STATISTICS BRIEF

OECD

December 2003
No. 7

Comparing growth in GDP and labour productivity: measurement issues

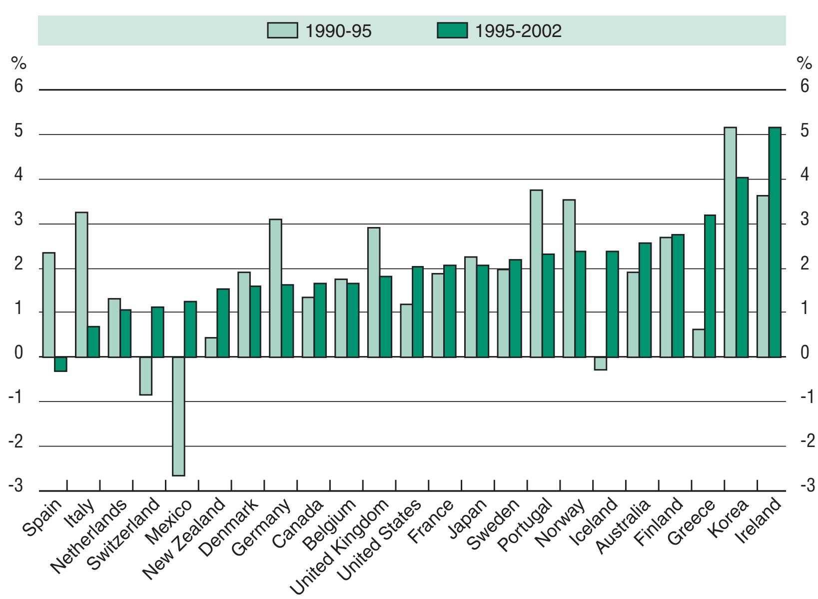
By Nadim Ahmad, François Lequiller, Pascal Marianna, Dirk Pilat, Paul Schreyer, Anita Wölfl

In this issue

Growth and productivity are on the policy agenda in most OECD countries. Recent OECD work has highlighted large diversities in growth and productivity as well as a range of policies that could enhance them (OECD, 2001*a*, 2003*a*, 2003*b*). In the United States, Gross Domestic Product (GDP) growth has increased substantially faster than in large European countries or Japan, partly because the US population expanded rapidly during the 1990s. Moreover, estimates of labour productivity growth, measured as GDP per hour worked, suggest that US labour productivity has grown faster than that of some large European Union countries such as Italy and Germany (see Chart 1). Also, US GDP per capita has grown more in comparative terms, since strong labour productivity growth was combined with increased labour utilisation over the 1990s, in contrast with several European countries.

This Statistics Brief highlights measurement issues that can affect international comparisons of GDP and productivity growth and therefore the validity of cross-country

Chart 1. **Growth of GDP per hour worked; 1990-95 and 1995-2002**
Annual average growth rate



Source: OECD estimates based on the OECD Productivity Database.

analysis.[1] These measurement issues do not undermine the strong performance of the United States compared to the large EU countries and Japan for real GDP growth during the period 1995-2002. However, differences in annual average growth of GDP per capita and labour productivity between these countries for the same period are small enough to fall within the range of statistical uncertainty.

Measuring nominal GDP

Comparability of nominal GDP is significantly dependent on the use of a common conceptual framework. The current framework is the 1993 version of the international "System of National Accounts" (SNA), which nearly all OECD member countries now use as the basis of their national accounts. Despite this convergence, however, some differences still exist between countries regarding the degree to which the manual has been implemented.[2]

Military expenditures

The coverage of government investment in the US National Income and Product Accounts (NIPA) is wider than that recommended by the SNA, since it includes expenditures on military equipment that are not considered assets by the SNA. The other OECD countries strictly follow the SNA in this matter. As the amount of public investment affects the level of GDP, this results in a statistical difference in the GDP measurement. Fortunately, the impact on GDP *growth* tends to be relatively small. Over the past decade, this methodological difference has only reduced annual US GDP growth by 0.03% on average. Recent planned increases in US military expenditure may reverse this effect, however. Convergence on this issue is expected in the next edition of the SNA, in 2008. In the meantime, the OECD publishes data for the United States in its Annual National Accounts Database, which adjusts for this difference.

