OECD Science, Technology and Industry Working Papers
2003/07

Productivity Growth in Service Industries: An Assessment of Recent Patterns and the Role of Measurement

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https://dx.doi.org/10.1787/086461104618

Unclassified **DSTI/DOC(2003)7**

Organisation de Coopération et de Développement Economiques
Organisation for Economic Co-operation and Development

25-Jun-2003

English text only

DIRECTORATE FOR SCIENCE, TECHNOLOGY AND INDUSTRY

DSTI/DOC(2003)7
Unclassified

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Statistical Analysis of Science, Technology and Industry

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JT00146676

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PRODUCTIVITY GROWTH IN SERVICE INDUSTRIES AN ASSESSMENT OF RECENT PATTERNS AND THE ROLE OF MEASUREMENT

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Abstract

This paper examines recent patterns in productivity growth of service industries and analyses the role of problems in measuring service productivity growth on industry and aggregate productivity growth. At the aggregate level, unbalanced growth can be observed between a dynamic manufacturing sector on one hand and a rather stagnant service sector on the other. The service sector itself is, however, composed of a set of heterogenous industries with productivity growth rates ranging from low or negative rates to growth rates exceeding those of high-growth manufacturing industries. The empirical evidence suggests that low or negative productivity growth rates in several services are linked to measurement problems. Computing constant price service output is particularly important. Potential under-estimation of service productivity growth leads eventually to an under-estimation of aggregate productivity growth, via aggregation effects and the flows of intermediate inputs. There is, however, no clear evidence on which service industries are the main problem areas. Moreover, the effect on aggregate productivity growth that arises from a potential under-estimation of labour productivity growth in specific services depends on industry-specific factors. These are the type and extent of the measurement bias, the weight of the under-estimated services in the whole economy, and in particular the degree to which the mismeasured service industry produces for intermediate demand.

* This paper benefited strongly from discussion at the meeting of the Working Party on Statistics of the Committee on Industry and Business Environment (CIBE) in December 2002, in particular comments by Carol Corrado, Marilyn Manser, Eunice Lau and Dean Parham. I would like to thank very much Dirk Pilat, Paul Schreyer, Seppo Varjonen, Henry van der Wiel and Andrew Wyckoff for their ideas, comments and methodological support. Particular thanks go to Colin Webb and Nadim Ahmad for their support with and their excellent work on the structural analysis (STAN) database and the input-output tables. The revival of the OECD I-O database is partly due to a generous voluntary contribution made by the UK DTI which is gratefully acknowledged. The views presented in this paper are those of the author and do not necessarily reflect those of the OECD or of the governments of its member countries.

CROISSANCE DE LA PRODUCTIVITE DANS LE SECTEUR DES SERVICES ANALYSE DES TENDANCES ACTUELLES ET ROLE DE LA MESURE

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Resumé

Le présent document examine les tendances de la croissance de la productivité dans les industries de services, et analyse le rôle des problèmes rencontrés pour mesurer la croissance de la productivité des services au niveau sectoriel et global. Au niveau global, on observe un déséquilibre de la croissance entre un secteur manufacturier dynamique d'un côté, et un secteur des services plutôt atone de l'autre. Le secteur des services lui-même se compose néanmoins d'un éventail d'industries hétérogènes dont la croissance de la productivité oscille entre des taux faibles ou négatifs et des taux supérieurs à ceux des industries manufacturières à forte croissance. Les données empiriques indiquent que les taux faibles ou négatifs de plusieurs domaines de services sont liés à des problèmes de mesure. La valorisation de la production de services est un point particulièrement important. La sous-estimation potentielle de la croissance de la productivité de services aboutit, en raison d'effets d'agrégation et d'apports de facteurs intermédiaires, à une sous-estimation de la productivité globale. On n'est toutefois pas certain de connaître vraiment les secteurs de services concernés par ces problèmes. En outre, l'incidence, dans certains secteurs de services, de la sous-estimation potentielle de la croissance de la productivité du travail sur la croissance de la productivité globale dépend de facteurs spécifiques auxdits secteurs : type et étendue de l'erreur de mesure, poids des services sous-estimés dans l'ensemble de l'économie, et en particulier niveau de production, pour la demande intermédiaire, du secteur de services mal mesuré.

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* Ce document s'appuie en grande partie sur les discussions qui ont eu lieu lors de la réunion du Groupe de travail sur les statistiques de décembre 2002 et, plus particulièrement, sur les commentaires de Carol Corrado, Marilyn Manser, Eunice Lau et Dean Parham. En outre, je souhaiterais remercier Dirk Pilat, Paul Schreyer, Seppo Varjonen, Henry van der Wiel et Andrew Wyckoff de leurs idées et de leurs commentaires ainsi que leur soutien au niveau méthodologique. Remerciements également à Colin Webb et Nadim Ahmad pour leur excellent travail et toute leur aide en ce qui concerne respectivement la base de données pour l'analyse de l'industrie (STAN) et les tableaux d'entrées-sorties. Enfin, nous remercions le ministère du Commerce et de l'Industrie (DTI) du Royaume-Uni de son importante contribution financière qui nous a grandement aidé à remettre sur pied la base de données entrées-sorties de l'OCDE. Les vues exprimées dans ce document sont celles de l'auteur et n'engagent ni l'Organisation ni les autorités nationales concernées.

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1. Introduction

This paper examines recent patterns in productivity growth of service industries and the contribution of the services sector to aggregate productivity growth. It follows up on previous OECD work on sectoral and aggregate productivity growth, which showed that growth performance in the OECD area was characterised by growing cross-country disparities in growth of GDP per capita during the 1990s and declining productivity growth in most countries during the same period (Scarpetta *et al.*, 2001). Furthermore, in most countries, the bulk of aggregate productivity growth can be attributed to the manufacturing sector. Finally, despite evidence of increased use of efficiency-enhancing technologies such as ICT in service industries, productivity growth has not accelerated in these industries.

These findings imply that some of the slowdown in aggregate productivity growth can be accounted for by low or even declining productivity growth in service industries. If this is indeed the case, concerns about the future growth performance of the OECD area could be warranted. This is particularly the case since the service sector now accounts for about 70% to 80% of aggregate production and employment of OECD economies and continues to grow, possibly leading to a further decline in aggregate productivity growth.

But is the evidence indeed that compelling? Some services sectors have experienced strong productivity growth over the recent period. Moreover, much depends on whether services industries produce for final or for intermediate demand. Positive productivity growth in services, such as ICT-related, financial and business services, which are delivering to intermediate demand, may raise aggregate productivity growth directly via aggregation or indirectly via intermediate input flows. Finally, measurement may play a part. Zero or negative productivity growth in service industries might reflect under-estimation due to biases in the measurement of output and productivity growth of specific service industries. If this is the case, the "negative prospects" for OECD productivity growth might not necessarily have to occur.

This paper examines the empirical evidence on these issues across OECD countries. It first analyses recent patterns of productivity growth and resource allocation across and within sectors. Secondly, it examines whether there is any evidence for a role of measurement bias in determining low or declining productivity growth in service industries. Finally, it assesses empirically the effect that a potential under-estimation of productivity growth in services may have on aggregate productivity growth.

The aim of this paper is however not only to provide an overview of the empirical evidence on productivity growth of service industries. By addressing the issue of possible measurement bias, it also attempts to contribute to the discussion on how to measure service industries' output and productivity growth adequately. Some work on this issue has been done for individual countries (*e.g.* Slifman and Corrado, 1996; Gullickson and Harper, 1999, 2002; Sharpe, Rao and Tang, 2002), but little internationally comparative evidence exists. The paper is also intended to complement efforts by the OECD Statistics Directorate to make progress on service output measurement in specific sectors, *e.g.* financial services and insurance. By examining actual productivity growth patterns across countries, useful evidence can be gained on the key industries where measurement may require improvement.

2. Patterns of productivity growth in services

2.1 Unbalanced growth?

In his seminal paper of 1967, Baumol stressed the possible long-term consequences of unbalanced growth between productive manufacturing industries and unproductive or stagnant service industries (Baumol, 1967; Box 1). This phenomenon is based on a relatively straightforward argumentation and is founded in the productivity developments of the 1960s. It states that increasing unbalanced growth across sectors induces resource reallocation towards industries characterised by slow or zero growth, which might eventually slow down aggregate growth. During the persistent decline of productivity growth rates in several countries over the 1970s and 1980s, several authors have re-examined the issue and searched for ways to "cure" the disease.

Box 1. **Baumol's Cost Disease**

The main idea behind Baumol's Cost Disease can be summarised as follows: increasing unbalanced growth across sectors induces resource reallocation towards slowly growing or stagnant industries, eventually slowing down aggregate growth. Baumol starts with the – empirically based – assumption that the economy consists of two sectors. The first is a growing (manufacturing) sector, characterised by technological progress, capital accumulation, and economies of scale. The second one is a relatively stagnant (service) sector, consisting of services such as education, performing arts, public administration and health and social work. Due to the specific nature of this second sector, the potential for technological progress would only be temporary. These services might thus be characterised by an eventual increase in the costs that would have to be incurred in providing them.

The crucial point for differentiation between the two sectors lies in the role of labour. In the first sector, labour is mainly an input in the production of some final good. In the second sector, labour is rather an end in itself.[1] In order to stress the point, Baumol (1967) assumes that labour is the only input into production, with the total supply of labour being constant. Furthermore, wages in the two sectors are assumed to change in parallel to money wages, and thus to income in the economy, rising as rapidly as output per man hour in the growing sector. As a consequence, costs (*i.e.* wage costs) would steadily increase in the stagnant sector, while costs could be held constant within the growing sector, due to the productivity growth that can be achieved there.

This leads to two possible scenarios of inter-sectoral resource allocation and aggregate economic performance. In the first scenario, there is a tendency for the output of the stagnant sector to disappear. This would mainly be the case if demand for the service industries is not highly price or income inelastic. In the second scenario, however, the relative supply of both sectors' goods is assumed to be constant. Either the demand for stagnant sectors' goods is highly price inelastic, as is the case for social and health services, or production of these sectors is subsidised, as is the case in cultural services. In this second scenario, an increasing share in labour would have to be transferred to the stagnant industry, while the share of labour allocated to the growing industry would eventually approach zero.

In the long term, the second scenario would lead to declining aggregate productivity growth. Aggregate productivity growth can be calculated as a weighted average of the two sectors with the weights being the relative employment shares of each contributing sector. However, whether also growth of GDP per capita declines, and thus the long-term ability of countries to create wealth, cannot be said a priori. It depends on the relative growth of productivity and labour utilisation per sector.

Despite the intuitive appeal of Baumol's argument and its foundation in empirical evidence, there are certain factors which argue against declining aggregate productivity growth. First, not all service industries are stagnant; ICT use, for instance, has improved productivity growth in several countries. Second, and related to the first point, declining aggregate productivity growth might only occur if these service industries produce final goods, not if they produce intermediate inputs (Oulton, 1999).

In what follows, this paper briefly describes the main factors driving this phenomenon and presents some thoughts on why declining aggregate productivity growth does not necessarily have to occur. The short theoretical consideration is then confronted with the empirical evidence on recent patterns of productivity growth within OECD countries.

1. As will be discussed below, labour input is often also a crucial indicator for the estimation of constant price value added in certain service industries.

2.1.1 High productivity growth service industries

Strong productivity growth in ICT-related industries in countries such as the United States and Australia since the 1980s and in particular the 1990s have challenged Baumol's theory. There are several service industries that show relatively high productivity growth rates, sometimes over a long period. One possible reason is the presence of increasing returns to scale in some services sectors, which would contradict Baumol's theory. In the case of ICT-related services, for instance, increasing returns might result from network effects in the production and use of ICT technologies.[2] Moreover, the strong uptake of ICT equipment during the 1980s and 1990s might have spurred productivity growth within ICT-related service industries or in other ICT-using industries such as financial and business services. Baily and Gordon (1988) showed that the introduction of computer equipment, such as ATMs or credit cards as means for check transactions, allow banks to economise on costs, a finding that was confirmed in later work by Fixler and Siegel (1999). Triplett and Bosworth (2002) examined US productivity growth over the 1995-2000 period, and found that ICT equipment contributed to between 30 and 37% of labour productivity growth in business services, wholesale trade and transportation services. Moreover, these sectors also experienced a relatively strong pick-up in multifactor productivity (MFP) growth, with MFP growth in wholesale trade accelerating from 1.1% annually to 2.4% annually from 1987-1995 to 1995-2000. In retail trade, the jump was from 0.4% annually to 3.0%, and in securities the acceleration was from 2.9% to 11.2%.

However, there are two points that need to be taken into account. Firstly, according to Baumol *et al.* (1985), there exists a third sector within each economy, the "asymptotically stagnant" industries. The specific characteristic of these industries is that they use, in fixed proportions, one set of inputs produced by the industries with rapid productivity growth and another set of inputs produced by "stagnant" industries. The cost difference between the two sets of inputs would inevitably lead to an increase in the share of the inputs from the stagnant input provider, thus eventually reducing the productivity growth of the purchasing industry. Implicitly, Baumol's theory thus applies, but now on a lower level of aggregation. The characteristics for such industries resemble those of some high-tech and high-growth service and manufacturing industries, such as electrical or optical equipment manufacturing. These industries use both inputs provided by low-productivity growth sectors such as basic metals manufacturing, or education, and inputs like computer equipment or other ICT technologies which are characterised by strong price declines and strong productivity growth.

Secondly, it is in the very nature of some service industries such as social and health services, education, or retail trade to provide a "service" to the final user. Baily and Gordon (1988) stress the importance of what they term "convenience .... as a technological change that allows the substitution of low-value for high value-hours of the day or the week." In retail trade, for instance, increased convenience is reflected in 24-hour stores, in increased staff per consumer or an extension of the services provided by retail stores despite the higher costs that these additional activities might incur. As a counterexample of convenience, Baily and Gordon (1988) mention rigid shop closing hours. With short opening hours, a given level of goods might be produced and sold by fewer people in a short period of time, raising productivity growth per hour. The value or the welfare that has been created would however be reduced by the fact that valuable time has been wasted by waiting in line or in traffic jams.[3] Johnston *et al.* (2000) emphasize that competition may induce retailers to provide for longer trading hours; retailers change the service mix,

2. The specific characteristic of network effects is that the benefits from the use of such technologies increase more than proportionately with the increasing number of users.

3. A similar effect may result from zoning regulation in retail trade. McKinsey (2002), for instance, estimated that it might be due to zoning regulations that French retailers now produce twice the output of similar-sized stores in other countries. However, zoning might indirectly reduce output via reduced convenience for the consumer.

however, in order to offset the cost increase that arise from longer trading hours.[4],. Furthermore, longer trading hours in larger retail stores could, to some extent, be offset by exit of and decreases in trading hours in smaller retail firms. The role of convenience must, therefore, be taken into account when examining productivity growth in the services sector.

2.1.2 Services as providers of intermediate goods

Another positive contribution of services to aggregate productivity growth may arise indirectly as several service industries produce not only for final demand but also for intermediate demand. Oulton (1999) and Fixler and Siegel (1999) show that if services produce for intermediate demand this might act in the opposite direction of the Baumol's unbalanced growth model or might at least lower the speed with which aggregate productivity growth would decline. Oulton (1999) shows moreover that this would even be the case if resources shift to the service industry with lower productivity growth and if intermediate service providers are industries where only low productivity growth can be realised. The underlying condition would however be that their productivity growth rate is positive.[5]

However, the assessment of the extent of such a positive effect on aggregate productivity growth is not straightforward. On the one hand, there are reasons to assume strong positive effects on aggregate productivity growth from services as intermediate goods providers. First, positive effects may arise from outsourcing services, notably from the specialisation advantages that can be achieved thereby. As is mentioned in the model of Oulton (1999), the important driver for productivity growth from outsourcing is that it becomes cheaper to buy the service than to deliver it in-house, *i.e.*, that services become cheaper relative to labour. In order to deliver accountancy services, for instance, investment into specific competencies is necessary. But these are costly investments that pay off only with a certain and increasing number of goods produced. To provide these services internally, a manufacturing firm would have to allocate such competencies and facilities to the delivery of the accountancy service – resources that could be allocated more efficiently to functions that are more directly linked to the goods produced. As a consequence, there will be a productivity increase in the service using industry from outsourcing, independent of whether the outsourced service is characterised by strong or weak productivity growth.

