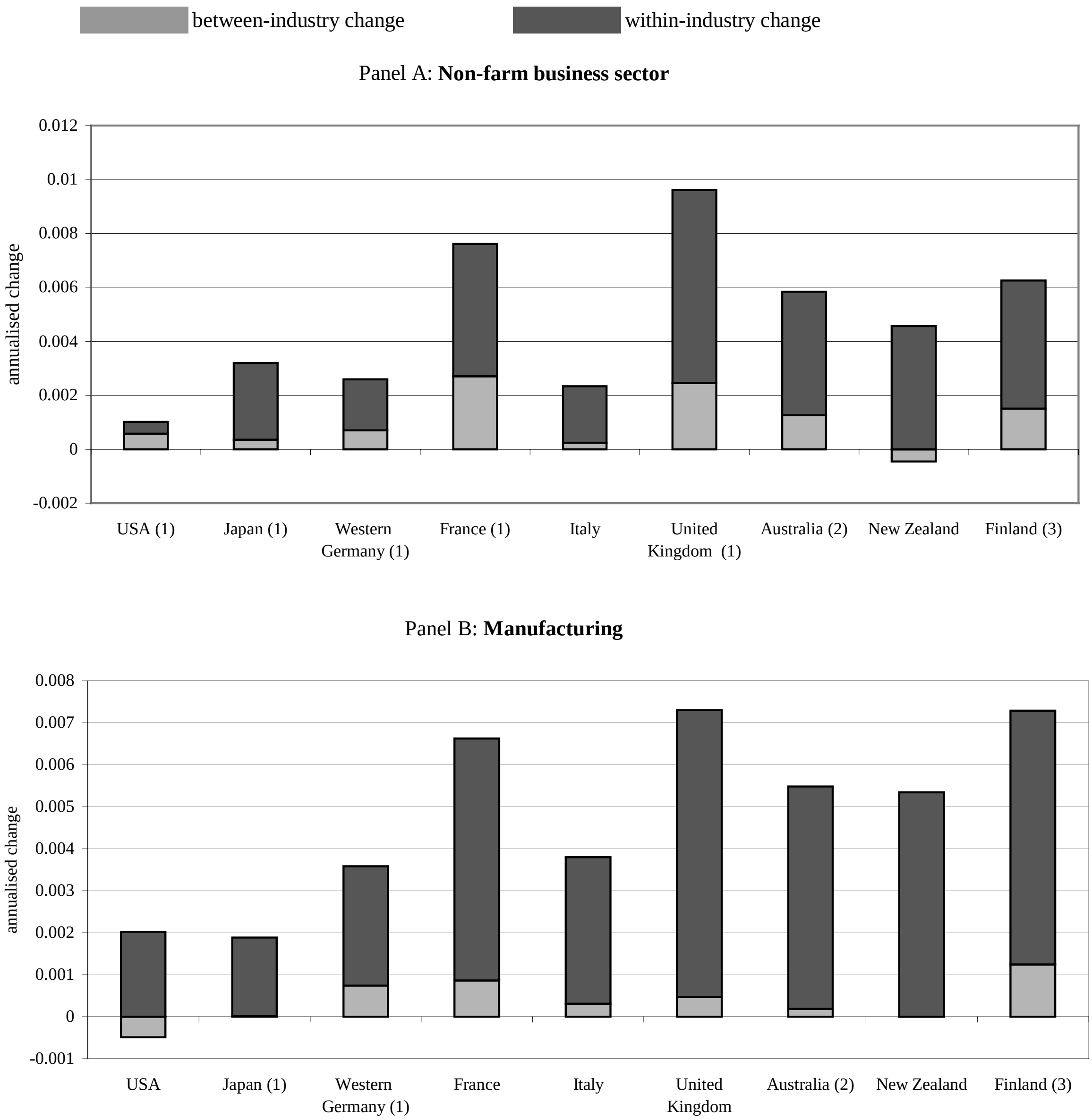
58. To shed further light on the possible role of structural shifts to economic performance it is possible to examine whether up-skilling of the aggregate workforce mainly occurs via employment shifts from low-skilled activities to more skilled activities or is rather a generalised process occurring within each industry. Figure 9 presents a decomposition of the annualised change in the proportion of high skilled white collars in total employment into a *between effect* and a *within-effect* for a selected group of OECD countries over the 1980-95 period. For the manufacturing sector, the figure confirms what was observed for labour productivity, namely that most of the skill upgrading is occurring within industries rather than because of employment shifts across industries.[62] However, in the non-farm business sector, the shift component is not negligible, suggesting that employment changes across sectors are still an important determinant of skill upgrading.

60. The calculations in Figure 8 are based on a detailed industry breakdown, with the 22 industry detail for manufacturing from OECD's STAN database, and 2-digit detail for the service sector.

61. To shed some light of the sensitivity of the decomposition of between and within effects to changes in the industry details, the shift-share analysis was replicated for the United States with three different industry breakdowns: 1) 1-digit data; 2) details for manufacturing but broad aggregates for services and mining (i.e. close to the decomposition used in the text); and 3) the maximum detail of 58 industries (4 mining industries, construction, 20 manufacturing industries and 33 service industries). The results do not show a high sensitivity of results to the degree of industry detail used, confirming the strong role of within-industry changes in productivity in explaining aggregate patterns. Data used are from US Department of Commerce, Bureau of Economic Analysis, Industry Economics Division. http://www.bea.doc.gov/bea/dn2/gpo.htm.

62. These results are consistent with those of Machin and van Reenen (1998) who used changes in the proportion of non-production workers and high education employment in total manufacturing employment as proxies for skill-upgrading. Machin and van Reenen (1997) also look at the non-manufacturing sector and obtained, again, broadly similar results.

Figure 9. **Structural changes and upskilling, 1981-95**
(changes in the proportion of high-skilled white collar in total employment)



he aggregate change in the share of high skilled workers can be decomposed into a *between* effect and a *within* effect (respectively the first and second term on he right hand side of the following equation) using the following decomposition: $\Delta P^{WCHS}=\sum_i \Delta S_i \, \overline{P}_i^{WCHS}+\sum_i \Delta P_i^{WCHS} \, \overline{S}_i$ where P_i^{WCHS} is the share of the employed ho are white-collar high skilled, S_i is the share of employment of sector i in total employment, and bars over variables denote period average.

1. 1981-94.
2. 1986-91.
3. 1981-90.

Source: Secretariat calculations based on ISDB and STAN databases, skill data from OECD (1998*f*) and OECD (1998g).

3.4 Productivity levels in manufacturing

59. There are still persistent differences across the OECD countries in productivity levels at the industry and aggregate manufacturing levels, which explain differences in aggregate performance.

Table 15 suggests that most OECD countries have made considerable relative productivity gains in the 1960s and 1970s and some further improvements in the 1980s. It is interesting to notice that the convergence of countries towards the US standards has been reversed in the 1990s, due to significant improvements in US productivity performances over the decade. In 1998, the average productivity level of the United States continues to outrank that of the other two major economies (Japan and Germany), even when differences in hours worked are accounted for. High productivity levels, especially in terms of hours worked, are estimated for some small economies, such as Belgium, Finland, the Netherlands and Sweden. In these countries, the manufacturing sector tends to be more specialised than in larger economies and is (with the exception of Sweden, see Pilat, 1996) relatively more capital intensive. In the middle of the OECD range in terms of productivity level in manufacturing are a number of relatively large countries such as France and Canada with high productivity levels and Australia and the United Kingdom with relatively lower rates. Mexico, Portugal and Korea are still far behind and are at the bottom rank of OECD productivity levels, although Korea has made impressive gains over the past two decades, and especially in the 1990s despite the major crisis that hit the country in 1997.

Table 15. **Manufacturing Productivity levels in selected OECD Countries, 1950-98**

GDP per person employed

	1950	1960	1970	1980	1990	1998[1]
USA	100.0	100.0	100.0	100.0	100.0	100.0
Japan	12.4	24.9	52.1	75.4	88.3	77.4
Germany	33.6	63.0	79.0	87.1	73.1	68.2
France	35.3	51.8	71.1	81.4	77.6	76.5
UK	42.3	49.9	51.6	49.0	56.5	49.5
Canada	63.4	80.4	85.1	82.5	77.9	69.2
Australia		40.7	46.7	54.5	48.7	45.5
Belgium		42.1	54.9	77.0	84.2	79.6
Finland	34.8	47.9	57.2	61.7	71.8	86.4
Korea			14.0	21.4	30.0	43.3
Mexico	32.7	37.0	40.2	36.1	26.7	25.6
Netherlands	32.7	54.4	72.6	86.8	84.7	87.3
Portugal	10.2	15.0	21.1	26.3	24.8	23.2
Spain	11.3	15.1	26.3	43.1	45.5	39.6
Sweden	44.3	53.6	76.7	76.2	70.4	83.3

GDP per hour worked

	1950	1960	1970	1980	1990	1998[2]
USA	100.0	100.0	100.0	100.0	100.0	100.0
Japan	11.1	19.9	43.4	65.2	80.7	80.0
Germany	28.5	57.9	77.6	94.8	87.5	86.5
France	35.5	49.8	71.0	87.8	92.1	92.8
U.K.	40.3	45.9	50.9	52.6	63.2	57.0
Canada	61.9	80.2	84.4	83.7	80.0	75.2
Australia		39.6	46.9	55.5	49.8	47.3
Belgium		42.2	58.6	94.0	105.0	102.4
Finland	33.9	45.5	57.0	65.9	84.7	103.5
Korea			9.6	14.6	21.7	32.6
Netherlands	31.3	50.2	74.8	99.4	109.7	117.1
Sweden	43.9	55.3	86.4	98.5	89.8	99.7

1. 1996 for Australia, Finland, Mexico and Spain, 1997 for Korea and 1995 for Portugal.
2. 1996 for Australia and Finland. 1997 for Korea.
Source: Estimates provided by Bart van Ark, University of Groningen. See Groningen Growth and Development Centre Database: http://www.eco.rug.nl/ggdc/Dseries/industry.html.

Summing up findings from the sectoral analysis

60. Differences in aggregate productivity performances can be explained by differences in both the economic structure of the OECD countries and in the productivity performances of individual industries. Available data suggest a significant degree of convergence in the sources of productivity growth amongst the OECD countries, *i.e.* the same industries provide the strongest contributions to aggregate productivity patterns, especially amongst the G7 economies. However, the ICT industry, at least so far, may have played a much stronger role in driving productivity performance in the United States than in most of the other countries. While productivity performance at the industry level tend to be associated with the effort to innovate (proxied by R&D intensity) in most countries, the relationship of productivity with both employment and human capital varies a great deal across the board, somewhat confirming differences observed at the aggregate level. Manufacturing data point to a strong role of skill-biased employment adjustment, which however has been associated with net employment losses in Continental Europe.[63] This has been partially compensated by employment growth in - relatively less productive - service sectors reinforcing the negative correlation between productivity and employment at the aggregate level. While at the firm level, the association of labour productivity with changes in employment depends upon demand conditions, return to scale and technological innovation[64], it is more difficult to use these concepts to explain observed country patterns at the aggregate and manufacturing levels. Relative wage rigidities, regulatory constraints and product market competition conditions are more likely to be behind poor employment performance in a number of European countries.[65]

61. Notwithstanding growth patterns in the past decade, there remains significant differences in the economic structure and individual sector productivity levels across the OECD countries. Structural shifts provide only a limited explanation of aggregate productivity patterns in most countries. This holds in particular for the manufacturing sector where a fine disaggregation of industries is available. For services the lack of evidence of a significant contribution of structural shifts to productivity performance in most countries has to be discounted for the lack of industry details which does not allow to identify shifts across detailed industries. Differences in productivity levels at the industry level remain important and may suggest that there is still scope for catching up to best practice in a number of countries. In manufacturing, the process of convergence of labour productivity to the US level has somewhat slowed down in the past decade over time and has even been reversed in the 1990s because of a speedup in US industries.

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63. These results seem to be consistent with patterns observed at the firm levels. According to OECD (1998a), productivity growth is almost equally due to successful upsizers (*i.e.* increasing labour productivity combined with rising employment) and successful downsizers (*i.e.* increasing labour productivity combined with falling employment) in the United States, Japan and the Netherlands but not in France where successful downsizers dominated in explaining increases in labour productivity in manufacturing.

64. The combination of increased employment and labour productivity can be explained by increased product demand combined with increasing return to scale, or technological innovation that allows firms to lower the price of output in the face of elastic product demand. By contrast, labour productivity growth with downsizing may indicate technological innovation combined with falling or inelastic demand (see Bartelsman *et al*., 1995; Baily *et al*., 1996).

65. The effects of rigidities in the product and labour markets on employment performances are extensively reviewed in the Jobs Strategy publications of the OECD. See in particular (OECD, 1999*g*) for a detailed overview of policy reforms and employment performance: the study suggests that there has been a close correlation between the effort of reform along the lines of the *OECD Jobs Strategy* and employment performances in the business sector.

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STATISTICAL ANNEX

Table A.1. Actual GDP growth in the OECD area, by sub-period
(Total economy, percentage change at annual rate)

Total Economy	1970-98	1970-80	1980-90	1990[1]-98	1995-98	1990	1991	1992	1993	1994	1995	1996	1997	1998
United States	3.1	3.2	3.2	3.0	4.0	1.8	-0.5	3.1	2.7	4.0	2.7	3.6	4.2	4.3
Japan	3.4	4.4	4.0	1.4	1.3	5.1	3.8	1.0	0.3	0.6	1.5	5.1	1.6	-2.5
Germany	..	..	..	1.4	1.5	..	..	2.2	-1.1	2.3	1.7	0.8	1.5	2.2
West Germany	..	2.7	2.2	..	..	5.7	5.0	..	..	..	..	..	..	..
France	2.4	3.3	2.4	1.4	2.1	2.5	1.1	1.3	-0.9	1.8	1.9	1.1	1.9	3.2
Italy	2.5	3.6	2.2	1.3	1.5	2.0	1.4	0.8	-0.9	2.2	2.9	1.1	1.8	1.5
United Kingdom	2.2	1.9	2.7	2.0	2.7	0.6	-1.5	0.1	2.3	4.4	2.8	2.6	3.5	2.2
Canada	3.2	4.3	2.8	2.2	2.9	0.3	-1.9	0.9	2.3	4.7	2.8	1.7	4.0	3.1
Australia	3.3	3.3	3.3	3.5	4.3	1.5	-0.9	2.6	3.8	5.0	4.4	4.0	3.9	5.1
Austria	2.7	3.7	2.3	1.9	2.0	4.6	3.4	1.3	0.5	2.4	1.7	2.0	1.2	2.9
Belgium	2.4	3.4	2.0	1.8	2.4	2.7	2.0	1.6	-1.5	3.0	2.5	1.0	3.5	2.7
Czech Republic	..	..	..	0.4	0.6	..	..	-6.4	-0.9	2.6	5.9	3.8	0.3	-2.3
Denmark	2.1	2.2	1.9	2.3	2.7	1.0	1.1	0.6	0.0	5.5	2.8	2.5	3.1	2.5
Finland	2.7	3.4	3.1	1.5	5.1	0.0	-6.3	-3.3	-1.1	4.0	3.8	4.0	6.3	5.0
Greece	2.8	4.7	1.6	2.0	3.1	0.0	3.1	0.7	-1.6	2.0	2.1	2.4	3.4	3.7
Hungary	..	..	..	1.6	3.6	..	..	-3.1	-0.6	2.9	1.5	1.3	4.6	4.9
Iceland	3.8	6.3	2.7	2.2	5.2	1.2	1.2	-4.1	0.7	3.6	1.0	5.5	5.3	4.7
Ireland	4.8	4.7	3.6	6.3	9.1	8.5	1.9	3.3	2.6	5.8	9.5	7.7	10.7	8.9
Korea	7.4	7.6	8.9	5.2	1.5	7.8	9.2	5.4	5.5	8.3	8.9	6.7	5.0	-6.7
Luxembourg	4.0	2.6	4.5	5.3	5.0	2.2	6.1	4.5	8.7	4.2	3.8	2.9	7.3	5.0
Mexico	3.7	6.6	1.4	3.0	5.6	5.1	4.2	3.6	2.0	4.5	-6.2	5.1	6.8	4.8
Netherlands	2.6	2.9	2.2	2.6	3.5	4.1	2.3	2.0	0.8	3.2	2.3	3.0	3.8	3.7
New Zealand	2.0	1.6	2.4	2.2	1.6	0.3	-2.3	0.6	4.9	6.1	3.4	2.6	2.9	-0.6
Norway	3.6	4.7	2.4	3.8	3.9	2.0	3.1	3.3	2.7	5.5	3.8	4.9	4.7	2.0
of which: Mainland	*2.9*	*4.2*	*1.5*	*3.1*	*3.9*	*1.0*	*1.4*	*2.2*	*3.1*	*3.9*	*2.7*	*4.0*	*4.4*	*3.3*
Poland	..	..	..	3.5	5.9	..	-7.0	2.6	3.8	5.2	7.0	6.0	6.8	4.8
Portugal	3.4	4.7	2.9	2.4	3.6	4.4	2.3	2.5	-1.1	2.2	2.9	3.2	3.7	3.9
Spain	2.9	3.5	3.0	2.1	3.4	3.7	2.3	0.7	-1.2	2.3	2.7	2.3	3.8	4.0
Sweden	1.7	1.9	2.1	1.1	2.0	1.6	-1.1	-1.6	-2.4	4.1	3.7	1.1	2.0	3.0
Switzerland	1.5	1.9	2.1	0.5	1.3	3.7	-0.8	-0.1	-0.5	0.5	0.5	0.3	1.7	2.1
Turkey	4.5	4.1	5.2	4.2	5.9	9.3	0.9	6.0	8.0	-5.5	7.2	7.0	7.5	3.1
Coefficient of variation OECD total	0.38	0.40	0.50	0.57	0.56									
Coefficient of variation EU15	0.28	0.28	0.29	0.62	0.59									
Coefficient of variation OECD24 [2]	0.28	0.33	0.31	0.56	0.54									

1. 1991 for Czech Republic and Germany.
2. Excluding Czech Republic, Hungary, Korea, Mexico and Poland.
Source: Secretariat calculations based on data for the OECD *Economic Outlook,* No 67, see Annex 2 for details.

Table A.2. Actual GDP per capita growth in the OECD area, by sub-period
(Total economy, percentage change at annual rate)

Total Economy	1970-98	1970-80	1980-90	1990[1]-98	1995-98	1990	1991	1992	1993	1994	1995	1996	1997	1998
United States	2.1	2.1	2.3	2.0	3.1	0.9	-1.5	1.9	1.6	3.0	1.7	2.6	3.3	3.3
Japan	2.8	3.3	3.4	1.1	1.1	4.8	3.4	0.7	0.1	0.4	1.0	4.8	1.4	-2.8
Germany	..	..	..	1.0	1.3	..	..	1.5	-1.8	2.0	1.4	0.5	1.3	2.2
West Germany	..	2.6	2.0	..	..	3.7	3.7	..	..	..	..	..	..	..
France	1.8	2.7	1.8	0.9	1.7	2.0	0.5	0.7	-1.4	1.4	1.4	0.7	1.5	2.8
Italy	2.1	3.1	2.2	1.2	1.3	3.4	1.3	0.6	-1.2	1.9	2.7	0.9	1.6	1.4
United Kingdom	1.9	1.8	2.5	1.7	2.4	0.3	-1.9	-0.3	1.8	4.2	2.4	2.2	3.1	1.8
Canada	1.9	2.8	1.6	1.1	1.9	-1.2	-3.0	-0.3	1.1	3.5	1.7	0.6	2.9	2.2
Australia	2.0	1.9	1.7	2.3	3.0	0.0	-2.0	1.4	2.8	3.9	3.0	2.6	2.7	3.8
Austria	2.4	3.5	2.1	1.3	1.9	3.3	2.0	0.6	-0.9	1.9	1.5	1.8	1.0	2.8
Belgium	2.2	3.2	1.9	1.5	2.2	2.4	1.6	1.2	-1.9	2.6	2.1	1.0	3.3	2.5
Czech Republic	..	..	..	0.4	0.7	..	..	-6.5	-1.0	2.6	6.1	3.9	0.4	-2.2
Denmark	1.9	1.8	1.9	1.9	2.3	0.8	0.9	0.3	-0.3	5.1	2.3	1.9	2.7	2.2
Finland	2.2	3.1	2.6	1.0	4.8	-0.4	-7.1	-3.6	-1.6	3.5	3.4	3.7	6.0	4.8
Greece	2.0	3.7	1.1	1.4	2.9	-0.5	2.0	-0.5	-2.1	1.5	1.8	2.3	3.1	3.4
Hungary	..	..	..	1.9	4.0	..	..	-2.9	-0.3	3.3	1.8	1.7	5.0	5.2
Iceland	2.8	5.2	1.6	1.3	4.3	0.3	0.0	-5.2	-0.3	2.7	0.4	4.9	4.5	3.6
Ireland	3.6	3.3	3.3	5.5	8.1	8.8	1.3	2.6	2.2	5.2	9.0	7.0	9.7	7.6
Korea	6.3	5.8	7.6	4.1	0.5	6.8	8.2	4.3	4.4	7.2	7.8	5.7	4.0	-7.6
Luxembourg	3.0	1.9	3.9	3.9	3.9	0.6	4.7	3.0	7.2	2.7	2.2	2.1	5.9	3.7
Mexico	1.4	3.4	-0.4	1.3	3.6	4.6	3.7	1.9	0.2	2.7	-8.3	3.4	5.0	2.5
Netherlands	1.8	2.1	1.6	2.0	3.0	3.4	1.5	1.3	0.1	2.6	1.8	2.6	3.3	3.1
New Zealand	1.0	0.5	1.7	0.7	0.4	-0.6	-5.5	-0.5	3.7	4.7	1.9	1.0	1.6	-1.4
Norway	3.1	4.2	2.0	3.2	3.3	1.6	2.6	2.7	2.1	4.9	3.3	4.4	4.1	1.4
of which: Mainland	*2.4*	*3.6*	*1.1*	*2.6*	*3.3*	*0.6*	*0.9*	*1.6*	*2.5*	*3.3*	*2.2*	*3.5*	*3.9*	*2.7*
Poland	..	..	..	3.4	5.8	..	-7.3	2.3	3.5	4.9	6.8	6.0	6.7	4.8
Portugal	2.8	3.4	2.9	2.3	3.4	4.9	2.5	2.5	-1.4	2.1	2.7	3.1	3.4	3.6
Spain	2.2	2.4	2.6	1.9	3.2	3.6	2.1	0.5	-1.4	2.1	2.6	2.2	3.7	3.8
Sweden	1.3	1.6	1.8	0.6	1.9	0.8	-1.8	-2.2	-3.0	3.4	3.2	0.9	1.9	2.9
Switzerland	1.0	1.7	1.5	-0.3	1.0	2.7	-2.1	-1.2	-1.4	-0.6	0.2	-0.1	1.4	1.8
Turkey	2.2	1.8	2.8	2.4	4.1	6.7	-1.0	4.0	6.1	-7.1	5.3	5.2	5.8	1.4
Coefficient of variation OECD total	0.45	0.41	0.59	0.67	0.60									
Coefficient of variation EU15	0.27	0.27	0.31	0.68	0.59									
Coefficient of variation OECD24 [2]	0.29	0.38	0.31	0.68	0.58									

1. 1991 for Czech Republic and Germany.
2. Excluding Czech Republic, Hungary, Korea, Mexico and Poland.
Source: Secretariat calculations based on data for the OECD *Economic Outlook*, No 67, see Annex 2 for details.