Financial intermediation services

Most banking services are not explicitly charged. Thus, in the SNA, the production of banks is estimated using the difference between interests received and paid, known as "Financial Intermediation Service Indirectly Measured" (FISIM). All OECD member countries estimate total FISIM. While it is relatively straightforward to estimate FISIM, the key problem is breaking it down between final consumers (households) and intermediate consumers (businesses). Only the former has a direct impact on GDP. In the United States, Canada and Australia, such a breakdown has been estimated in the national accounts for some time, in accordance with the SNA. In Europe and Japan, however, the implementation of a breakdown between final and intermediate consumers has been delayed until 2005.

Before the NIPA was comprehensively revised in December 2003, imputed household consumption of financial services accounted for 2.3% of US GDP compared to zero in Europe and Japan. Fortunately, the impact on GDP *growth* is limited to less than 0.1% per year, the effect being positive in some years and negative in others. Furthermore, the recent revision of the US accounts has significantly reduced the difference in levels to probably just over 1% of GDP, thus roughly halving the impact on growth. Preliminary estimates suggest that with the implementation of the allocation of FISIM between both sectors in 2005, GDP levels would increase by approximately 1.3% in European countries and by nearly 3% in Japan. With these changes, diversities arising from methodological differences should be mostly eliminated.

Investment in software

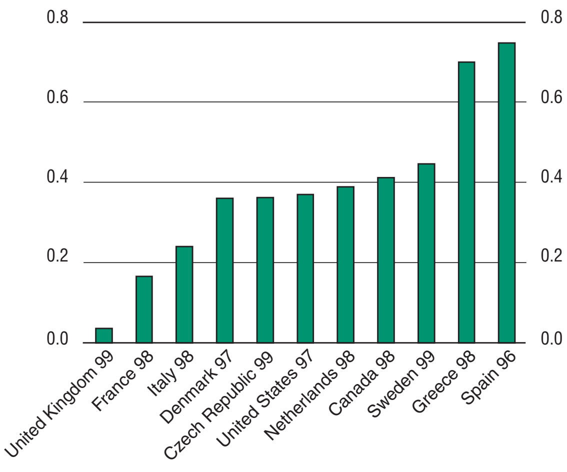
Measurement of software investment is another significant issue in the comparability of GDP. The SNA recommends that software expenditures be treated as investment once the acquisition satisfies conventional asset requirements. When introduced, this change added nearly 2% to GDP for the United States, around 0.7% for Italy and France, 0.5% for the United Kingdom. Doubts on the comparability of these data were raised when comparing "investment ratios", which are defined as the share of total software expenditures that are recorded as investments. These ratios range from under 4% in the United Kingdom to over 70% in Spain (see Chart 2). One would have expected them to be roughly the same across OECD countries.

An OECD/Eurostat Task Force established in October 2001 confirmed that different estimation procedures contributed significantly to the differences in software capitalisation rates, and a set of recommendations describing a harmonised method for estimating software was formulated (see Lequiller, *et al*, 2003; Ahmad, 2003). Most of these recommendations eventually will be

1. For more detail on this subject, see Ahmad, *et al*, 2003 at http://www.oecd.org/findDocument/0,2350,en_2649_33715_1_119684_1_1_1,00.html

2. An important issue not considered in this paper relates to valuing activities in the non-observed economy. This is the subject of Statistics Brief No. 5.

Chart 2. **Investment ratios for purchased software**



Source: OECD.

implemented by countries but until then differences in software and GDP measures will persist.

In practice, National Statistical Offices use one of two distinct methods to estimate software investment. The first derives data from business accounts. The second disregards business accounts, measures the total supply of computer services in an economy and estimates directly the amount of software with asset characteristics. The first approach tends to produce systematically lower estimates of investment than the second. This is mainly because businesses tend to use very prudent criteria when capitalising software, particularly if there are no tax incentives for doing so. Countries using the second approach, such as the United States, had a higher measured investment than countries such as France, the United Kingdom and Japan where statistical methods were more inspired by the first approach. As a result, while the amount of total software expenditures may be more or less similar, the amount of software expenditures recorded as investment, *and thus included in GDP*, is significantly higher in the United States than in France, the United Kingdom or Japan for purely methodological reasons.