Second, intermediate service providers do not necessarily produce at lower productivity growth than the final good producing manufacturing firm – as was assumed within the model of Oulton (1999) and Baumol (1967). This is particularly the case since intermediate demand itself drives productivity increases in service industries. Many services are less involved in international trade or foreign direct investment than many manufacturing industries; those services, however, that produce for intermediate goods markets, *e.g.* business or telecommunications services, are often confronted with intensive competition, and are, therefore, likely to be induced to increase productivity.

On the other hand, if intermediate input providing service industries are indeed characterised by lower productivity growth than the service using industry from which they are outsourced, a shift of labour towards the high-cost, low-productivity growth service sector may be induced. As in the case of the

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4. The effect on measured productivity growth depends on whether these changes are appropriately covered in the quality adjusted output measure.

5 . It has to be noted that with the introduction of intermediate inputs in the analysis, the appropriate productivity concept to examine aggregate productivity growth is multifactor rather than labour productivity (OECD, 2001*a*). The model of Oulton (1999) therefore examines the impact of intermediate inputs on aggregate multifactor productivity growth. However, since this model assumes that the service sector produces only with labour input, labour and multifactor productivity growth in the service sector are identical.

asymptotically stagnant industries, this might represent a case of unbalanced growth at a lower level of aggregation. Within the model of Oulton (1999), growth in productivity of the services sector more than outweighs the increase in the share of services in total demand, eventually raising aggregate productivity growth. The main reason behind is, however, that, in this model, the manufacturing industry is assumed to be the only industry that produces for final demand. Thus, the impact on aggregate productivity growth is driven by the fact that services are becoming cheaper relative to labour and it is of minor importance that the shift of resources to the services sector may render services more expensive relative to the manufactured goods. In reality, however, aggregate productivity growth would be a weighted average of productivity growth in manufacturing and services, with both sectors producing for intermediate and final demand. As a consequence, the eventual effect on aggregate productivity growth when services produce increasingly for intermediate demand would depend on the industrial composition of both sectors and the whole economy as well as on relative productivity growth of each industry.

2.2. Productivity growth of service industries in OECD countries

In what follows, the previous theoretical considerations are confronted with the empirical evidence. The paper uses the OECD STAN Database as well as the OECD input output tables.[6] These datasets provide data for a broad variety of indicators such as gross output and value added at current and constant prices, as well as employment, working hours and compensation of employees. The data are available on a sectorally disaggregated level and, for most countries, in long time series, ranging from 1970 or at least 1980 until 2000 or even 2001. Moreover, activity breakdowns of both data sources allow the analysis of inter- and intra-sectoral interdependencies. The paper focuses on labour productivity growth as measured by growth of value added per unit of labour input. The main reason is the lack of sufficient data on capital stock and capital services at the industry level, which would be necessary to analyse multifactor productivity growth. The choice of value added as output variable is largely due to the fact that constant price data on gross output are only available for few countries.

2.2.1 Trends in productivity growth and employment

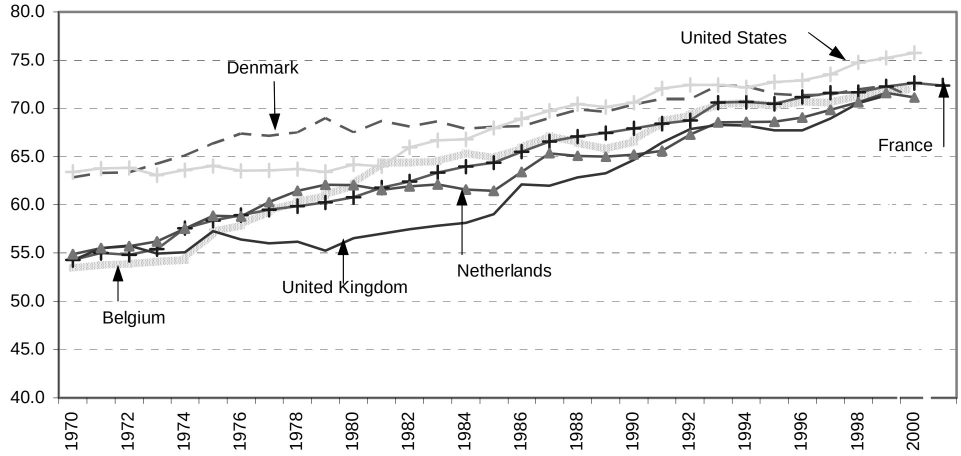
Figure 1 illustrates that productivity growth patterns in service industries – whether positive or negative – play an important role in aggregate growth performance. Since the 1970s, the service sector has become the quantitatively most important sector in almost all OECD economies. The share of the service sector has strongly increased since the 1970s and, by 2000, amounted to about 60% or 70% of total value added in most OECD economies. In general, this trend might be explained by the increasing demand for services as income rose in most OECD countries over the 1980s and 1990s.[7] Some different patterns can be distinguished, though. A first group of countries, including the United States and Denmark, have had a relatively high share of services since the 1970s. Other countries in this group, *i.e.*, Belgium, France, the Netherlands and the United Kingdom, show strong increases in their value added share from initially low levels. In a second group of countries, including Austria, Germany, Italy, Sweden and Spain, value added shares are between 65% and 70% of total value added in 2000, and have continuously increased since the 1970s. Finally, there is a third group of countries where value added shares are continuously low, in particular in Korea, or show only slight increases over the whole period, such as in Canada and Norway.

6. Calculations have been undertaken for countries for which data are relatively abundant in both, the STAN Database and the input-output tables.

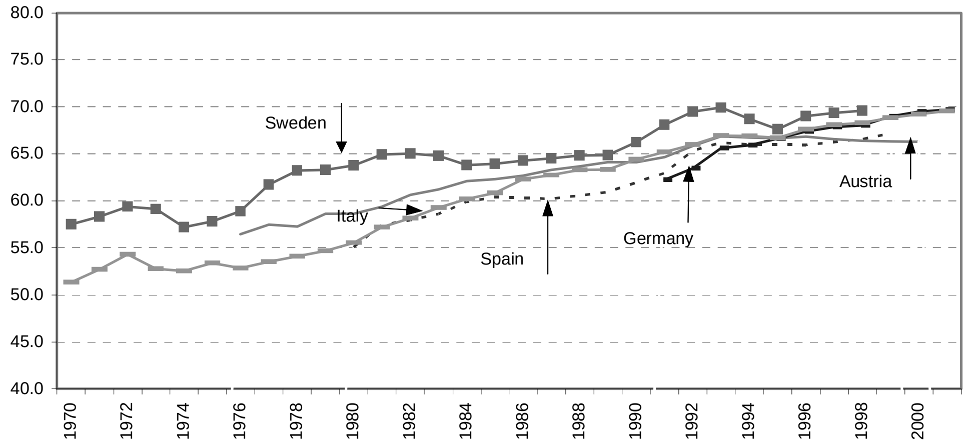
7. As OECD countries are characterised by growing incomes and ageing societies, the demand for many services is likely to increase further in the future.

Figure 1. **Value added shares of the service sector over time (in per cent)**

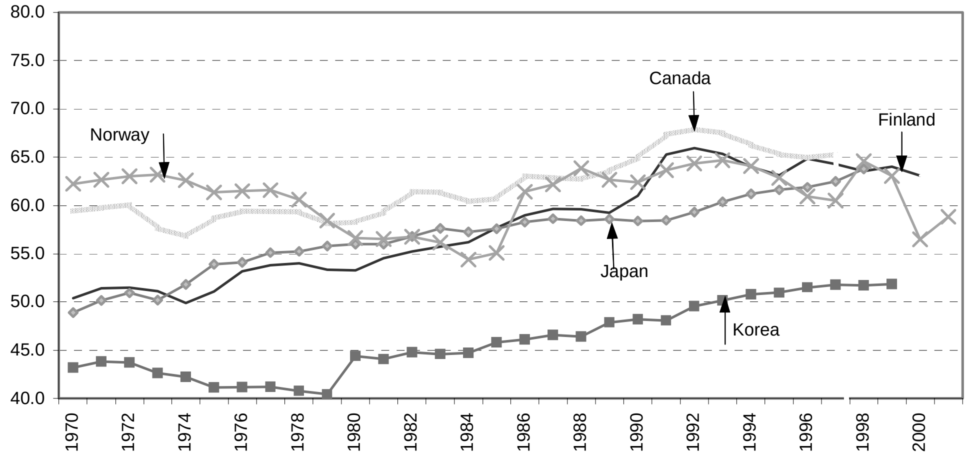
Countries with shares above 70% in 2000



Countries with shares between 65% and 70% in 2000



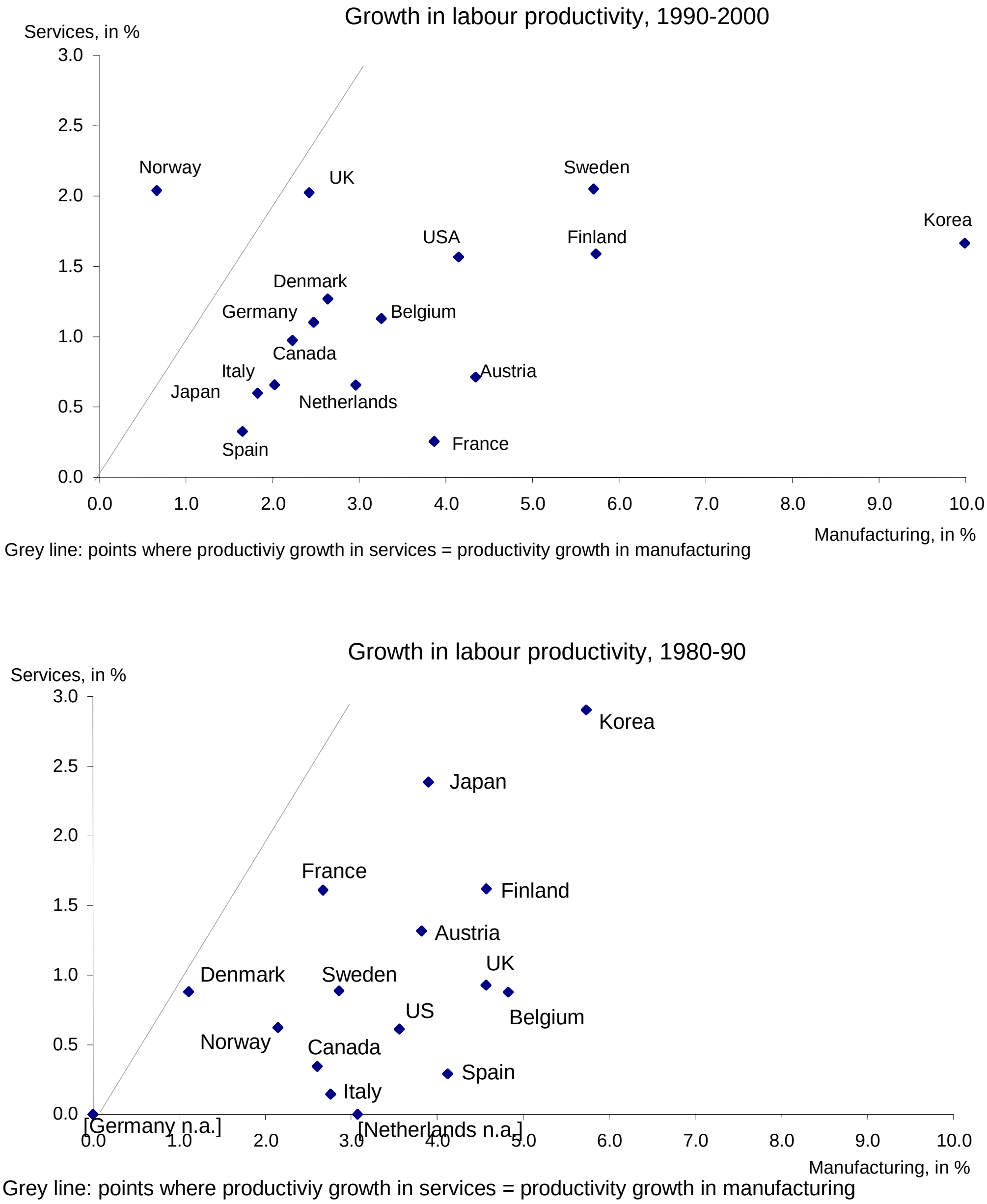
Countries with shares around or below 65% in 2000



1. Shares in total value added at current prices. The services sector covers ISIC classes 50-99.
Source : OECD STAN Database 2002.

Figures 2 and 3 illustrate the presence of Baumol's Cost Disease within OECD economies at the rather aggregate level.

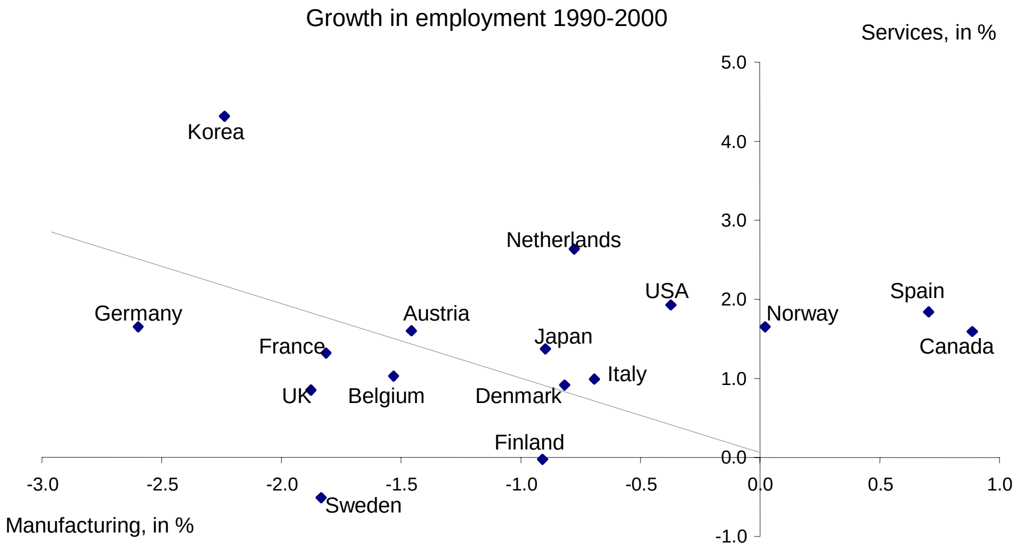
Figure 2**. Productivity growth in manufacturing and services**



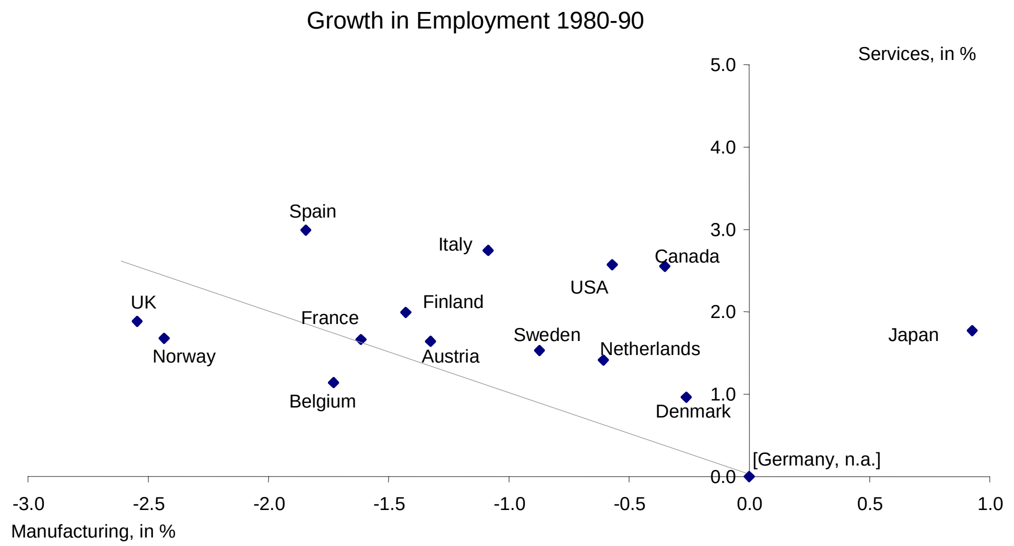
1. The services sector covers ISIC classes 50-99.
Source : OECD STAN Database 2002.