Table A4.3. **Actual GDP per person employed in the OECD area, by sub-period**
(Total economy, percentage change at annual rate)

Total Economy	1970[1]-98	1970[1]-80	1980[2]-90	1990[3]-98	1995-98	1990	1991	1992	1993	1994	1995	1996	1997	1998
United States	1.3	0.8	1.4	1.7	2.3	0.5	0.4	2.4	1.1	1.7	1.2	2.1	2.0	2.8
Japan	2.5	3.6	2.7	0.9	1.0	3.0	1.9	0.0	0.1	0.6	1.4	4.6	0.5	-1.9
Germany	..	..	..	2.1	1.9	..	..	3.9	0.5	2.7	1.8	1.5	2.3	1.8
West Germany	..	2.6	1.7	..	..	2.7	2.5	..	..	..	..	..	..	..
France	2.1	2.7	2.1	1.3	1.5	1.7	1.0	2.0	0.3	1.7	1.0	0.9	1.3	2.1
Italy	2.3	2.9	2.1	1.8	0.8	0.7	0.7	1.8	2.3	3.9	3.6	0.6	1.4	0.5
United Kingdom	1.9	1.7	2.0	2.0	1.4	0.3	1.6	2.2	2.7	3.4	1.6	1.4	1.8	1.0
Australia	1.6	1.5	1.1	2.4	2.9	0.1	1.3	3.3	3.4	1.8	0.2	2.6	3.0	3.2
Austria	2.2	3.0	2.1	1.5	1.7	2.6	1.5	-0.1	0.8	2.2	2.1	2.6	0.7	1.9
Belgium	2.3	3.2	1.9	1.6	1.6	1.8	1.9	2.1	-0.8	3.3	1.8	0.6	2.7	1.4
Canada	1.0	0.8	1.1	1.2	1.0	0.3	-0.1	1.7	1.5	2.7	0.9	0.9	1.6	0.4
Czech Republic	..	..	..	0.8	1.2	..	..	-4.9	0.3	1.5	5.0	3.7	0.9	-1.0
Denmark	1.7	1.8	1.4	1.9	0.8	1.8	1.7	1.5	1.5	5.9	2.0	1.1	1.0	0.4
Finland	2.6	2.5	2.3	3.0	3.1	0.1	-1.1	4.1	5.3	4.8	1.6	2.6	4.2	2.5
Greece	2.0	4.0	0.6	1.3	2.3	-1.3	5.6	-0.7	-2.5	0.1	1.2	2.9	3.7	0.3
Hungary	..	..	..	4.7	3.2	..	..	7.2	6.2	6.5	3.4	1.9	4.3	3.4
Iceland	2.0	3.6	1.0	1.4	2.6	2.2	1.3	-2.7	1.5	3.1	0.1	3.1	3.4	1.2
Ireland	3.4	3.8	3.9	2.3	3.1	5.0	2.0	0.2	1.2	2.5	3.9	3.7	6.8	-1.2
Korea	4.7	3.8	5.9	3.9	2.3	4.7	6.1	3.5	3.9	5.1	6.0	4.8	3.6	-1.5
Luxembourg	2.1	1.4	2.6	2.4	1.4	-2.0	3.3	1.9	6.8	1.8	1.3	-0.3	4.4	0.1
Mexico	..	..	-0.5	-0.3	1.1	2.2	1.4	-0.1	-1.7	1.2	-6.2	1.1	0.7	1.4
Netherlands	1.6	2.6	1.3	0.6	0.6	1.0	-0.3	0.4	0.1	3.3	-0.2	1.0	0.3	0.4
New Zealand	0.8	0.0	2.2	0.3	0.5	-0.5	-1.0	-0.3	2.3	1.4	-1.7	-1.0	2.5	0.0
Norway	2.5	3.2	1.8	2.4	1.2	2.9	4.1	3.6	2.7	3.9	1.6	2.4	1.7	-0.5
of which: Mainland	*1.7*	*2.6*	*0.9*	*1.8*	*1.2*	*2.1*	*2.8*	*2.4*	*3.1*	*2.2*	*0.4*	*1.4*	*1.4*	*0.8*
Poland	..	..	..	5.6	4.0	..	-3.9	6.5	6.1	11.2	4.9	6.2	3.0	2.9
Portugal	2.0	3.0	1.5	1.4	1.2	2.1	-0.6	1.6	0.9	2.4	3.4	2.6	1.8	-0.7
Spain	2.7	3.8	2.3	1.8	0.8	1.1	2.0	2.7	3.3	3.2	0.9	0.9	0.9	0.5
Sweden	1.6	1.0	1.5	2.6	2.1	0.6	0.9	2.8	3.6	5.1	2.1	1.7	3.1	1.5
Switzerland	0.8	1.8	0.2	0.4	0.9	0.6	-2.6	1.5	0.3	0.9	0.2	0.0	1.9	0.8
Turkey	2.8	2.1	3.5	2.8	5.1	7.4	-0.8	5.8	7.8	-8.0	3.4	4.9	10.2	0.3
Coefficient of variation EU15	0.22	0.33	0.38	0.32	0.48									
Coefficient of variation OECD24 [4]	0.32	0.46	0.46	0.43	0.61									

1. 1978 for Australia, 1973 for Korea.
2. 1983 for Mexico.
3. 1991 for Czech Republic, Germany and Hungary, 1993 for Poland.
4. Excluding Czech Republic, Hungary, Korea, Mexico and Poland.

Source: Secretariat calculations based on data for the OECD *Economic Outlook*, No 67, see Annex 2 for details.

Table A.4. Trend GDP growth in the OECD area, by sub-period
(Total economy, percentage change at annual rate)

Total Economy	1970-98[1]	1970-80	1980-90	1990[2]-98[1]	1995-98[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998
United States	2.9	2.9	2.9	3.1	3.5	2.7	2.6	2.7	2.8	3.0	3.2	3.4	3.5	3.6
Japan	3.6	4.8	3.8	1.9	1.4	3.6	3.1	2.6	2.2	1.8	1.6	1.5	1.4	1.3
Germany	..	..	..	1.3	1.4	..	..	1.2	1.2	1.2	1.3	1.3	1.4	1.4
West Germany	..	2.7	2.2	..	..	3.2	..	..	..	..	..	..	..	..
France	2.4	3.3	2.1	1.6	1.7	2.2	1.9	1.7	1.5	1.5	1.5	1.6	1.7	1.8
Italy	2.5	3.5	2.4	1.4	1.4	2.0	1.8	1.5	1.4	1.4	1.4	1.4	1.4	1.4
United Kingdom	2.2	1.9	2.5	2.2	2.5	2.0	1.8	1.8	2.0	2.2	2.4	2.5	2.5	2.5
Canada	3.1	4.0	2.7	2.3	2.7	2.0	1.8	1.8	2.0	2.3	2.5	2.6	2.8	2.8
Australia	3.3	3.4	3.2	3.6	4.0	2.9	2.9	3.0	3.3	3.5	3.8	3.9	4.0	4.1
Austria	2.7	3.5	2.3	2.3	2.1	2.8	2.7	2.5	2.3	2.2	2.1	2.1	2.1	2.1
Belgium	2.4	3.2	2.0	2.0	2.0	2.4	2.2	2.0	1.9	1.8	1.9	1.9	2.0	2.0
Denmark	2.2	2.3	2.0	2.5	2.9	1.6	1.7	2.0	2.3	2.6	2.8	2.9	2.9	2.9
Finland	2.7	3.5	2.6	1.8	3.0	0.8	0.4	0.4	0.8	1.5	2.1	2.7	3.1	3.2
Greece	2.8	4.5	1.8	1.8	2.1	1.7	1.6	1.5	1.5	1.6	1.8	2.0	2.1	2.2
Iceland	3.5	5.5	2.9	1.6	2.3	1.3	1.1	1.0	1.2	1.6	1.9	2.2	2.4	..
Ireland	4.6	4.6	3.3	6.3	7.3	4.6	4.9	5.2	5.6	6.2	6.8	7.2	7.4	7.4
Korea	7.7	8.1	8.4	6.4	5.4	8.4	7.9	7.4	7.0	6.6	6.1	5.7	5.3	5.1
Luxembourg	4.0	2.4	4.5	5.3	5.0	6.2	6.0	5.8	5.6	5.3	5.1	5.0	5.0	4.9
Mexico	3.8	6.2	2.1	2.9	3.2	2.6	2.8	2.8	2.7	2.7	2.7	2.9	3.2	3.3
Netherlands	2.6	2.9	2.1	2.7	2.8	2.9	2.8	2.7	2.6	2.6	2.7	2.8	2.8	2.8
New Zealand	2.0	1.9	1.9	2.3	2.6	1.1	1.3	1.7	2.2	2.5	2.7	2.7	2.6	2.5
Norway	3.5	4.3	2.8	3.4	3.7	2.4	2.7	3.0	3.3	3.6	3.7	3.8	3.7	3.6
of which: Mainland	*2.8*	*3.9*	*1.8*	*2.7*	*3.3*	*1.2*	*1.5*	*2.0*	*2.4*	*2.8*	*3.1*	*3.3*	*3.3*	*3.3*
Portugal	3.4	4.4	2.9	2.6	2.4	3.5	3.1	2.7	2.5	2.4	2.4	2.4	2.5	..
Spain	2.8	3.4	2.7	2.4	2.5	3.1	2.7	2.3	2.1	2.1	2.2	2.4	2.5	2.6
Sweden	1.8	2.1	1.8	1.3	1.8	1.0	0.8	0.7	0.8	1.1	1.4	1.6	1.8	1.9
Switzerland	1.6	1.6	2.1	0.8	0.8	1.7	1.3	0.9	0.7	0.6	0.6	0.7	0.8	0.9
Turkey	4.4	4.5	4.5	4.2	4.2	4.6	4.4	4.2	4.1	4.0	4.1	4.2	4.2	4.1
Coefficient of variation OECD total[3]	0.39	0.40	0.47	0.54	0.50									
Coefficient of variation EU15	0.27	0.27	0.28	0.58	0.57									
Coefficient of variation OECD24 [4]	0.27	0.31	0.28	0.51	0.51									

1. 1997 for Iceland and Portugal.
2. 1991 for Germany.
3. Excluding Czech Republic, Hungary and Poland.
4. Excluding Czech Republic, Hungary, Korea, Mexico and Poland.

Source: Secretariat calculations based on data for the OECD *Economic Outlook,* No 66, see Annex 2 for details.

Table A.5. Trend GDP per capita growth in the OECD area, by sub-period
(Total economy, percentage change at annual rate)

Total Economy	1970-98[1]	1970-80	1980-90	1990[2]-98[1]	1995-98[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998
United States	2.0	1.8	2.0	2.2	2.7	1.6	1.5	1.6	1.7	2.0	2.2	2.5	3.0	2.7
Japan	2.9	3.6	3.3	1.6	1.1	3.3	2.8	2.3	1.9	1.6	1.2	1.2	1.1	1.0
Germany	..	..	..	0.9	1.2	..	..	0.4	0.5	0.9	1.0	1.1	1.2	1.5
West Germany	..	2.5	1.9	..	..	1.2	..	..	..	..	..	..	..	..
France	1.9	2.7	1.6	1.2	1.3	1.6	1.3	1.1	1.0	1.0	1.1	1.2	1.3	1.3
Italy	2.3	3.0	2.3	1.3	1.2	3.5	1.7	1.4	1.1	1.1	1.2	1.2	1.2	1.3
United Kingdom	2.0	1.8	2.2	1.8	2.2	1.7	1.4	1.4	1.5	2.0	2.0	2.2	2.1	2.1
Canada	1.8	2.5	1.5	1.2	2.0	0.4	0.6	0.3	0.6	1.2	1.2	2.5	1.6	1.8
Australia	2.0	1.9	1.6	2.4	2.7	1.4	1.7	1.8	2.3	2.5	2.4	2.6	2.8	2.8
Austria	2.4	3.4	2.1	1.7	2.0	1.6	1.3	1.7	0.9	1.7	1.9	1.9	1.9	2.0
Belgium	2.2	2.9	1.9	1.7	1.9	2.1	1.8	1.6	1.5	1.5	1.5	1.9	2.0	1.8
Denmark	2.0	1.9	2.0	2.1	2.4	1.4	1.5	1.6	1.9	2.3	2.4	2.2	2.5	2.5
Finland	2.3	3.1	2.2	1.3	2.7	0.3	-0.5	0.1	0.3	1.0	1.7	2.4	2.8	3.0
Greece	2.1	3.6	1.3	1.3	1.9	1.2	0.5	0.3	0.9	1.2	1.5	1.9	1.8	2.1
Iceland	2.4	4.3	1.7	0.8	1.6	0.5	-0.2	-0.2	0.2	0.7	1.4	1.6	1.6	..
Ireland	3.8	3.1	3.0	5.6	6.3	5.0	4.2	4.4	5.2	5.6	6.3	6.5	6.4	6.1
Korea	6.3	6.3	7.2	5.3	4.3	7.3	6.9	6.5	6.0	5.2	5.1	4.6	4.3	4.1
Luxembourg	3.2	1.7	4.0	4.0	3.8	4.5	4.5	4.3	4.1	3.8	3.5	4.2	3.7	3.6
Mexico	1.5	3.0	0.3	1.2	1.3	2.1	2.3	1.1	1.0	1.0	0.4	1.2	1.5	1.1
Netherlands	1.9	2.1	1.6	2.1	2.3	2.2	2.0	1.9	1.9	2.0	2.2	2.3	2.3	2.3
New Zealand	0.9	0.8	1.2	0.8	1.4	0.1	0.0	0.6	1.1	1.2	-1.0	1.1	1.3	1.7
Norway	3.1	3.8	2.4	2.9	3.1	2.1	2.2	2.4	2.7	3.0	3.5	3.2	3.2	3.0
of which: Mainland	*2.3*	*3.3*	*1.4*	*2.2*	*2.7*	*0.9*	*1.0*	*1.4*	*1.8*	*2.2*	*2.8*	*2.7*	*2.8*	*2.7*
Portugal	2.8	3.1	2.9	2.5	2.3	3.9	3.2	2.7	2.2	2.2	2.2	2.3	2.2	..
Spain	2.3	2.3	2.3	2.2	2.4	2.9	2.5	2.1	1.9	1.9	2.0	2.2	2.4	2.5
Sweden	1.4	1.8	1.5	0.9	1.7	-0.1	0.2	0.1	0.2	0.3	1.2	1.5	1.8	1.8
Switzerland	1.1	1.4	1.6	0.1	0.5	0.7	0.0	-0.2	-0.2	-0.6	0.3	0.3	0.6	0.7
Turkey	2.2	2.2	2.0	2.3	2.5	2.1	2.4	2.3	2.2	2.2	2.3	2.5	2.5	2.4
Coefficient of variation OECD total[3]	0.45	0.41	0.56	0.66	0.52									
Coefficient of variation EU15	0.26	0.25	0.31	0.61	0.54									
Coefficient of variation OECD24 [4]	0.29	0.34	0.32	0.61	0.51									

1. 1997 for Iceland and Portugal.
2. 1991 for Germany.
3. Excluding Czech Republic, Hungary and Poland.
4. Excluding Czech Republic, Hungary, Korea, Mexico and Poland.
Source: Secretariat calculations based on data for the OECD *Economic Outlook,* No 66, see Annex 2 for details.

Table A.6. Trend GDP per person employed in the OECD area, by sub-period
(Total economy, percentage change at annual rate)

Total Economy	1970[1]-98[2]	1970[1]-80	1980[3]-90	1990[4]-98[2]	1995-98[2]	1990	1991	1992	1993	1994	1995	1996	1997	1998
United States	1.1	0.6	1.1	1.7	1.9	1.3	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.9
Japan	2.7	3.9	2.6	1.3	1.1	2.3	1.9	1.6	1.3	1.2	1.2	1.1	1.0	1.0
Germany	..	..	..	1.9	1.9	..	..	2.0	2.0	2.0	1.9	1.9	1.9	1.9
West Germany	..	2.7	1.6	..	..	1.9	..	..	..	..	..	..	..	..
France	2.1	2.8	1.9	1.4	1.4	1.8	1.7	1.5	1.4	1.3	1.3	1.3	1.4	1.4
Italy	2.4	2.9	2.2	1.9	1.6	2.2	2.1	2.1	2.1	2.0	1.9	1.7	1.6	1.5
United Kingdom	1.9	1.9	1.9	1.8	1.9	1.5	1.6	1.7	1.9	1.9	1.9	1.9	1.8	1.8
Canada	1.0	0.9	1.0	1.1	1.1	0.8	0.9	0.9	1.0	1.1	1.1	1.1	1.1	1.1
Australia	1.5	1.3	1.2	2.0	2.3	1.2	1.4	1.7	1.9	2.0	2.1	2.2	2.3	2.3
Austria	2.3	3.1	2.0	1.8	2.0	1.8	1.7	1.7	1.7	1.8	1.9	1.9	2.0	2.0
Belgium	2.3	3.2	1.8	1.7	1.7	1.8	1.8	1.8	1.7	1.7	1.7	1.7	1.7	1.7
Denmark	1.9	1.8	1.5	2.4	2.2	1.9	2.1	2.4	2.6	2.6	2.5	2.4	2.2	2.1
Finland	2.6	2.6	2.4	2.9	2.8	2.6	2.7	2.8	3.0	3.1	3.0	2.9	2.8	2.7
Greece	2.0	3.8	0.9	1.0	1.2	1.2	1.1	0.9	0.8	0.8	0.9	1.1	1.3	..
Iceland	1.8	2.8	1.3	1.2	1.1	1.5	1.4	1.3	1.2	1.2	1.2	1.1	1.0	..
Ireland	3.6	4.0	3.5	3.2	3.2	3.5	3.3	3.2	3.1	3.1	3.2	3.2	3.2	3.1
Korea	4.8	4.5	5.6	4.0	3.2	5.1	4.9	4.6	4.3	4.1	3.7	3.3	3.0	..
Luxembourg	2.1	1.2	2.8	2.4	2.0	3.0	2.9	2.8	2.6	2.4	2.2	2.1	2.0	2.0
Mexico	..	..	-0.4	-0.2	-0.2	0.0	0.0	-0.1	-0.3	-0.4	-0.5	-0.3	-0.2	0.0
Netherlands	1.6	2.8	1.1	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
New Zealand	0.8	0.2	1.6	0.4	0.3	1.0	0.7	0.5	0.4	0.3	0.2	0.2	0.3	0.4
Norway	2.4	2.7	2.1	2.5	2.0	2.7	2.9	2.9	2.8	2.7	2.4	2.2	2.0	1.8
of which: Mainland	*1.7*	*2.2*	*1.1*	*1.7*	*1.5*	*1.6*	*1.8*	*1.9*	*2.0*	*1.9*	*1.7*	*1.6*	*1.5*	*1.5*
Portugal	2.0	2.6	1.6	1.7	1.5	1.9	1.8	1.8	1.7	1.7	1.7	1.6	1.4	..
Spain	2.7	3.8	2.4	1.7	1.4	1.9	2.0	2.0	2.0	1.8	1.7	1.5	1.3	1.3
Sweden	1.7	1.2	1.6	2.4	2.4	1.7	2.0	2.2	2.5	2.6	2.6	2.5	2.4	2.3
Switzerland	0.8	1.6	0.4	0.4	0.6	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.7
Turkey	2.7	2.6	2.8	2.6	2.7	2.8	2.7	2.6	2.5	2.5	2.5	2.7	2.7	2.6
Coefficient of variation EU15	0.22	0.32	0.33	0.33	0.33									
Coefficient of variation OECD24[5]	0.34	0.45	0.40	0.41	0.41									

1. 1978 for Australia, 1973 for Korea.
2. 1997 for Greece, Iceland, Korea and Portugal.
3. 1983 for Mexico.
4. 1991 for Germany.
5. Excluding Czech Republic, Hungary, Korea, Mexico and Poland.

Source: Secretariat calculations based on data for the OECD *Economic Outlook,* No 66, see Annex 2 for details.

Table A.7. Trend GDP growth in the OECD area, by sub-period, business sector
(Percentage change at annual rate)

Business sector	1970[1]-98[2]	1970[1]-80	1980-90	1990[3]-98[2]	1995-98[2]	1990	1991	1992	1993	1994	1995	1996	1997	1998
United States	3.1	3.0	3.1	3.3	3.8	2.7	2.7	2.8	3.0	3.2	3.5	3.7	3.8	3.9
Japan	3.9	4.8	4.0	2.5	2.2	3.9	3.3	2.8	2.4	2.2	2.1	2.1	2.2	..
Germany	..	..	..	1.6	1.7	..	..	1.5	1.5	1.6	1.6	1.7	1.7	1.8
West Germany	..	2.7	2.3	..	..	3.4	..	..	..	..	..	..	..	..
France	2.6	3.6	2.3	1.7	1.8	2.4	2.1	1.8	1.6	1.5	1.6	1.7	1.8	1.8
Italy	2.7	3.7	2.5	1.7	1.7	2.2	2.0	1.7	1.6	1.6	1.6	1.7	1.7	..
United Kingdom	2.4	1.9	3.0	2.1	2.3	2.4	2.1	1.9	2.0	2.2	2.3	2.3	..	..
Canada	3.2	4.1	2.8	2.5	3.1	1.9	1.7	1.8	2.1	2.5	2.8	3.0	3.2	3.2
Australia	3.6	3.2	3.5	4.1	4.6	3.3	3.3	3.4	3.7	4.1	4.3	4.5	4.6	4.7
Austria	2.8	3.6	2.3	2.4	2.2	3.0	2.9	2.6	2.4	2.3	2.2	2.2	2.2	..
Belgium	2.4	2.9	2.1	2.0	1.9	2.6	2.3	2.1	1.9	1.8	1.8	1.9	1.9	..
Denmark	2.1	1.6	2.0	2.9	3.4	1.6	1.8	2.2	2.6	3.0	3.3	3.4	3.5	3.4
Finland	2.5	2.8	2.6	2.1	3.6	0.7	0.3	0.4	1.0	1.8	2.6	3.3	3.7	3.8
Greece	2.8	4.8	1.6	1.8	2.2	1.7	1.6	1.5	1.5	1.7	1.9	2.1	2.2	2.3
Iceland	..	..	..	1.5	2.3	0.3	0.4	0.7	1.1	1.6	2.0	2.3	2.4	..
Ireland	5.0	4.7	4.0	6.6	7.4	5.6	5.7	5.9	6.2	6.7	7.1	7.4	7.4	..
Korea	8.6	8.2	9.3	7.9	7.7	8.9	8.4	8.0	7.8	7.7	7.7	7.7	..	..
Netherlands	2.6	2.8	2.2	3.0	3.0	3.2	3.0	2.9	2.9	2.9	2.9	3.0	3.1	3.0
New Zealand	2.1	1.9	1.6	3.0	3.6	1.2	1.6	2.2	2.8	3.3	3.6	3.6	3.6	..
Norway[4]	2.5	3.6	1.4	2.6	3.4	0.7	1.1	1.6	2.2	2.7	3.1	3.4	3.5	3.5
Portugal	3.3	4.3	2.7	2.4	..	3.3	2.9	2.5	2.3	2.2	2.1	..	..	..
Spain	2.7	3.2	2.4	2.3	2.5	3.0	2.6	2.2	2.1	2.1	2.2	2.4	2.5	2.6
Sweden	1.7	1.4	2.0	1.6	2.0	1.4	1.2	1.1	1.3	1.6	1.9	2.0	2.0	..
Switzerland	1.6	1.4	2.2	0.8	..	1.6	1.2	0.9	0.7	0.6	0.7	..	..	..
Turkey	4.5	4.0	4.7	5.1	..	5.1	5.1	5.1	5.2	..	..	..	..	..
Coefficient of variation OECD total[5]	0.48	0.43	0.56	0.58	0.53									
Coefficient of variation EU15[6]	0.28	0.34	0.23	0.52	0.56									
Coefficient of variation OECD24 [7]	0.29	0.33	0.32	0.49	0.45									

1. 1975 for Korea, 1972 for Turkey.
2. 1997 for Austria, Belgium, Iceland, Ireland, Italy, Japan, New Zealand and Sweden, 1995 for Portugal and Switzerland, 1996 for United Kingdom, Korea and Mexico, 1993 for Turkey.
3. 1991 for Germany.
4. Mainland only.
5. Excluding Czech Republic, Hungary, Luxembourg and Poland.
6. Excluding Luxembourg.
7. Excluding Czech Republic, Hungary, Korea, Luxembourg, Mexico and Poland.

Source: Secretariat calculations based on data for the OECD *Economic Outlook,* No 66, see Annex 2 for details.