The impact of these methodological differences on GDP growth can be substantial. Chart 3 shows the estimated impact on GDP growth in the United States, assuming an investment ratio of 0.04 (which is the one currently used in the United Kingdom), and for the United Kingdom, assuming an investment ratio of 0.4 (which is close to that used in the United States and some other countries). In both cases, the OECD Task Force procedure for own-account production is applied and a number of assumptions are made.

The results show that the impact on UK GDP growth can reach 0.2%, and even 0.4%, in some years. Similar results are likely to occur depending on the size of the investment ratio in each country and the approach used. Changes of between +/-0.25% of GDP should thus be expected. However, the variations in growth arising from the different methodologies is unlikely to be as large from 2000 onwards, since expenditure on software before then was exceptionally high to address the Y2K problem.

Measuring real GDP

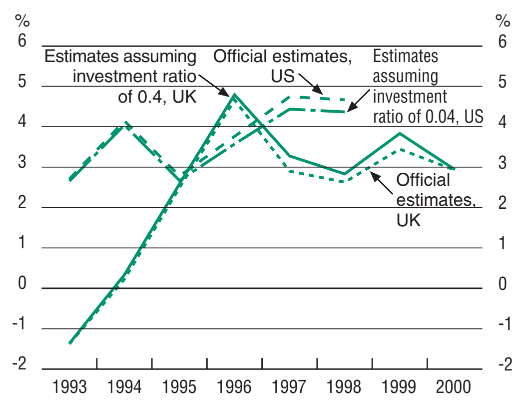
Measurement becomes even more complicated when price and quality changes have to be accounted for. In this paper only temporal price indices are discussed, not spatial price indices (see Box "Purchasing power parities in comparisons of labour productivity growth").

Adjusting for quality change: the role of hedonic price indexes

A widely discussed issue at the height of the "new economy" debate was the international comparability of rates of economic growth, given that the United States and some European countries apply very different statistical methodologies to the computation of price indices for information and communication technology (ICT) products. Because an alternative price index

Chart 3. **Sensitivity of GDP growth rates to different investment ratios for purchased software**

Annual growth rate



Source: OECD.

translates into a different measure of volume growth, the question has been posed whether some, or all, of the measured variation in growth between countries is a statistical illusion rather than reality.

The main challenge is to accurately account for quality changes in these high-technology goods, for example computers. The necessary quality adjustments are not standardised across countries. Consequently, between 1995 and 1999, the US price index of office accounting and photocopying equipment (which includes computers) dropped by more than 20% annually, compared with 13% in the United Kingdom and – at that time - a mere 7% in Germany.[3] Because computers are internationally traded, their price changes should be similar across countries.

Another illustration of the difference in price indices is evident in Chart 4, which shows deflators for software investment. For example, the price index for Australia fell by about 30% between 1995 and 2000, while the price index for Sweden rose by about the same amount. This does not reflect real price movements but rather the dearth of price information available in this area.

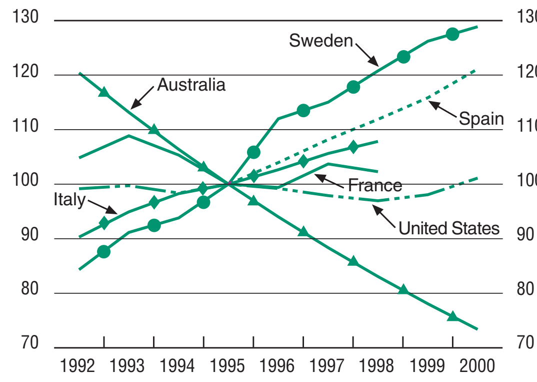
Thus, at least part of the differences in measured price changes appears to be due to methodological differences. The natural question is: how would GDP growth in Germany, the United Kingdom or any other country change if US methods were applied? Clearly, if the US price index for computers is applied to Italy's or the United Kingdom's investment expenditure, their investment volume will show more rapid growth, as will the volume measures of the computer industry's output. However, the direct effect on GDP growth of different price indices is limited owing to three factors.