First, the results show a differential in productivity growth between relatively strong productivity growth in the "progressive" manufacturing sector and low productivity growth in the "stagnant" service sector. This is illustrated by the help of a grey line in each graph. Equal productivity growth in manufacturing and service industries would mean that all country points are on or close to that line. What can be observed however is a concentration of productivity growth to the right of the line. Productivity growth is thus higher in manufacturing than in services in (almost) all OECD countries. Moreover, in most countries, service productivity growth is only about one half of manufacturing productivity growth. In the United States, Sweden, Finland and especially in Korea, the ratio is less than one third. Secondly, Figure 3 illustrates that the differential in productivity growth between manufacturing and services is combined with a resource allocation towards the service sector. In most countries, employment growth is positive in services, but negative in manufacturing. This is especially the case for Korea, Netherlands, the United States and Japan.

Figure 3. **Employment growth in manufacturing and services**



Grey line: points where productiviy growth in services = productivity growth in manufacturing



Grey line: points where productiviy growth in services = productivity growth in manufacturing

1. The services sector covers ISIC classes 50-99.
Source : OECD STAN Database 2002.

There are two results from these graphs that argue against Baumol's Cost Disease. First, in some OECD countries there has been a slight increase in productivity growth of the service sector relative to the manufacturing sector from the 1980s to the 1990s (Figure 2). Examples of a relative increase in service productivity growth are Norway, the United Kingdom, the United States, Italy, Canada, Belgium and Spain. In the case of Norway, the United Kingdom and the United States, the relative increase partly resulted from a strong absolute increase in productivity growth of the service sector. Denmark shows a strong increase in service sector productivity growth, which is, however, compensated by a much stronger increase of productivity growth in the manufacturing sector. Second, employment growth in the service sector was weaker in the 1990s as compared with the 1980s. In the 1990s, more countries are located to the left of the grey line indicating equal employment growth between both sectors than was the case in the 1980s (Figure 3).

2.2.2 Evidence for high productivity growth in services?

More detailed evidence for individual services industries, shown in Figures 4 and 5, also questions Baumol's Cost Disease. Firstly, Figure 4 shows that there has been a change in the role of different industries within the service sector during the past 20 years. Overall growth in the share of the service sector in value added can mainly be attributed to relative growth of value added in market-related services, such as trade, hotels and restaurants, post and telecommunications and finance, insurance and business services.[8] In particular, finance, insurance and business services show a strong increase in value added shares. These sectors now account for about 20% to 30% of value added in the total economy, while their respective shares were between 10% and 20% in 1980. These services are also primarily driven by market conditions, which might imply greater pressures to improve productivity.

At the same time, there has been very little change in the value added shares of trade, restaurants and hotels as well as transport and communications services. In the case of transport and communications services, this might be due to two trends in prices and quantities that act in opposite directions. On the one hand, there might have been an increase in value added of transportation and particularly telecommunication services in the 1990s due to increased demand for these services. If prices were assumed to be constant and the increase in production in these services was higher than in other industries, this would have resulted in an upward shift in the value added shares of these services. On the other hand, increased demand and more efficient production may lead to a decline in relative prices and consequently to lower current price shares on value added. As will be shown later, the 1980s, and especially the 1990s, have shown constant or even declining price trends in transport and storage and particularly post and telecommunications services. The effects of these price trends may thus have compensated for the increase in value added shares from increased demand.

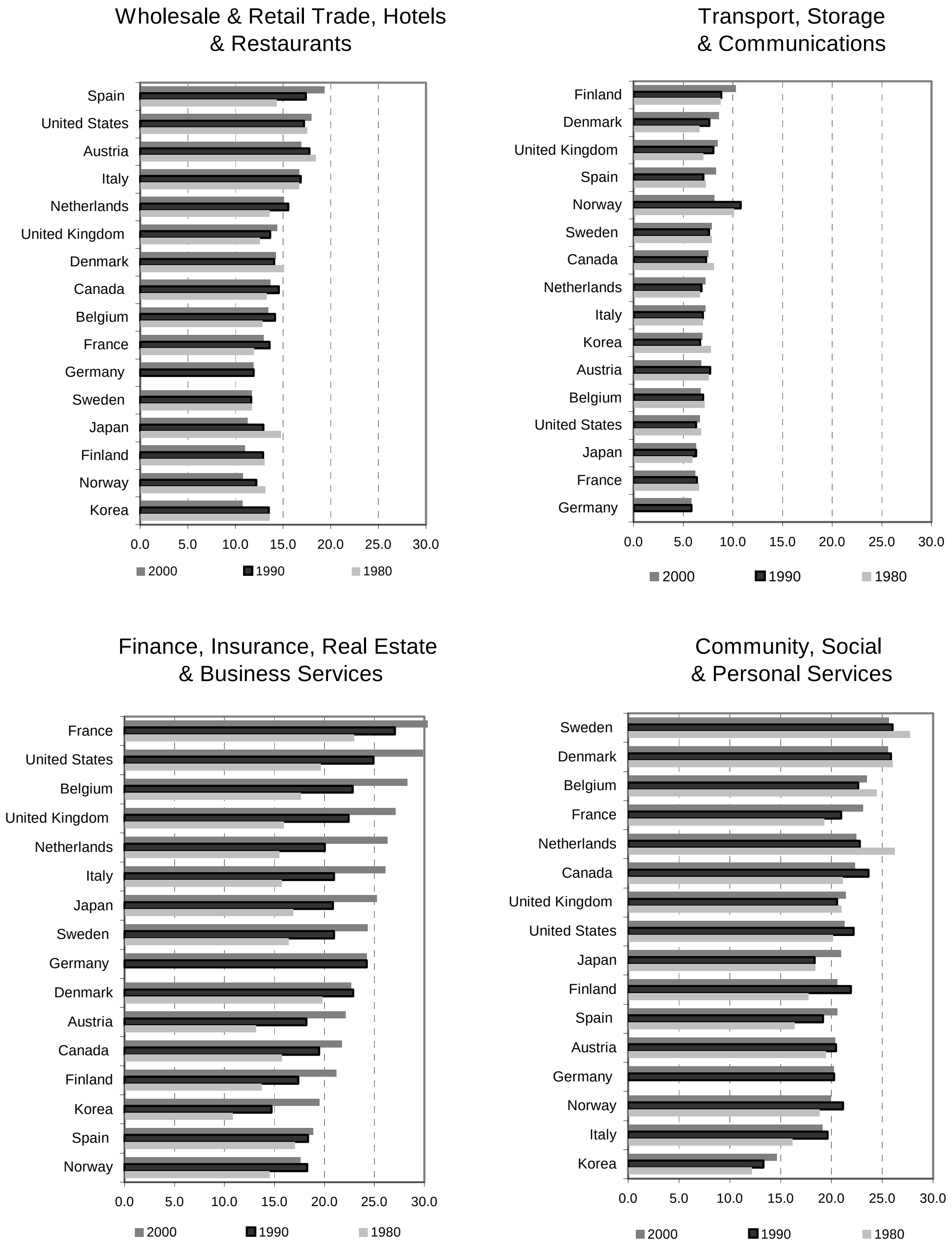
The results in Figure 4 show a relatively stable pattern of specialisation over time, except for finance and business services.[9] Italy, Spain, the United States and Austria show a large share of value added in trade, restaurants and hotels over the whole period. Countries with relatively high shares in transport and communications services for the whole period are Norway and Finland, as well as the United Kingdom and Denmark since 1980. In finance, insurance, real estate and business services, Belgium, France and the

8. A similar pattern can be observed with regard to structural change in employment during the 1990s [OECD (2000b)]. Producer services, including business, financial and real estate services, showed the most dynamic growth in employment, with particularly strong employment growth in the late 1990s.

9. Also this is in general in line with the result on structural change in employment. According to OECD (2000b), cross-country convergence in employment shares has been stronger for the broad shift of employment from manufacturing to services than for the distribution of employment across disaggregated service activities.

United States have been above average in value added shares since 1980, with this share increasing strongly up to 2000. Finally, Sweden, Denmark and Belgium show above-average shares of community, social and personal services over the whole period.

Figure 4. **Value added shares within the service sector**



1. Share of service industries in current price value added of the whole economy; Services Sector: ISIC classes 50-99.
Source: OECD, STAN Database 2002.

Secondly, Figure 5 shows that there are indeed some industries within the service sector which are characterised by strong productivity growth.[10] This is especially the case for post and telecommunications and for financial intermediation; productivity growth rates amount to an average level of about 4.5% in financial intermediation and about 10% in post and telecommunications. These growth rates are comparable to some high-growth industries within manufacturing, such as machinery and equipment, where productivity growth has been around 5% on average across countries since the 1980s. Moreover, these business-related services show persistently strong positive growth rates over the past 20 years. There is thus no real indication that these services are asymptotically stagnant. In contrast, the further increase of productivity growth since 1995 in several countries may indicate a potential for the future. Productivity growth in the United States has been below average in post and telecommunications, however, which can be attributed to two factors. First, productivity growth in the United States shows a stable pattern over time, which may reflect its early start in liberalising this sector. Second, low US productivity growth partly reflects a high level of productivity compared with other countries.[11]

Relatively strong productivity growth can also be found – albeit to a lesser degree – in wholesale and retail trade as well as transport and storage services. Productivity growth rates in these services are on average about 2.5% across countries, which is equivalent to productivity growth in the economy as a whole. Positive growth rates in these services are sometimes attributed to the introduction of cost-reducing technologies such as ICT, which have helped to enhance logistics in wholesale trade and in transport services, and inventory control in retail trade. Low productivity growth rates are found in social and personal services, which may not be surprising. These industries are relatively labour-intensive and the potential for growth in labour productivity may be relatively small. Low productivity growth rates in social services may also reflect the specific nature of these service industries. Low productivity growth in real estate services partly reflects measurement, as much output in this sector is imputed.

Some other patterns emerge from the analysis. Firstly, there are large disparities in productivity growth rates across countries in most service industries. To some degree, this might reflect differences in general economic performance. For example, Japan shows lower and declining productivity growth in almost all services industries as compared with other countries. In contrast, Sweden shows relatively high productivity growth rates for all services industries, which are increasing over time. Industry-specific factors may also determine the differences in productivity growth. Some countries show relatively high productivity growth in those services in which they are specialised. This is the case for Austria in trade, hotels and restaurants, for Finland and Denmark in transport and communication services, for the United States and the United Kingdom in financial and business services, and for Sweden, Finland and France in social and personal services.

Secondly, several service industries show a large variation in productivity growth over time. This is especially true for wholesale and retail trade and for some countries for hotels and restaurants. For instance, Japan and France showed relatively high productivity growth in the 1980s in wholesale and retail trade but only relatively low rates in the 1990s. In contrast, countries such as Norway and the United States had low productivity growth in the 1980s but improved strongly over the 1990s. A high degree of variation can also be observed for some countries in transport and storage and in post and telecommunications services. For instance, Denmark, France, Austria showed relatively high growth in the 1980s in transport and storage services. The productivity growth rate declined in the first years of the 1990s, but was reversed in the most recent years where productivity growth was again above average.

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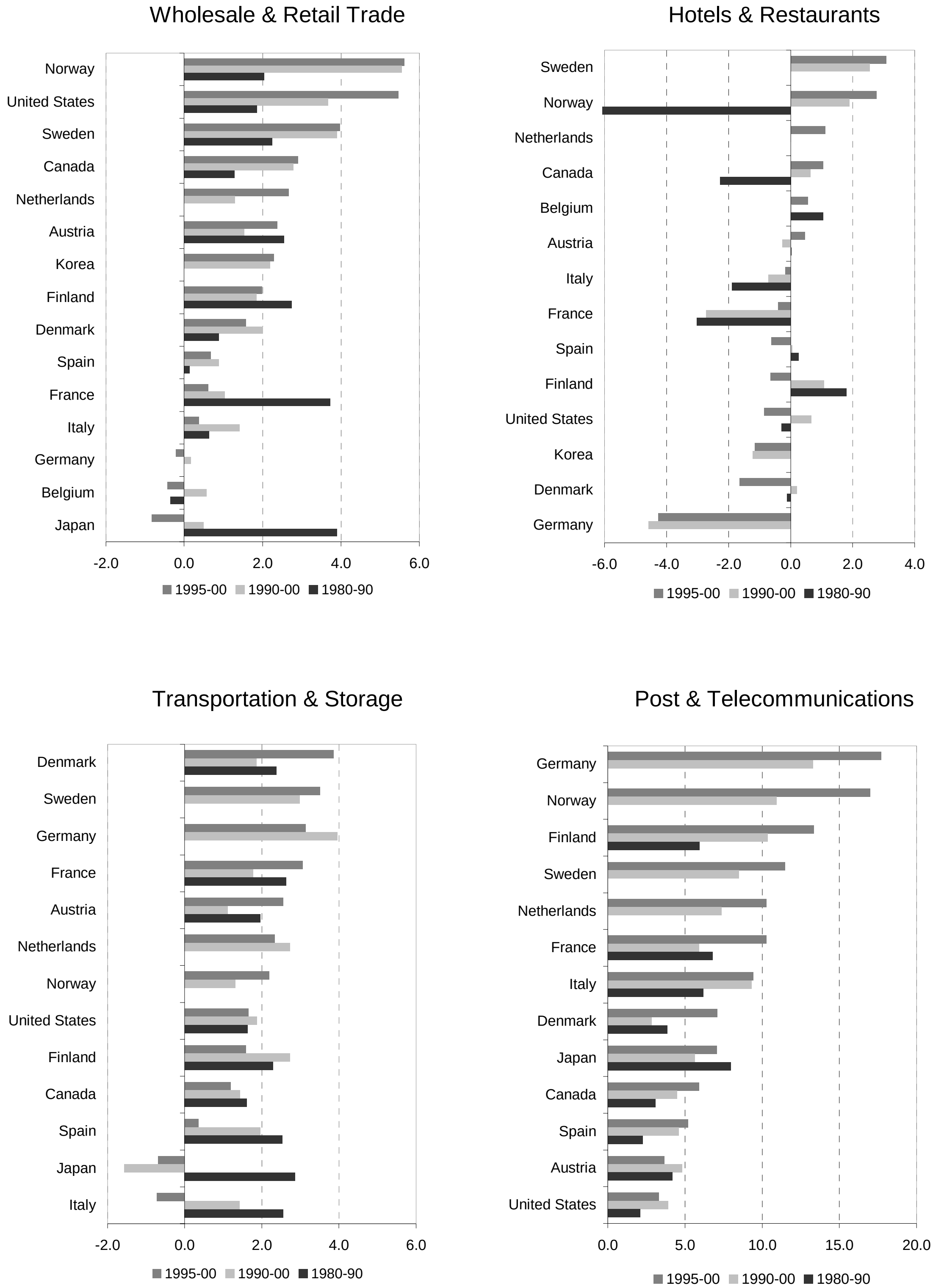
10. Tables with productivity rates per industry and for several time periods are included in the annex.

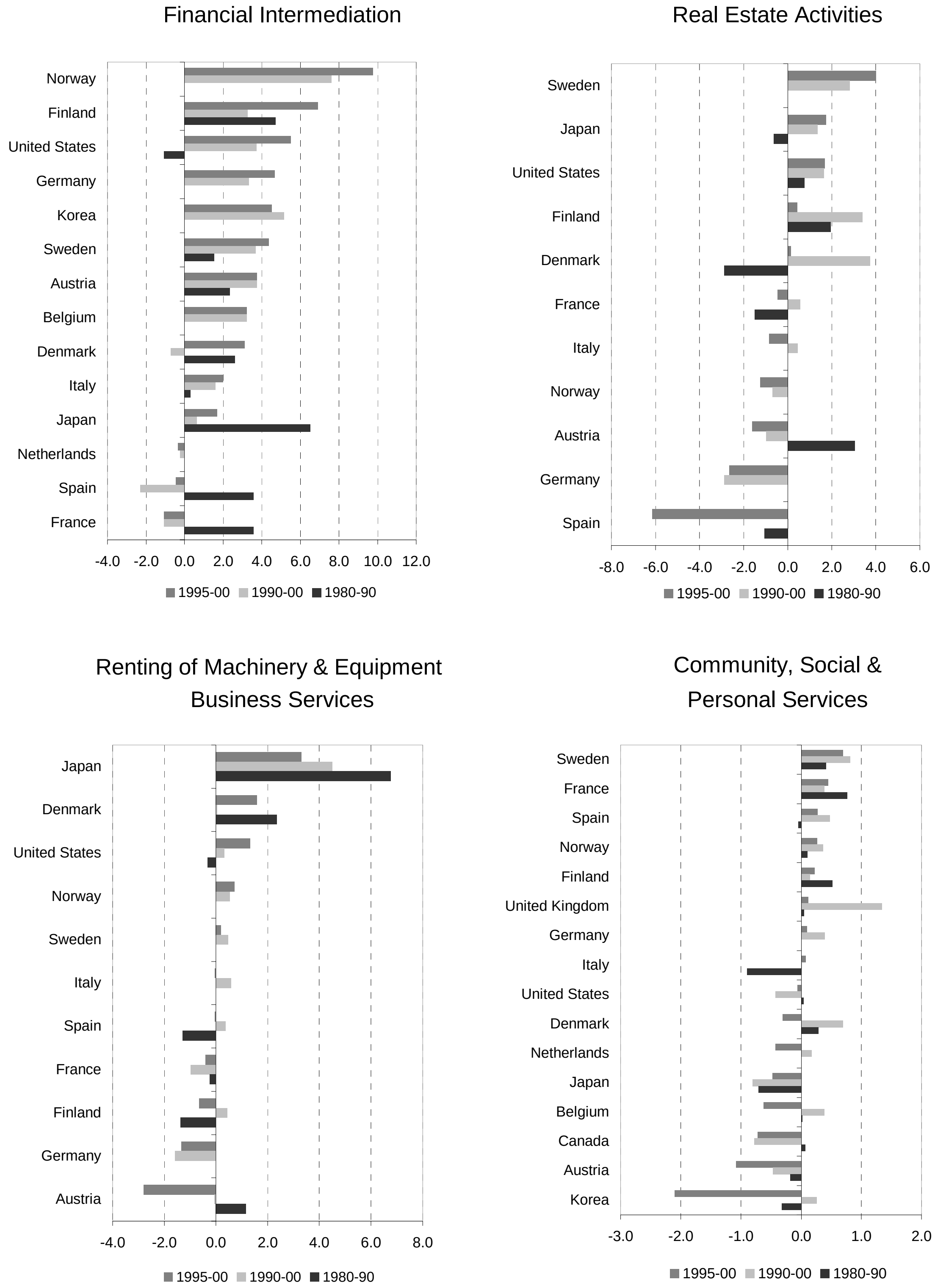
11. See OECD (2003a).