Table A.8. Trend GDP per person employed in the OECD area, by sub-period, business sector
(Percentage change at annual rate)

Business sector	1970[1]-98[2]	1970[1]-80	1980[3]-90	1990[4]-98[2]	1995-98[2]	1990	1991	1992	1993	1994	1995	1996	1997	1998
United States	1.1	0.8	1.1	1.4	1.6	1.2	1.2	1.3	1.3	1.4	1.4	1.5	1.6	1.6
Japan	3.0	4.0	2.7	1.8	1.9	2.4	2.1	1.8	1.6	1.6	1.7	1.8	1.9	..
Germany	..	..	..	2.1	2.0	..	..	2.2	2.1	2.1	2.1	2.1	2.0	2.0
West Germany	..	3.0	1.8	..	..	2.1	..	..	..	..	..	..	..	..
France	2.6	3.4	2.4	1.7	1.6	2.3	2.1	1.9	1.8	1.7	1.6	1.6	1.6	1.6
Italy	2.5	3.0	2.0	2.3	2.3	2.3	2.3	2.3	2.4	2.4	2.4	2.3	2.3	..
United Kingdom	2.2	2.4	2.3	1.5	1.6	1.4	1.4	1.5	1.5	1.6	1.6	1.6	..	..
Canada	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.1	1.2	1.2	1.2	1.2	1.1	1.1
Australia	1.7	1.4	1.4	2.2	2.5	1.3	1.6	1.9	2.1	2.2	2.3	2.4	2.5	2.5
Austria	2.7	3.5	2.4	2.0	2.1	2.1	2.0	1.9	1.9	2.0	2.0	2.1	2.1	..
Belgium	2.5	3.5	2.1	1.5	1.4	1.8	1.7	1.6	1.5	1.5	1.5	1.4	1.4	..
Denmark	2.4	2.6	1.7	2.9	2.8	2.0	2.4	2.8	3.1	3.2	3.1	3.0	2.8	2.6
Finland	3.5	3.3	3.4	4.0	3.9	3.7	3.8	4.0	4.2	4.2	4.1	4.0	3.9	3.9
Greece	2.2	4.2	1.1	1.1	1.4	1.4	1.2	1.0	0.9	0.9	1.1	1.3	1.4	..
Iceland	..	..	..	1.4	1.4	0.9	1.2	1.4	1.5	1.6	1.5	1.5	1.3	..
Ireland	4.1	4.6	4.2	3.2	2.8	4.2	3.9	3.6	3.4	3.2	3.1	2.9	2.7	..
Korea	5.8	5.2	6.3	5.2	5.3	5.6	5.4	5.2	5.2	5.2	5.2	5.3	..	..
Netherlands	2.0	3.1	1.4	1.3	1.2	1.3	1.4	1.4	1.4	1.4	1.3	1.2	1.2	1.2
New Zealand	0.8	0.4	1.2	0.6	0.7	1.0	0.8	0.7	0.6	0.6	0.5	0.6	0.7	..
Norway[5]	2.1	2.8	1.4	2.2	1.9	2.2	2.5	2.6	2.6	2.4	2.2	2.0	1.9	1.8
Portugal	2.3	2.9	1.9	2.2	..	2.3	2.2	2.1	2.1	2.2	2.2	..	..	..
Spain	2.9	4.1	2.7	1.8	1.4	2.2	2.3	2.3	2.2	2.0	1.8	1.6	1.4	1.3
Sweden	2.1	1.9	1.8	2.8	3.0	1.9	2.2	2.5	2.8	3.0	3.0	3.0	2.9	..
Switzerland	0.8	0.6	0.9	0.9	..	0.8	0.9	0.9	0.9	0.9	0.9	..	..	..
Turkey	2.8	2.3	3.0	3.6	..	3.4	3.5	3.7	3.7	..	..	..	..	..
Coefficient of variation EU15[6]	0.23	0.22	0.36	0.37	0.39									
Coefficient of variation OECD24[7]	0.37	0.44	0.42	0.43	0.40									

1. 1978 for Australia, 1975 for Korea, 1976 for Switzerland and 1972 for Turkey.
2. 1997 for Austria, Belgium, Greece, Iceland, Ireland, Italy, Japan, New Zealand and Sweden, 1996 for Korea and United Kingdom, Mexico, 1995 for Portugal and Switzerland, 1993 for Turkey.
3. 1983 for Mexico.
4. 1991 for Germany.
5. Mainland only.
6. Excluding Luxembourg.
7. Excluding Czech Republic, Hungary, Korea, Luxembourg, Mexico and Poland.

Source: Secretariat calculations based on data for the OECD *Economic Outlook,* No 66, see Annex 2 for details.

Table A.9. **Basic data for international comparisons of income and productivity, 1985**

	Gross domestic product (million nominal NC)	1985 PPPs (1993 EKS benchmark)	Gross domestic product (million nominal US$)	Population (1000s)	Working-age population (15-64 years) (1000s)	Labour force (1000s)	Employment (1000s)	Annual hours worked per person employed	Total annual hours worked (1000000s)	GDP per capita (US$)	GDP per person employed (US$)	Employment per capita	GDP per hour worked (US$)	Hours worked per capita	Ratio of working-age population to total	Ratio of labour force to working-age population	Unemploy-ment rate
United States	4 213 000	1.0	4 213 000	238 466	158 517	117 695	107 150	1 825	195 549	17 667	39 319	44.9	21.5	820	66.5	74.2	9.0
Japan	320 418 700	209.6	1 528 623	121 049	82 535	59 630	58 070	2 093	121 541	12 628	26 324	48.0	12.6	1 004	68.2	72.2	2.6
Germany	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
West Germany	1 877 104	2.2	856 616	61 024	42 740	28 897	26 062	1 693	44 123	14 037	32 868	*42.7*	*19.4*	723	*70.0*	*67.6*	*9.8*
France	4 778 709	6.6	724 183	55 284	36 405	23 917	20 915	1 669	34 898	13 099	34 625	37.8	20.8	631	65.9	65.7	12.6
Italy	812 177 022	1 194.8	679 765	56 498	39 286	23 495	20 508	1 665	34 146	12 032	33 146	36.3	19.9	604	69.5	59.8	12.7
United Kingdom	354 229	0.5	658 340	56 685	37 198	27 714	24 210	1 606	38 881	11 614	27 193	42.7	16.9	686	65.6	74.5	12.6
Canada	485 139	1.3	384 761	25 942	17 773	13 200	11 742	1 791	21 027	14 832	32 768	45.3	18.3	811	68.5	74.3	11.0
Australia	238 071	1.2	202 603	15 788	10 442	7 319	6 676	1 798	12 005	12 833	30 348	42.3	16.9	760	66.1	70.1	8.8
Austria	1 369 095	14.1	96 805	7 558	5 099	3 355	3 234	-	-	12 808	29 934	42.8	-	-	67.5	65.8	3.6
Belgium	4 892 000	37.4	130 701	9 858	6 636	4 112	3 517	1 731	6 088	13 258	37 163	35.7	21.5	618	67.3	62.0	14.5
Czech Republic	-	-	-	10 337	6 697	-	5 208	-	-	-	-	50.4	-	-	64.8	-	-
Denmark	628 699	8.7	72 313	5 114	3 399	2 753	2 522	1 553	3 917	14 140	28 673	49.3	18.5	766	66.5	81.0	8.4
Finland	336 202	5.7	59 439	4 902	3 339	2 596	2 427	1 715	4 162	12 125	24 491	49.5	14.3	849	68.1	77.7	6.5
Greece	5 664 693	69.9	81 045	9 934	6 531	3 892	3 588	1 945	6 979	8 158	22 588	36.1	11.6	703	65.7	59.6	7.8
Hungary	-	-	-	-	-	-	-	1 742	-	-	-	-	-	-	-	-	-
Iceland	120 899	36.0	3 357	241	154	122	121	-	-	13 907	27 790	50.0	-	-	63.7	79.3	0.9
Ireland	19 245	0.6	29 723	3 540	2 123	1 321	1 099	1 905	2 094	8 396	27 040	31.1	14.2	592	60.0	62.2	16.8
Korea	82 158 708	432.6	189 926	40 806	26 759	15 592	14 970	2 619	39 205	4 654	12 687	36.7	4.8	961	65.6	58.3	4.0
Luxembourg	238 597	42.1	5 674	367	256	164	160	1 719	276	15 451	35 394	43.7	20.6	750	69.7	63.9	2.0
Mexico	49 872	0.1	516 350	77 938	40 514	-	26 806	-	-	6 625	19 263	34.4	-	-	52.0	56.9	2.9
Netherlands	443 091	2.4	181 009	14 491	9 922	5 812	5 076	1 637	8 309	12 491	35 660	35.0	21.8	573	68.5	58.6	12.7
New Zealand	45 023	1.2	38 288	3 272	2 130	1 399	1 329	1 791	2 380	11 702	28 809	40.6	16.1	727	65.1	65.7	5.0
Norway	544 990	9.0	60 560	4 153	2 669	2 068	1 984	1 473	2 922	14 582	30 524	47.8	20.7	704	64.3	77.5	4.1
Poland	-	-	-	37 203	24 201	-	-	-	-	-	-	-	-	-	65.1	-	-
Portugal	4 109 581	60.6	67 843	10 014	6 472	4 514	4 057	1 842	7 473	6 775	16 722	40.5	9.1	746	64.6	69.7	10.1
Spain	29 437 728	88.0	334 700	38 419	24 865	13 976	10 637	1 855	19 732	8 712	31 466	27.7	17.0	514	64.7	56.2	23.9
Sweden	894 190	8.0	111 396	8 350	5 394	4 424	4 299	1 459	6 272	13 341	25 912	51.5	17.8	751	64.6	82.0	2.8
Switzerland	237 206	2.1	113 741	6 533	4 482	3 382	3 352	-	-	17 410	33 932	51.3	-	-	68.6	75.5	0.9
Turkey	35 095 435	205.9	170 460	50 306	29 280	18 572	16 782	-	-	3 388	10 157	33.4	-	-	58.2	63.4	9.6
North America	-	-	5 133 354	338 098	216 804	153 939	141 268	1 822	257 337	15 183	36 338	41.8	19.9	761	64.1	71.0	8.2
European Union	-	-	4 089 552	342 038	229 665	150 941	132 312	1 684	222 794	11 956	30 909	38.7	18.4	651	67.1	65.7	12.3
G7	-	-	9 045 288	614 948	414 454	294 548	268 657	1 824	490 164	14 709	33 669	43.7	18.5	797	67.4	71.1	8.8
Euro area	-	-	3 166 457	261 955	177 143	112 158	97 693	1 708	166 822	12 088	32 412	37.3	19.0	637	67.6	63.3	12.9

Total OECD do not include the Czech Republic, Hungary and Poland. European aggregates include Western Germany before 1991 and total Germany beyond.

Hours worked for agregates are estimates.

Sources: GDP from OECD ADB database; population, working-age population, labour force and employment from OECD (1999), *Labour Force Statistics 1977-1997* , except for Ireland (ADB database 1999); average annual hours worked from sources quoted in Annex 2.

Table A.10. **Basic data for international comparisons of income and productivity, 1990**

	Gross domestic product (million nominal NC)	1990 PPPs (1993 EKS benchmark)	Gross domestic product (million nominal US$)	Population (1000s)	Working-age population (15-64 years) (1000s)	Labour force (1000s)	Employment (1000s)	Annual hours worked per person employed	Total annual hours worked (1000000s)	GDP per capita (US$)	GDP per person employed (US$)	Employment per capita	GDP per hour worked (US$)	Hours worked per capita	Ratio of working-age population to total	Ratio of labour force to working-age population	Unemploy-ment rate
United States	5 803 250	1.0	5 803 250	249 911	164 577	128 007	118 793	1 819	216 084	23 221	48 852	47.5	26.9	865	65.9	77.8	7.2
Japan	430 039 900	189.9	2 264 979	123 611	86 140	63 840	62 490	2 031	126 917	18 323	36 245	50.6	17.8	1 027	69.7	74.1	2.1
Germany	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
West Germany	2 497 753	2.1	1 194 526	63 254	43 947	30 369	27 988	1 611	45 080	18 885	42 680	*44.2*	*26.5*	713	*69.5*	*69.1*	*7.8*
France	6 619 068	6.6	999 498	56 735	37 381	24 853	22 098	1 652	36 506	17 617	45 230	38.9	27.4	643	65.9	66.5	11.1
Italy	1 320 833 300	1 423.2	928 053	56 737	39 076	24 515	21 215	1 674	35 514	16 357	43 745	37.4	26.1	626	68.9	62.7	13.5
United Kingdom	554 486	0.6	915 618	57 561	37 603	28 498	26 639	1 613	42 969	15 907	34 371	46.3	21.3	746	65.3	75.8	6.5
Canada	678 135	1.3	523 794	27 791	18 910	14 408	13 165	1 790	23 562	18 848	39 787	47.4	22.2	848	68.0	76.2	8.6
Australia	393 662	1.4	283 757	17 085	11 438	8 551	7 870	1 809	14 236	16 609	36 055	46.1	19.9	833	66.9	74.8	8.0
Austria	1 813 482	13.5	133 841	7 718	5 206	3 526	3 412	-	-	17 341	39 226	44.2	-	-	67.5	67.7	3.2
Belgium	6 577 000	36.6	179 696	9 967	6 674	4 179	3 726	1 699	6 330	18 029	48 228	37.4	28.4	635	67.0	62.6	10.8
Czech Republic	703 362	5.1	136 930	10 363	6 843	5 034	4 995	1 999	9 983	13 213	27 413	48.2	13.7	963	66.0	73.6	0.8
Denmark	825 310	9.1	91 194	5 141	3 463	2 912	2 638	1 492	3 936	17 739	34 569	51.3	23.2	766	67.4	84.1	9.4
Finland	521 021	6.3	82 462	4 986	3 356	2 576	2 457	1 677	4 119	16 539	33 562	49.3	20.0	826	67.3	76.8	4.6
Greece	13 315 043	126.8	105 039	10 089	6 761	4 000	3 719	1 912	7 111	10 411	28 244	36.9	14.8	705	67.0	59.2	7.0
Hungary	2 282 398	19.5	117 061	10 390	6 934	4 783	4 196	1 710	7 176	11 266	27 897	40.4	16.3	691	66.7	69.0	12.3
Iceland	364 402	78.6	4 638	255	164	128	126	1 772	223	18 201	36 807	49.5	20.8	876	64.4	78.2	1.8
Ireland	28 524	0.6	44 206	3 503	2 151	1 332	1 160	1 922	2 229	12 620	38 119	33.1	19.8	636	61.4	61.9	12.9
Korea	178 796 800	501.7	356 386	42 869	29 648	18 539	18 085	2 433	44 002	8 313	19 706	42.2	8.1	1 026	69.2	62.5	2.4
Luxembourg	372 618	40.7	9 158	384	266	192	189	1 724	326	23 825	48 483	49.1	28.1	847	69.1	72.2	1.5
Mexico	738 898	1.1	658 488	83 657	46 234	-	29 710	1 625	48 281	7 871	22 164	35.5	13.6	577	55.3	52.0	2.7
Netherlands	537 850	2.2	249 302	14 951	10 305	6 872	6 268	1 454	9 114	16 675	39 774	41.9	27.4	610	68.9	66.7	8.8
New Zealand	72 776	1.6	46 861	3 363	2 209	1 616	1 481	1 762	2 609	13 934	31 642	44.0	18.0	776	65.7	73.2	8.4
Norway	722 705	9.3	77 752	4 241	2 746	2 142	1 992	1 432	2 853	18 333	39 032	47.0	27.3	673	64.7	78.0	7.0
Poland	56 027	0.2	270 790	38 119	24 711	17 637	15 233	-	-	7 104	17 776	40.0	-	-	64.8	71.4	13.6
Portugal	9 855 074	96.4	102 272	9 873	6 556	4 948	4 658	1 882	8 766	10 359	21 956	47.2	11.7	888	66.4	75.5	5.9
Spain	52 345 374	106.2	492 741	38 851	25 849	15 333	12 578	1 824	22 941	12 683	39 175	32.4	21.5	590	66.5	59.3	18.0
Sweden	1 403 172	9.5	147 381	8 590	5 516	4 540	4 465	1 480	6 610	17 157	33 008	52.0	22.3	769	64.2	82.3	1.7
Switzerland	317 303	2.1	153 592	6 712	4 593	3 581	3 563	1 627	5 797	22 883	43 108	53.1	26.5	864	68.4	78.0	0.5
Turkey	393 060 171	1 488.9	264 000	56 203	34 022	20 650	18 538	-	-	4 697	14 241	33.0	-	-	60.5	60.7	10.2
North America	-	-	7 006 210	358 952	229 721	166 478	155 361	1 853	287 927	19 519	45 096	43.3	24.3	802	64.0	72.5	6.7
European Union	-	-	5 674 988	348 340	234 110	158 645	143 210	1 656	237 202	16 292	39 627	41.1	23.9	681	67.2	67.8	9.7
G7	-	-	12 629 718	635 600	427 634	314 490	292 388	1 801	526 633	19 871	43 195	46.0	24.0	829	67.3	73.5	7.0
Euro area	-	-	4 415 756	266 959	180 767	118 695	105 749	1 670	176 624	16 541	41 757	39.6	25.0	662	67.7	65.7	10.9

European aggregates include Western Germany before 1991 and total Germany beyond.

Hours worked for agreggates are estimates.

Sources: GDP from OECD ADB database; population, working-age population, labour force and employment from OECD (1999), *Labour Force Statistics 1977-1997* , except for Ireland (ADB database 1999); average annual hours worked from sources quoted in Annex 2.

Table A.11. **Basic data for international comparisons of income and productivity, 1995**

	Gross domestic product (million nominal NC)	1995 PPPs (1993 EKS benchmark)	Gross domestic product (million nominal US$)	Population (1000s)	Working-age population (15-64 years) (1000s)	Labour force (1000s)	Employment (1000s)	Annual hours worked per person employed	Total annual hours worked (1000000s)	GDP per capita (US$)	GDP per person employed (US$)	Employment per capita	GDP per hour worked (US$)	Hours worked per capita	Ratio of working-age population to total	Ratio of labour force to working-age population	Unemploy-ment rate
United States	7 400 550	1.0	7 400 550	263 168	172 156	133 924	124 900	1 841	229 941	28 121	59 252	47.5	32.2	874	65.4	77.8	6.7
Japan	483 220 200	175.6	2 751 349	125 570	87 260	66 660	64 570	1 884	121 650	21 911	42 610	51.4	22.6	969	69.5	76.4	3.1
Germany	3 523 000	2.1	1 672 651	81 661	55 452	39 507	35 903	1 581	56 770	20 483	46 588	44.0	29.5	695	67.9	71.2	9.1
West Germany	3 152 770	2.2	1 465 111	65 125	44 503	30 592	27 454	1 561	42 844	22 497	53 366	*42.2*	*34.2*	658	*68.3*	*68.7*	*10.3*
France	7 750 440	6.5	1 188 258	58 143	38 021	25 329	21 894	1 609	35 219	20 437	54 273	37.7	33.7	606	65.4	66.6	13.6
Italy	1 787 278 500	1 598.8	1 117 883	56 638	39 088	23 271	19 934	1 635	32 592	19 737	56 079	35.2	34.3	575	69.0	59.5	14.3
United Kingdom	712 548	0.6	1 120 417	58 606	38 019	28 426	25 839	1 599	41 317	19 118	43 361	44.1	27.1	705	64.9	74.8	9.1
Canada	807 088	1.2	645 732	29 617	20 076	14 998	13 506	1 780	24 038	21 803	47 811	45.6	26.9	812	67.8	74.7	9.9
Australia	491 587	1.3	370 907	18 072	12 032	9 059	8 235	1 816	14 952	20 524	45 040	45.6	24.8	827	66.6	75.3	9.1
Austria	2 328 739	14.0	165 996	8 047	5 417	3 903	3 729	1 561	5 821	20 628	44 515	46.3	28.5	723	67.3	72.1	4.5
Belgium	8 132 000	37.1	219 333	10 157	6 703	4 301	3 699	1 642	6 074	21 594	59 295	36.4	36.1	598	66.0	64.2	14.0
Czech Republic	1 381 100	8.4	163 529	10 331	7 044	5 172	4 927	1 999	9 847	15 829	33 190	47.7	16.6	953	68.2	73.4	4.7
Denmark	1 009 756	8.6	117 093	5 228	3 523	2 798	2 566	1 501	3 852	22 397	45 633	49.1	30.4	737	67.4	79.4	8.3
Finland	561 387	6.2	90 994	5 108	3 410	2 522	2 059	1 687	3 473	17 814	44 193	40.3	26.2	680	66.8	74.0	18.4
Greece	27 235 200	215.5	126 374	10 454	7 064	4 248	3 824	1 922	7 350	12 089	33 048	36.6	17.2	703	67.6	60.1	10.0
Hungary	5 614 042	47.8	117 437	10 229	6 933	4 095	3 623	1 765	6 395	11 481	32 414	35.4	18.4	625	67.8	59.1	11.5
Iceland	451 548	83.3	5 419	267	172	149	142	1 761	250	20 267	38 164	53.1	21.7	935	64.3	86.6	4.7
Ireland	41 028	0.7	62 524	3 601	2 312	1 449	1 273	1 835	2 336	17 363	49 112	35.4	26.8	649	64.2	62.7	12.2
Korea	377 349 800	653.7	577 288	45 093	31 900	20 796	20 377	2 404	48 987	12 802	28 330	45.2	11.8	1 086	70.7	65.2	2.0
Luxembourg	538 448	39.9	13 501	413	278	219	214	1 678	359	32 707	63 150	51.8	37.6	869	67.4	78.8	2.5
Mexico	1 840 431	2.3	806 801	90 487	53 267	-	33 881	2 003	67 856	8 916	23 813	37.4	11.9	752	58.9	64.4	5.7
Netherlands	666 035	2.1	312 866	15 459	10 569	7 410	6 838	1 348	9 218	20 238	45 754	44.2	33.9	596	68.4	70.1	7.7
New Zealand	90 616	1.5	60 039	3 656	2 398	1 738	1 622	1 784	2 894	16 422	37 015	44.4	20.7	792	65.6	72.5	6.7
Norway	928 745	8.8	105 372	4 348	2 809	2 186	2 047	1 414	2 894	24 235	51 476	47.1	36.4	666	64.6	77.8	6.4
Poland	306 318	0.9	340 996	38 588	25 516	17 205	14 792	-	-	8 837	23 053	38.3	-	-	66.1	67.4	14.0
Portugal	15 817 691	125.4	126 176	9 918	6 707	4 802	4 404	1 822	8 024	12 722	28 650	44.4	15.7	809	67.6	71.6	8.3
Spain	72 841 749	122.3	595 596	39 210	26 703	15 849	12 049	1 814	21 859	15 190	49 431	30.7	27.2	557	68.1	59.4	24.0
Sweden	1 705 526	10.0	170 700	8 834	5 523	4 319	3 986	1 544	6 156	19 323	42 825	45.1	27.7	697	62.5	78.2	7.7
Switzerland	363 329	2.1	173 029	7 041	4 761	3 936	3 800	1 636	6 217	24 574	45 534	54.0	27.8	883	67.6	82.7	3.5
Turkey	7 762 456 069	22 200.8	349 648	61 646	38 831	22 409	20 396	-	-	5 672	17 143	33.1	-	-	63.0	57.7	9.0
North America	-	-	8 853 083	382 980	245 499	183 247	170 791	1 884	321 835	23 116	51 836	44.6	27.5	840	64.1	74.6	6.8
European Union	-	-	7 100 362	371 477	248 789	168 354	148 211	1 622	240 418	19 114	47 907	39.9	29.5	647	67.0	67.7	12.0
G7	-	-	15 896 840	673 403	450 072	332 115	306 546	1 767	541 526	23 607	51 858	45.5	29.4	804	66.8	73.8	7.7
Euro area	-	-	5 565 779	288 355	194 660	128 563	111 996	1 623	181 744	19 302	49 696	38.8	30.6	630	67.5	66.0	12.9

European aggregates include Western Germany before 1991 and total Germany beyond.

Hours worked for agreggates are estimates.

Sources: GDP from OECD ADB database; population, working-age population, labour force and employment from OECD (1999), *Labour Force Statistics 1977-1997* , except for Ireland (ADB database 1999); average annual hours worked from sources quoted in Annex 2.