First, only final products have an impact on GDP. Thus, errors on the price index of an intermediate good such as semiconductors will only affect the contribution of the semiconductor industry to total GDP growth but not GDP growth itself. A second distinction is that, even for final demand products such as personal computers, the impact of an error on the price index will only affect GDP if the product is manufactured in the country. Third, if imported products are used as intermediate inputs then the absence of hedonic deflators in a country's national accounts will lead to an *overstatement* of real GDP growth (assuming that hedonic deflators represent the preferred measure) because imports will be lower and imports have a negative impact on GDP.

3. Germany has recently introduced hedonic methods for IT products. The first publication of these data took place in 2002.

Chart 4. **Price indices for software investment**

Indices, 1995 = 100



Source: OECD.

This is why simulations to obtain an order of magnitude for the impact of price adjustments of ICT products on the rate of change of real GDP lead, in general, to only modest effects, around +0.1% (Lequiller, 2001; Deutsche Bundesbank, 2001; Schreyer, 2002). A review of the impact of hedonic price indices on aggregate volume growth in the United States found that the quality change in personal computers added 0.25% to the estimate of annual real GDP growth over the period 1995-99 (Landefeld and Grimm, 2000). While quite high, this has to be put in proportion to a rate of real GDP growth of 4.15% per year in the United States during this period.

Measuring real output in services

The service sector now accounts for about 70 to 80% of aggregate production and employment in OECD economies and continues to grow. But measuring output and productivity growth in many services is not straightforward. The measurement of *non-market services* is even more difficult, because, by definition, there is no output price and thus no deflator, other than costs. Health and education are the main non-market services and they have a significant impact on GDP because they contribute to final demand. This difficulty may raise doubts regarding the international comparability of the volume estimate of production of these sectors. In this paper we have focused on the health and social services sector.

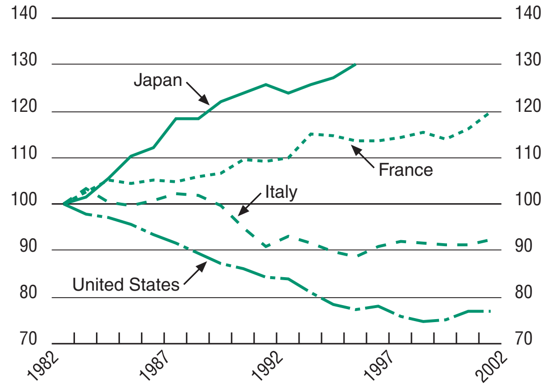
Currently, a vast majority of OECD countries measure volumes of health services as the sum of deflated costs. However, such input-based methods fail to reflect the quantity and quality of output, thereby mis-measuring productivity growth. Some countries have therefore tried to implement what are called output measures. Chart 5 shows that measured productivity in health and social services is in secular decline in the United States and Italy, while increasing slightly in France and steadily in Japan. Given the nature of the industry and given the difficulty in obtaining appropriate price and volume measures, it would seem that at least some of the cross-country differences in productivity growth are due to measurement differences. However, it is very difficult to quantify these effects.

Zero productivity simulations

Noting that certain service industries have been characterised by prolonged periods of negative measures of productivity growth, one could conclude that poor measurement may provide an explanation. Wölfl (2003) simulated what would happen if productivity growth in these services for France, the United States and Germany had not been negative but zero and further simulated the impacts on measured overall labour productivity growth. The empirical results suggest strong negative indirect effects on measured productivity growth for industries that use these services, partly outweighing the direct positive effect of the adjustment on productivity growth for the services themselves. The effect on aggregate productivity growth may be very small, depending on the type of measurement problem and the importance of the adjusted services for other industries and for the total economy. Setting negative productivity growth rates at zero, would lead, for instance, to a 0.19 percentage point change in measured aggregate productivity growth for France and a 0.08 percentage point change for the United States over the period 1990-2000. While these effects would directly translate into measured labour productivity growth, they are comparatively small.

Chart 5. **Real value added per employed person in the health and social work industry**

Indices, 1982 = 100



Source: OECD.