Figure 5. **Labour productivity growth within the service sector**
(compound annual growth rates, in percent)



Source: OECD STAN Database 2002.

Figure 5. **Labour productivity growth within the service sector** *(continued)*
(compound annual growth rates, in percent)



Source: OECD STAN Database 2002.

Finally, Figure 5 shows that several industries have negative productivity growth over long periods. This is especially the case for hotels and restaurants, real estate services, renting of machinery and equipment and business services, as well as for community, social and personal services. To some degree, zero or negative productivity growth might be linked to labour-intensive production and small firm size. Small firms, for instance, are not able to exploit economies of scale and often lack the financial needs to invest into expensive or risky cost-reducing technologies. Small firm size is often found in service industries where productivity growth is low. For instance, many businesses in social and personal services are made up of one self-employed person. Certain business and professional services are also still characterised by very small firms and have not yet seen the trend towards larger firms that has occurred in other sectors, *e.g.* financial services.

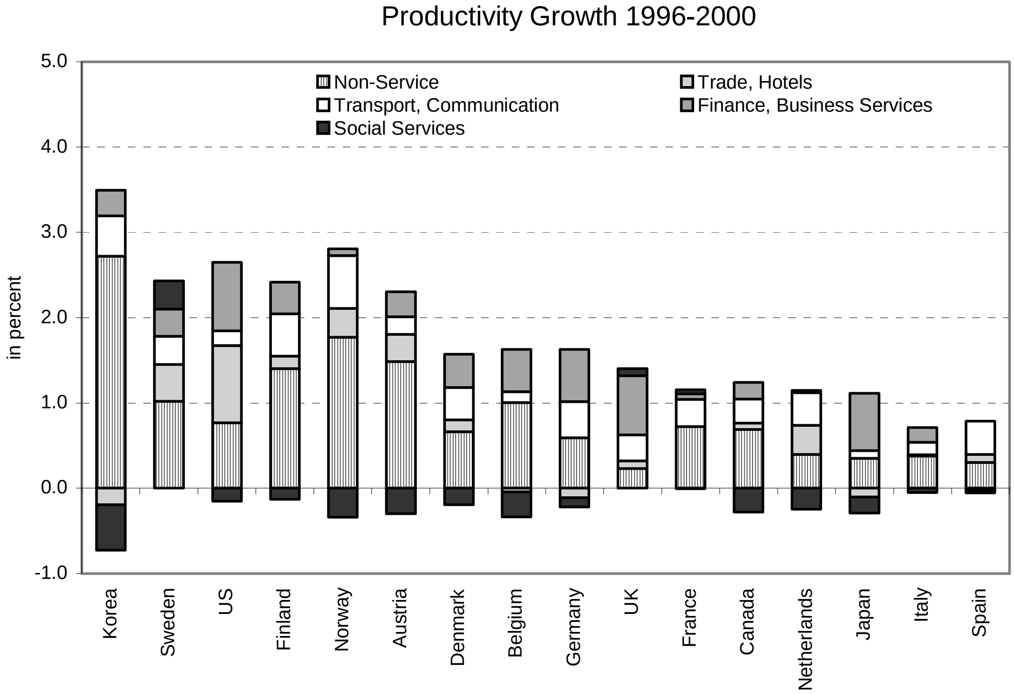
Despite possible explanations for zero or negative productivity growth rates, it is difficult to envisage why productivity growth rates should be negative over longer time periods. This is particularly the case in industries such as renting of machinery and other business services where an opposite trend might be expected. For example, these services are strong users of cost-reducing technologies such as ICT. Moreover, they mainly produce for intermediate production and may be confronted with potentially intensive competition. Both factors might contribute to positive productivity growth rates. In addition, negative productivity growth over long periods would mean a steady decline in efficiency, and it could be questioned how such firms could survive in the market.

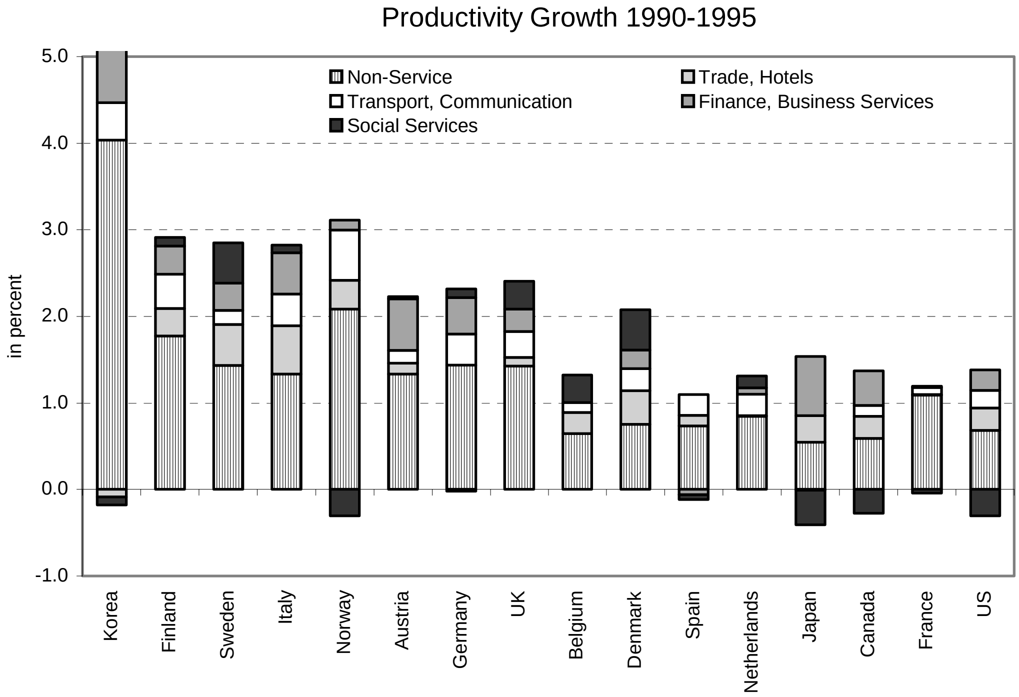
While there is empirical evidence for high growth services industries, the question whether productivity growth in services also contributes strongly to aggregate productivity growth cannot be answered unambiguously. On the one hand, Figure 6 illustrates that in some OECD countries, notably the United States, Sweden, Finland, Germany, the United Kingdom and Japan, the contribution of the service sector to overall productivity growth increased during the past ten years. Productivity growth in services accounted for more than half of overall productivity growth over the 1995-2000 period. In these countries, aggregate productivity growth can also be attributed to high-growth services, such as finance, insurance and business services as well as transport, storage and communications. High-growth services contributed about 1 percentage point and thus to about one-third of aggregate productivity growth between 1995 and 2000. Furthermore, the relative contribution of these services increased in the late 1990s. This is especially the case with regard to financial and business services where the absolute increase in productivity growth also led to an increase in the relative contribution to aggregate productivity growth.

On the other hand, Figure 6 illustrates that in most OECD countries, it is the non-service sector, consisting of manufacturing, agriculture, construction and utilities, which is the main pillar of productivity growth; services account for a relatively small part of overall productivity growth in most OECD countries. Moreover, high productivity growth in some services is compensated by low or negative productivity growth in social services or hotels and restaurants, which in some countries have a relatively high share in value added. This is particularly the case for Korea, Norway and Austria, and to a lesser degree also for Finland. In Korea, the low contribution of services to aggregate productivity growth reflects the generally low share of services in total value added. In Norway, high growth in some services, such as transport, storage and telecommunications is compensated by the negative contribution of social and other services. In Belgium and Canada, and to some degree also the Netherlands, the contribution of high growth services, such as finance and business services or transport, storage and communications is almost fully outweighed by negative contributions of social and personal services, as well as trade, hotels and restaurants.[12]

12. A negative contribution may also be due to the way the contribution is calculated, *i.e.* as the difference of growth in value added and labour input, each weighted with their respective shares in this industry. Thus, labour-intensive and low growth industries such as social and personal services, and hotels and restaurants might have a “double” negative effect on the contribution of services to aggregate productivity growth.

Figure 6. **Contribution to aggregate labour productivity growth**



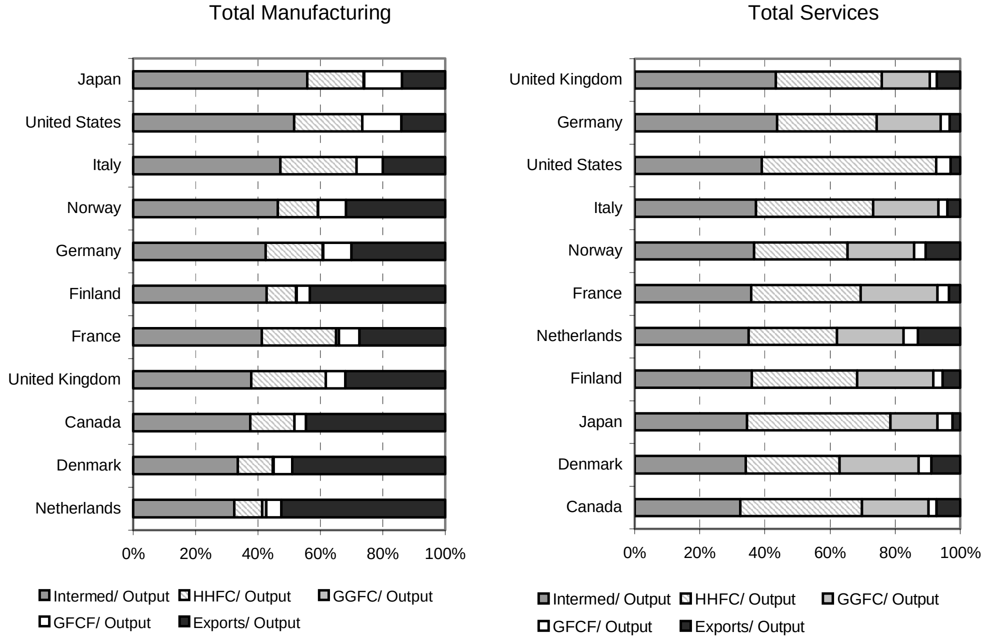


Source : OECD STAN Database 2002, Pilat, Lee and Van Ark (2002).

2.2.3 The role of services in providing intermediate goods

Differences in productivity growth across service industries and their contribution to aggregate growth also depend on whether the respective services produce for final demand or for intermediate production (Figures 7 and 8). Price and income elasticity might differ accordingly and there may be differences depending on whether the respective service provider is involved in intensive (international) competition or more locally or regionally oriented. For instance, demand for health or cultural services may not be very price elastic, may primarily be locally or regionally oriented and may not be confronted with international competition. It is however (potential) competition, both through international trade and investment, which puts downward pressure on prices and thus forces firms to steadily increase their level of productivity. While many services are not as much involved in international trade or foreign direct investment as many manufacturing industries, those that produce for markets with intensive competition, such as business or telecommunications services, are more likely to be induced to increase productivity.

Figure 7. **Share of intermediate and final demand in gross output**
Total manufacturing and total services

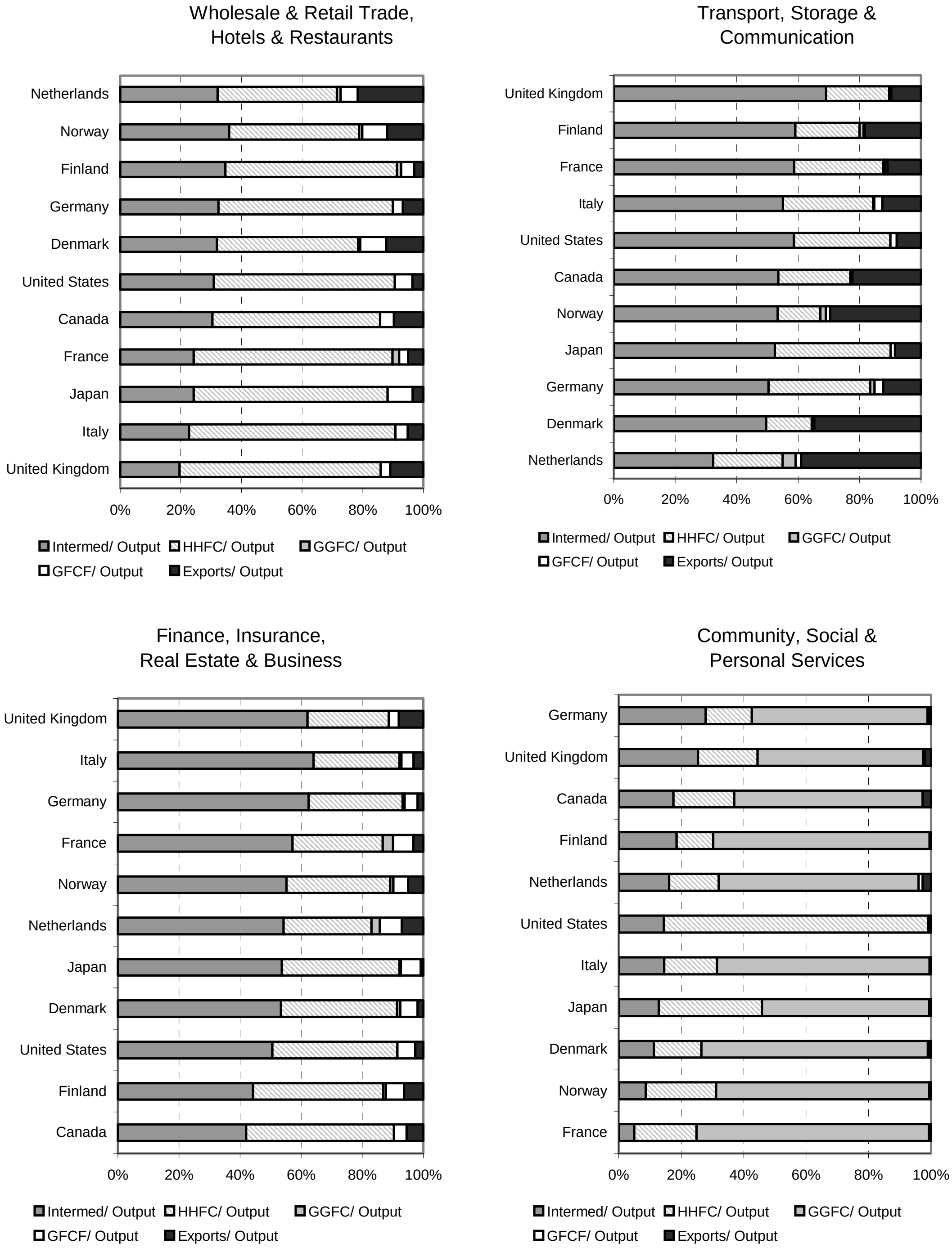


1. The Services Sector covers ISIC classes 50-99. HHFC: household final consumption, GGFC: government final consumption, GFCF: gross fixed capital formation.
Source : OECD input-output tables.