Table A.12. **Basic data for international comparisons of income and productivity, 1998**

	Gross domestic product (million nominal NC)	1995 PPPs (1993 EKS benchmark)	Gross domestic product (million nominal US$)	Population (1000s)	Working-age population (15-64 years) (1000s)	Labour force (1000s)	Employment (1000s)	Annual hours worked per person employed	Total annual hours worked (1000000s)	GDP per capita (US$)	GDP per person employed (US$)	Employment per capita	GDP per hour worked (US$)	Hours worked per capita	Ratio of working-age population to total	Ratio of labour force to working-age population	Unemploy-ment rate
United States	8 759 950	1.0	8 759 950	269 092	177 207	138 935	131 457	1 833	241 022	32 554	66 638	48.9	36.3	896	65.9	78.4	5.4
Japan	495 210 800	165.9	2 984 202	126 449	86 892	67 928	65 144	1 842	119 995	23 600	45 809	51.5	24.9	949	68.7	78.2	4.1
Germany	3 784 200	2.1	1 829 636	82 272	55 841	39 534	35 478	1 580	56 065	22 239	51 571	43.1	32.6	681	67.9	70.8	10.3
West Germany	3 429 683	2.1	1 623 664	65 636	44 648	30 572	27 040	1 562	42 239	24 738	60 047	*41.2*	*38.4*	644	*68.0*	*68.5*	*11.6*
France	8 582 113	6.5	1 327 307	58 799	38 426	25 858	22 339	1 599	35 717	22 574	59 417	38.0	37.2	607	65.4	67.3	13.6
Italy	2 057 731 300	1 694.0	1 214 753	56 871	39 158	23 714	20 253	1 648	33 377	21 360	59 979	35.6	36.4	587	68.9	60.6	14.6
United Kingdom	843 725	0.7	1 273 937	58 154	37 908	28 867	26 882	1 587	42 661	21 906	47 391	46.2	29.9	734	65.2	76.1	6.9
Canada	895 704	1.2	737 310	30 541	20 803	15 699	14 330	1 768	25 333	24 142	51 452	46.9	29.1	829	68.1	75.5	8.7
Australia	579 111	1.3	440 970	18 730	12 518	9 364	8 585	1 801	15 463	23 543	51 362	45.8	28.5	826	66.8	74.8	8.3
Austria	2 622 572	14.0	187 723	8 120	5 493	3 912	3 709	1 515	5 619	23 117	50 615	45.7	33.4	692	67.6	71.2	5.2
Belgium	9 064 000	36.8	246 158	10 224	6 709	4 365	3 814	1 635	6 235	24 076	64 549	37.3	39.5	610	65.6	65.1	12.6
Czech Republic	1 820 700	10.4	174 275	10 290	7 105	5 205	4 823	2 003	9 662	16 936	36 132	46.9	18.0	939	69.0	73.3	7.3
Denmark	1 168 307	8.7	133 605	5 294	3 545	2 875	2 705	1 527	4 130	25 237	49 398	51.1	32.3	780	67.0	81.1	5.9
Finland	686 013	6.2	110 600	5 154	3 440	2 586	2 216	1 674	3 708	21 459	49 919	43.0	29.8	719	66.7	75.2	14.3
Greece	35 910 600	247.2	145 260	10 527	7 111	4 271	3 836	1 930	7 404	13 799	37 863	36.4	19.6	703	67.6	60.1	10.2
Hungary	10 672 137	80.7	132 219	10 094	6 876	3 940	3 620	1 788	6 473	13 099	36 521	35.9	20.4	641	68.1	57.3	8.1
Iceland	550 027	85.5	6 432	276	178	150	145	1 747	253	23 328	44 402	52.5	25.4	918	64.6	84.2	3.4
Ireland	59 637	0.7	85 096	3 666	2 453	1 646	1 521	1 797	2 732	23 211	55 966	41.5	31.1	745	66.9	67.1	7.6
Korea	449 508 700	704.2	638 355	46 391	33 167	21 884	21 336	2 313	49 359	13 760	29 919	46.0	12.9	1 064	71.5	66.0	2.5
Luxembourg	665 735	40.6	16 392	429	286	240	234	1 648	385	38 229	70 169	54.5	42.6	898	66.7	83.9	2.7
Mexico	3 846 739	3.8	1 009 033	96 068	57 699	-	38 618	2 092	80 798	10 503	26 129	40.2	12.5	841	60.1	67.3	3.0
Netherlands	776 161	2.1	363 343	15 353	10 605	7 791	7 423	1 368	10 155	23 666	48 946	48.4	35.8	661	69.1	73.5	4.7
New Zealand	98 204	1.5	65 820	3 801	2 491	1 822	1 679	1 767	2 967	17 315	39 195	44.2	22.2	780	65.5	73.2	7.9
Norway	1 107 082	9.0	123 298	4 418	2 853	2 331	2 227	1 401	3 119	27 909	55 374	50.4	39.5	706	64.6	81.7	4.5
Poland	551 110	1.3	425 095	38 679	26 074	17 298	15 362	-	-	10 990	27 671	39.7	-	-	67.4	66.3	11.2
Portugal	19 020 678	130.6	145 655	9 946	6 757	5 123	4 665	1 732	8 080	14 645	31 220	46.9	18.0	812	67.9	75.8	8.9
Spain	86 968 544	126.2	689 258	39 360	26 788	16 480	13 201	1 821	24 037	17 512	52 212	33.5	28.7	611	68.1	61.5	19.9
Sweden	1 872 849	9.9	189 195	8 867	5 554	4 256	3 979	1 551	6 171	21 337	47 549	44.9	30.7	696	62.6	76.6	6.5
Switzerland	380 011	2.0	188 695	7 135	4 782	3 968	3 849	1 579	6 078	26 447	49 018	54.0	31.0	852	67.0	83.0	3.0
Turkey	51 625 142 598	119 173.5	433 193	64 749	41 600	22 996	21 077	-	-	6 690	20 553	32.6	-	-	64.2	55.3	8.3
North America	-	-	10 491 722	395 701	255 708	193 449	183 449	1 892	347 154	26 514	57 191	46.4	30.2	877	64.6	75.7	5.2
European Union	-	-	7 957 916	373 036	250 073	171 518	152 253	1 619	246 478	21 333	52 268	40.8	32.3	661	67.0	68.6	11.2
G7	-	-	18 127 095	682 178	456 235	340 534	315 882	1 754	554 172	26 572	57 386	46.3	32.7	812	66.9	74.6	7.2
Euro area	-	-	6 215 920	290 194	195 956	131 249	114 851	1 620	186 111	21 420	54 121	39.6	33.4	641	67.5	67.0	12.5

European aggregates include Western Germany before 1991 and total Germany beyond.
Hours worked for agreggates are estimates.
Sources: GDP from OECD ADB database; population, working-age population, labour force and employment from OECD (1999), *Labour Force Statistics 1977-1997* , except for Ireland (ADB database 1999); average annual hours worked from sources quoted in Annex 2.

Table A.13. **Average hours worked annually, 1980-1998**

Total Economy	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
United States	1831	1815	1800	1808	1822	1825	1803	1805	1820	1831	1819	1808	1798	1813	1827	1841	1837	1842	1833
Japan	2121	2106	2104	2095	2108	2093	2097	2096	2092	2070	2031	1998	1965	1905	1898	1884	1892	1864	1842
Germany	1742	1725	1730	1724	1716	1693	1683	1671	1670	1651	1625	1573	1622	1610	1604	1581	1576	1570	1580
West Germany	1742	1725	1730	1724	1716	1693	1683	1671	1670	1651	1611	1591	1602	1582	1581	1561	1557	1553	1562
France	1792	1770	1703	1694	1696	1669	1657	1659	1664	1664	1652	1640	1641	1637	1633	1609	1602	1600	1599
Italy	1724	1717	1710	1699	1650	1665	1663	1658	1675	1672	1674	1668	1631	1637	1634	1635	1636	1640	1648
United Kingdom	1704	1649	1663	1650	1593	1606	1606	1618	1621	1615	1613	1589	1589	1575	1594	1599	1589	1595	1587
Canada	1805	1805	1786	1783	1785	1791	1790	1799	1810	1803	1790	1769	1761	1765	1783	1780	1787	1777	1768
Australia	1818	1818	1807	1792	1808	1798	1782	1798	1818	1813	1809	1798	1790	1814	1819	1816	1807	1806	1801
Austria	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1680	1561	1608	1515
Belgium	..	..	..	1704	1724	1731	1717	1706	1700	1688	1699	1666	1649	1610	1612	1642	1614	1627	1635
Czech Republic	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1999	2005	1997	2003
Denmark	..	..	..	1645	1536	1553	1534	1514	1531	1508	1492	1484	1503	1469	1539	1501	1509	1520	1527
Finland	1755	1740	1721	1720	1721	1715	1689	1713	1734	1713	1677	1659	1680	1658	1692	1687	1702	1691	1674
Greece	..	..	..	1983	1917	1945	1929	1889	1882	1913	1912	1916	1944	1964	1932	1922	1939	1924	1930
Hungary	1930	1928	1847	1829	1765	1742	1734	1772	1768	1746	1710	1682	1644	1644	1759	1765	1777	1786	1788
Iceland	..	..	..	..	..	..	..	..	..	..	1772	1772	1788	1757	1744	1761	1788	1768	1747
Ireland	..	..	..	1909	1901	1905	1936	1924	1921	1929	1922	1892	1844	1832	1835	1835	1836	1797	1797
Korea	2603	2618	2629	2646	2642	2619	2646	2618	2576	2482	2433	2418	2398	2397	2391	2404	2388	2358	2313
Luxembourg	..	..	..	1726	1714	1719	1708	1707	1729	1724	1724	1703	1684	1683	1663	1678	1657	1655	1648
Mexico	..	..	..	..	..	..	..	..	..	..	2063	2063	2062	2061	2078	2095	2233	2201	2145
Netherlands	1719	1704	1688	1664	1651	1637	1576	1514	1480	1469	1454	1427	1318	1312	1359	1348	1387	1380	1368
New Zealand	..	..	..	..	..	1704	1704	1704	1699	1687	1676	1659	1668	1698	1705	1698	1693	1679	1681
Norway	1512	1502	1490	1485	1479	1473	1469	1443	1444	1440	1432	1427	1437	1434	1431	1414	1407	1399	1401
Portugal	..	..	..	..	..	1842	1842	1861	1859	1889	1882	1808	1797	1788	1784	1822	1799	1760	1732
Spain	2003	1968	1946	1912	1865	1855	1847	1838	1835	1822	1824	1832	1824	1815	1815	1814	1810	1812	1821
Sweden	1439	1431	1444	1453	1455	1459	1457	1466	1485	1484	1480	1468	1485	1501	1537	1544	1554	1552	1551
Switzerland	..	..	..	..	..	..	..	..	..	..	1627	1627	1628	1626	1632	1636	1585	1579	1579

Source: Annex 2.

Table A.14. **Industry's contribution to labour productivity growth of the total manufacturing**

Average annual percentage changes (%)

1979-89	Australia	Canada	Finland	France	Italy	Japan	Netherlands	Norway	Sweden	United Kingdom	United States	West Germany
3000 Total manufacturing industry	**1.936**	**1.901**	**4.580**	**2.500**	**3.853**	**3.615**	**2.791**	**2.280**	**2.256**	**3.692**	**2.970**	**1.256**
3100 Food, drink & tobacco	0.276	0.088	0.388	0.089	0.309	-0.055	0.507	-0.094	0.129	0.323	0.037	0.093
3200 Textiles, footwear & leather	0.080	0.263	0.483	0.399	0.527	0.029	0.168	0.260	0.108	0.329	0.325	0.231
3300 Wood, cork & furniture	-0.068	0.164	0.460	0.128	0.242	0.202	0.068	0.128	0.146	-0.043	0.127	0.006
3400 Paper & printing	0.137	-0.004	0.844	0.076	0.224	0.271	0.235	0.290	0.203	0.224	0.021	0.044
3500 Chemical products	0.272	0.289	0.421	0.358	0.693	0.120	0.751	0.578	0.251	0.518	0.563	0.005
3510 Industrial chemicals	0.074	0.115	0.181	0.146	0.207	0.057	0.409	0.241	0.106	0.176	0.224	0.041
3520 Other chemicals	0.086	0.111	0.092	0.187	0.237	0.116	0.171	0.148	0.052	0.215	0.196	0.061
3534A Petrol refineries & products	0.061	0.056	0.042	-0.051	0.026	-0.011	0.113	0.090	0.066	0.024	0.049	-0.144
3556A Rubber & plastics products	0.051	0.005	0.111	0.076	0.228	-0.044	0.069	0.090	0.028	0.103	0.094	0.039
3600 Stone, clay & glass	0.136	0.022	0.162	0.109	0.144	0.179	0.108	0.033	0.080	0.085	0.082	0.050
3700 Basic metal industries	0.522	0.250	0.213	0.177	0.235	0.058	0.013	0.294	0.283	0.375	0.058	0.176
3710 Ferrous metals	0.333	0.091	0.128	0.109	0.190	0.018	0.006	0.144	0.238	0.312	0.067	0.136
3720 Non-ferrous metals	0.189	0.152	0.085	0.066	0.045	0.039	0.006	0.147	0.046	0.064	-0.008	0.038
3800 Fabricated metal products and machinery	0.652	0.859	1.559	1.183	1.470	2.478	0.928	0.777	1.113	1.819	1.660	0.649
3810 Fabricated metal products	0.033	0.152	0.286	0.151	0.415	0.258	0.166	0.073	0.214	0.092	0.225	0.066
3820 Non-electrical machinery	0.184	0.075	0.621	0.237	0.052	0.662	0.111	0.355	0.395	0.448	0.666	0.094
3830 Electrical machinery	0.063	0.226	0.417	0.407	0.463	1.096	0.455	0.121	0.440	0.564	0.550	0.335
3840 Transport equipment	0.388	0.412	0.174	0.345	0.404	0.434	0.193	0.240	-0.069	0.672	0.049	0.167
3850 Professional goods	-0.009	-0.004	0.066	0.044	0.133	0.121	-0.001	-0.007	0.104	0.046	0.163	-0.010
3900 Other manufacturing	-0.070	-0.013	0.050	-0.017	0.015	0.306	0.006	-0.007	-0.057	0.064	0.097	0.009

1990-97	Australia	Canada	Finland	France	Italy	Japan	Netherlands	Norway	Sweden	United Kingdom	United States	West Germany
3000 Total manufacturing industry	**2.232**	**1.833**	**6.067**	**3.144**	**2.641**	**1.579**	**2.991**	**1.126**	**5.213**	**1.701**	**3.314**	**2.293**
3100 Food, drink & tobacco	0.358	0.193	0.512	0.391	0.318	-0.191	0.562	0.183	0.353	0.265	-0.055	-0.038
3200 Textiles, footwear & leather	0.017	0.065	0.448	0.259	0.464	0.226	0.100	0.071	0.150	0.139	0.227	0.212
3300 Wood, cork & furniture	0.260	-0.022	0.503	0.084	0.094	-0.051	-0.015	0.123	0.268	-0.022	-0.073	0.049
3400 Paper & printing	0.218	-0.061	1.195	0.126	0.163	-0.109	0.184	0.000	0.466	0.034	-0.038	0.022
3500 Chemical products	0.207	0.314	0.318	0.468	0.233	0.147	1.058	0.002	0.631	0.495	0.450	0.498
3510 Industrial chemicals	0.049	0.137	0.159	0.138	0.059	0.088	0.604	0.124	0.255	0.167	0.116	0.259
3520 Other chemicals	0.045	0.090	-0.012	0.201	0.122	0.073	0.146	0.016	0.223	0.237	0.187	0.138
3534A Petrol refineries & products	0.042	0.013	0.087	0.066	0.009	0.011	0.224	-0.078	0.031	0.018	0.067	-0.044
3556A Rubber & plastics products	0.072	0.073	0.084	0.063	0.043	-0.025	0.085	-0.061	0.122	0.072	0.080	0.146
3600 Stone, clay & glass	0.071	0.025	0.218	0.060	0.176	0.025	0.094	0.129	-0.003	0.017	0.030	0.045
3700 Basic metal industries	0.222	0.249	0.254	0.180	0.220	0.138	0.115	0.097	0.409	0.048	0.129	0.376
3710 Ferrous metals	0.116	0.119	0.215	0.128	0.161	0.133	0.086	0.030	0.308	0.035	0.091	0.299
3720 Non-ferrous metals	0.106	0.130	0.039	0.051	0.059	0.004	0.030	0.066	0.101	0.012	0.037	0.077
3800 Fabricated metal products and machinery	0.796	1.068	2.601	1.496	0.960	1.391	0.923	0.552	2.949	0.753	2.655	1.098
3810 Fabricated metal products	0.031	-0.008	0.273	0.266	0.098	0.039	0.023	0.216	0.454	-0.009	0.113	0.320
3820 Non-electrical machinery	0.161	0.179	0.609	0.369	0.358	0.008	0.207	0.025	0.405	0.060	0.958	0.131
3830 Electrical machinery	0.270	0.375	1.810	0.512	0.173	1.240	0.500	0.318	1.684	0.416	1.771	0.257
3840 Transport equipment	0.343	0.450	0.005	0.267	0.175	0.078	0.119	0.062	0.524	0.269	0.011	0.330
3850 Professional goods	-0.009	0.075	0.000	0.083	0.156	0.037	0.074	-0.074	-0.057	0.017	-0.158	0.061
3900 Other manufacturing	0.083	0.001	0.027	0.080	0.013	-0.002	-0.031	-0.030	-0.017	-0.027	-0.014	0.031

Source: OECD, STAN databases.

ANNEX 2. MEASUREMENT ISSUES AND DATA SOURCES

62. Several measurement issues arise when time series of inputs, outputs and productivity are constructed and compared at the international level. The three most important points are: a) conceptual independence of output quantity measures from input quantity measures; b) chained and fixed-weighted indices; c) methodology to derive price and quantity measures for products that are rapidly changing in terms of type and quality, in particular computers and semiconductors. These issues are discussed in the first section of this annex.

63. In recent years, international comparisons have also been affected by the different timing and scope of the transition of National Accounts from the 1968 system (SNA68) to the new 1993 system (SNA93). The implications of the shift of National accounts to the new system are discussed in the second section of the annex.

64. International comparisons of income per capita and productivity have to take into account international price differences that affect the purchasing power of the same dollar in different countries. Purchasing Power Parity indexes are discussed in the third section of the annex.

65. While the main data sources used in this paper come from the OECD *Analytical Data Base* (ADB), for aggregate data, and the OECD *International Sectoral Data Base* (ISDB) as well as the OECD *STAN Database for Industrial Analysis*, for sectoral data, some adjustments have been made to enhance cross-country comparability. The fourth section of this annex documents sources of data used for the purpose of this study, provides methodological details of the adjustment that has been made and compares adjusted series with time-series available from national sources.

A2.1 Measuring inputs and output for the purpose of international comparisons

A2.1.1 Independence of input and output statistics

66. A vital point for the validity of productivity measures is that price and volume indices of output are constructed independently of price and volume indices of inputs. Dependence occurs, for example, when output volume series are based on extrapolation of input measures. Extrapolation implies that quantity indicators of inputs, frequently employment, are used to carry forward and backward real output series. Input-based extrapolation is more frequent in the service industries than in other parts of the economy. However, extrapolation of base-year value added can also be based on physical output indicators or on volume measures obtained by deflating outputs. This may be a good first approximation for certain sectors (transport, for instance).

67. From the perspective of productivity measurement, the independence of statistics on inputs and outputs is key. Input-based indicators that are used to deflate output series generate an obvious bias in productivity measures: (labour) productivity growth will either be zero by construction or will reflect any assumption about productivity growth made by statisticians. Occurrences of input-based extrapolation are concentrated mainly in non-market activities where output prices are difficult to observe. This creates a

case for restricting productivity measurement to the market sector of the economy and thereby partially avoiding potential biases from output measurement.

68. In 1996, OECD published a report on the different methods to construct constant-price series of value-added in Member countries. The study focused on service industries as the part of the economy where output tends to be more difficult to measure than elsewhere. It suggests that direct extrapolation of base year value-added is the most important approach, followed by double deflation and single deflation. Extrapolation of base-year value-added using employment or hours worked turns out to be a popular technique for service activities where output is difficult to define such as public administration and defence or where output is difficult to measure such as financial and insurance services. It should be noted, though that many countries have changed compilation methodologies in conjunction with implementing SNA 93.

A2.1.2 Chained and fixed-weighted index numbers

69. Whenever price or quantity indices of two non-adjacent periods have to be compared, the question arises of which period should be chosen as a basis of comparison. One option is to choose the first or last observations as the base ("fixed-weight" or "fixed-base" Laspeyres or Paasche indexes respectively)[66] - another is to use the chain principle. In principle, chain indices can use the Laspeyres, Paasche or Fisher formulas. They are obtained by linking either price or volume indices for consecutive periods. The period-to-period movements are calculated using weighting patterns appropriate to the periods concerned.

70. In a time-series context, *i.e.* for the measurement of the rates of change of outputs, inputs and productivity, there is a strong presumption in the literature in favour of chained indices. This is because they are much less prone to a substitution bias than fixed-weight indices. The difference between fixed and chain-weighted indices became highly visible with the rising importance of information technology products, in particular computers (see below). Computer prices have fallen very rapidly relative to other goods and their quantities have increased relatively more rapidly. Fixed-weight volume series tend to be biased upwards after the base year and downwards prior to the base year (see Table A2.1). One disadvantage of chained indices of output is that they lack additive consistency over time.

66. Use of Fisher ideal index is a further option.

Table A2.1: **Comparison of fixed and chain-weighted indices**
Australia, Netherlands and the United States; Percentage change over preceding period

Australia						
Fiscal year	GDP			Gross fixed capital formation		
	Fixed 1989/90 weights (Laspeyres index)	Annual weights (Fisher index)	Difference	Fixed 1989/90 weights (Laspeyres index)	Annual weights (Fisher index)	Difference
1985-86	4.5	4.6	-0.1	-1.4	0.2	-1.6
1986-87	2.4	2.7	-0.3	2.2	4.1	-1.9
1989-90	3.3	3.2	0.1	-4.7	-4.8	0.1
1993-94	3.8	3.7	0.1	8.2	6.0	2.2
1994-95	3.7	4.0	-0.3	21.4	19.4	2.0

	Netherlands			**United States**		
Year	GDP			Value-added in the non-farm business sector		
	Fixed 1986 weights (Laspeyres index)	Annual weights (Laspeyres index)	Difference	Fixed 1987 weights (Laspeyres index)	Annual weights (Fisher index)	Difference
1979-90	-	-	-	2.4	2.6	-0.2
1987	1.4	1.4	0.0	-	-	-
1988	3.4	2.6	0.8	-	-	-
1989	4.8	4.7	0.1	-	-	-
1990	4.2	4.1	0.1	-	-	-
1991	2.3	2.3	0.0	-1.1	-1.3	0.2
1992	2.0	2.0	0.0	2.6	2.3	0.3
1993	1.3	0.8	0.5	3.9	3.2	0.7
1994	-	-	-	4.6	4.1	0.5

Sources: Australian Bureau of Statistics (1997); De Boer, Van Dalen and Verbiest (1997); Dean, Harper and Sherwood (1996).

71. The introduction of chain-weighted indices into OECD Member countries' national accounts can have marked implications on the time path of growth rates and therefore on international comparability of economic growth, in particular in years where the base year of a fixed-weighted index is remote from the reference year. Three examples of comparisons between output measures based on fixed and chain-weighted indices support this statement (Table A2.1).

– *Australia* carried out empirical analyses to compare the outcome of fixed-weighted and chain indices in its GDP calculations. The fixed-weight index uses the constant prices of 1989/90 to calculate data covering the period since 1984/85. These fixed-weight data can be compared with a chained (Fisher) index. Table A2.1 confirms that, for the period under consideration, differences between the fixed-weighted and the chained index are comparatively modest for years close to the base year but increasing as the reference period moves on. It also occurs that differences between index numbers widen as one considers individual components of GDP. For example, volume growth of gross fixed capital formation between 1986 and 1987 is at 2.2 per cent based on a fixed-weighted index and at 4.1 per cent based on a chained index.

- *The Netherlands* introduced chain-weighted volume indices into its annual national accounts from 1981 onwards. A comparison between fixed-weight and chained Laspeyres indices confirms the observations made for Australia, including increased discrepancy between index numbers at lower levels of aggregation.

- In 1996, the *United States* Bureau of Economic Analysis introduced chain-type, annual-weighted Fisher indices as its featured measures of real output and prices. In their analysis of the new measure, Landefeld and Parker (1997) find that the old fixed-weighted (1987) index understated real GDP growth prior to 1987 by an average of 0.4 percentage point and overstated growth since the early 1990s by 0.5 percentage points. As a result, comparisons of the relative strength of the current expansion may have been overstated by roughly a full percentage point.

72. For a broader comparison, Table A2.2 surveys the price bases and frequency of their change in a number of OECD countries. The resulting picture is far from uniform:

- A minority of countries has implemented chain indices although, since the table was established in 1997, some of the European countries have moved to chain indices since, following the recommendation in ESA 1995.

- However, even when countries move to chain indices, they differ in the degree to which accounts are backcast under the new methodology.

- The finest level of detail at which volume aggregates are formed is extremely variable between countries. This reduces comparability because index numbers are generally sensitive to the level of detail from which they are built up. In addition, countries' practices diverge as to whether volume GDP data is constructed from the demand side, supply side or on the basis of input-output tables.

73. In conclusion, the international comparability of volume output measures is far from perfect. Whether the introduction of chain indices by a subgroup of countries reduces or increases comparability is difficult to assess. Comparability is reduced with respect to a (hypothetical) situation where every country employs fixed weight indices with the same base year. However, in practice, there have always been significant differences in the periodicity at which countries re-based fixed-weight index numbers and in the degree to which the new base was carried backwards. It is certain that international comparability is improved between those countries that employ chain-weighted indices.

Table A2.2 **Price bases of national accounts**

Country	Price base	Number of bases since 1970
Australia	Annually-weighted	-
Belgium	Fixed-weighted	3
Canada	Annually-weighted and fixed-weighted	-
Denmark	Fixed-weighted	5
Finland	Fixed-weighted	5
France	Annually-weighted and fixed-weighted	2
Germany	Fixed-weighted	5
Greece	Annually-weighted	-
Ireland	Fixed-weighted	5
Italy	Fixed-weighted	4
Netherlands	Annually-weighted	-
Portugal	Annually-weighted	-
Sweden	Fixed-weighted	5
United Kingdom	Fixed-weighted	5
United States	Annually-weighted	-

Note: Actual practices in individual countries are still evolving as the switch-over to SNA93 proceeds.
Source: Adapted from Eurostat (1997).

A2.1.3 Price indices for rapidly changing products

74. The rapid development of information and communication technology products has brought to centre-stage two long-standing questions of price measurement: how to deal with quality changes of existing goods and how to account for new goods in price indices. The distinction between these two issues is blurred because it is unclear where to draw the borderline between a 'truly' new good and a new variety of an existing good.

75. In the case of items that are replaced by new models, the new model or variety is compared to the old one, and a judgement is made to which extent any price difference between the two should be considered a change in quality or a change in prices. However, if quality improvements are larger than can be explained by the observed price difference, quality-changes will be under-valued and price changes overstated. This can be avoided only through the explicit imputation of quality-adjusted prices for the replacement item. Restricting the sample to models that are identical between two periods can isolate pure price changes of these established models but fails to be representative for an entire product group if the established models' price changes fail to duplicate the price changes of new models - a situation that is frequently encountered in markets of information technology products.