Purchasing Power Parities in comparisons of labour productivity growth

Purchasing Power Parities (PPPs) for GDP are spatial price indices that compare levels of real GDP and its components internationally. As they are associated with level comparisons, there is normally no need to invoke PPPs for comparisons of growth in GDP and productivity. Thus, the method used by countries to compile the data discussed in the main text does not involve PPP. However, in principle, it is possible to construct an index of relative output growth by using a time series of PPPs, and applying them to one country's current-price GDP. The resulting GDP level, expressed in current international prices, can then be related to the GDP level of another country to form an index of relative GDP growth between two countries. This method is based on different weighting schemes and indeed, empirical differences can be sizable as recently shown by Callow (2003). One might argue that the comparison of the two methods should in itself be interesting because it reveals effects of different weighting schemes. This is true in a world of complete and high-quality statistics. Practically, however, PPPs are based on a smaller sample of prices and on less detailed weights than national price indices. For purposes of comparing relative output and productivity growth, the comparison based on constant national prices is preferred. PPPs should be used when output and productivity levels are the object of comparison across countries. For more detailed discussion of PPPs, see Statistics Brief No. 3.

The choice of index numbers

GDP growth is a single number, drawn up as a combination of the change in volumes of the several hundred goods and services categories that constitute the classifications of national accounts. To compile this number, countries use different formulae in practice, even if the trend is toward using chained rather than fixed formulae. “Fixed base” Laspeyres volume indices are currently still in use in some OECD countries (e.g. Japan, Germany, Finland, Spain, Sweden and Switzerland). Annually chained Laspeyres indices are the formula recommended by Eurostat for its Member countries. About half of the EU countries have changed their national accounts to a chained annually re-based Laspeyres method, and the remainder will change by 2005. The Australian and New Zealand accounts are also based on this index number formula. Annually weighted Fisher indices are currently used in the national accounts of the United States and Canada.

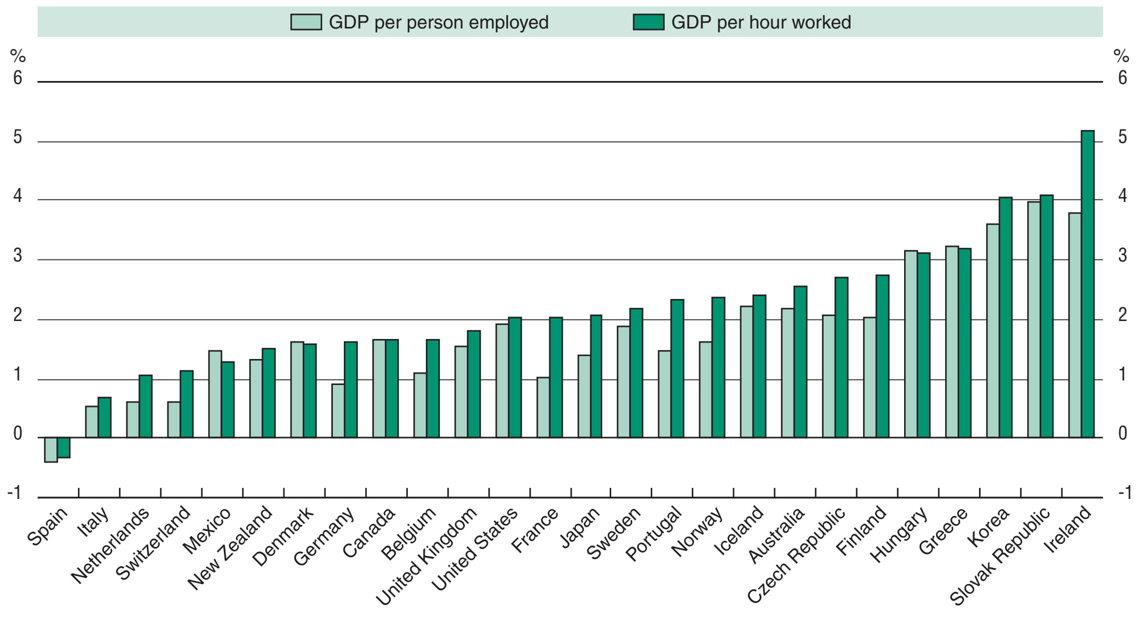
With regard to international comparability, does it matter which index number formula is chosen to compute volume GDP growth, given the same set of prices and quantities for GDP components in two countries? Schreyer (2001) used detailed final expenditure statistics to assess the effects of choosing fixed Laspeyres index numbers over chained Fisher index numbers, in the presence of significant relative price changes. The results confirmed that chained Fisher indices tend to produce systematically lower figures for GDP growth than fixed Laspeyres, ranging from -0.26% per year in Japan to -0.06% per year in Canada, the US being at -0.15%. In this case, the statistical methods implemented in the United States have thus decreased the estimate of GDP growth compared to other methods.