Figures 7 and 8 show strong cross-industry differences with regard to the composition of demand of each industry's products between the manufacturing and service sector. Figure 8 illustrates that the service sector itself consists of relatively heterogeneous industries. This heterogeneity is reflected in the relative importance of intermediate and final goods production across service industries. The traditional view of services can be found in community, social and personal services; about 80% of output in this sector is aimed at final consumption, with government consumption accounting for the bulk.[13] Only about 10% of these services serve intermediate demand. A strong share of final demand in output can also be observed in trade, hotels and restaurants.

13. The strong role of government consumption shows that several of these services are public goods, particularly in those countries characterised by strong welfare states.

Figure 8. **Share of intermediate and final demand in gross output**
Broad Service Sectors



1. The services sector covers ISIC classes 50-99. HHFC: household final consumption, GGFC: government final consumption, GFCF: gross fixed capital formation.
Source : OECD I-O tables, 1995, 1997.

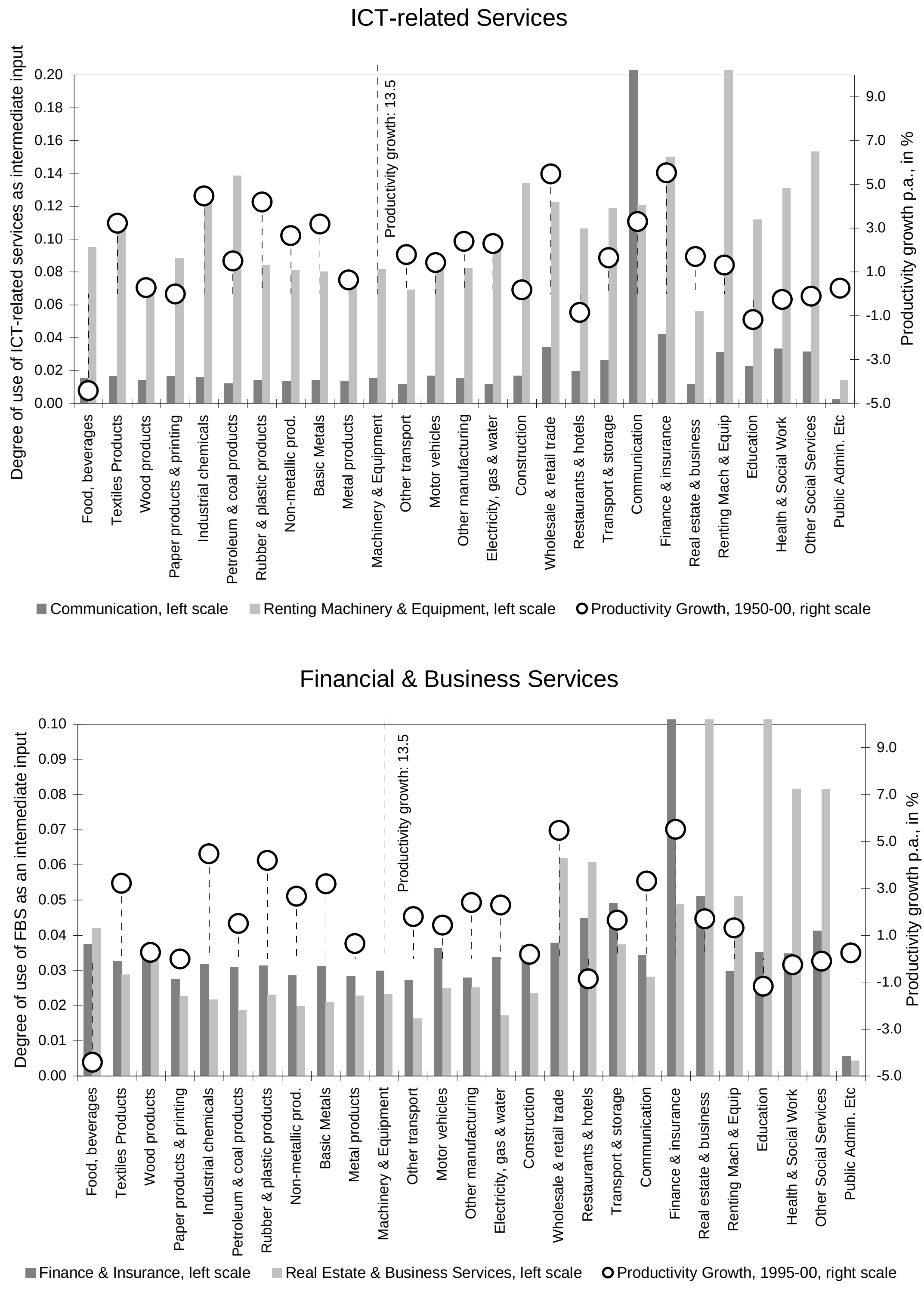
Transportation, storage and communication services present a very different perspective. Its demand structure is similar to manufacturing industries, as is their pattern of productivity growth. On average, more than half of transport and communications services are used as intermediate inputs while the share of services for final demand is relatively low, accounting for about 20%. In smaller countries such as Netherlands, Denmark or Norway, exports account for about 30 to 40% of total production. This is almost equivalent to the share of exports in the manufacturing sector. Finance, insurance, real estate and business services are also characterised by a very high share of intermediate goods production in total gross output.

Strong productivity growth and large deliveries to intermediate demand may imply that sectors, such as transport and communications services, as well as financial and business services, have a strong indirect impact on productivity growth in other industries and the economy as a whole. Figure 9 shows some evidence for such an effect for the United States although the picture is ambiguous and differs between ICT-related services and financial and business services. Figure 9 also compares the direct and indirect use of services as measured by the inverse input-output coefficient of one industry with the productivity growth rate of the using industry. The inverse coefficient states how many units of inputs are required to produce one unit of final demand. In contrast to the technical coefficients, the inverse coefficients take into account that inputs from one industry are relevant at several stages of the value-chain. For instance, renting of machinery and equipment services is directly used in car production. But it is also used in electrical machinery and precision instruments, and these again deliver intermediates to automobile production. Thus, renting of machinery and equipment services influences automobile production directly, and influences it indirectly via electrical machinery and precision instruments. Through the calculation of the inverse input-output coefficients, both effects are taken into account. Thus, if demand for automobile production increases by one unit, the inverse coefficients state how much of renting of machinery and equipment services are directly and indirectly necessary to produce this additional unit.

Figure 9 suggests a positive effect of the direct and indirect use of ICT-related financial and business services on productivity growth in manufacturing industries. Several manufacturing industries show a relatively strong use of renting of machinery and equipment and relatively high productivity growth rates. This is the case for the textiles industry, for industrial chemicals, machinery and equipment and for other manufacturing. Moreover, some manufacturing industries, such as wood products and metal products show average or below average use of ICT-related services and average or below average productivity growth rates. There are also some signs for a positive effect from financial and business services as intermediate goods providers for several manufacturing industries.

However, similar indications for a positive correlation between the use of ICT-related or financial and business services, and productivity growth rates can not be found in the service sector. For instance, only wholesale and retail trade, communication services and finance and insurance show above average rates of use of ICT-related services and relatively high productivity growth rates. In contrast, renting of machinery and equipment, education and health and social work show above average rates of use of ICT-related services, but low rates of productivity growth. Furthermore, in the case of financial and business services, the relationship between the use of these services and productivity growth seems to be lower. Moreover, the correlation between the use of ICT-related or business services and productivity growth is not significant. Even in the case of ICT-related services, where strong effects could be expected, the correlation coefficient is with 0.3 relatively low. This suggests that services as intermediate goods for other industries might not have a strong positive effect on productivity growth of other industries. Other factors are more important, or a positive effect might only result from the use of these services in combination with other factors.

Figure 9. **Direct and indirect use of services and productivity growth per industry**
The example of the United States, 1995-2000



Note: ICT-related defined as post and telecommunications and renting of machinery & equipment (ISIC 64, 71-74). See here also OECD (2002e): Measuring the Information Economy).
Source: OECD STAN Database 2002, I-O table 1997.

3. The role of measurement

The empirical evidence presented above points to low or negative productivity growth rates over long periods for several service industries, despite other evidence, such as rapid technological change and increased competitive pressures that might argue for an opposite trend. The evidence may, however, be linked to an under-estimation of service productivity growth. For instance, possible mismeasurement of output might give a biased picture of which industries are actual or asymptotically stagnant industries. Additionally, inadequate measurement of output or prices of services that are used as intermediate goods might lead to an under-estimation of aggregate productivity growth. The effect of different measurement biases would depend on the importance of mismeasured service industries to other industries and overall production. This section analyses how measurement bias might influence industry and aggregate productivity growth. It asks what precisely is meant by 'bias in measuring service labour productivity growth', whether there is evidence for an under-estimation of service productivity growth due to measurement bias, and what might be the impact of a measurement bias in service industries on aggregate productivity growth?

3.1. Measurement bias – some prior considerations

3.1.1 Components of measurement bias

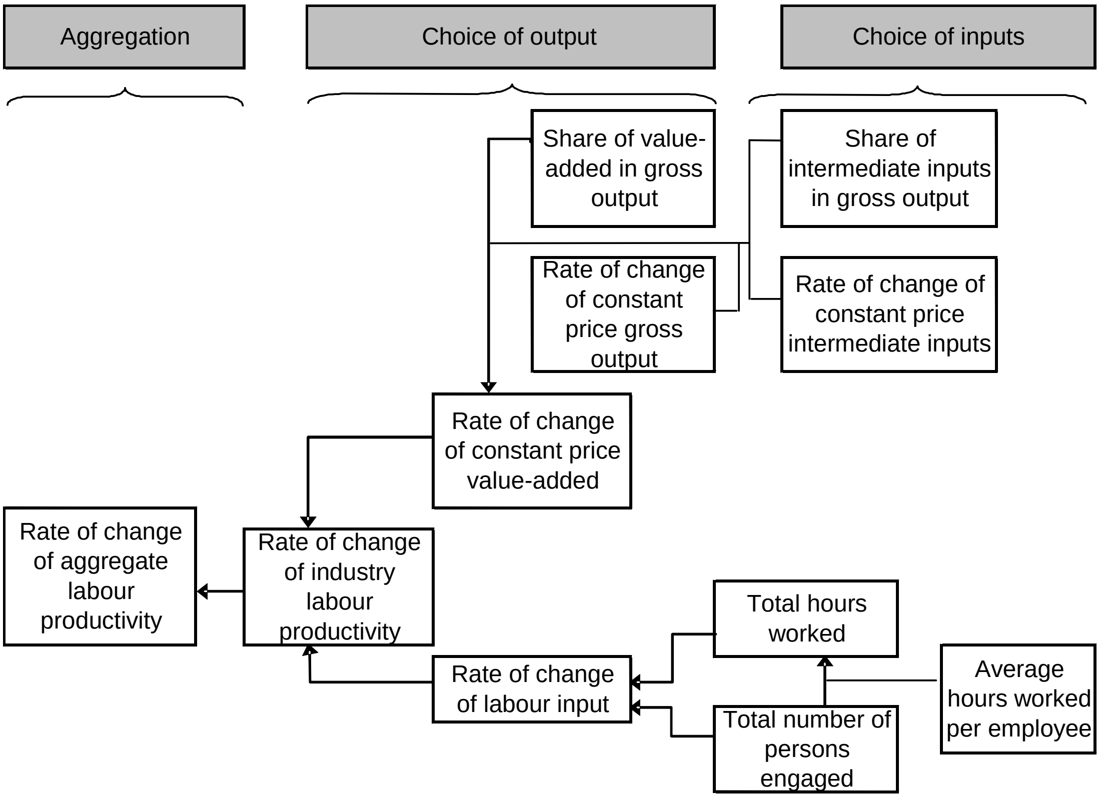
As outlined in Figure 10, there are three areas where measurement biases may arise. These relate, firstly, to the choice of inputs, secondly to the choice of outputs at current and constant prices, and finally to the method of aggregation across industries. These channels result from the breakdown of value added based labour productivity growth into its main components. For present purposes, value added based labour productivity growth is defined as the rate of change of constant price value added per unit of labour input. And growth in value added is defined as the weighted difference between growth in constant price gross output and intermediate inputs, with the current price shares of value added and intermediate inputs in gross output as weights.[14]

The first component of measurement bias relates to the choice of inputs. In the case of labour productivity growth, this means first of all measuring the primary input labour in terms of total number employed or total hours worked. The main sources for measurement bias, especially in cross-country comparisons, are differences in definitions, data collections and methodologies that are used to estimate employment and hours worked. These problems may differ across industries, in particular as regards the measurement of hours worked, *e.g.* the treatment of part-time labour. Some empirical illustrations are presented below.

Another issue concerning the choice of inputs is the relationship between labour input and intermediate input. This is particularly relevant in relation to the increasing tendency of firms towards outsourcing. Measurement problems might, in particular, arise indirectly via the the input-output flow of goods and services. As will be shown below, measurement bias influences the productivity growth of industries through the share of difficult-to-measure intermediates, such as financial services, in total intermediates, and the way the constant price value added of these service industries is estimated.

14. The *OECD Productivity Manual* provides an extensive description of measurement issues (OECD, 2001*a*). For a short discussion of measurement of service output and productivity, see Kendrick (1985).

Figure 10. **Breakdown of labour productivity growth into its measurement components**



1. For a more formal analysis see OECD (2001*a*).
Source: OECD.

The second measurement component relates to the choice of output at current and constant prices. This is the most discussed component of measurement bias in the context of service productivity growth. A first key question is the definition of output of some services, *e.g.* financial services, which is not necessarily the same across countries. Griliches (1999) and Sichel (1997) even speak of the "unmeasurable" sector. Griliches mentions the potential negative effects on aggregate productivity growth and sees the economy shifting "… into uncharted waters".

The most relevant issue concerning the output component of measurement bias and the one which is central for the analysis in this paper is the calculation of constant price value added. It is for instance difficult for several services to isolate price effects that are due to changes in the quality or mix of services from pure price changes, and to adjust for such quality changes in the price index. Problems of how to estimate an appropriate price index arise also in several manufacturing industries. There are, however, reasons to assume that measurement problems may be stronger in the service sector than in manufacturing. This might result from the general problem of how to define output of specific services. Empirical evidence and common practice in statistical offices indicate also a lack of information for price index estimation in services such as health care, telecommunications, computer-related services and personal services.

As a result, different measures are used in OECD countries for the computation of constant price value added as can be seen from Annex Table 5. In general, there are three groups of methods. Firstly, constant price value added can be estimated by deflating current price value-added with a price or wage index. Alternatively, base-year value added can be extrapolated by the help of a volume index. Secondly, either deflation or extrapolation may be based on a single or a double indicator method. In that respect, the procedure which is recommended is the use of double deflation (or double extrapolation), where output and intermediate input are each deflated by the most appropriate index. Thirdly, deflation or extrapolation may be based on output or input variables, such as a gross output price or volume index as compared to an index of wage rates or employment. Some empirical evidence will be presented below.

The third component of potential measurement bias relates to the estimation of aggregate productivity growth. There are two main channels through which measurement bias in services might work through to the aggregate level. The first channel is via aggregation and is related to the relative weight that is attributed to the mismeasured services in total value-added and employment of the economy. The second channel concerns the role of specific services as intermediate inputs for other industries. This relates to the question whether service productivity growth is under-estimated as compared to manufacturing productivity growth or, the other way round, productivity growth of manufacturing is overestimated as compared to the one in service industries. As has been shown above, market-related services, such as financial and business services, as well as transport and communications services, produce to a large degree for intermediate production. If intermediate production of services is used by manufacturing industries, and if output growth in these services was underestimated, correcting for the under-estimated service output might reduce value added growth in the manufacturing industries. The final effect on aggregate productivity growth of such a correction depends on the relative role of service and manufacturing industries in intermediate and final production. The extent of the effect of such a correction will be analysed by the help of a simulation exercise below.