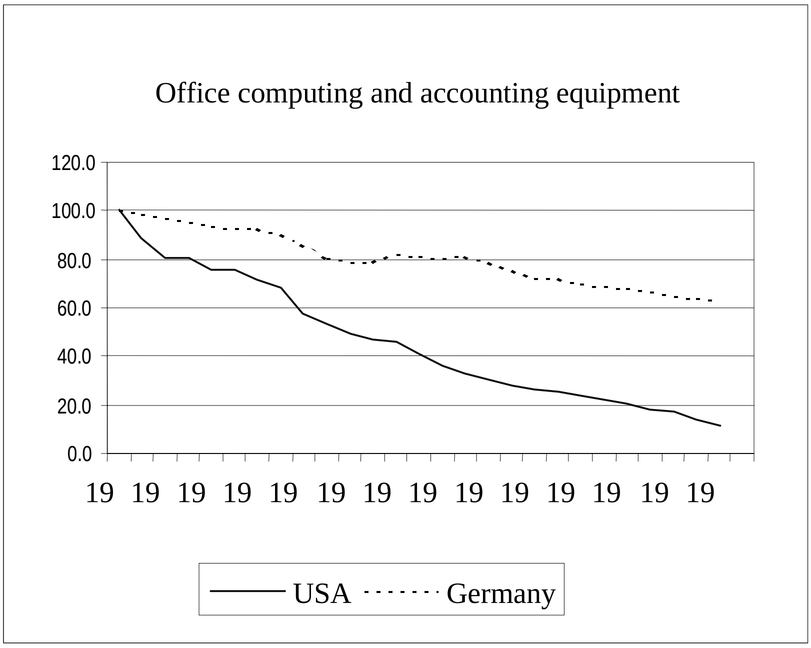
76. Genuinely new items within a product group are normally linked into the sample of observations some time after their appearance on the market. However, in technologically dynamic industries, new products' prices often fall very rapidly and before they are linked into the sample. A price index will then not pick up the initial fall in prices. Immediate introduction of new items, on the other hand, poses the problem of reservation prices, *i.e*. the imputation of hypothetical prices for the new items in the preceding period when they were still unavailable.

77. The treatment of quality change has far-reaching consequences for productivity measurement. One obvious impact is on the volume measures of output where understatement of quality change leads to an understatement of output and productivity growth. Moreover, measures of real inputs - capital input or intermediate inputs - are also concerned. Understatement of quality change in these products implies an understatement of real inputs and an overstatement of productivity growth. There is no straightforward answer to the eventual effects on industry-level productivity measures and a more complete assessment requires analysis based on input-output techniques.

78. The hedonic approach to price measurement is one of the tools for quality-adjustment. Essentially, it redefines goods in terms of their characteristics so that modified or new models do not open up a new product category but simply represent a new combination of characteristics. Thus, to some extent, the shift to characteristics space does away with the question of how to deal with new goods; at least as long as new goods do not incorporate fundamentally new characteristics. In the case of computers, for example, typical characteristics are speed, memory size and so forth. Empirically, a hedonic function is estimated, relating observations of prices of computer 'boxes' to their respective characteristics. One of the uses of the hedonic function is to estimate reservation prices of new models, *i.e*. an indication how much a new model would have cost in a previous period had it been available. Alternatively, price changes can be obtained directly from hedonic regressions.

79. To illustrate, consider the graph below which plots the US price index for office, computing and accounting machinery (based on hedonic methods) against the closest equivalent component of the German producer price index (not based on hedonic methods). Differences are striking and show that international comparisons of output and productivity measures in information technology industries have to be interpreted very cautiously.

Figure A2.1 **Price indices for IT equipment**



Source: Bureau of Economic Analysis and Statistisches Bundesamt.

80. Despite its features, there has been no systematic uptake of hedonic methods in national price statistics. One of the reasons is that the construction of hedonic deflators tends to be costly for statistical offices because a sizeable amount of primary data must be gathered, evaluated by specialists and treated in a comparatively resource-demanding econometric methodology. Reservations against hedonic price indices exist also when they are used in the context of fixed-weighted price indices. The substitution bias implicit in fixed-weight price indices is compounded when there are large changes of relative prices such as the ones induced by rapidly falling computer prices combined with rapidly growing quantities. This bias is minimised when price or quantity indices are based on index numbers with flexible weights, such as the Fisher Ideal index or the Törnqvist index or continually changing weights as in chain indices.

81. Table A2.3 confirms the varied treatment of price deflators for computers and office equipment between countries. It is obvious that international comparisons of output and productivity growth, in particular at the level of individual industries, have to be treated with great caution so as not to mistake consequences of methodological differences with true differences in the dynamics of the computer industry.

Table A2.3 **Output deflators for computers in selected OECD countries**

Canada	Belgium	Denmark	Finland	France	Germany
Hedonic price index for computers and peripherals	Industrial production price index – no hedonic adjustment	Currently US hedonic index, exchange rate-adjusted	Volume indicator	Hedonic price index for micro computers, otherwise unit value indices or industrial selling price index	Producer price index – no hedonic adjustment
Greece	**Italy**	**Spain**	**Sweden**	**United Kingdom**	**United States**
Wholesale price index – no hedonic adjustment	Producer price index – no hedonic adjustment	Index of industrial prices and unit value index – no hedonic adjustment	Producer price index with hedonic adjustment	Producer price index – no hedonic adjustment	Hedonic price index for computers, peripherals and semiconductors

Note: Actual practices in individual countries are still evolving as the switch-over to SNA93 proceeds.
Source: Adapted from Eurostat (1997).

A2.2 The impact of SNA revisions on productivity level estimates and time series

82. In recent years, there have been major revisions in the way in which national accounts are to be calculated. The two new systems of national accounts, the 1995 European System of National Accounts (ESA95) and the 1993 System of National Accounts (SNA93) are fully consistent, with ESA95 further enhancing the comparability of national accounts in the European Union. The changes in the national accounts system will ultimately lead to an improved picture of developments in OECD economies. However, given the large scale of the changes, implementation of the new sources and methods has been gradual, with progress uneven across countries and across different parts of the national accounts. In addition, many countries have only implemented the new system over a limited number of years in the past, at least in its initial phase. During this period of implementation, the interpretation of data is rendered more difficult and cross-country comparisons are particularly difficult.

83. The SNA93 convention represents the first major overhaul of the national accounting framework in 25 years and the changes are substantial. The main innovations include: greater prominence to chain volume series; more systematic use of accruals as opposed to cash-based measures, notably as regards interest payments and taxes; a broader concept of investment, including expenditure on software; changed treatment of some taxes, fees and subsidies; and greater efforts to capture the grey economy. For the analysis of growth performance across countries, two effects are considered in this section. The first is the impact of the new system of national accounts on levels of gross domestic product, the second the impact on growth rates. Other impacts, such as the impact of the new SNA on investment and sectoral output and value added, are not considered here. [67] However some description of the impact on the adopted series of

67. For an overview of some of these changes, see OECD (1999*a*) and the Economic Outlook Database Inventory description on http://www.oecd.org/eco/data/eoinv.pdf. United Nations (1993) discussed the SNA in great detail.

capital stock is discussed in the last subsection. Finally, it has to be underlined that time series used in this study were partially corrected through time-series splicing for the effect of breaks induced by partial backcasting of national accounts revisions.

A2.2.1 The impact on levels of GDP and productivity

84. The changes due to the new SNA tend to increase the level of total GDP, although not uniformly over time or countries. Table A2.4 shows the estimated impact of the SNA revision on 1996 GDP levels and the degree to which the SNA revision has been implemented in OECD countries. The following results emerge:

- The SNA revision raised the level of 1996 GDP in all OECD countries, ranging from 0.3 per cent in Belgium, to 7.4 per cent in Korea.
- A limited number of countries have not yet implemented the new SNA, including Iceland, Japan, New Zealand, Switzerland and Turkey. Austria has only recently revised its figures. GDP (and productivity) levels in these countries are likely to be underestimated compared with countries that have implemented the new SNA, though the extent of this bias is unknown.

A2.2.2 The impact on growth rates

85. In raising the GDP level over time, the growth record of OECD countries is often changed as well. Only a few countries, including Australia, Canada, France, the United Kingdom, have implemented the new SNA over a long historical record, however. Many OECD countries have only published new series for a short historical time period, implying that most of the time series for the longer time period remains based on the 1968 SNA (or ESA79). The impact on growth rates can be quite substantial, although it often proves difficult to separate the impact of the SNA revision from other changes in national accounting methodology. For instance, the recent revision of the US NIPA (which is related to the SNA93) raised annual average growth rates over the 1977-92 period by 0.3 per cent, and by 0.4 per cent over 1992-98 (Seskin, 1999). While substantial, only part of this change can be linked to the SNA revision. Other changes include the incorporation of a new input-output benchmark, and incorporation of geometric-mean-type consumer price indices.

Table A2.4 **Estimated impact of the SNA revision on GDP levels, and the available time series**

	Level of GDP, 1998 (million national currency units)	National accounts concept for 1998 GDP	Estimated impact of SNA/EAS revision on 1996 GDP level	Introduction of SNA93 or ESA95 in expenditure accounts	Time series for expenditure accounts
Australia	579,111	SNA93	0.9%	December 1998	from 1959
Austria	2,622,572	ESA79	n.a.	Winter 2000	n.a.
Belgium	9,064,000	ESA95	0.3%	June 1999	from 1980
Canada	895,704	SNA93	2.8%	December 1997	from 1955
Czech Republic	1,820,700	SNA93	2.5%	September 1999	from 1980
Denmark	1,168,307	ESA95	5.1%	October 1997	from 1988
Finland	686,013	ESA95	2.3%	April 1999	from 1988
France	8,582,113	ESA95	1.0%	July 1999	from 1978
Germany	3,784,200	ESA95	1.8%	April 1999	from 1991
Greece	35,910,600	ESA95	0.8%	September 1999	from 1995
Hungary	10,672,137	SNA93	0.9%	September 1999	from 1990
Iceland	550,027	SNA68	n.a.	expected in 2000	n.a.
Ireland	59,637	ESA95	0.4%	July 1999	from 1990
Italy	2,057,731,300	ESA95	1.2%	April 1999	from 1988
Japan	495,210,800	SNA68	n.a.	expected Oct. 2000	from 1990
Korea	449,508,700	SNA93	7.4%	March 1999	from 1990
Luxembourg	665,735	ESA79	7.3%	n.a.	from 1995
Mexico	3,791,191	SNA93	1.0%	October 1997	from 1980
Netherlands	776,161	ESA95	3.7%	October 1999	from 1995
New Zealand	98,204	SNA68	n.a.	n.a.	n.a.
Norway	1,107,082	SNA93	n.a.	since 1995	from 1978
Poland	551,110	SNA93	6.2%	September 1998	from 1991
Portugal	19,020,678	ESA79	n.a.	n.a.	n.a.
Spain	86,968,544	ESA95	4.4%	June 1999	from 1995
Sweden	1,872,849	ESA95	3.6%	May 1999	from 1993
Switzerland	380,011	SNA68	n.a.	n.a.	n.a.
Turkey	51,625,142,598	SNA68	n.a.	n.a.	n.a.
United Kingdom	843,725	ESA95	2.0%	September 1998	from 1948
United States	8,759,950	NIPA	2.0%	December 1999	from 1959

Source: 1998 GDP from Annex Table A.12. Estimated impact of SNA revision based on OECD Annual National Accounts and OECD Quarterly National Accounts, various issues. Implementation of SNA from OECD (1999*a*).

A2.2.3 The impact on capital stock

86. In the transition period, no official revised data and no new official estimates on capital stock are currently provided to the OECD by National Statistical Offices. Thus, the data currently in use have been estimated on the basis of new business investment series using certain assumptions concerning either the scrapping rate or, more directly, the growth of the capital stock. In certain cases, it has been assumed that for the reference period the capital/output ratio was unaffected by the rebasing. In other cases, the nominal value of the capital stock was assumed to be unchanged. In addition, for some countries, the scrapping rates has been kept unchanged at their pre-rebasing level, and the capital stock series has been calculated on the basis of the new investment data.[68] Overall, assessment exercises undertook by the Secretariat seem to show that the impact on capital stock growth rates is marginal.

68. Specific country details are available in the Economic Outlook Database Inventory description on http://www.oecd.org/eco/data/eoinv.pdf.

A2.3 Estimates of purchasing power parities

87. A key requirement in comparing income and productivity across countries is a purchasing power parity (PPP). A PPP is needed to convert expenditure and total GDP in the currency of each individual country to a common currency, customarily the US dollar. Market exchange rates are not suitable for this purpose, since they do not properly reflect international price differences, and because they are heavily influenced by short-term fluctuations. Over the past two decades, the OECD has regularly published estimates of PPPs, derived from its joint programme with Eurostat. Benchmark estimates of PPPs are currently available for 1980, 1985, 1990, 1993 and 1996, and work is underway for a new benchmark comparison for 1999.[69] In using PPP estimates for international comparisons of income and productivity, two issues must be addressed, namely the choice of aggregation method and the choice of benchmark year.

A2.3.1 The choice of aggregation method

88. The choice of aggregation method for international comparisons has been a source of debate over the past two decades. Initial work on international comparisons, such as the seminal study by Kravis, Heston and Summers (1982), provided a wide range of aggregation methods. The latest benchmark comparisons offer only two alternatives, namely those based on the Geary-Khamis method, and those based on the EKS method.[70] Aggregation takes place after price ratios for individual goods and services have been averaged to obtain unweighted parities for small groups of homogeneous commodities. It involves weighting and summing the unweighted commodity group parities to arrive at PPPs and real values for each category of expenditure up to the level of total GDP.

89. The EKS method treats countries as a set of independent units with each country being assigned equal weight. The EKS prices are obtained by minimising the differences between multilateral binary PPPs and bilateral binary PPPs. The EKS PPPs are thus close to the PPPs that would have been obtained if each pair of countries had been compared separately. The Geary-Khamis method treats countries as members of a group. Each country is weighted according to its share in GDP and the prices that are calculated are characteristic of the group overall. Both methods have a number of advantages and disadvantages:

– For countries with price structures that are very different from the average, the Geary-Khamis approach leads to higher estimates of volumes (and GDP per capita) than if more characteristic prices had been used. This effect is known as the Gerschenkron effect, and is particular important when comparing countries with great differences in income levels. The GK approach leads to results that are additively consistent, however, which implies that the real value of aggregates is the sum of the real value of its components. This is an advantage for national accounts and permits comparisons of price and volume structures across countries.

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69. The internet site of the OECD Statistics Department provides an overview of some of the key issues related to the construction of purchasing power parities, see http://www.oecd.org/std/ppps.htm. An evaluation of the PPP programme was prepared by the former chief statistician of the Australian Bureau of Statistics, Ian Castles, in 1997 (OECD, 1997), and has led to a range of improvements in the construction of PPPs. The recently published benchmark study for 1996 also contains an extensive discussion of many of the issues related to the OECD/Eurostat work on PPPs (OECD, 2000*b*).

70. See Elteto and Coves (1964) and Szulc (1964). More elaborate descriptions of these methods and the differences between them are available in OECD (2000*b*). See also Van Ark (1996), Pilat (1997) and OECD (1998*b*) for a discussion of the use of PPPs for international comparisons of productivity.

– The EKS method leads to results that are more characteristic of each country's own prices, and does not suffer from the Gerschenkron effect. Its results are not additive, however.

90. For OECD countries, the differences between the two methods are relatively small, since relative prices differ only little between countries (Table A2.5). The comparisons of income and productivity in the main paper utilise the EKS results, however, since these do not suffer from the Gerschenkron effect and are more closely aligned with index number theory.[71] The EKS method is also the method officially accepted by Eurostat for administrative purposes.

A2.3.2 The choice of benchmark year

91. For several OECD countries, the OECD/Eurostat estimates of PPPs are currently available for 5 benchmark years. This raises a problem of which benchmark to choose for international comparisons. In principle, it seems appropriate to use the most recent benchmark, *i.e*. 1996, since this is most likely to reflect current price differences in the OECD area. To indicate the sensitivity of comparisons of income and productivity to the choice of benchmark, Table A2.5 and 6 provide an overview of comparative estimates of GDP per capita for 1996, based on alternative benchmark results.[72] A number of results emerge:

– There is a wide variation in results between the different benchmark years.

– The 1985 benchmark provides the lowest estimate of GDP per capita relative to the United States for almost all OECD countries.

– The most recent benchmark results, for 1996, provide the highest level of GDP per capita relative to the United States for almost all OECD Member countries. This is even the case when the estimate is based on the EKS index, which is likely to lead to the lowest estimate of the two alternative aggregation methods.

– The estimates for 1990 and 1993 are quite close for most countries.

92. The 1996 benchmark results, even if they are the most recent, thus lead to estimates of relative income and productivity that are substantially higher than previously published results. The 1996 PPPs lead to estimates of comparative productivity that suggest that the United States has been surpassed by a considerable number of countries in Western Europe (Table A2.6). This is at odds with most other evidence on this point. In addition, the 1993 estimates have recently been used for several international comparisons of productivity (OECD, 1999*b*; Van Ark and McGuckin, 1999). For these reasons, the main paper applies the 1993 EKS benchmark PPPs.[73]

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71. The EKS method is closely related to superlative index numbers, such as the Theil-Tornqvist index.

72. An alternative approach is to compare PPP estimates for 1996, based on the different benchmarks. This approach leads to the same results as those shown in Table A2.6, since both approaches use time series of GDP in current and constant prices to update the estimates to non-benchmark years.

73. For the Czech Republic, Hungary, Mexico and Poland, 1996 EKS PPPs are used since no other estimates are available. For Western Germany, 1990 EKS PPPs were used since no recent estimates are available. Korea is based on official OECD estimates, published in the OECD National Accounts.

Table A2.5 **1996 level of GDP per capita based on different PPP benchmarks**
(United States=100)

	Benchmark years for PPP estimates									
	1980		1985		1990			1993		1996
	Fisher index	Geary-Khamis	Fisher index	Geary-Khamis	Fisher index	EKS index	Geary-Khamis	EKS index	Geary-Khamis	EKS index
Australia	n.a.	n.a.	66.8	68.5	72.6	72.4	74.2	72.3	74.8	78.5
Austria	66.6	67.9	57.5	60.5	67.4	68.3	69.2	71.0	71.7	76.0
Belgium	72.1	74.3	60.5	62.1	69.6	68.6	70.6	74.0	76.0	79.3
Canada	81.3	84.1	75.8	76.6	75.4	73.5	75.4	74.2	76.1	81.4
Czech Republic	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	52.0
Denmark	78.4	82.1	65.6	68.8	76.2	74.7	80.6	77.5	81.9	88.5
Finland	n.a.	71.5	57.7	62.5	64.2	65.2	67.0	65.9	69.1	73.9
France	71.1	73.5	61.0	62.9	69.7	69.4	71.2	69.3	72.1	73.1
West Germany	75.3	78.4	64.4	67.1	77.5	76.0	77.4	n.a.	n.a.	n.a.
Germany	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	68.3	69.6	75.5
Greece	38.7	43.3	36.2	38.3	38.1	38.1	41.5	42.4	46.8	48.6
Hungary	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	40.2
Iceland	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	71.7	75.0	81.8
Ireland	72.3	78.1	61.5	63.9	64.8	66.6	66.9	71.3	74.1	75.1
Italy	66.1	69.1	58.0	60.2	64.9	65.7	67.5	65.6	67.1	71.8
Japan	70.7	73.2	61.9	68.5	69.8	70.4	74.3	72.5	78.5	85.0
Korea[1]	n.a.	42.7	33.9	39.8	n.a.	n.a.	n.a.	42.3	n.a.	n.a.
Luxembourg	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	117.4	119.9	124.9
Mexico	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	31.8
Netherlands	74.5	78.6	67.0	69.8	73.8	72.3	75.3	72.7	76.7	83.2
New Zealand	n.a.	n.a.	42.5	46.3	52.0	51.2	53.0	53.2	54.3	55.9
Norway	99.7	109.7	82.8	89.4	81.4	81.8	86.4	85.7	93.6	91.6
Poland	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	33.8
Portugal	37.4	41.8	36.2	41.2	41.7	41.8	47.3	45.0	51.1	55.0
Spain	53.3	56.3	47.1	49.6	50.9	52.2	54.1	53.8	56.3	58.1
Sweden	n.a.	n.a.	61.4	64.6	67.5	66.8	69.5	65.5	67.0	72.5
Switzerland	n.a.	n.a.	n.a.	n.a.	76.6	76.1	77.7	81.2	84.4	91.0
Turkey	n.a.	n.a.	21.4	27.7	20.7	20.5	26.0	20.6	24.0	26.4
United Kingdom	65.6	69.8	61.1	63.7	67.1	67.7	69.4	67.3	67.6	69.8
United States	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: Korean benchmark for 1993 based on OECD estimates.
Source: PPP estimates for 1980, 1985 and 1990 from Maddison (1995), 1993 and 1996 from data files provided by the OECD Statistics Department; Estimates of GDP and population from sources quoted in main paper.

Table A2.6 **Range of estimates on GDP per capita and GDP per hour worked, 1996**
(United States=100)

	Lowest estimate (a)		Highest estimate (a)		Average level over available estimates (a)	Relative difference highest - lowest estimate	GDP per hour worked, 1993 EKS PPPs (USA=100)	GDP per hour worked, 1996 EKS PPPs (USA=100)
	GDP per capita (United States=100)	Benchmark for lowest estimate	GDP per capita (United States=100)	Benchmark for highest estimate				
Australia	66.8	1985	78.5	1996	72.5	18%	82.5	89.5
Austria	57.5	1985	76.0	1996	67.9	32%	96.4	103.2
Belgium	60.5	1985	79.3	1996	70.9	31%	116.9	125.4
Canada	73.5	1990	84.1	1996	77.2	15%	80.1	87.9
Czech Republic	52.0	1996	52.0	1996	52.0	0%	n.a.	52.2
Denmark	65.6	1985	88.5	1996	76.9	35%	91.7	104.7
Finland	57.7	1985	73.9	1996	65.7	28%	88.4	99.1
France	61.0	1985	73.5	1996	68.8	20%	100.1	105.5
West Germany (b)	64.4	1985	78.4	1990	71.9	22%	105.8	n.a.
Germany	68.3	1993	75.5	1996	71.9	11%	89.8	99.2
Greece	36.2	1985	48.6	1996	40.8	34%	56.4	64.6
Hungary	40.2	1996	40.2	1996	40.2	0%	n.a.	61.0
Iceland	71.7	1993	81.8	1996	76.7	14%	70.0	79.9
Ireland	61.5	1985	78.1	1996	69.3	27%	92.7	97.6
Italy	58.0	1985	71.8	1996	65.4	24%	104.4	114.3
Japan	61.9	1985	85.0	1996	72.1	37%	68.4	80.3
Korea	33.9	1985	42.3	1993	38.1	25%	37.4	n.a.
Luxembourg	117.4	1993	124.9	1996	121.2	6%	120.1	127.8
Mexico	31.8	1996	31.8	1996	31.8	0%	n.a.	33.9
Netherlands	67.0	1985	83.2	1996	73.9	24%	103.0	117.9
New Zealand	42.5	1985	55.9	1996	50.7	32%	64.2	67.4
Norway	81.4	1990	109.7	1980	88.3	35%	108.8	116.3
Poland	33.8	1996	33.8	1996	33.8	0%	n.a.	n.a.
Portugal	36.2	1985	55.0	1996	43.1	52%	49.9	61.0
Spain	47.1	1985	58.1	1996	52.9	23%	87.0	94.1
Sweden	61.4	1985	72.5	1996	66.6	18%	87.0	96.2
Switzerland	76.1	1990	91.0	1996	82.8	20%	85.4	95.7
Turkey	20.6	1993	27.7	1996	22.2	35%	n.a.	n.a.
United Kingdom	61.1	1985	69.8	1996	66.3	14%	83.1	86.2
United States	100.0	n.a.	100.0	n.a.	100.0	0%	100.0	100.0

Note: (a) Levels based on the Fisher (1980 and 1985) and EKS (1990, 1993 and 1996) aggregation methods only.
(b) 1993 estimate for Western Germany based on 1990 EKS PPP.
Source: Table A2.6. Productivity estimates derived from sources quoted in the main paper.

A2.4 Data sources and link with national sources

93. As a rule, two OECD databases were used in this study:

- the Analytical Data Base (ADB) for indicators at the level of the entire economy or at the level of the total business sector;
- the Structural Analysis (STAN/ISDB) database at the level of individual industries or sectors (see Table A2.7).

94. In consultation with the OECD Directorate for Employment, Labour and Social Affairs, several specific adjustments were made to data on hours worked. These are discussed in a subsection. Also, in some cases, the latest (1999) edition of the STAN database does not reflect the latest data available from national sources and where updates were available, they have been used in this study.

95. For some analytical parts, information is drawn from additional sources. These include recent work by DSTI (Schreyer, 2000) which is the source for information on the compositional change of the capital stock and on the flow of capital services in the G-7 countries. Similarly, the data needed to differentiate labour input by type of worker comes from OECD *Education at a Glance,* OECD Database, 1999**.**

96. In individual cases, a decision was taken to use alternative sources or to construct specific estimates in order to enhance time-series and cross-country comparability in the derived growth rates. Specific adjustments have been made for three countries: United Kingdom, Canada and United States. In a specific subsection for each country, these adjustments are discussed and compared with national sources. Among the most important adjustments are those concerning capital stock series for the United States and Canada. These adjustments reflect efforts to use a gross capital stock measure for basic productivity calculations, so as to be in line with the majority of data available for other countries.