Measuring labour input

Labour input can be measured using total employment, total hours worked, or a quality adjusted measure of labour input. Considering the importance of the change in the number of hours worked, adjusting for this is particularly important for cross country comparisons of labour productivity. Chart 6 illustrates that in most OECD countries, while productivity growth over the 1995-2002 period was much more rapid after adjustment for hours worked, this difference is not similar for all countries. It is negligible for the United States, but important for Japan, France and Germany. Unfortunately, adjustments for the composition of labour are not available.

Data on total hours worked (computed using surveys carried out on households or enterprises) are often not consistent with National Accounts. Some uncertainty remains regarding the comparability of measures of hours worked in OECD countries although this uncertainty is greater for the level of hours worked than for its growth

Chart 6. **Comparison of growth in GDP per hour worked and GDP per person employed, 1995-2002**
Annual compound growth rates



Source: OECD.

rate. Nevertheless, comprehensive estimates of annual working time currently exist only for a limited number of OECD countries and the quality of data in this area therefore differs across Member countries, introducing some uncertainty in measures of labour productivity growth. Total hours worked can be derived by combining estimates of annual hours worked per person employed with average employment levels over the year that are in accordance with National Accounts production boundaries. Such employment series have not been collected systematically or examined very closely in the past. The quality of the labour productivity measures has relied on the vigilance of the analysts and their understanding of the annual hours and employment series. Work is currently underway at the OECD to develop a series of estimates of total hours worked that ensure the consistency over time of employment and annual hours worked in calculations of labour productivity.

Conclusion and future work

This paper cannot be considered to fully cover all statistical differences in GDP and productivity growth between countries. In particular, the comparability of imputed rents has not been explored and some methodological differences remain probably yet to be discovered. However, the impression is that the known differences remain small when compared to total growth differentials. Therefore, the assessment of a substantially more rapid growth in the US cannot be undermined by statistical defects. However, growth differentials for GDP per capita or labour productivity between the US and other countries have been smaller on average during 1995-2002. The diagnosis remains therefore more fragile for these variables, in particular considering the difficulties regarding the measurement of labour input. The OECD is highly committed to working with Member countries towards maximising convergence on statistical methodologies and to provide a better statistical base for such analyses. In this regard the organisation is currently developing a reference database on productivity at the aggregate level. ■

Glossary

ICT: This stands for Information and Communication Technologies. It covers the range of new information goods and services, from software and computers to mobile phones, including semi-conductors.

Hedonic pricing: This refers to a technique which consists of using econometrics to price the different characteristics of a product, thus allowing price index compilers to take better account of the differences in the quality of the product. A good synonym would be "fully quality adjusted price indices". In general, hedonic pricing leads to price indices which grow slower (or decrease more) than non-hedonic pricing.

Previous issues of Statistics Brief
www.oecd.org/statistics

No. 1, October 2001 – Trade in Goods and Services: Statistical Trends and Measurement Challenges

No. 2, February 2002 – Creation of the Euro Area: Implications for Economic Statistics

No. 3, March 2002 – Purchasing Power Parities – Measurement and Uses

No. 4, June 2002 – Measuring Student Knowledge and Skills: The PISA 2000 Experience