3.1.2 Previous empirical analysis

Not all of these possible measurement biases can be easily examined. This might be the reason why, in the empirical literature, there are only few studies that analyse measurement bias in a comprehensive way. In principle, three main strands of empirical studies can be distinguished. The first strand of studies uses some (anecdotal) evidence to assess the size of the unmeasurable sector. The effect of measurement bias on the whole economy is typically assessed by analysing the changes in the size of and the composition within this unmeasurable sector over time. Examples of such studies are Griliches (1994) and Sichel (1997). Sichel (1997), for instance, concludes that even if a measurement error within the unmeasureable sector of about 2.4 percentage points was corrected, aggregate productivity growth would be only between 0.06 and 0.13 percentage points a year higher.

The second strand of empirical studies focuses on specific services for which the extent of statistical or methodological problems underlying measurement bias can be assessed empirically. These studies analyse the effect on aggregate productivity growth by aggregation across industries or – in rare cases – by looking at the indirect impacts for other industries via the input-output flows. Several of these studies conclude that the price index that has been used for estimating output over time is a key factor in the under-estimation of service output.[15] One prominent example for price-induced measurement bias in services is the impact of the choice of price indices for ICT-related industries, such as post and telecommunications services, on industry and aggregate output and productivity growth. These issues have been examined, for example, by Schreyer (1998, 2001), and Pilat *et al.* (2002). Concerning ICT-investment, for instance, Schreyer (2001) concludes that the overall effect of price adjustment, *i.e.* the substitution of the actual price index by a hedonic price index, on aggregate output growth might be relatively small. This is because some of the

15. The impact of different price indices on the measurement of output and productivity of service industries is, for instance, discussed in Baumol and Wolff (1984), Berndt *et al.* (1998), Eldridge (1999) and Lebow and Rudd (2001). Measurement issues in the Australian wholesale and retail services are analysed in detail in Johnston *et al.* (2000).

measurement effects balance out at the aggregate level, for instance if the areas where hedonic deflators are used concern intermediate and/or imported products.[16]

A third strand of empirical studies explicitly link measurement bias in (several) service industries and the slowdown in aggregate productivity growth after the 1970s. Examples are Baily and Gordon (1988), work at the US Bureau of Labor Statistics and the US Federal Reserve Board, such as Slifman and Corrado (1996) and Gullickson and Harper (1999), and, more recently, Vijselaar (2003) and Sharpe *et al.* (2002).[17] For instance, Slifman and Corrado noted that several US service industries, notably construction, utilities, insurance, banking and health, were characterised by prolonged periods of negative productivity growth. Negative productivity growth even occurred during periods of rapid technological change, *e.g.* the introduction of information and communications technologies. Poor measurement, *e.g.* the deflation of output series by wages or consumer prices or by extrapolation from changes in employment, was considered to be among the causes of this problem.[18] Gullickson and Harper (1999, 2002) and Slifman and Corrado (1996) then examine what would happen if productivity growth in these services was not negative but zero. After adjusting industry output and input for this measurement bias, and calculating industry and aggregate productivity growth, the studies conclude that aggregate productivity growth over the last two decades would increase by about 0.4 to 0.5 percentage points.[19]

Vijselaar (2003) undertook a similar exercise for the Euro-Area and the United States for the periods 1991 to 1999 and 1995 to 1999. This study focuses on labour productivity growth as measured by growth in value added per employment. The sectors for which labour productivity growth was raised from negative to zero rates were hotels and restaurants, real estate, renting, and business services, as well as communities, social and personal services.[20] The work suggests that the correction for the “measurement bias” raised aggregate productivity growth between 1991 and 1999 by about 0.3 percentage points in the United States and 0.2 percentage points in the Euro area. Within the service sector, stronger effects could be found for the second half of the 1990s and in particular for the business services; the counterfactual productivity growth in the business service sector was about 0.5 percentage points higher than the actual rate in the United States and about 1.0 percentage point higher in the Euro area.

Sharpe *et al.* (2002) undertook a “Slifman Corrado” type of exercise for the United States and Canada on the basis of labour productivity growth. Their analysis differs from the previously mentioned studies in two ways. Firstly, Sharpe *et al.* (2002) calculate two different scenarios. They ask what would happen to aggregate productivity growth if the negative service productivity growth rates were either zero or if they were as high as the average rate of the service sector, excluding the “mismeasured” services. Secondly, they calculate the effect on aggregate productivity growth solely by aggregating the new productivity growth rates. They thereby assume that the biggest share of output of the adjusted service industries is meant for final production, and that the mismeasurement in the adjusted services would not affect intermediate input flows. This study suggests that assuming zero productivity growth rates would increase

16. For the simulations Schreyer (2001) used the ICT-producing industries. The quantitative results are thus not directly applicable for the ICT services. The qualitative results do apply however, as the empirical evidence below will show.

17. See also Dean (1999) for an overview.

18. While a recent update of this work (Gullickson and Harper, 2002) found less strong evidence of a measurement bias at the aggregate level, some sectors were still characterised by negative productivity trends, possibly pointing to measurement problems.

19. Since these studies differ in the productivity concept, the data base and time frame used, the results are not fully comparable with each other. They provide, though, for a rough idea of the quantitative effect of measurement bias for aggregate productivity growth.

20. Although the Euro area showed slightly positive productivity growth rates for the social services.

aggregate productivity growth rate by 0.2 percentage points in Canada and the United States. Assuming the adjusted productivity growth rate were as high as the average service sector rate would increase aggregate productivity growth by 0.6 percentage points in Canada and 0.45 percentage points in the United States.

Since the early 1990s and particularly in more recent years, systematic attempts have been undertaken within statistical offices and the OECD to deal with the problem of measurement of service output and productivity growth. Taskforces have been established that seek to assess the extent of measurement biases at the level of data collection and definition and with regard to the choice of methodologies to calculate productivity growth. Examples are productivity commissions or specific taskforces in statistical offices in Australia, Canada, Netherlands, United Kingdom and the United States. Recently, the OECD set up taskforces for a better measurement of specific services within the System of National Accounts, such as financial services, especially banking and financial corporations, and insurance.[21]

Such redefinitions or revisions of output and value added estimates within statistical offices and the OECD show that measurement bias might indeed impact on the growth rate of output and productivity.[22] OECD (1999), Lum *et al.* (2000) and Pike and Drew (2002), for instance, found that main revisions of the price indices or the methods used to compute constant price value added have led to an upward revision of the growth rate of real value added. These revisions did not only influence estimates of constant price value added or output in services that are difficult to measure.[23] Rather, the revision of estimates of real output in specific industries indirectly influenced other services through their share in intermediate goods. Revisions of estimates in computer software, for instance, turned out to have particularly strong effects on productivity growth of financial and business services as well as wholesale and retail trade, which are both strong users of computer software. Such revisions finally show that measurement bias in selected services may not only impose a bias in productivity growth of the specific service industry, but also in aggregate productivity growth. Since the revision of the price indices did not affect the current price shares of each industry, the increase in the growth rate was not outweighed by a smaller share of GDP and, thus, a smaller contribution to aggregate GDP growth.

3.2. Effect of measurement bias on productivity growth – an empirical assessment

The following section presents results from an empirical analysis of the extent and the impact of measurement bias for labour productivity growth. This follows the breakdown into the three main components of measurement bias. It looks at those issues which can be addressed through cross-country analysis and on a sectoral level, notably the measurement of labour input and computation of constant price value added, as well as the possible impacts on aggregate measures of productivity growth. This quantitative analysis will provide, to the extent possible, a tool to diagnose key areas of measurement problems in services themselves, and the channels through which sectoral measurement problems influence aggregate productivity growth.

21. See also OECD (2001b), OECD (2002a to 2002d), as well as Moulton (2000), and Yuskavage (1999).

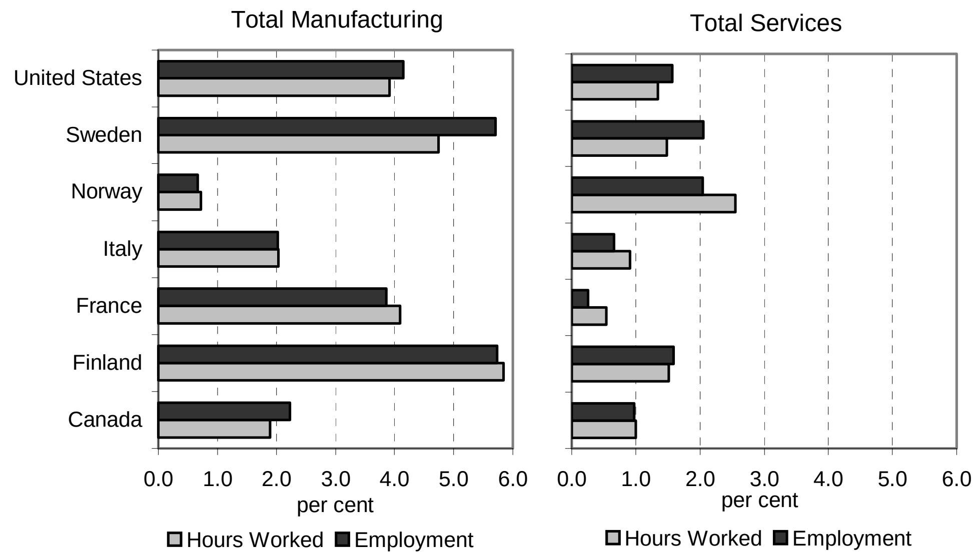
22. The effect of measurement bias for the growth rate of productivity is not clear *a priori*. For instance, measurement bias might only impose a shift of output to an extent which is identical for every period, but would not affect the rate of growth of productivity in this industry.

23. Daffin *et al.* (2002) refers to the framework of the national accounts balancing process, where coherence adjustments are made to individual industry groups within the output estimates. It turned out that such adjustments tend to appear most frequently in a limited set of service industries, and that their effect for industry growth was particularly significant in the "transport and communication" as well as the "business services and finance" industry sections of the GDP. It was concluded this would reflect the relatively strong extent of measurement difficulties in these industries.

3.2.1 Employment or hours worked?

Figures 11 and 12 present results on cross-country and cross-industry comparisons of labour productivity growth between 1990 and 2000 whereby labour productivity growth is measured either as value added per person employed or value added per hour worked. The Figures illustrate the effect of different measures of labour input on the estimation of labour productivity growth.[24] Figure 11 compares the two different measures of labour productivity growth for total manufacturing and total services.

Figure 11. **Labour productivity growth per person employed and per hour worked in manufacturing and services, 1990-2000**
(compound annual growth rates)



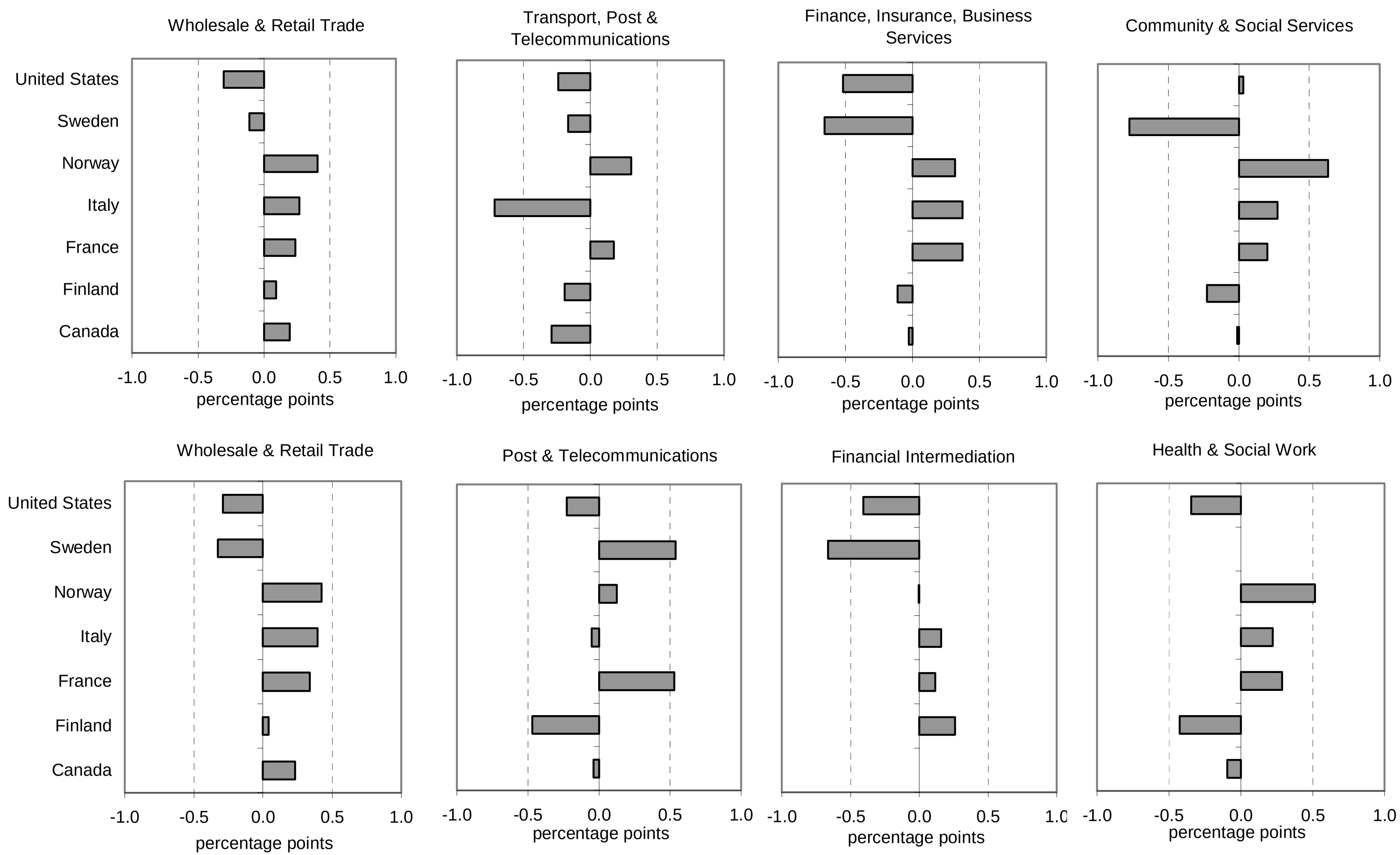
1. The Services Sector covers ISIC classes 50-99.
Source : OECD STAN Database 2002.

For several countries, there are relatively small differences between labour productivity growth per person employed and per hour worked across countries and industries. Differences range between 0.1% and 0.3 % for both manufacturing and services. However, the two indicators differ between the two sectors. In Norway and Italy, for example, the two labour productivity growth measures differ very little for manufacturing, but show much faster growth measured on an hours worked basis in the services sector than on a persons employed basis. In general, the absolute difference between productivity growth in manufacturing and services is larger if productivity growth is measured per person employed than per hour worked across all countries. For Canada, for instance, Maclean (1997) shows that the differences between manufacturing and services productivity growth on an hour-basis as compared to a person employed basis was particularly high in the 1962-71 period, when hours rapidly declined in the services sector.

24. The countries examined are those for which data on employment and hours worked are available in STAN. In the case of Italy, productivity growth per hours worked has been calculated as value added per full-time equivalent employment due to lack of data on hours worked.

Figure 12: **Difference in labour productivity growth per hour worked as compared to per person employed, selected industries, 1990-2000**

Differences in annual average compound growth rates, in percentage points



Source: OECD STAN Database 2002.

Within the services sector (Figure 12), there is no clear picture of which of the two measures of labour productivity growth is higher. On the one hand, differences may be influenced by country-specific factors. For example, in Sweden, the United States and, to some degree, also in Finland, labour productivity growth per person employed grew more quickly than productivity growth per hour worked in (almost) all industries. In France, productivity growth per person employed grew less rapidly than per hour worked in all service industries. On the other hand, there are certain sectors where the differences between the two measures are small (*e.g.* wholesale and retail trade) and others where the differences are substantial (*e.g.* finance, insurance and business services).

Measurement has an important impact on these findings. Adjustment for hours worked is thus of considerable importance in measuring and comparing productivity growth at the sectoral level, although, currently, data constraints do not allow this for many countries. Firstly, the services sector is characterised by more part-time employment and more self-employed persons, groups for which hours worked are more difficult to establish, as well as higher turnover rates of employment and in general more irregular working hours than the manufacturing sector. Secondly, the source of data for hours worked affects comparability of hours worked estimates. For example, labour force surveys, that are the main source of information on hours worked, may overestimate hours worked by self-employed workers. Differences in the share of self-employed workers, and other possible differences across sectors in the measurement of hours worked, may therefore affect the comparison of productivity growth across sectors. This may, however, lead to greater uncertainty in estimates of productivity growth in the services sector than in the manufacturing sector.