97. Furthermore, three OECD countries (the United States, Canada and Australia) have undertaken specific statistical programmes to develop national series on multi-factor productivity growth. Because of somewhat different methodologies, these national indicators may not coincide with those developed by OECD in the present study. It is therefore useful to reconcile national and international results so as to maximise transparency about possible differences. The subsections on data sources for the United States and Canada accomplish this task as well. In the comparison with national sources, measures used for this study will be termed as OECD measure for simplicity.

Table A2.7 **Industry breakdown (ISDB, STAN databases)**

ISIC 2 classification
3000 Total manufacturing industry
3100 Food, drink & tobacco
3200 Textiles, footwear & leather
3300 Wood, cork & furniture
3400 Paper & printing
3500 Chemical products
3510 Industrial chemicals
3520 Other chemicals
3512X Chemicals excl. drugs
3522 Drugs and medicines
3534A Petrol refineries & products
3556A Rubber & plastics products
3600 Stone, clay & glass
3700 Basic metal industries
3710 Ferrous metals
3720 Non-ferrous metals
3800 Fabricated metal products and machinery
3810 Fabricated metal products
3820 Non-electrical machinery
382X Machinery & equipment, nec
3825 Office machinery & computers
3830 Electrical machinery
383X Electrical machinery excl. comm. equipment
3832 Radio, TV & communication equipment
3840 Transport equipment
3841 Shipbuilding
3843 Motor vehicles
3845 Aircraft
3842A Other transport equipment
3850 Professional goods
3900 Other manufacturing
1000 Agriculture
2000 Mining and quarrying
4000 Electricity, gas, water
5000 Construction
6000 Wholesale & retail trade, restaurants and hotels
6120 Wholesale and retail trade
6300 Restaurants and hotels
7000 Transports, storage, and communications
7100 Transport and storage
7200 Communication services
8000 Finance,insurance,real estate, & business services
8120 Finance and insurance
8300 Real estate and business services
9000 Community, social, and personal services
9100 Public administration and defence
9200 Sanitary and similar services
9300 Social and related community services
9400 Recreational and cultural services
9500 Personal and household services
9600 International services

A2.4.1 Hours worked

98. Estimates of hours worked come mainly from two national or EU sources:

- For Austria, Belgium, Denmark, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and the United Kingdom, a country-specific adjustment has been applied to data from the European Labour Force Survey (EULFS). This adjustment factor varies by year and is obtained as the ratio of adjusted versus non-adjusted estimates of hours worked based on the EULFS under the assumption that there is a 50 per cent underestimation for time lost due to illness and maternity. The average adjustment factor for the countries reported above is 0.97.

- For Finland and Iceland, an average adjustment factor derived from the EULFS has been applied to national Labour Force Survey (LFS) estimates due to the limited length of EULFS series.

- For Australia, Czech Republic, Korea, and New Zealand, data come from LFS, adjusted with the average adjustment factor of 0.97.

- For Canada, France, Germany, Hungary, Japan, Norway, Spain, Sweden, and Switzerland, data are national estimates (either from LFS, or from national accounts/enterprise surveys). For the United States data are the BLS estimate of total hours worked on the basis of the Current Population Survey, the Current Employment Statistics, and the Hours at Work Survey, divided by the average number of employed persons.

- For Mexico hours worked are based on a level estimate from Maddison (1995) for 1992 and a time series from the National Survey of Employment (see OECD, 1999*d*, for more detailed information on national sources).

Where possible, estimates has also been extended backwards through splicing with the estimates from Maddison (1995).

A2.4.2 United States

99. In the United States, BLS provides official series on labour and multi-factor productivity. In what follows, comparisons are made with BLS's annual multifactor statistics for the United States business sector. The table below compares average annual rates of change of output and different input measures for the period 1980-97. The following observations can be made:

Output

100. Small differences occur, because OECD (ADB) business sector data is based on national income and product accounts data, reflecting revisions as of 28 Oct. 1999 which have not yet been incorporated into the BLS series. Also, the BLS business sector output measures exclude government enterprises to be fully consistent with its capital input series. The OECD series does not make this adjustment and therefore

includes government enterprises. Also, the ADB adjustment to move from an aggregate for the total economy to the value-added of the business sector is not identical to national procedures.[74]

Labour

101. The number of persons in the OECD series is taken from employment data as published in the United States' National Income and Product Accounts. It reflects persons employed in production, *i.e*. the number of employees plus self-employed. Hours worked per person were derived separately, as discussed above. BLS, in its multi-factor productivity series, uses an index of labour input. Conceptually, the measure of labour input is similar to OECD's labour input measure as described in Annex 3 (Section A3.1): it reflects total hours worked, adjusted for changes in the composition of the quality of labour. Although BLS is able to use a much finer level of differentiation between types of labour, the two labour input measures differ only by 0.2 percentage points over the period under consideration. While this difference would appear small, it may be the result of compensating differences or simply due to the specific period chosen for comparison.

Capital

102. As pointed out earlier, for its basic MFP series, OECD uses an estimated measure of the gross capital stock[75], while available data in ADB refer to a concept of net capital stock as published by BEA. BLS, akin to its labour input measure, uses a measure of capital services that reflects both the quantity and the changing composition of capital input. The underlying concept is briefly described in Annex 3 (Section A3.1) as well as in the body of the text, and more fully in OECD (1999a). As would be expected, the gross capital stock measure grows by much less (at an average 2.8 per cent) than BLS' capital service measure (at an average of 3.2 per cent). However, there is significant similarity between OECD's capital service series and that of BLS. The construction of the OECD capital service data is described above in Annex 3 (Section A3.1).

MFP measures

103. Depending on the ingredients, different MFP measures are constructed: a simple MFP term based on unadjusted labour and capital data, grows by 1.0 per cent per year over the period 1980-97. It falls to 0.8 per cent when labour input is adjusted for compositional change and falls further to 0.6 per cent when adjusted capital input is used. The latter measure is the one closest comparable to BLS' MFP index, and the resulting 0.2 percentage point difference would appear within the bounds of comparability.

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74. More specific information is available from the Economic Outlook data base description on http://www.oecd.org/eco/data/eoinv.pdf.

75. The estimate of the gross stock uses BEA's former gross stock measure up to 1993, the last available update. More recent estimates were obtained as follows: the historical series of gross stock were regressed against BEA's net stock series and BLS' capital services series. For years after 1993, the gross stock was then estimated as the predicted value from this regression, using recent observations on the net stock and on capital services.

Table A2.8 **Comparison between productivity measures by OECD and by the Bureau of Labour Statistics***

Measure		Methodology/definition OECD	Methodology/definition BLS	1980-97 Average annual rate of change OECD	BLS	Difference
Output		Value-added of business sector		3.1%	3.2%	-0.1%
Labour		a) Number of persons		1.8%		
		Hours per person		0.0%		
		b) Labour input**	Labour input**	2.0%	2.2%	-0.1%
Capital	1980-97	a) Gross capital stock	Capital services**	2.8%	3.2%	-0.4%
	1980-96	b) Capital services**	Capital services**	3.2%	3.2%	
	1980-97	c) Memorandum item: Wealth capital stock (US Bureau of Economic Analysis)			2.5%	
Results:						
MFP, based on hours worked and capital stock				1.0%		
MFP, based on labour input and capital stock				0.8%		
MFP, based on labour input and capital services			1980-97		0.5%	
MFP, based on labour input and capital services			1980-96	0.6%	0.4%	0.2%

* BLS Annual multifactor productivity statistics

** See text for explanations.

A2.4.3 Canada

104. In Canada, labour and MFP statistics are published annually by Statistics Canada. In what follows, comparisons are made with Statistics Canada's data for the business sector, and based on a value-added concept. The table below compares average annual rates of change of output and different input measures for the period 1980-97. The following observations can be made:

Output

105. There are only minor differences between OECD business sector series and the ones published by Statistics Canada, due to differences in the definition of the business sector.

Labour

106. The number of persons in the OECD series is taken from employment data as published by Statistics Canada's Input-Output Division. Series on both the number of persons and on total hours are available. Statistics Canada, in its multi-factor productivity series, uses an index of labour input. Conceptually, this labour input measure is not as elaborate as the one used by BLS but is more developed than a simple sum of all hours. Differentiation takes place by industry, because each industry's contribution to the economy's labour input is weighted by the share that a given industry occupies in the economy's total labour compensation. If average wages in an industry exceed those of other sectors, an

implicit weighting of hours by industry takes place. However, there is no explicit differentiation by educational attainment or the skills of workers. As it turns out, over the period 1980-97 presented here, there is only a minor difference between total hours and the labour input series. However, and not surprisingly, the comparison with OECD's labour input series (which reflects an attempt to explicitly differentiate between types of workers) shows a more important difference: the former grows by 1.4 per cent, the latter by 1.7 per cent.

Capital

107. As pointed out earlier, for its basic MFP series, OECD uses an estimated measure of the gross capital stock. For Canada, gross capital stock is the Statistics Canada capital stock series that is constructed on a one-hoss shay age-efficiency pattern. Statistics Canada's own MFP calculations use as input another of their capital stock series, one based on a geometric age-efficiency pattern. A second difference lies in the aggregation procedure: Statistics Canada uses a Fisher index number formula to aggregate capital input across industries. The gross capital stock measure used by OECD is based on a Laspeyres-type aggregation formula. Again, the final outcome does not differ by much, although this reflects the combined, and partly offsetting, effects of a different age-efficiency pattern and a different index number formula. Finally, the table shows OECD's capital services measure which aims at capturing the changing composition of capital input. The underlying concept is briefly described in Annex 3 as well as in the body of the text.

MFP measures

108. Depending on the ingredients, different MFP measures are constructed: a simple MFP term based on unadjusted labour and capital data, grows by 0.6 per cent per year over the period 1980-97. This compares with a 0.7 per cent change in Statistics Canada's data. The OECD MFP measure falls to 0.4 per cent when labour input is adjusted for compositional change and falls further to 0.2 per cent when adjusted capital input is used.

Table A2.9 **Comparison between productivity measures by OECD and by Statistics Canada**

1980-97 Average annual rate of change						
Measure		Methodology/definition				
		OECD	Statistics Canada	OECD	Statistics Canada	Difference
Output						
		Value added of business sector		2.5%	2.6%	0.0%
Labour		a) Number of persons		1.5%		
		Hours per person	Labour input**	-0.1%	1.4%	0.1%
		b) Labour input**		1.7%		
Capital	a)1980-97	Gross capital stock	Capital input**	2.9%	2.7%	0.1%
	b)1980-96	Capital services**		3.1%		
MFP, based on hours worked and capital stock			1980-97	0.6%	0.7%	-0.1%
MFP, based on labour input and capital stock			1980-97	0.4%		
MFP, based on labour input and capital services			1980-96	0.2%		

* Statistics Canada's Multifactor Productivity Measures based on value-added (as of December 1999)
** See text for explanations.

A2.4.4 United Kingdom

109. In the United Kingdom, time series for business sector GDP and employment have been corrected to take into account the fact that the National Health Service (NHS) Trust, created in 1991, is not accounted for in the government sector. Conversely all public health services were accounted for in the government sector before 1991. For comparability reasons both employment and GDP of NHS Trust have been subtracted from business sector series. The method of calculation of GDP of NHS Trust is as follows: First on the basis of United Kingdom *Abstract of Statistics, 1998*, a productivity level at current prices of NHS Staff was computed on the basis of Total Current Expenditure on the NHS (item KJQJ) and Total Employment of NHS (items KDBC+KDBO+KWUH). Then a real (at 1995 prices) productivity was computed through the implicit deflator of Health and Social Work sector (Sector N in the National Accounts - *National Accounts, 1998* - Blue Book). Then this productivity was applied to data on NHS Trust staff.

ANNEX 3. METHODOLOGICAL NOTES

A3.1 Measurement of labour and capital inputs

110. Measures of factor use for the purpose of productivity analysis should be constructed so as to reflect the role that each factor plays as input in the production process. In the case of labour input, the simple count of hours worked is only a crude approximation to the correct measure of labour input insofar as workers show great differences in education, experience, sector of activity and other attributes that greatly affect their marginal productivity. In particular, different types of labour should be weighted by their marginal contribution to the production activity in which they are employed. Since these productivity measures are generally not observable, information on relative wages by characteristics is used to derive the required weights to aggregate different types of labour. The resulting measure of labour input can be quite different from a simple aggregate of total hours or total persons (Dean *et al*., 1996). The difference between the weighted and unweighted series yields an index for the compositional change of labour input, or its quality.

111. Jorgenson (1963) and Jorgenson and Griliches (1967) were the first to develop aggregate capital input measures that took the heterogeneity of assets into account: they defined the flow of quantities of capital services individually for each type of asset, and then applied asset-specific user costs as weights to aggregate across services from the different types of assets. User costs are prices for capital services and, under competitive markets and equilibrium conditions, these prices reflect marginal productivities of the different assets. User cost weights are thus a means to effectively incorporate differences in the productive contribution of heterogeneous investments as the composition of investment and capital changes. Changes in aggregate capital input therefore have two distinct sources – changes in the quantity of capital of a given type, and changes in the composition of the various types of assets with different marginal products and user costs (Ho *et al*., 1999). Computationally, the comparison of an aggregate capital stock with a measure of capital services based on user costs weights, yields a measure of the compositional change of capital input.

A3.1.1 Productivity growth measures without adjustment for different types of factor input

112. The following notation is used to discuss factor productivity with and without control for quality effects:

Y Current price value-added;

P Price index of value-added;

N Total number of persons engaged;

H Average hours worked per person;

$N*H$ Total hours worked;

K Aggregate gross capital stock.

113. Letting lower case letters represent logarithms and Δ the first difference operator, Δx approximates the (instantaneous) growth rate of any variable x. The standard measure of factor productivity growth rates, $d\pi_L$ *and* $d\pi_K$ are given by:

$\Delta\pi_L = \Delta y - \Delta p - (\Delta n + \Delta h)$ Labour productivity

$\Delta\pi_K = \Delta y - \Delta p - \Delta k$ Capital productivity

114. This standard specification does not differentiate between different types of inputs: it attaches the same weight to each hour worked, and it does not differentiate between assets even though their marginal contribution to output may be quite different. Such differentiation can be introduced when there is information on quantities and prices of the different types of factor inputs. In the case of labour, prices will represent the skill-specific wage rate, in the case of capital the asset specific rental price or user cost of capital. In what follows different types of labour and capital will be distinguished by the subscript *j*.

A3.1.2 Productivity growth measures with adjustment for different types of factor input

115. Given a set of observations on different types of labour or capital and given a set of corresponding prices, $w_{j,t}$ it is possible to construct an aggregate variable F that combines quantities of different types of inputs to a measure of total, quality-adjusted labour or capital input. In this regard, productivity studies often use the Törnqvist index and this practice is followed here. A Törnqvist index of factor input F is given by the expression below, where $v_{j,t}$ stands for the share of the component *j* in total costs of the factor. This is a conceptually correct measure for the flow of the total quantity of labour or capital services:

$$\Delta f_t(adj) = \sum_j \bar{v}_{j,t} \cdot \Delta f_{j,t} \quad where \;\; \bar{v}_{j,t} = \frac{1}{2}\left(v_{j,t} + v_{j,t-1}\right) \; and \;\; v_{j,t} = \frac{w_{j,t}F_{j,t}}{\sum_i w_{i,t}F_{i,t}}. \qquad [A3.1]$$

116. Thus, the growth rate of total factor input Δf, using the Törnqvist index, is a weighted average of the growth rates of different components. Weights correspond to the current price share in the overall cost for each factor. Subtracting the unadjusted measure of factor input from the one adjusted for compositional changes yields an expression Δcf for the effects of changing factor quality on total factor input services:

$$\Delta cl = \Delta l(adj) - (\Delta n + \Delta h). \qquad [A3.2]$$

$$\Delta ck = \Delta k(adj) - \Delta k. \qquad [A3.3]$$

117. Equations [A3.2] and [A3.3] can be rearranged to yield a decomposition of the overall growth in factor input:

$$\Delta l(adj) = \Delta cl + \Delta n + \Delta h$$

$$\Delta k(adj) = \Delta ck + \Delta k$$

A3.1.3 Labour input

118. In order to consider changes in the composition of labour input, six different types of labour were considered, based on gender and three different educational levels: below upper secondary education; upper secondary education and tertiary education. Thus, if L_j indicates the labour input *j*th with *j=1,2,..6* and each type of labour is remunerated with wage rate $w_{,j}$, the following observation concerning calculations should be made:

- First, it is assumed that the rate change in average weekly or yearly hours is identical between education and gender groups, *i.e.* $\Delta h_j = \Delta h$ for all *j*. This simplification can be used, in conjunction with the relation $\Delta l_{,j} = \Delta n_{,j} + \Delta h_{,j}$.
- Second, data on relative wage rates by education attainment and gender are only available for the 1990s, and thus relative wage rates were assumed to be constant over the period considered in the analysis. More specifically, for the six available categories of education and gender, the wage spread was computed as $\dfrac{w_j}{w_{M,US}}, j = 2,3,4,5,6$ as each education category's wage rate relative to wages of male workers with upper-secondary education $(w_{M,,US})$.
- The weights $v_{j,c}$ from equation [A3.1] for country *c* can be rewritten in terms of relative wages:

$$v_{j,c} = \frac{w_{j,c} N_{j,c}}{\sum_{i=1}^{6} w_{i,c} N_{i,c}} = \frac{\dfrac{w_{j,c}}{w_{M,US,c}} N_{j,c}}{\sum_{i=1}^{6} \dfrac{w_{i,c}}{w_{M,US,c}} N_{i,c}}.$$

119. Data on the level of education attainment of employment and relative wages are from the OECD *Education at a Glance* and refers to the ISCED classification. Available data have been re-grouped into three education groups, for both men and women: 1) below upper secondary education (ISCED 0 to ISCED 2); 2) upper secondary education (ISCED 3); and 3) tertiary education (ISCED 5 to ISCED 7). The level of education attainment for male and female workers is available for the early 1980s and 1996 for the following countries: Denmark, Finland, France, New Zealand, Norway, Spain and Sweden. For the other countries, the first available data in the OECD database is 1989. To estimate changes in the composition of employment from the 1980s to the 1990s, the OECD data have been complemented with information from the Barro and Lee (1996) database. In particular, growth rates of employment by different level of education were used to estimate missing observations for the early 1980s. For Austria, Belgium, Czech Republic, Greece, Hungary, Korea, Mexico, Poland, Spain, Switzerland and Turkey the calculation of labour input was not possible due to the unavailability of either the education composition of employment or relative wages by education level.

A3.1.4 Capital input[76]

120. In the case of capital, it is assumed that capital services from asset type *j*, $K_{j,t}$, are in constant proportion to the productive stock[77] of capital asset *j*, $K^P_{j,t}$:

76. For a fuller description, see Schreyer (2000).

$$K_{j,t} = \rho_j K^P_{j,t} \;\; j = 1,2,...6.$$

121. Six types of assets were used as a basis for calculation: non-residential structures, transport equipment, information technology equipment, communication equipment, other producer durable equipment and other capital goods. For each asset, a productive capital stock is constructed by aggregating across different vintages of investment and by allowing for losses of productive efficiency over an asset's service life.

122. Because countries employ different methodologies to construct deflators for information and communication technology assets, a harmonised deflator was used to measure real investment expenditure in these products.

123. Associated with the quantity flow of capital services (such as ton-kilometres provided by a freight truck or cubic feet of storage space provided by a warehouse) comes a price component, the user cost or rental price of capital. Capital services are sometimes traded between asset owners and the producers who need to use them. However, most capital services are produced for own consumption within producers' establishments and cannot be observed in the marketplace. Jorgenson (1963) and Jorgenson and Griliches (1967) demonstrated how user cost expressions can be computed. They are composed of i) the opportunity costs of investing money in the bank rather than in a capital good; ii) of the costs of depreciation, *i.e.* the loss in value of the capital asset as it ages; and iii) of capital gains or losses, or the change in value of the asset that is unrelated to ageing.[78] These three components are reflected in the user cost expression μ_j for asset *j* below, where q_j is the asset's acquisition price, *r* is the internal rate of return (equal across all assets), and d_j is the asset-specific rate of depreciation.

$$\mu_{j,t} = q_{j,t}\left(r_t + d_{j,t} - \frac{\Delta q_{j,t+1}}{q_{j,t}}\right) = q_{j,t}(r_t + d_{j,t}) - \Delta q_{j,t+1}$$

77. There are different ways how the loss in productive efficiency can be modelled, including at a constant rate (geometric age-efficiency profile), by a constant amount (linear declining balance), in a single step at the end of the service life ('one hoss shay), or at a changing rate that accelerates over an asset's service life (hyperbolic pattern). The choice of a particular age-efficiency profile is an empirical one – and a matter of plausibility. For the present exposition, a hyperbolic profile underlies the calculation but other results can be tested.

78. Taxes and depreciation allowances are further elements that should enter user cost expressions. For a more comprehensive treatment of the measurement of user costs, see OECD (1999*a*).

124. Given the time series on $K^P_{j,t}$ and $\mu_{j,t}$, asset specific weights $v_{j,t}$ as in equation [A3.1] are given by:

$$v_{j,t} = \frac{\mu_{j,t} K^P_{j,t}}{\sum_{i=1}^{6} \mu_{i,t} K^P_{i,t}}$$

A3.2 Sensitivity analysis of multi-factor productivity

125. Table 6 and Table 7 in the main text report various measures of MFP growth. Using trend series for output and labour, Table 6 shows the effect of different measures of partial output elasticities (namely average labour shares, time-varying labour shares and estimated elasticities). Table 7 shows how the measure of MFP growth rates is affected by changes in the way inputs are measured (namely accounting for hours worked and quality changes). Results and consequent interpretation of different MFP measures are discussed in the main text and are not repeated here. This section expands further the sensitivity analysis by reporting measures of MFP growth based on actual series. Furthermore, in a separate subsection, it gives details on the estimation of partial output elasticities.

A3.2.1 Trend vs. actual time series

126. All the analysis on growth rates of MFP developed in the main text considers trend series of real GDP and employment in the business sector. In principle, it can be expected that the use of trend rather than actual time series makes little difference for average growth rates over a long period (*e.g.* 10 years). Conversely, over a shorter period, averages of trend growth rates of MFP can be rather different from averages of actual growth rates, due to the fact that the latter incorporate short-run dynamics due to partial adjustment, cyclical phenomena and the effect of transitory shocks. Table A3.1 reports MFP growth rates based on actual time-series (The table has the same structure of Table 6 in the main text). As expected, differences between MFP growth rates based on actual and trend series are small except for the period 1995-98 for few countries.[79] A similar conclusion can be drawn for MFP growth rates adjusted for hours worked, reported in Table A3.2.