No. 5, November 2002 – Measuring the Non-Observed Economy

No. 6, October 2003 – Measuring Regional Economies

Further information

- Ahmad, N, F. Lequiller, P. Marianna, D. Pilat, P. Schreyer and A. Wölfl (2003), "Comparing labour productivity growth in the OECD area: the role of measurement", *Statistics Directorate Working Paper 2003/5* , OECD, Paris.
- Ahmad, N. (2003), “Measuring Investment in Software”, *STI Working Paper 2003-6*, OECD, Paris.
- Callow, Julien (2003); “Getting Europe to work”; *Credit Suisse First Boston Fixed Income Research*; 10 April.
- Deutsche Bundesbank (2001), “Problems of international comparisons of growth - a supplementary analysis”; Appendix to *Monthly Report*, May.
- Landefeld, Steven J. and Bruce T. Grimm (2000); “A Note on the Impact of Hedonics and Computers on Real GDP”; *Survey of Current Business*, December.
- Lequiller, François (2001); “La nouvelle économie et la mesure de la croissance du PIB”; *Série des documents du travail de la Direction des Etudes et Synthèses Economiques G2001/01*; INSEE.
- Lequiller, F., N. Ahmad, S. Varjonen, W. Cave and K.H. Ahn (2003), “Report of the OECD Task Force on Software Measurement in the National Accounts”, *Statistics Directorate Working Paper 2003/1*, OECD, Paris.
- OECD (2001a), *The New Economy: Beyond the Hype*, Paris.
- OECD (2003a), *The Sources of Economic Growth in OECD Countries*, Paris.
- OECD (2003b), *ICT and Economic Growth – Evidence from OECD countries, Industries and Firms*, Paris, forthcoming.
- Schreyer, Paul (2001); “Information and Communication Technology and the Measurement of Real Output, Final Demand and Productivity”; *Economics of Innovation and New Technology*, Vol. 10. 2001.
- Schreyer, Paul (2002); “Computer price indices and international growth and productivity comparisons”; *Review of Income and Wealth*.
- Wölfl, Anita (2003); “Productivity Growth in Service Industries: an Assessment of Recent Patterns and the Role of Measurement”; *STI Working Papers 2003-6*, OECD, Paris.

The Statistics Brief is published by the Statistics Directorate of the OECD
Editor in chief: Enrico Giovannini
Editor: Brian Finn
Editorial team: Benoit Arnaud, Eileen Capponi

For further information contact:
The Editor
STATISTICS BRIEF
Statistics Directorate
OECD
2, rue André-Pascal
75775 Paris France
email: STD.STATBRIEF@oecd.org

Do you want to subscribe to Statistics Brief?
Register now at **www.oecd.org/OECDdirect** *and choose Statistics Brief or e-mail/write to the Editor.*

OECD Worldwide

OECD NORTH AMERICA

OECD Washington Center
2001 L Street N.W., Suite 650
Washington, DC 20036-4922, USA
Toll free: +1 (800) 456-6323
Fax: +1 (202) 785-0350
General information:
+1 (202) 785-6323
E-mail: washington.contact@oecd.org
Internet: www.oecdwash.org

OECD JAPAN

OECD Tokyo Centre
Nippon Press Center Bldg., 3rd floor
2-2-1 Uchisaiwaicho, Chiyoda-ku
Tokyo 100-0011, Japan
Tel.: +81 (3) 5532 0021
Fax: +81 (3) 5532 0035
E-mail: center@oecdtokyo.org
Internet: www.oecdtokyo.org

OECD GERMANY

OECD Berlin Centre
Albrechtstrasse 9
10117 Berlin-Mitte
Tel: +49 30 288 8353
Fax: +49 30 288 83545
E-mail: berlin.contact@oecd.org
Internet: www.oecd.org/deutschland

OECD Bonn Centre
August Bebel Allee 6
53175 Bonn
Tel: +49 228 959 12 0
Fax: +49 228 959 12 18
E-mail: bonn.contact@oecd.org
Internet: www.oecd.org/deutschland

OECD MEXICO

OECD Mexico Centre
Av. Presidente Mazaryk 526
Colonia: Polanco
C.P. 11560
Mexico D.F., Mexico
Tel: +5255 52 81 38 10
Fax: +5255 52 80 04 80
E-mail: mexico.contact@oecd.org
Internet: rtn.net.mx/ocde/

OECD PARIS

OECD Paris Centre
2, rue André-Pascal
75775 Paris Cedex 16, France
Tel: +33 1 45 24 81 67
Fax: +33 1 45 24 19 50
E-mail: sales@oecd.org
Internet: www.oecd.org/bookshop

82415

OECD