Figure 13 shows that working hours are in general lower and declining in the service sector while they are relatively high and, in some countries, increasing in the manufacturing sector. Average working hours per employed person range between 1 300 and 1 700 hours per year in the service sector and between 1 500 and 2 000 hours per year in manufacturing.[25] The average hours worked per employed person is, however, to a considerable degree country-specific and not necessarily related to industry factors as far as the more aggregate manufacturing and service sector are compared. For instance, working hours are on average only 1 300 (in services) and 1 500 hours per year (in manufacturing) in Norway and they are 1 800 and 1 900 hours per year in Canada. Figure 14 shows larger differences in working hours across industries and countries within the service sector. Average hours worked are lowest in personal and social services and highest in transport and communications services and financial and business services. Within service industries, average hours worked differ by approximately 300 hours per person across countries, which is about six to seven hours per week (see footnote 25).

Adjustment for hours worked is particularly important due to cross-industry and cross-country differences in the share of self-employed persons and part-time work. Since these do not have regular working hours, measuring the hours worked is difficult and may not be comparable across industries and countries. OECD (2001c), for instance, showed that the incidence of part-time jobs was much stronger in services than in manufacturing. Part-time jobs would have a particularly high share on all jobs in personal and social services and in retail trade. Figure 13 (right hand side) illustrates that the share of self-employment on total employment is much higher – albeit decreasing – in services than in manufacturing industries. It shows also that the level and development of the share of self-employed on total employment differs across countries.

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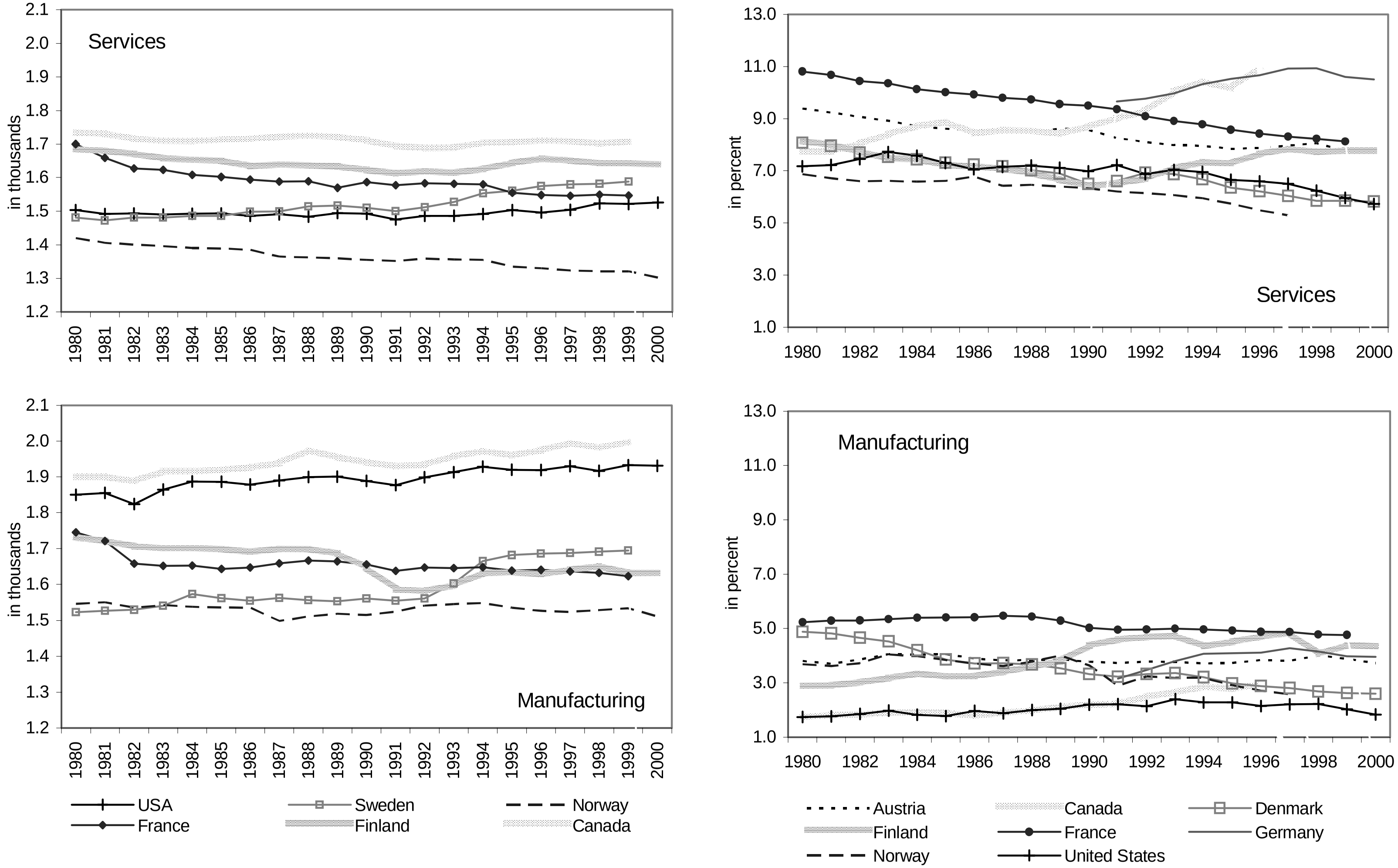
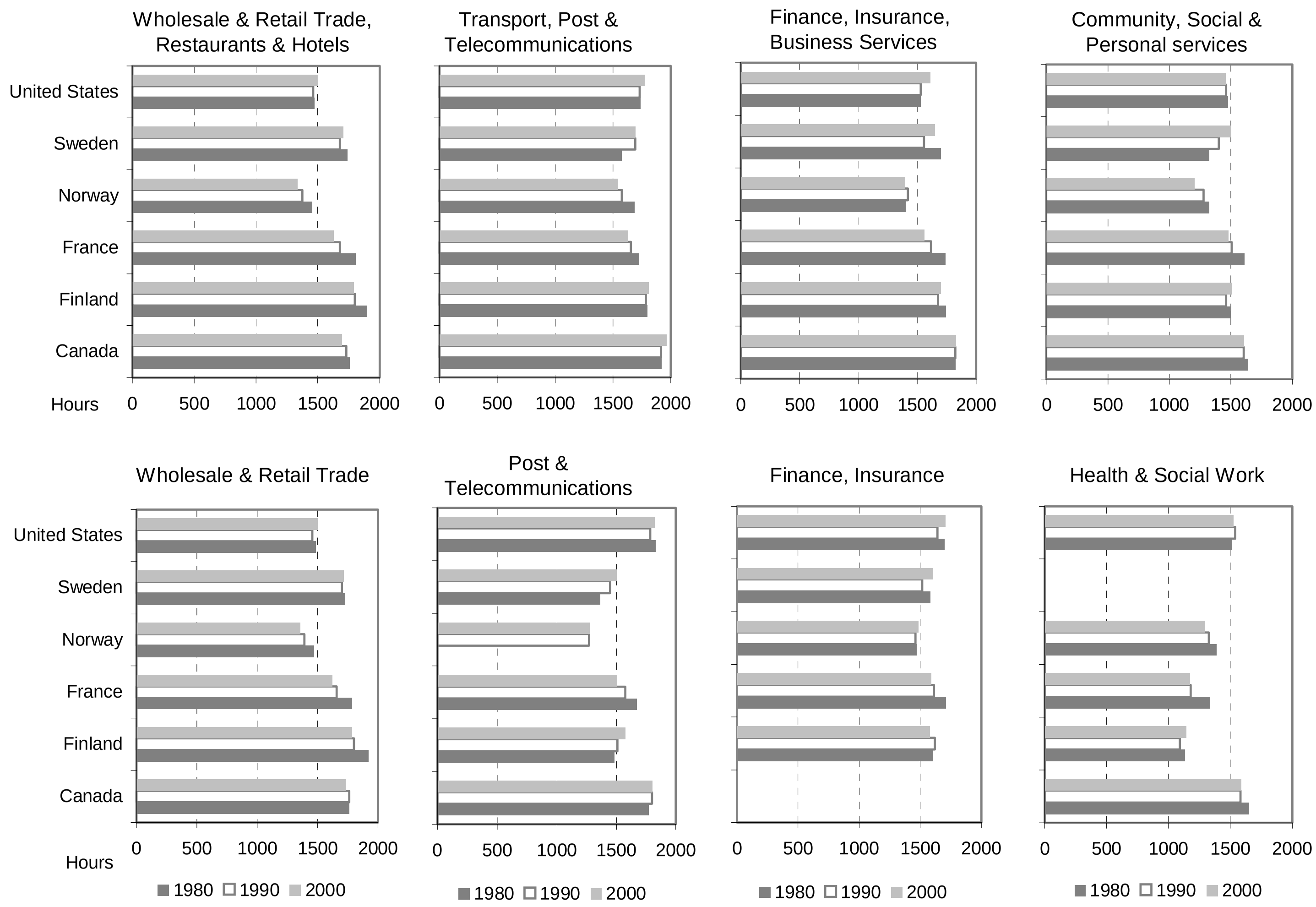
25. The numbers refer to total hours worked per person employed per year. If one assumes five weeks of annual leave and holidays, the figure 1 700 hours per year would be equivalent to about 36 hours per week.

Figure 13. **Hours worked per employed person and share of self-employment in services and manufacturing**



1. The Services Sector covers ISIC classes 50-99.
Source : OECD STAN Database.

Figure 14. H**ours worked per employed person in selected service industries**



Source : OECD STAN Database.

3.2.2 The computation of constant price value added and productivity growth in services

The key output-related component of measurement bias relates to the computation of constant price value added. The role of the choice of the method used to compute constant price value added for productivity growth can be observed through cross-country comparisons of trends of price indices or implicit deflators at the aggregate level as well as within the service sector. Figure 15 presents the implicit deflators for value added of selected service industries, relative to the deflator of value added of the whole economy. Figure 15 suggests that lower productivity growth in the service sector as compared to the manufacturing sector may be due to the choice of method to compute constant price value added. For almost all countries, the implicit deflator of the service sector increased relative to the one of the whole economy, while the respective deflator of the manufacturing sector declined during the 1980s and 1990s. This partly reflects Baumol's Cost Disease, but may also be linked to measurement bias.

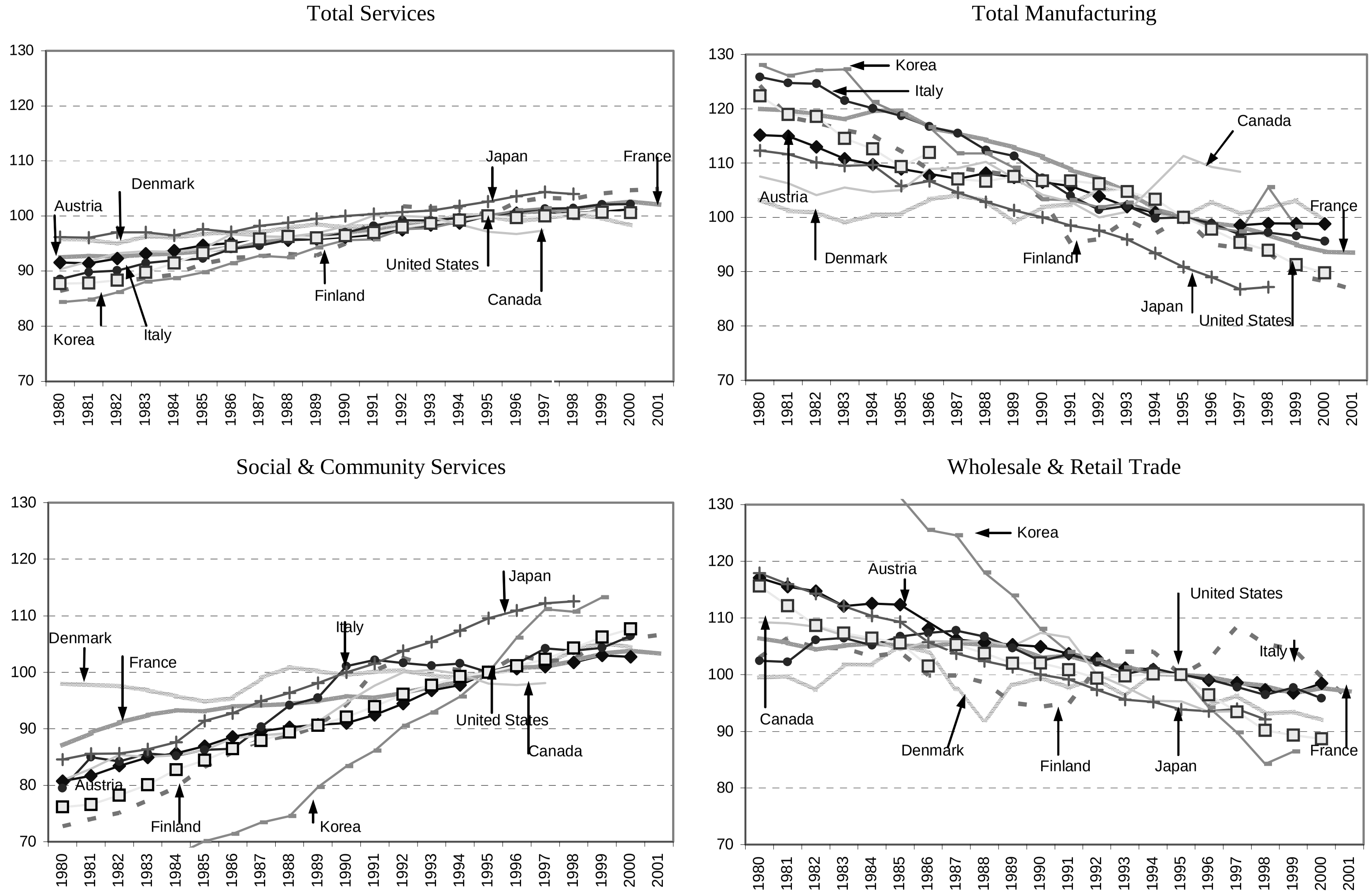
Some indication for measurement problems that are related to computing constant price value added can be seen in the large variety in developments of implicit deflators within same industries across countries. Figure 15 presents implicit value added deflators relative to the one of the whole economy. It shows particular diversity in developments of deflators in transport and storage services, post and telecommunications and in financial services. Differences prevail also in the other service industries for which measurement problems may be expected, such as social and community services or wholesale and retail trade. However, the development of value added deflators relative to the ones of the whole economy is more homogenous across countries in these services.

Country-specific factors, such as the pattern of overall economic development, regulatory reform and the role of (international) competition, may all affect this diversity. However, the method that is chosen in order to compute constant price value added may also be one factor in this diversity. Generally, measuring volumes in the national accounts requires that current-price values of flows of goods and services can be divided into volume and price components. Typically, this is more difficult for services than for manufacturing goods. Characteristics of goods can normally be identified and changes in quantities and qualities are measurable in principle, whereas for services even quantitative changes are often hard to measure, let alone quality change.[26] Annex Table 5 gives some evidence for this. While there is relative conformity concerning the methods used in service industries where output is defined in a straightforward way, a broad variety of methods are used by different OECD countries in services where there is no standard measurement of value added. Figure 15 and Annex Table 5 point to two different, possibly interacting, ways through which the method used to calculate constant price value added may affect volume measures of value added.

26. Omitting qualitative changes lead to measurement bias, although it does not necessarily mean that volumes of services will be underestimated. For example, technical progress may improve the quality of medical services, but may also lead to a decline in quality, when it leads to increased self-service or longer queuing time in post offices or shops which put a heavier burden on customers. Work to refine the estimation of price indices for service industries and to analyse their effect on the measurement of productivity growth is ongoing within OECD countries and in the OECD Statistics Directorate. See here for instance Daffin *et al.* (2002), Eldridge (1999), Lebow and Rudd (2001), Lum *et al.* (2000), OECD (1999).