79. Somewhat significant differences can be observed for Japan also the period 1990-97.

Table A3.1. **Multifactor productivity growth, based on actual series**
Average annual growth rates

		1970-98[1]	1980-90	1990[2]-98[1]	1995-98[1]
United States	Average factor shares	0.7	0.9	1.1	1.7
	Time-varying factor shares	0.8	0.9	1.1	1.7
	Estimated factor elasticities	0.9	1.0	1.3	1.9
Japan	Average factor shares	1.4	1.7	0.4	1.7
	Time-varying factor shares	1.4	1.8	0.3	1.6
	Estimated factor elasticities	1.1	1.5	0.2	1.5
Germany	Average factor shares	1.2	1.2	1.1	1.1
	Time-varying factor shares	1.3	1.2	1.1	1.0
	Estimated factor elasticities	1.5	1.3	1.3	1.3
France	Average factor shares	1.5	1.6	0.8	1.2
	Time-varying factor shares	1.6	1.7	0.7	1.2
	Estimated factor elasticities	1.8	1.8	1.1	1.3
Italy	Average factor shares	1.3	1.1	1.0	0.4
	Time-varying factor shares	1.4	1.1	0.9	0.3
	Estimated factor elasticities	1.2	1.0	0.9	0.3
United Kingdom	Average factor shares	1.7	2.1	1.3	1.0
	Time-varying factor shares	..	..	1.3	1.0
	Estimated factor elasticities	1.6	2.0	1.2	0.9
Canada	Average factor shares	0.7	0.3	0.9	1.5
	Time-varying factor shares	0.7	0.3	0.9	1.5
	Estimated factor elasticities	1.0	0.6	1.1	1.7

Table A3.1. **Multifactor productivity growth, based on actual series** (continued)
Average annual growth rates

		1970-98[1]	1980-90	1990[2]-98[1]	1995-98[1]
Australia	Average factor shares	..	0.8	2.2	2.4
	Time-varying factor shares	..	0.9	2.2	2.4
	Estimated factor elasticities	..	0.9	2.2	2.6
Austria	Average factor shares	0.9	1.0	0.3	1.4
	Time-varying factor shares	1.0	1.1	0.3	1.2
	Estimated factor elasticities	1.0	1.0	0.4	1.4
Belgium	Average factor shares	1.4	1.0	0.6	0.5
	Time-varying factor shares	1.4	1.1	0.6	0.5
	Estimated factor elasticities	1.5	1.1	0.7	0.6
Denmark	Average factor shares	1.1	0.7	1.9	0.7
	Time-varying factor shares	1.2	0.8	1.9	0.7
	Estimated factor elasticities	1.4	1.0	2.1	0.9
Finland	Average factor shares	2.3	2.1	2.8	3.6
	Time-varying factor shares	2.4	2.2	3.0	3.7
	Estimated factor elasticities	2.6	2.3	3.1	3.6
Greece	Average factor shares	0.3	-0.4	0.2	0.7
	Time-varying factor shares	0.3	-0.3	0.1	0.7
	Estimated factor elasticities	..	..	..	..
Iceland	Average factor shares	..	..	-1.4	..
	Time-varying factor shares	..	..	-1.3	..
	Estimated factor elasticities	..	..	-1.7	..
Ireland	Average factor shares	3.6	3.7	3.2	4.6
	Time-varying factor shares	3.7	3.8	3.2	4.7
	Estimated factor elasticities	3.8	4.0	3.2	4.5
Netherlands	Average factor shares	1.4	1.2	0.9	0.8
	Time-varying factor shares	1.5	1.3	0.9	0.8
	Estimated factor elasticities	1.4	1.2	0.9	0.8
New Zealand	Average factor shares	0.6	0.9	1.0	..
	Time-varying factor shares	..	0.9	1.1	..
	Estimated factor elasticities	0.7	1.1	0.7	..
Norway[3]	Average factor shares	1.5	0.3	2.0	1.4
	Time-varying factor shares	1.5	0.4	2.2	1.7
	Estimated factor elasticities	1.3	0.1	2.0	1.4
Portugal	Average factor shares	1.1	0.7	2.8	..
	Time-varying factor shares	..	0.8	2.6	..
	Estimated factor elasticities	..	..	..	..
Spain	Average factor shares	1.2	1.5	0.8	0.5
	Time-varying factor shares	1.5	1.7	0.6	0.4
	Estimated factor elasticities	1.4	1.6	1.0	0.6
Sweden	Average factor shares	0.9	1.0	1.8	1.1
	Time-varying factor shares	0.9	1.0	1.8	1.0
	Estimated factor elasticities	..	..	..	..
Switzerland	Average factor shares	..	-0.2	-0.6	..
	Time-varying factor shares	..	-0.2	-0.5	..
	Estimated factor elasticities	..	-0.2	-0.7	..

1. 1997 for Australia, Belgium, Canada, Italy, Japan, Norway, Spain and United States, 1996 for Austria, Finland, Greece, Ireland, Sweden and United Kingdom, 1995 for New Zealand and Switzerland, 1992 for Iceland and Portugal.
2. 1991 for Germany.
3. Mainland only.
Source: Secretariat calculations mainly based on data for the OECD *Economic Outlook*, No 66, see Annex 2 for further details.

Table A3.2. **Multifactor productivity growth (adjusted for hours worked)**

Average annual growth rates

(based on trend and actual series)

	Method of estimation	1970[1]-98[2]	1980-90	1990[3]-98[2]	1995-98[2]
United States	Average factor shares / trend series	0.7	0.7	1.0	1.0
	Time-varying factor shares / trend series	0.7	0.8	1.0	1.0
	Time-varying factor shares /actual series	0.8	0.7	1.0	1.7
Japan	Average factor shares / trend series	..	1.9	1.7	1.7
	Time-varying factor shares / trend series	..	2.0	1.6	1.6
	Time-varying factor shares /actual series	..	2.0	1.2	2.0
Germany	Average factor shares / trend series	..	1.6	1.4	1.5
	Time-varying factor shares / trend series	..	1.6	1.4	1.5
	Time-varying factor shares /actual series	..	1.7	1.2	1.0
France	Average factor shares / trend series	2.0	1.9	1.2	1.2
	Time-varying factor shares / trend series	2.1	2.1	1.1	1.1
	Time-varying factor shares /actual series	2.1	2.2	1.0	1.3
Italy	Average factor shares / trend series	1.7	1.4	1.3	1.2
	Time-varying factor shares / trend series	1.8	1.5	1.2	1.0
	Time-varying factor shares /actual series	1.7	1.3	1.1	0.2
United Kingdom	Average factor shares / trend series	2.1	2.4	1.3	1.4
	Time-varying factor shares / trend series	..	..	1.3	1.4
	Time-varying factor shares /actual series	..	..	1.5	1.4
Canada	Average factor shares / trend series	0.8	0.4	0.8	0.8
	Time-varying factor shares / trend series	0.7	0.4	0.8	0.8
	Time-varying factor shares /actual series	0.9	0.3	1.0	1.5

Table A3.2. **Multifactor productivity growth (adjusted for hours worked)** (continued)

Average annual growth rates

(based on trend and actual series)

	Method of estimation	1970[1]-98[2]	1980[1]-90	1990-98[2]	1995-98[2]
Australia	Average factor shares / trend series	..	0.8	2.1	2.1
	Time-varying factor shares / trend series	..	0.9	2.1	2.1
	Time-varying factor shares /actual series	..	0.9	2.2	2.6
Belgium	Average factor shares / trend series	..	1.4	1.0	0.9
	Time-varying factor shares / trend series	..	1.4	1.0	0.8
	Time-varying factor shares /actual series	..	1.3	1.0	0.8
Denmark	Average factor shares / trend series	..	1.0	1.9	1.8
	Time-varying factor shares / trend series	..	1.0	1.8	1.7
	Time-varying factor shares /actual series	..	1.4	1.7	0.4
Finland	Average factor shares / trend series	2.5	2.4	3.2	3.6
	Time-varying factor shares / trend series	2.6	2.4	3.2	3.5
	Time-varying factor shares /actual series	2.7	2.6	2.8	3.2
Greece	Average factor shares / trend series	..	0.4	0.3	0.6
	Time-varying factor shares / trend series	..	0.5	0.3	0.6
	Time-varying factor shares /actual series	..	1.1	0.0	0.1
Iceland	Average factor shares / trend series	..	..	0.4	..
	Time-varying factor shares / trend series	..	..	0.4	..
	Time-varying factor shares /actual series	..	..	-1.7	..
Ireland	Average factor shares / trend series	..	3.8	3.9	3.6
	Time-varying factor shares / trend series	..	3.9	3.9	3.6
	Time-varying factor shares /actual series	..	4.5	3.7	4.6
Netherlands	Average factor shares / trend series	..	2.1	1.7	1.3
	Time-varying factor shares / trend series	..	2.2	1.7	1.2
	Time-varying factor shares /actual series	..	2.2	1.4	0.5
New Zealand	Average factor shares / trend series	..	0.7	1.1	..
	Time-varying factor shares / trend series	..	0.7	1.1	..
	Time-varying factor shares /actual series	..	0.9	1.0	..
Norway[4]	Average factor shares / trend series	2.0	1.1	2.1	1.8
	Time-varying factor shares / trend series	2.1	1.1	2.1	1.8
	Time-varying factor shares /actual series	2.2	0.8	2.4	2.0
Portugal	Average factor shares / trend series	..	1.9	2.1	..
	Time-varying factor shares / trend series	..	1.9	2.2	..
	Time-varying factor shares /actual series	..	2.4	4.2	..
Spain	Average factor shares / trend series	..	2.0	0.8	0.6
	Time-varying factor shares / trend series	..	2.2	0.6	0.4
	Time-varying factor shares /actual series	..	2.5	0.7	0.4
Sweden	Average factor shares / trend series	1.1	0.8	1.3	1.4
	Time-varying factor shares / trend series	1.1	0.8	1.3	1.3
	Time-varying factor shares /actual series	1.1	0.7	1.3	0.6
Switzerland	Average factor shares / trend series	..	..	0.2	..
	Time-varying factor shares / trend series	..	..	0.2	..
	Time-varying factor shares /actual series	..	..	-0.6	..

1. 1973 for Japan, 1981 for Germany, 1979 for Australia, 1986 for Greece, New Zealand and Portugal, 1984 for Belgium and Denmark, 1978 for Netherlands and Spain.
2. 1997 for Australia, Belgium, Canada, Italy, Japan, Norway, Spain and United States, 1996 for Finland, Greece, Ireland, Sweden and United Kingdom, 1995 for New Zealand and Switzerland, 1992 for Portugal.
3. 1991 for Germany.
4. Mainland only.

Source: Secretariat calculations, see Annex 2 for further details.

A3.2.2 Estimates of partial output elasticities

127. In the context of the sensitivity analysis of estimates of MFP growth rate, partial output elasticities were also estimated directly using a production function (see Table 6 in the main text and Table A3.1 for estimates based on actual series). The rationale for this is to avoid postulating a relationship between partial output elasticities and income shares.[80]

128. Estimating partial output elasticities involves direct estimation the production function using actual time series:

$$Q = F(L, K)$$

and deriving partial elasticities for labour as:

$$a = \frac{\partial F(L,K)}{\partial L} \frac{L}{F(L,K)}$$

where *Q* is output, *L* is labour and *K* is capital stock.

129. The analysis can also be undertaken in intensive form by imposing constant returns to scale and dividing output and one of the factors by the other. Generally the choice of imposing rather than testing constant returns to scale depends on availability of data, given that sufficiently long time series are required for testing the assumption. In the analysis of this study constant returns to scale has been imposed, together with the assumption of unit elasticity of substitution between labour and capital (Cobb-Douglas production function) and Hicks- or Harrod-neutral technological progress. The latter assumption deserves some attention. Hicks/Harrod-neutral technological progress means that, in a Cobb-Douglas production function expressed in logarithms, the effect of technological change is additively separable. This allows testing trend-stationarity of technological change. Trend-stationarity is necessary to estimate the full relationship in levels. In fact, expressed in logarithms, the full relationship in labour-intensive form to be estimated is:

$$q - l = \alpha_{ql} + \beta t + \gamma (k - l) + u \qquad \text{[A3.4]}$$

with $\hat{a} = 1 - \hat{\gamma}$, or in capital-intensive form,

$$q - k = \alpha_{qk} + \beta t + \delta (l - k) + u \qquad \text{[A3.5]}$$

with $\hat{a} = \hat{\delta}$;

α, β, and γ are the parameters to be estimated, *t* is time (semester or year), and *u* is a stationary random disturbance. If technological progress $MFP = \alpha + \beta t + u$ were not trend-stationary, the relationships would

80. The methods based on income shares can be sensitive to measurement errors in inputs and outputs. For instance, even under the assumption of perfect competition and thus when inputs are paid their (correctly measured) marginal productivity, the labour share corresponds to the coefficient of the labour input only if human capital has been included in the measure of labour input. Conversely, it can be different from the coefficient when the labour input is approximated with employment.

not be cointegrated, and output elasticities could not be estimated directly from the foregoing equations using standard techniques.[81]

130. There are important issues related to the direct econometric estimation of equations [A3.4] and [A3.5] which relate to sample size and unreliability of measures of capital stock. The latter problem has often been partially solved in the literature by relying on estimation in first differences rather than in levels. However, first differences capture only short-run relationships and can provide very imprecise approximations of long-run relationships. Furthermore estimation in first differences gives up the convenient property of superconsistency of estimators in the case of cointegrated relationships between non-stationary variables, that is often the case with production functions. Senhadji (1999) compares estimates in first differences and estimates in levels based on cointegration techniques for 88 countries to conclude that reliability of level estimates is greater.

131. Estimation of equation [A3.4] or [A3.5] in levels involves several steps. First, unit root tests has to be carried out to select pairs of variables in intensive terms - (q-l,k-l) or (q-k,l-k) - that are either difference-stationary (presence of a unit root) or trend-stationary (absence of a unit root). Second, if the selected pair contain a unit root, the existence of a cointegration vector has to be tested. Third, if the test shows evidence of cointegration, or if the variables of the selected pair are trend-stationary, the corresponding equation can be estimated using an appropriate technique.

132. Table A3.3 reports standard Augmented Dickey-Fuller (ADF) unit root tests for the logarithm of output, employment and capital stock, as well as for variables in intensive form. The null hypothesis is that the tested time series contains a unit root, the alternative hypothesis is absence of unit roots. The number of lags in the equation depends on the significance of the coefficient of the maximum lag amongst those specifications that do not suffer from autocorrelation, according to a Box-Pierce test with appropriate choice of lags (see Banerjee *et al*., 1993). When autocorrelation is present in all models up to four lags, then the model with the lowest autocorrelation is chosen. The model always contains a deterministic time trend.

133. For each country reported in Table A3.3, it is possible to find at least a couple of variables in intensive terms - (q-l,k-l) or (q-k,l-k) - for which the tests show evidence of one unit root, with the only exception of Greece and Portugal, where the logarithm of the capital/labour ratio appears trend-stationary but the output in either labour or capital intensive form is only difference-stationary.[82]

81. Although they could be estimated in first differences.

82. Greece and Portugal were then eliminated from the analysis. Furthermore, for completeness, Table A3.3 and A3.4 report results for Iceland, although the number of observations is too short to have large confidence in estimates.

Table A3.3. **Unit root tests**

Semi-annual observations

Country	Variable [1]	Lags	ADF[2]		Q [3]	(df)
United States	GDP	1	-3.725	**	24.930	31
	Employment	1	-4.463	***	32.256	31
	Capital Stock	3	-0.048		27.946	30
	Output/Labour Ratio	1	-4.032	***	25.154	31
	Capital/Labour Ratio	4	-1.401		30.761	29
	Output/Capital Ratio	2	-2.657		18.898	30
Japan	GDP	1	-1.872		20.096	25
	Employment	1	-1.897		19.239	26
	Capital Stock	4	-0.948		28.413	24
	Output/Labour Ratio	4	-0.873		18.271	23
	Capital/Labour Ratio	4	-2.985		15.666	24
	Output/Capital Ratio	1	-3.030		20.695	25
Germany	GDP	1	-2.241		14.362	18
	Employment	1	-1.332		16.362	18
	Capital Stock	4	-2.169		7.494	16
	Output/Labour Ratio	1	-2.419		13.758	18
	Capital/Labour Ratio	1	-1.265		11.516	18
	Output/Capital Ratio	2	-0.527		11.574	17
France	GDP	1	-2.871		29.087	26
	Employment	2	-2.565		31.655	25
	Capital Stock	2	-3.559	**	33.401	25
	Output/Labour Ratio	0	-2.524		26.203	26
	Capital/Labour Ratio	2	-1.050		32.866	25
	Output/Capital Ratio	1	-2.507		23.715	26
Italy	GDP	2	-1.825		16.089	24
	Employment	1	-1.431		30.000	25
	Capital Stock	2	-3.245	*	15.688	25
	Output/Labour Ratio	1	-3.630	**	15.213	25
	Capital/Labour Ratio	1	-2.387		31.324	25
	Output/Capital Ratio	2	-2.273		14.488	24
United Kingdom	GDP	1	-1.950		17.556	18
	Employment	1	-2.607		16.158	18
	Capital Stock	1	-2.484		23.744	18
	Output/Labour Ratio	3	-3.019		9.852	17
	Capital/Labour Ratio	1	-3.122		15.613	18
	Output/Capital Ratio	1	-2.265		16.235	18
Canada[4]	GDP	0	-2.697		12.243	12
	Employment	1	-2.270		3.555	11
	Capital Stock	2	-0.466		7.278	11
	Output/Labour Ratio	1	-3.588	**	13.339	11
	Capital/Labour Ratio	1	-3.158	*	3.008	11
	Output/Capital Ratio	1	-2.969		5.908	11

Table A3.3. **Unit root tests** (continued)
Semi-annual observations

Country	Variable [1]	Lags	ADF[2]		Q [3]	(df)	
Australia	GDP	1	-3.197	*	26.094	23	
	Employment	1	-3.601	**	9.196	15	
	Capital Stock	2	-0.302		16.464	22	
	Output/Labour Ratio	1	-3.196	*	7.056	15	
	Capital/Labour Ratio	1	-2.388		10.453	15	
	Output/Capital Ratio	2	-0.684		17.418	22	
Austria	GDP	0	-3.678	**	22.418	25	
	Employment	4	-2.144		16.321	23	
	Capital Stock	1	-3.636	**	13.708	24	
	Output/Labour Ratio	4	-2.960		8.968	23	
	Capital/Labour Ratio	1	-2.664		11.543	24	
	Output/Capital Ratio	0	-1.733		21.837	24	
Belgium	GDP	4	-3.268	*	23.471	23	
	Employment	3	-1.495		26.813	25	
	Capital Stock	4	-3.976	***	35.246	24	*
	Output/Labour Ratio	4	-3.856	**	30.787	23	
	Capital/Labour Ratio	4	-1.290		24.463	24	
	Output/Capital Ratio	4	-1.795		24.025	23	
Denmark	GDP	1	-1.982		24.596	26	
	Employment	1	-2.260		23.217	26	
	Capital Stock	1	-2.958		35.486	26	
	Output/Labour Ratio	2	-2.969		27.701	25	
	Capital/Labour Ratio	1	-2.079		25.326	26	
	Output/Capital Ratio	1	-1.644		26.750	26	
Finland	GDP	3	-3.924	**	19.370	25	
	Employment	2	-2.678		25.179	25	
	Capital Stock	4	-0.264		21.861	22	
	Output/Labour Ratio	3	-3.121		20.527	25	
	Capital/Labour Ratio	3	-3.073		17.568	23	
	Output/Capital Ratio	3	-3.779	**	16.574	23	
Greece	GDP	4	-2.849		29.589	24	
	Employment	4	-1.813		26.973	23	
	Capital Stock	4	-4.344	***	24.833	22	
	Output/Labour Ratio	4	-2.783		32.101	23	*
	Capital/Labour Ratio	4	-5.505	***	20.737	22	
	Output/Capital Ratio	4	-2.220		25.703	22	
Iceland	GDP	1	-1.585		7.978	8	
	Employment	4	-1.470		20.935	24	
	Capital Stock	2	0.664		16.529	11	
	Output/Labour Ratio	1	-4.261	***	11.027	8	
	Capital/Labour Ratio	3	-1.768		7.634	10	
	Output/Capital Ratio	0	-0.950		3.741	3	

Table A3.3. **Unit root tests**(continued)
Semi-annual observations

Country	Variable [1]	Lags	ADF[2]		Q [3]	(df)	
Ireland	GDP	3	-0.746		33.493	24	*
	Employment	4	0.684		30.158	24	
	Capital Stock	4	-2.189		52.588	22	***
	Output/Labour Ratio	4	-2.004		24.799	23	
	Capital/Labour Ratio	4	-0.360		13.875	22	
	Output/Capital Ratio	3	-1.068		39.265	23	**
Netherlands	GDP	1	-1.629		14.284	26	
	Employment	2	-1.345		18.377	25	
	Capital Stock	1	-1.874		23.186	26	
	Output/Labour Ratio	0	-2.967		20.697	26	
	Capital/Labour Ratio	4	-1.824		9.849	24	
	Output/Capital Ratio	0	-1.404		19.347	26	
New Zealand	GDP	0	-2.227		32.677	25	
	Employment	4	-3.475	**	42.686	24	**
	Capital Stock	1	-4.025	***	16.333	23	
	Output/Labour Ratio	1	-2.840		27.185	25	
	Capital/Labour Ratio	4	-1.940		26.304	21	
	Output/Capital Ratio	0	-2.051		28.274	23	
Norway[5]	GDP	2	-2.738		12.631	25	
	Employment	3	-3.349	*	26.630	25	
	Capital Stock	1	-3.604	**	20.187	26	
	Output/Labour Ratio	3	-3.121		27.016	25	
	Capital/Labour Ratio	3	-2.418		24.316	25	
	Output/Capital Ratio	2	-2.017		13.914	25	
Portugal	GDP	3	-3.351	*	46.131	22	***
	Employment	1	-1.822		8.734	23	
	Capital Stock	4	-2.534		23.530	18	
	Output/Labour Ratio	2	-2.678		8.222	22	
	Capital/Labour Ratio	1	-3.504	**	7.950	20	
	Output/Capital Ratio	2	-1.297		33.043	19	**
Spain	GDP	1	-3.771	**	17.705	26	
	Employment	2	-1.947		27.331	25	
	Capital Stock	2	-5.685	***	14.706	24	
	Output/Labour Ratio	1	-2.532		34.714	26	
	Capital/Labour Ratio	2	-2.077		34.347	24	*
	Output/Capital Ratio	1	-1.181		15.019	25	
Sweden	GDP	2	-2.587		15.153	24	
	Employment	2	-2.115		10.777	24	
	Capital Stock	2	-3.299	*	14.205	23	
	Output/Labour Ratio	0	-1.648		23.098	25	
	Capital/Labour Ratio	2	-2.195		12.101	23	
	Output/Capital Ratio	2	-2.060		14.877	23	
Switzerland	GDP	1	-2.367		20.630	23	
	Employment	1	-1.863		21.469	17	
	Capital Stock	2	-4.248	***	22.846	23	
	Output/Labour Ratio	4	-2.898		8.672	15	
	Capital/Labour Ratio	4	-0.499		13.078	15	
	Output/Capital Ratio	1	-2.393		21.309	23	

* significant at 10 % level.
** significant at 5 % level.
*** significant at 1% level.

1. Variables are expressed in logarithms.
2. Augmented Dickey-Fuller test.
3. Box-Pierce test of autocorrelation based on the Portmanteau Q statistic. The number of lags is set equal to the greatest integer less than or equal to (N/2)-2, where N is sample size. The test statistic is asymptotically distributed as a Chi-square with degrees of freedom equal to the number of lags under the null of no autocorrelation up to the specified number of lags.
4. Annual observations.
5. Mainland only.

134. The labour intensive form of the production function (that is, eq. [A3.4]) is chosen whenever the output-labour ratio has a unit root[83]; otherwise the capital-intensive form (eq. [A3.5]) is considered. Cointegration is checked through Shin's test (Shin, 1994) that, contrary to most single-equation cointegration tests, takes the hypothesis of cointegration as the null and that of no cointegration as the alternative, consistently with standard ways of testing the presence of unit roots. Given the strong theoretical ground for the existence of a stable relationship such as [A3.4] or [A3.5] (existence of a stable production function with constant returns to scale), a test that assumes cointegration as the null hypothesis seems more appropriate.[84] Shin's test is constructed on the basis of the residuals of the selected equation, estimated using dynamic estimators involving backward and forward lags for the first differences of the dependent variable (Saikkonen, 1991). Its critical values have been tabulated for large samples. As shown in Table A3.4, the test cannot reject the null of cointegration at 1 per cent confidence level for any country, although it leads to evidence of no-cointegration at 5 per cent confidence level for three countries (Australia, Iceland and Switzerland). However, these are the countries for which the period of observation is the shortest. Keeping into account that the behaviour of the test is not known in small samples, production functions were estimated for these three countries as well.

135. Production functions are estimated using standard dynamic estimators, to correct for small-sample biases of static estimators in cointegrated regressions. In other words, equation [A3.4] and [A3.5] are rewritten as:

$$\Delta y_t = \alpha + \beta t + \gamma(y_{t-1} - x_{t-1}) + \delta x_{t-1} + \sum_{i=1}^{K} \phi_i \Delta y_{t-i} + \sum_{i=0}^{K} \varphi_i \Delta x_{t-i} + u_t$$

where *x* and *y* are the independent and the dependent variables respectively, *K* is the chosen number of lags and greek letters indicate parameters to be estimated, that can be estimated by Ordinary Least Squares (see Bårsden, 1989, Banerjee *et al.*, 1990, and Banerjee *et al.*, 1993). Long-run partial output elasticity of *y* to *x* can be obtained as 1-(δ/γ).[85] Lags in the dynamic specification were chosen with the same criteria used for unit root tests.

83. However the analysis was replicated in capital-intensive terms for both cointegration testing and production function estimation without finding any significant difference.

84. Other cointegration tests based on the null of no-cointegration applied to production function relationship usually lead to overwhelming amount of no-cointegration results due to the relatively low power of the tests (see Senhadji, 1999).

85. In many cases dynamic estimators of this type perform equally good as Fully Modified estimators (Phillips and Hansen, 1990), although the formers can be more easily implemented (see Banerjee *et al.*, 1993).

Table A3.4. **Production functions estimation** [1]

Country	Output/Labour elasticity	Lags	Observations[2]	Statistical tests: Q [3]	(df)		Jarque-Bera[4]		Shin [5]		Dependent variable
United States	0.796	2	68	22.84	31		0.81		0.101	*	Output/Capital Ratio
Japan	0.696	1	56	24.68	25		5.12	*	0.061		Output/Labour Ratio
Germany[6]	0.735	3	42	20.26	17		2.04		0.097		Output/Labour Ratio
France	0.757	1	58	25.05	26		12.15	***	0.087		Output/Labour Ratio
Italy	0.623	2	56	23.62	25		1.02		0.051		Output/Capital Ratio
United Kingdom	0.605	1	42	14.46	18		2.47		0.103	*	Output/Labour Ratio
Canada	0.876	1	28	6.53	11		16.15	***	0.076		Output/Capital Ratio
Australia	0.704	3	36	8.39	14		1.25		0.123	**	Output/Capital Ratio
Austria	0.656	1	54	18.84	24		4.54		0.060		Output/Labour Ratio
Belgium	0.716	6	56	36.78	23	***	0.53		0.067		Output/Capital Ratio
Denmark	0.743	1	58	29.49	26		0.17		0.120	*	Output/Labour Ratio
Finland	0.743	1	54	23.02	24		0.13		0.120	*	Output/Labour Ratio
Iceland	0.563	3	12	3.73	2		0.14		0.141	**	Output/Capital Ratio
Ireland	0.848	3	54	33.39	23	***	1.20		0.069		Output/Labour Ratio
Netherlands	0.669	2	58	14.31	26		0.63		0.072		Output/Labour Ratio
New Zealand	0.800	2	52	24.69	23	*	11.33	***	0.106	*	Output/Labour Ratio
Norway[7]	0.638	1	58	30.36	26		1.70		0.090		Output/Labour Ratio
Spain	0.717	6	56	21.97	23		1.98		0.065		Output/Labour Ratio
Sweden	1.078	1	54	19.67	24		1.62		0.080		Output/Labour Ratio
Switzerland	0.646	6	40	11.50	15	**	8.51	**	0.131	**	Output/Labour Ratio

* significant at 10 % level.
** significant at 5 % level.
*** significant at 1% level.

1. Production functions are estimated in levels using a specification in logarithms and dynamic estimators (with a consistent criterion for the choice of lags). Constant returns to scale are imposed. The choice of the dependent variable follows from unit-root tests.
2. Semiannual observations except for Canada.
3. Box-Pierce test of autocorrelation based on the Portmanteau Q statistic. The number of lags is set equal to the greatest integer less than or equal to (N/2)-2, where N is sample size. The test statistic is asymptotically distributed as a Chi-square with degrees of freedom equal to the number of lags under the null of no autocorrelation up to the specified number of lags.
4. Jarque-Bera test of normality of the residuals (asymptotically distributed as a Chi-square with 2 degrees of freedom under the null of normality of the residuals).
5. Shin's test of cointegration (with the null of cointegration).
6. Western Germany.
7. Mainland only.

136. Estimation results are reported in Table A3.4. To make estimated equations for different countries comparable, only derived long-run partial elasticities of output to labour are reported. However, the retained functional form is also reported in the table. Furthermore, for the sake of comparison, the table presents observed average labour share as a memo item. The table shows implausible results for Sweden (negative partial elasticity of output with respect to capital), due probably to the fact that in this country employment has shown a strong downward trend over the whole period of analysis. Overall, however, only few countries (namely United States, Canada, Iceland, Ireland, and New Zealand, as well as Sweden) display estimated elasticities that differs more than 0.1 from average observed factor shares, but this turns out to have only limited importance in the computation of MFP growth rate.[86] Given the small sample size for input quality and hours worked or production functions were not re-estimated with hours worked and input quality.

86. See Table 6 and Table A3.1. MFP growth rates are not computed with elasticity estimates for Sweden, because of the estimate implausibility mentioned above.

A3.3 Estimates of trend output and trend labour productivity

137. This section describes the methods used to estimate trend time series in this paper: i) the Hodrick-Prescott filter (Hodrick and Prescott, 1997); ii) a univariate extension of the Hodrick-Prescott filter; and iii) a semi-structural approach based on the Multivariate filter (Laxton and Tetlow, 1992; Hostland and Côté, 1993). The latter has only been applied to the G-7 countries.

A3.3.1 The Hodrick-Prescott filter and the Extended Hodrick-Prescott filter

138. The Hodrick-Prescott (H-P) filter belongs to a family of stochastic approaches that treats the cyclical component of observed output as a stochastic phenomenon. The cyclical component (demand shocks) is separated from the permanent component (supply shocks) under the assumption that the former has only a temporary effect, while the latter persists. The H-P filter is derived by minimising the sum of squared deviations of log output (y) from the estimated trend τ_y, subject to a smoothness constraint that penalises squared variations in the growth of the estimated trend series. Thus, H-P trend values are those that minimise:

$$HP(\lambda) = \sum \left(y_t - \tau_{y,t}\right)^2 + \lambda \sum \left[\left(\tau_{y,t+1} - \tau_{y,t}\right) - \left(\tau_{y,t} - \tau_{y,t-1}\right)\right]^2$$

139. Estimated trend output τ_y is a function of λ and both past and future values of y. Higher values of λ imply a large weight on smoothness in the estimated trend series (for very large values the estimated trend series will converge to a linear time trend). Apart from the arbitrary choice of the λ parameter (set to the standard value of 400 for semi-annual time series), the H-P filter may lead to "inaccurate" results if the temporary component contains a great deal of persistence. The distinction between temporary and permanent components then becomes particularly difficult, especially at the end of the sample when the H-P filter suffers from an in-sample phase shift problem.

140. In order to reduce the end-of-sample problem various alternatives can be explored. One of them consists in modifying the H-P filter to take into account the information carried by the average historical growth rate (Butler, 1996, Conway and Hunt, 1997). Thus, trend values obtained through the growth rate restricted Extended Hodrick-Prescott filter (EHP) would be those that minimise:

$$EHP(w_1, w_2, \lambda) = \sum w_1 \left(y_t - \tau_{y,t}\right)^2 + \sum w_2 \left(\Delta\tau_{y,t} - g_{y,T_1,T_2}\right)^2 + \lambda \sum \left[\left(\tau_{y,t+1} - \tau_{y,t}\right) - \left(\tau_{y,t} - \tau_{y,t-1}\right)\right]^2$$

where the two w parameter vectors are the vectors of weights attached to the gap terms, $\Delta\tau_y$ is the growth rate of estimated trend output and g is the historical growth rate between dates T_1 and T_2. The choice of weights determines the importance of the two gaps in the minimisation problem. In the actual estimation w_1 is set equal to 1 in the sample period and to 0 afterwards, w_2 is set equal to 0 in the sample period and to 1 afterwards. Given the objective of estimating recent growth patterns, this way to solve the end-point problem can be considered as a prudent approach. In fact it underestimates sharp deviations from the historical pattern in the neighbourhood of the end of the sample. On the other hand, its estimates can be considered as a lower bound in the case of acceleration of the growth rate in the most recent years (or vice versa in the case of deceleration). Another alternative consists in extending the time series of log output by means of the OECD Medium Term Reference Scenario (MTRS, see OECD, 1999*g*). The two solutions can be applied together as well.

141. The end-point problem is not the only severe theoretical pitfall of the H-P filter. When the supply-side components are subject to temporary stochastic shocks with greater variance than that of the demand-side component, or when the demand-side component has a significant degree of persistence, the

decomposition of cycle and trend estimated by an H-P filter turns out to be inaccurate (see *e.g*. Harvey and Jaeger, 1993, and Conway and Hunt, 1997). The Multivariate filter described in the next subsection is one of the attempts to solve this problem. It exploits additional economic information while keeping a simple estimation algorithm (for more details on alternative methods used by the Secretariat see OECD, 2000*a*).

A3.3.2 The Multivariate filter

142. The Multivariate (MV) filter is a more complicate alternative that generalises the EHP filter by taking into account some of the theoretical critiques to the H-P filter. In order to better disentangle demand from supply disturbances, the multivariate filter used in this paper relies on two well established macroeconomic relationships: i) a Phillips curve relating output and inflation; and ii) an Okun-type relationship, which maps output gaps into employment gaps.

Phillips curve: $\Delta\pi = \alpha(L)\Delta\pi + \beta(y - \tau_y) + \gamma(L)\mathbf{z} + \varepsilon_\pi$

Okun's curve: $E - E^* = \delta(L)(E - E^*) + \phi(y - \tau_y) + \varepsilon_E$

where: $E^*_t = LFS^*_t\ (1\text{-NAIRU}_t)$ [A3.6]

and π is the CPI inflation rate, y is log of output, U is the unemployment rate, E^* is trend employment, LFS^* is the H-P series of the labour force, NAIRU is the non-accelerating inflation rate of unemployment, τ_y is the trend value of the variable *y*, $X(L)$ terms are polynomial lag operators, and **z** is a vector of temporary supply shocks affecting inflation over and above the effects stemming from the labour market. The NAIRU is derived through a separate multivariate filtering procedure based on a Phillips curve specified in a similar way as above (see OECD, 2000). The problem of the multivariate filter is to minimise:

$$EMV(w_1, w_2, w_3, w_4, \lambda) =$$
$$\sum w_1 (y_t - \tau_{y,t})^2 + \sum w_2 (\Delta\tau_{y,t} - g_{y,T_1,T_2})^2 + \sum w_3 \varepsilon_{\pi,t}{}^2 + \sum w_4 \varepsilon_{U,t}{}^2 + \lambda \sum [(\tau_{y,t+1} - \tau_{y,t}) - (\tau_{y,t} - \tau_{y,t-1})]^2$$

The four *w* parameter vectors correspond to the weights attached to the gap terms. In the actual estimation, w_1 and w_2 are set in the same way as for the EHP filter[87]; w_3 and w_4 are set to be the same for all countries and are chosen in such a way to give equal importance to all the gap terms in the minimisation process. The first and the last terms in the equation are the usual H-P filter terms.

143. The MV filtered series are estimated through a recursive procedure: a first estimate of τ_y is obtained applying the standard H-P filter. Second, this provisional estimate of τ_y is then used to estimate a Phillips curve and an Okun's curve. Third, the revised estimate of τ_y is obtained by using the H-P filter augmented by the residuals from the estimated Phillips curve and the Okun's curve. Finally, with the new τ_y estimate obtained from the third step, the whole procedure is repeated starting with the second step until convergence in the parameters is obtained.

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87. This means that w1 is set equal to 1 in the sample period and to 0 afterwards, w2 is set equal to 0 in the sample period and to 1 afterwards.

144. With the MV filter, information about the output-inflation process and the employment-output process is thus included in the optimisation problem.[88] To the extent that these two processes are well identified, data on inflation and employment help in the identification of trend output. The combined estimation of trend output, the Phillips curve and the Okun's curve guarantee consistent estimation of trend output and trend employment. Moreover, the ratio of the two series yields a consistent measure of trend labour productivity. Trend labour productivity can be estimated consistently by dividing trend output by trend employment as expressed by [A3.6].

145. The H-P filter and the MV filter can be rationalised as optimal estimators of the trend component of different unobserved component models of the data generating process. Spelling out these models explicitly allows a better understanding of the relationships between the two procedures as well as it helps defining an unambiguous choice of the *w* weights to be used for the residuals of the Phillips and the Okun's curve (for more details see OECD, 2000*a*).

146. Consider the following data generating process:

$$y_t = \tau_{y,t} + e_t^1 \text{ with } e_t^1 \sim N(0,\sigma_1^2) \qquad \text{[A3.7]}$$

$$\tau_{y,t} = \tau_{y,t-1} + \mu_{t-1} \qquad \text{[A3.8]}$$

$$\mu_t = \mu_{t-1} + e_t^2 \text{ with } e_t^2 \sim N(0,\sigma_2^2) \qquad \text{[A3.9]}$$

where μ stands for the non-stationary growth rate of the unobserved trend component τ_y and all disturbances are assumed to be uncorrelated. Equations [A3.8] and [A3.9] can be combined to give:

$$\Delta\tau_{y,t} = \Delta\tau_{y,t-1} + e_t^2 .$$

147. The H-P filter can be rationalised as the optimal estimator of the trend component in the model made by the equations [A3.7], [A3.8] and [A3.9], provided that variances of disturbances are calibrated rather than estimated, and the parameter λ is set equal to $\frac{\sigma_1^2}{\sigma_2^2}$ (see Harvey and Jaeger, 1993, and the literature quoted there). For example, $\sigma_1^2 = 0.25$ and $\sigma_2^2 = 0.000625$ justifies the standard H-P filter with smoothing parameter λ of 400.

148. The same intuition can be extended to the MV filter (see also Boone, 2000). Abstracting from growth rate restrictions in the out-of-sample period (setting w_2=0 always), the issue here is only to extend the model composed of equations [A3.7], [A3.8], [A3.9] by adding the Phillips curve and/or the Okun's curve:

$$\Delta\pi_t = \alpha(L)\Delta\pi_t + \beta(y_t - \tau_{y,t}) + \gamma(L)\mathbf{z}_t + e_t^3 \text{ with } e_t^3 \sim N(0,\sigma_3^2)$$

$$E_t - E*_t = \delta(L)(E - E*)_t + \phi(y - \tau_{y,t}) + e_t^4 \text{ with } e_t^4 \sim N(0,\sigma_4^2)$$

88. The use of both is not frequent in the literature: The Phillips curve has been used more widely (*e.g.* Gordon, 1997, and OECD, 1999*c*, 2000*a*), however the Okun's law has been used by Moosa (1997). Laxton and Tetlow (1992), Conway and Hunt (1997) and Apel and Jansson (1999) use both.

149. The argument used before for the H-P filter can be extended to the calibration of weights in the MV filter. Putting it another way, w_3 and w_4 has to be calibrated on variances in such a way that:

$$w_3 = \frac{\sigma_1^2}{\sigma_3^2} \text{ and } w_4 = \frac{\sigma_1^2}{\sigma_4^2}.$$

A3.3.3 Empirical implementation

150. Measures of trend that are used in all the tables and figures of the main text are based on the EHP filter, if not differently specified. However, a sensitivity analysis with the MV filter and an H-P filter has been carried over. Comparative results are discussed in the next subsection.

151. EHP filter-based trend estimates of derived variables (such as GDP per employee or GDP per hour) are computed from EHP filters applied to source variables (that is GDP and employment for what concerns GDP per employee and GDP, employment and hours per employee). Initial and final dates (T_1 and T_2 respectively) for the computation of the average historical growth rate (g) are set to be equal to 1980:1 or earlier available semi-annual observation and 1999:1 or later available semi-annual observation. The out-of-sample period starts from 1999:2 or after the last observed value and ends in 2009.

152. The MV filter has been implemented in a similar way to the EHP filter. Initial and final dates for the computation of the historical growth rate are set to be equal to 1980:1 or earlier available semi-annual observation and 1999:1 or later available semi-annual observation while the end date of the out-of-sample period is set to 2009. All w parameters except w_2 are set equal to 0 out of sample. Conversely, w_2 is set equal to 0 in the sample period. In the sample period the weights of the residuals from the Phillips curve (w_3) is calibrated to 16. This is motivated by the fact that on an annual basis an average output gap (y-τ_y) close to 1-2 percent is considered to be the norm among most OECD countries, suggesting that a gap well above or below 2 percent should probably be seen as exceptional. On semi-annual data, Phillips curve errors of 0.5 percent are typical (see OECD, 2000*a* for more details). Similarly, this argument can be extended to the determination of the weights given to the residuals from the Okun's curve (w_4). Simple regressions between an output gap estimated with an H-P filter and the employment gap (E-E^*)[89] give an average error of 0.4 per cent, that leads to a weight of about 24. This can be considered as a cautious calibration, given that it can be expected *a priori* that residuals from the Okun's curve could turn out smaller once the latter is estimated with the MV filter using the full recursive procedure.[90]

153. The choice of temporary supply shock variables in the Phillips curve has largely been governed by which variables are most often statistically significant across a number of country specifications of the Phillips curve expressed in terms of unemployment (and used in the estimation of the NAIRU, see OECD, 2000). In particular the variables included in the empirical regressions include the *change* in real import price inflation (weighted by the degree of openness of the economy), the *change* in real oil price inflation (weighted by a measure of the degree of oil intensity in production), as well as the difference between these inflations and the CPI inflation. Dummies have been kept to a minimum and constrained to reflect well-identified specific historical episodes. Tables A3.5 and A3.6 report final estimates of the Phillips and Okun's curve obtained with MV filtering recursive procedure. Overall equations turn out to be sufficiently good in terms of autocorrelation and explanatory power, taking into account that the minimisation of the sum of the square errors from four relationships reduces the *ex ante* expected explanatory power of each

89. As said in the previous section, trend employment is based on the MV filter estimate of NAIRU (see OECD, 2000*a*) and an extended H-P filter applied to the labour market participation rate.

90. *A posteriori*, this has been confirmed by the results. See the last two rows of Table A3.6.

single regression. The most troublesome estimated relationship is the Phillips curve for Canada with an adjusted R^2 of 0.24.

Table A3.5. **Estimated Phillips curve relationships for the G7 with the MV filter approach**

	United States	Japan	Germany	France	Italy	United Kingdom	Canada
Sample period	66:1 99:1	70:1 99:1	70:2 99:1	75:1 99:1	64:2 99:1	72:2 99:1	74:2 99:1
$\Delta\pi_{-1}$	-0.560 *** (0.125)		-0.401 *** (0.092)	-0.531 *** (0.111)		-0.194 * (0.110)	-0.283 ** (0.126)
$\Delta\pi_{-2}$	-0.370 *** (0.111)				-0.391 *** (0.082)		
(Y - Y*)	0.144 *** (0.026)	0.162 *** (0.056)	0.070 ** (0.031)	0.121 ** (0.053)	0.293 *** (0.057)	0.297 *** (0.073)	0.099 ** (0.048)
$\omega_{-1}\Delta\pi^{m}_{-1}$	0.741 *** (0.190)			0.433 *** (0.083)			
$\omega_{-2}\Delta\pi^{m}_{-2}$	0.618 *** (0.196)			0.197 ** (0.075)			0.297 * (0.168)
$[\omega_{-1}(\pi^{m}-\pi)]_{-1}$			0.358[1] *** (0.094)			0.454 ** (0.073)	
$[\omega_{-2}(\pi^{m}-\pi)]_{-2}$			-0.358[1] *** (0.094)				
$\nu_{-1}\Delta\pi^{O}$	0.104 *** (0.013)	1.022 *** (0.166)	0.138 *** (0.029)	0.229 *** (0.057)	0.390 *** (0.134)	0.299 *** (0.074)	
$\nu_{-2}\Delta\pi^{O}_{-1}$		0.660 *** (0.166)			0.542 *** (0.153)	-0.348 *** (0.078)	1.202 *** (0.402)
$[\nu_{-1}(\pi^{O}-\pi)]_{-1}$	0.101 *** (0.022)					0.450 *** (0.136)	
Dummy variables			91:2=1 92:2=-1	82:1=1 82:2=-1	70:1=1 70:2=-1 71:2=-1 72:2=1		
R^2 adjusted	0.64	0.55	0.58	0.58	0.64	0.50	0.24
Portmanteau Q statistic[2]	15.28 (16)	13.26 (14)	13.35 (14)	7.98 (12)	20.99 (17)	20.08 * (13)	14.57 (12)
Residual s.e.	0.33	0.74	0.38	0.46	0.70	1.02	0.65
Average abs. error	0.26	0.48	0.29	0.34	0.52	0.65	0.50

Notes : OLS estimation on semi-annual data. Dependent variable is the change in PCP inflation. $\Delta\pi$. Standard errors in parentheses. All dummies are significant at 1% level. Y = logarithm of real GDP. Y* = logarithm of trend GDP. π^{m} = Inflation rate of imported goods and services. ω = weight of nominal imports in GDP. π^{o} = Inflation rate of imported energy. ν = intensity of oil consumption in relation to GDP.

[1]Restricted coefficients (difference between coefficients constrained to be equal 0).

[2]Box-Pierce test of autocorrelation based on the Q statistic (number of lags in parentheses). The number of lags is set equal to the greatest integer less than or equal to N/4, where N is sample size. The test statistic is asymptotically distributed as a Chi-square with degrees of freedom equal to the number of lags under the null of no autocorrelation up to the specified number of lags.

* Significant at 10% level.

** Significant at 5% level.

*** Significant at 1% level.

Table A3.6. **Estimated Okun's curve relationships for the G7 with the MV filter approach**

	United States	Japan	Germany	France	Italy	United Kingdom	Canada
Sample period	65:1 99:1	69:2 99:1	70:2 99:1	74:2 99:1	64:1 99:1	72:1 99:1	69:1 99:1
(Y - Y*)	0.416 *** (0.028)	0.164 *** (0.025)	0.331 *** (0.065)	0.214 *** (0.040)	0.190 *** (0.055)	0.247 *** (0.040)	0.557 *** (0.039)
(Y - Y*) after 74:2 (0 before)					0.172 ** (0.081)		
$(E - E^*)_{-1}$	0.429 *** (0.043)	0.698 *** (0.066)	0.435 *** (0.094)	1.175 *** (0.112)	0.658 *** (0.061)	1.077 *** (0.108)	0.470 *** (0.042)
$(E - E^*)_{-2}$				-0.497 *** (0.088)		-0.356 *** (0.094)	
R^2 adjusted	0.92	0.77	0.54	0.96	0.77	0.95	0.93
Portmanteau Q statistic[1]	24.32 * (16)	19.06 (14)	14.00 (14)	19.77 * (12)	23.32 (17)	4.99 (13)	21.62 (15)
Residual s.e.	0.34	0.33	0.84	0.19	0.57	0.38	0.45
Average abs. error	0.27	0.24	0.42	0.14	0.47	0.27	0.35

Notes : OLS estimation on semi-annual data. Dependent variable is employment gap (E - E*). Standard errors in parentheses. Y = logarithm of real GDP. Y* = logarithm of trend GDP. E = logarithm of employment. E* = logarithm of trend employment.

[1] Box-Pierce test of autocorrelation based on the Q statistic (number of lags in parentheses). The number of lags is set equal to the greatest integer less than or equal to N/4, where N is sample size. The test statistic is asymptotically distributed as a Chi-square with degrees of freedom equal to the number of lags under the null of no autocorrelation up to the specified number of lags.

* Significant at 10% level.

** Significant at 5% level.

*** Significant at 1% level.

A3.3.4 Comparison of results

154. As discussed above, the H-P filter suffers from important theoretical drawbacks. In practice, however, if some care is taken in dealing with the end-of-sample problem, differences between the H-P filter and multivariate methods turns out to be relatively insignificant, especially when the main concern is the long-run growth pattern. The table in Box 1 in the main text shows the magnitude of differences between trend estimates based on the Extended H-P filter and the MV filter. Differences are limited for most countries with a partial exception for Germany in the 1990s (where the effect of reunification on filters is important) and for France in recent years. Slowdown in labour productivity is strong in France in the most recent years, and this is better captured by a multivariate filter rather than a univariate filter extended with a growth rate restriction. The table in Box 1 in the main text contains also growth rates of trend GDP based on an H-P filter where sample size has been extended using OECD medium term

projections. Differences are even more limited in this case.[91] Similarly, Table A3.7 compares trend labour productivity series, which imply estimating trends for GDP and employment separately. The results from the latter approaches broadly confirm the patterns based on the Extended HP filter.

Table A3.7. **Comparing different estimates of trends in GDP per person employed in the G7 countries**
(Total economy, percentage changes at annual rates)

		1970-98	1970-79	1980-89	1990-98 [1]	1995-98
United States	Actual	1.2	0.7	1.2	1.8	2.4
	MV filter	1.1	0.7	1.1	1.7	2.0
	EHP filter[2]	1.1	0.6	1.1	1.7	1.9
	EHP filter[3]	1.1	0.6	1.1	1.7	2.0
Japan	Actual	2.5	3.6	2.7	0.8	0.9
	MV filter	2.5	3.4	2.7	1.3	1.2
	EHP filter[2]	2.7	3.9	2.6	1.3	1.1
	EHP filter[3]	2.7	3.9	2.6	1.3	1.0
Germany	Actual	1.5	2.6	1.7	2.1	1.9
	MV filter	1.4	2.6	1.4	1.5	1.8
	EHP filter[2]	1.5	2.7	1.6	1.9	1.9
	EHP filter[3]	1.5	2.7	1.6	1.9	1.8
France	Actual	2.1	2.8	2.0	1.3	1.5
	MV filter	..	..	1.9	1.3	1.0
	EHP filter[2]	2.1	2.8	1.9	1.4	1.4
	EHP filter[3]	2.1	2.8	2.0	1.4	1.3
Italy	Actual	2.3	2.9	2.1	1.7	0.6
	MV filter	2.3	3.0	2.1	1.8	1.4
	EHP filter[2]	2.4	2.9	2.2	1.9	1.6
	EHP filter[3]	2.3	2.9	2.2	1.8	1.4
United Kingdom	Actual	1.9	1.7	2.0	2.0	1.4
	MV filter	..	..	2.0	1.8	1.7
	EHP filter[2]	1.9	1.9	1.9	1.8	1.9
	EHP filter[3]	1.9	1.9	1.9	1.8	1.7
Canada	Actual	1.0	0.8	1.0	1.1	0.9
	MV filter	0.9	0.8	1.1	1.0	1.0
	EHP filter[2]	1.0	0.9	1.0	1.1	1.1
	EHP filter[3]	1.0	0.9	1.0	1.1	1.1

EHP : Extended Hodrick-Prescott filter, MV: Multivariate filter.
1. 1991-98 for Germany.
2. Extended Hodrick-Prescott filter with out-of-sample growth rate restriction.
3. Extended Hodrick-Prescott filter using OECD projections to extend time-series out of sample.
Source: Secretariat calculations based on data for the OECD *Economic Outlook*, No 66.

91. All H-P, EHP and MV filters used in this study set λ=400. Moreover, in the case of Germany, all filters consider a break in the series at the time of the reunification (between 1990:2 and 1991:1).

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