Figure 15. **Implicit value added deflators for selected industries relative to the GDP deflator**[1]

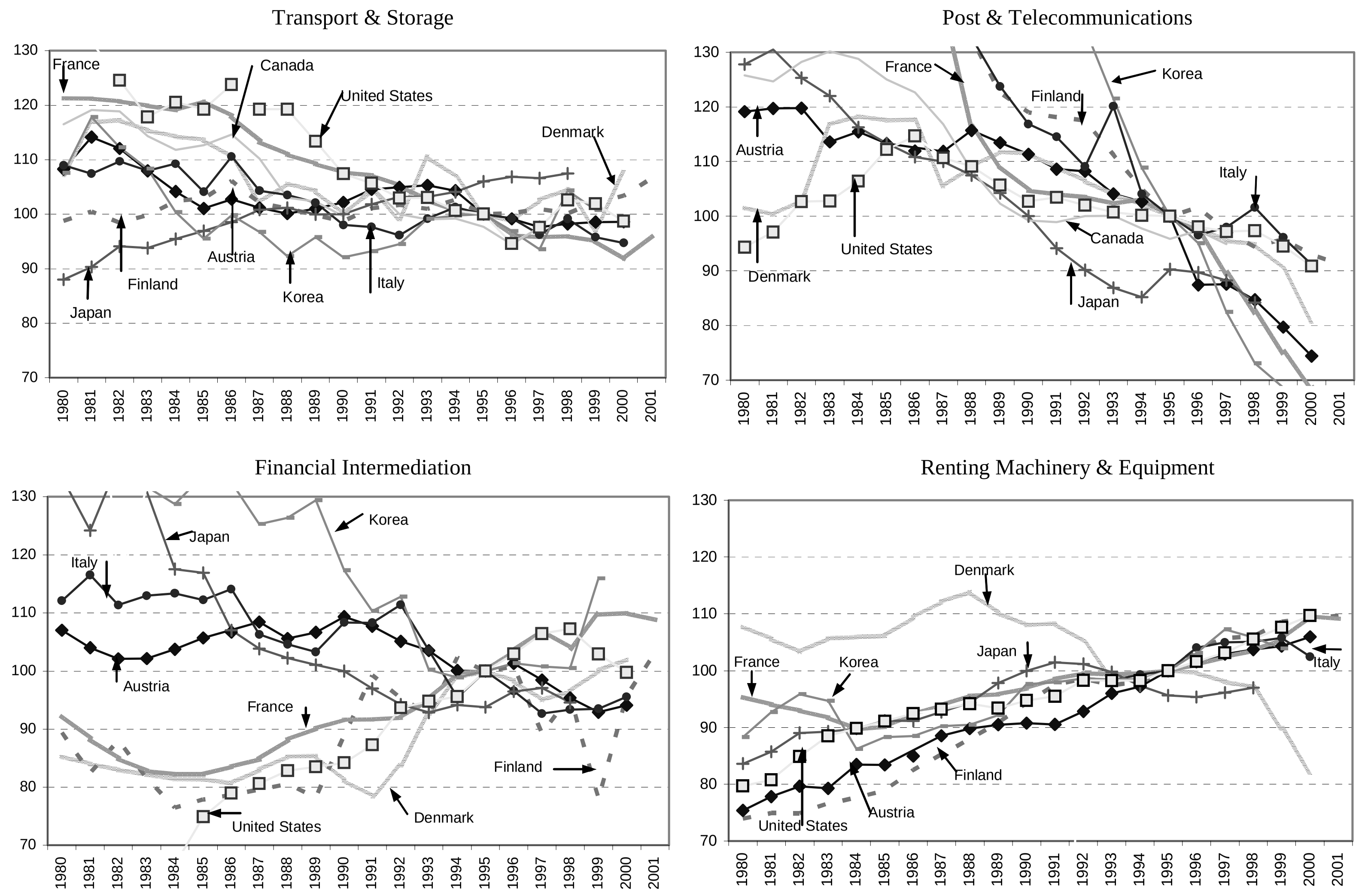
Total = 100, 1995 = base year[2]



1. The service sector covers ISIC classes 50-99; 2. Base year Japan: 1990, Canada: 1992.
Source: OECD STAN Database 2002.

Figure 15. **Implicit value added deflators for selected industries relative to the GDP deflator** *(continued)*

Total = 100, 1995 = base year[2]



1. The service sector covers ISIC classes 50-99; 2. Base year Japan: 1990, Canada: 1992.
Source: OECD STAN Database 2002.

First, measurement of constant price value added influences the rate of value added growth. Take wholesale and retail trade services, for example. These services are “margin” industries for national accounts purposes which means that their output is computed as the difference between products bought and products sold rather than as the value of turnover. One way to estimate volume measures of output is the deflation of the margins with an appropriate price index. The statistical practice assumes a direct relationship between wholesale and retail trade services and the volume of sales (OECD, 2003c). Retail margins are thus deflated using the volume of sales or the sales price index as reference. Such a treatment ignores, however, all changes in the quality of distribution services provided. For example, an extension of opening hours that adds to consumers’ convenience but does not necessarily increase the volume of sales would go unnoticed in output and productivity statistics. In addition, the volume measure of distribution services would change in line with a change in the volume measure of sales or the sales price. This would also be the case if the sales price changed due to a change in the quality of the goods sold, although distribution services do not necessarily change simply because the particular good is of better or lower quality than a similar item in the preceding period.

Another example of this first type of impact of measuring constant price value added concerns health and social services, an industry which constitutes a large and growing part of the service sector. In many countries, significant parts of this sector operate on a non-market basis, implying that observed prices and fees do not cover costs to any significant extent. Currently, a vast majority of OECD countries measure volumes of health services as the sum of deflated costs. Indeed, for services where the definition of output is not clear, information on labour input is often the only available indicator for the computation of constant price value added. However, such input-based methods insufficiently grasp the quantity and quality of output, and mismeasure – typically understate – thereby productivity growth.

The second type of measurement problem with respect to the way constant price value added is estimated relates to cross-country differences in the method chosen. This type of measurement bias may not necessarily lead to an under-estimation of productivity growth of specific services, but would imply reduced comparability of productivity growth estimates across countries. Cross-country differences may be prevalent in post and telecommunications services, in particular due to the difficulty in finding an appropriate quality adjusted price index. Another example is financial services. For instance, although the basic approach towards measuring the production of these services industry is similar across OECD countries, there are differences in the degree to which financial services are considered intermediate purchases by other industries or final purchases by consumers (OECD, 2003c). Thus, in countries that treat financial services predominantly or exclusively as an input to business, the methodology of price-volume splits of current-price output will be of little consequence to macro-economic comparisons of growth rates. However, when a sizeable share of financial services is treated as final consumption, the choice of deflation methodology will matter for economy-wide measures of productivity growth.

Another way to illustrate how the way constant price value added is computed affects productivity growth is presented in Figure 16. It examines time series that are based on different methods to compute constant price value added. The example provided concerns Denmark, since it is one of the few countries for which time series data are available for a whole range of input and output variables, such that several different price and volume indices can be derived. These include gross output and value added at current and constant prices, employment, and data on wages and labour compensation. Moreover, the actual national accounts series for constant price value added of all industries that is included in STAN has been derived using double deflation. This makes it possible to examine a time series of intermediate inputs in both current and constant prices, which enables the calculation of an intermediate goods price index.

The influence of measurement is examined by asking how the time series of value added would change if alternative methods to computate constant price value added were used. The following methods are presented in Figure 16:

a) Double extrapolation: Base year values of gross output and of intermediate consumption are extrapolated using volume indices. The time series of constant price value added result then by subtracting the extrapolated constant price series of intermediates from constant price gross output series.

b) Extrapolation/deflation: Base year values of gross output are extrapolated using volume indices and the series of intermediate consumption is deflated using intermediate goods price indices. Time series of value added result then by subtracting constant price intermediates from constant price gross output series.

c) Direct deflation of current price value added using gross output price indices.

d) Direct extrapolation of current value added of the base year using gross output volume indices.

e) Direct deflation of current price value added using intermediate goods price indices.

f) Direct deflation of current price value added using wage rate indices.

g) Direct extrapolation of current price value added of the base year using volume indices of compensation of employees, which are deflated by wage rate indices.

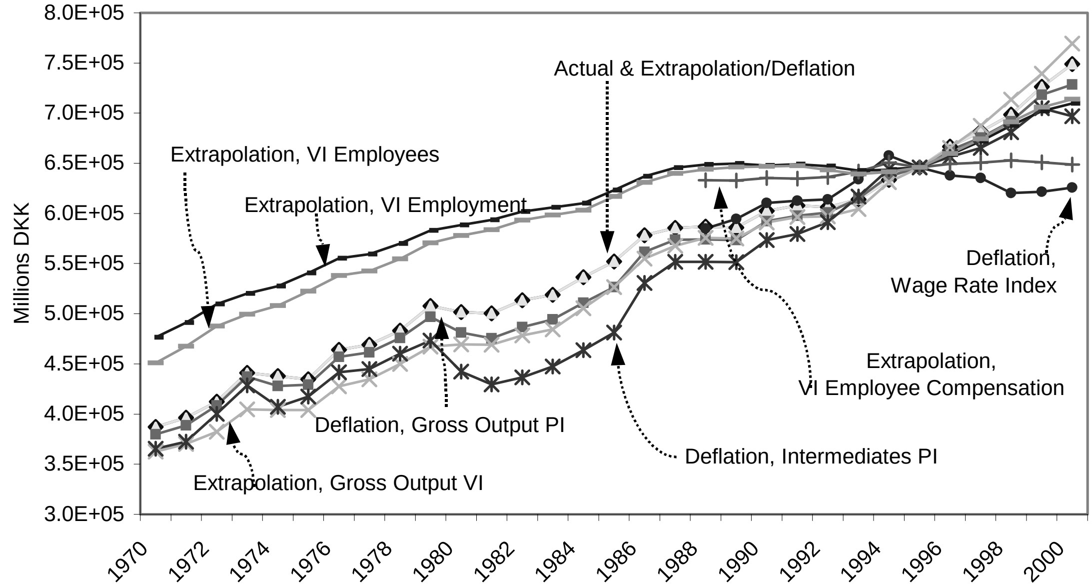
h) Direct extrapolation of current price value added of the base year using volume indices of employment.

i) Direct extrapolation of current price value added of the base year using indices of employees.[27]

Figure 16 illustrates that the method used to compute constant price value added clearly affects the development of value added and, therefore, productivity growth per industry. Value-added growth would typically be under-estimated in services where constant price value added is computed on the basis of labour input. Time series of constant price value added show very low rates of growth where value added has been extrapolated using a volume index of employment, employees or of labour compensation of employees. Obviously, the use of these volume series would lead to zero growth in labour productivity. Low growth of output also occurs when value added is deflated by a wage rate index. In contrast, time series of constant price value added show much higher rates of growth whenever value added has been extrapolated or deflated using price or volume indices based on output or intermediate goods. These time series come also very close to the actual series for Denmark that have been calculated using double deflation.

27. For reasons of comparability with the actual method used, *i.e.* double deflation, 1995 is used as the base year for each method. This has however as consequence that the first two methods lead to identical results as the actual series for constant price value added.

Figure 16. **Scenarios of value added growth using alternative methods to compute constant price value added**
(The example of Denmark)



Source: OECD STAN Database 2002.

3.2.3 Measurement bias in services and its role for aggregate productivity growth

The analysis until now shows that measurement bias in service industries might lead to an under-estimation of productivity growth of some services industries. In what follows, it will be analysed whether slow aggregate productivity growth might partly result from such an under-estimation of productivity growth in service industries. The analysis of the effect of measurement bias in services on aggregate productivity growth is based on a Slifman-Corrado type of thought experiment. This examines what would happen if negative productivity growth rates were not negative but set to zero, and is in line with previous empirical work mentioned above.[28] Such a thought experiment is primarily intended to show the potential size of the problem. It does not suggest that negative productivity growth necessarily implies mismeasurement, nor does it suggest that the size of the adjustment made in the paper is the correct one.[29] Such a thought experiment does provide, however, an initial picture of the extent of a potential under-estimation of productivity growth in industries with service inputs. It can therefore be regarded as a diagnostic tool to examine key areas for measurement problems.

Mismeasurement not only affects productivity growth of the service industry under consideration, but also works through other industries via input-output flows and thus influences productivity growth of the whole economy indirectly. Two effects might emerge. As long as the service industry under consideration produces mainly for final demand, the increase in real output due to a correction for measurement bias

28. The thought experiment in this paper is based on labour productivity growth although it might be more plausible to assume zero productivity growth in multifactor productivity growth. The main reasons for the choice of labour productivity is lack of data for capital services on a detailed industrial level.

29. While setting negative productivity growth rates to zero may overstate the size of the measurement problem, it is also possible that it understates the size of the problem. Actual, *i.e.* correctly measured, productivity growth rates might be substantially above zero.

would lead to an increase in productivity growth of this industry[30]. Eventually, this adjustment would raise aggregate productivity growth via aggregation across industries. However, if the service industry for which real output is under-estimated mainly produces for intermediate production, the increased output leads to higher growth in the value of intermediate inputs that are used by other industries. All other things equal, productivity growth in these industries would be lower, which might limit the effect of an increase in productivity growth in the service producing industry for which output has been adjusted. The total effect depends thus on the extent and type of measurement bias, on the share of production of the mismeasured service industry destined for intermediate demand and on the weight as well as the productivity growth achieved in service-producing and service using industries in the economy.

This section illustrates the potential impact on the basis of a simulation exercise, taking account of the direct and indirect effects of measurement bias in selected service industries on aggregate productivity growth. This simulation or "what-if experiment" is divided into three steps (see Annex B2). The first step consists of calculating the percentage change in the measure of gross output that would have been required to achieve a zero measure of productivity growth in industries where the current measure of productivity growth is negative.[31] The second step consists of estimating the effect of this percentage change in the measure of gross output on the growth rate of intermediate inputs of the other industries, using input-output tables. The final step is to calculate the adjusted measures of growth in value added and, thus, productivity growth rates per industry and for the whole economy.

This three-step procedure has strong data requirements, however, and can thus only be applied to selected countries.[32] First, it is necessary to have consistent data on the industry level from the STAN Database and the input-output tables. Second, a precise simulation exercise would require time series for gross output and intermediate inputs at current and constant price basis. Since these are, however, not available for many countries, the analysis at hand is based on appropriate assumptions on the relationship between the growth rate of gross output and value added as well as the intermediate input flows. Finally, the examination focuses on service industries that have negative productivity growth rates in STAN over the 1990-2001 period (see Annex Table 2). While several countries show negative growth rates at the lowest level of aggregation that is available in the STAN Database, industries are somewhat more aggregated in the input-output tables.

The countries for which the simulation exercise is undertaken are France, Germany and the United States. France experienced negative productivity growth over the 1990-2000 period in hotels and restaurants, finance and insurance, renting of machinery and equipment, as well as other social services. In the United States, services with negative productivity growth rates are education, health and social work and other social services. In Germany, hotels and restaurants, real estate services, renting of machinery and equipment, as well as other social services experienced negative productivity growth over the 1990-2000 period. Since these service industries have a considerable weight in the economy and are different with respect to the degree to which they produce for final or intermediate demand, the simulation for these three countries would provide a broad set of conclusions concerning the direct and indirect impacts of mismeasurement in service industries on aggregate productivity growth.

30. As was indicated above, the effect on the growth rate of productivity depends however on the extent of the measurement bias over time. For instance, the measurement bias might be directly proportional to the output itself and might thus increase output to a rate which is the same in every period. In this case, productivity growth in this industry would be the same as in the situation without the correction.

31 . The measurement bias is assumed to result from a bias in measuring production and value added, not from employment or hours worked. See Annex B.2. for further details on the assumptions made.

32. Countries for which the data are available and for which the analysis can be undertaken include France, Germany, Italy, Japan, Norway, and United States.

One of the central issues in the simulation exercise is the question on how the assumed change in productivity growth affects the growth rate of intermediate input flows to other industries. In general, there are two channels through which the growth of intermediate inputs may change. Firstly, assuming that the input-output coefficients stay the same, the growth rate of each individual intermediate input changes proportionally to the change in the output of the service industries for which productivity growth has been adjusted. Secondly, if the mismeasurement of services also concerned the measurement of current price output or value added, measurement bias in individual service industries would additionally affect the weight with which this specific service industry enters the growth rate of overall intermediate inputs for other industries. However, since this paper focuses on the impact of measuring constant price value added this second effect does not arise.[33]

Table 1, together with the empirical evidence in the first part of this paper, suggest that the adjustment of productivity growth of selected services may significantly affect the growth rate of intermediate inputs of other industries, in particular manufacturing industries. In France, for instance, total intermediate inputs account for about 73% of overall production of manufacturing industries, while they account only for about 36% of production of the service industries (Table 1). The empirical evidence suggests also that the effect of the adjustment will be stronger if the adjustment was undertaken in business related services such as financial intermediation and renting of machinery and equipment as compared to services that produce mainly for final demand, such as social services or hotel and restaurants. Figure 8 above has shown that about 60% of gross output of financial and business services in France flows to other industries, while the respective share is about 20% in the case of trade, hotels and restaurants and 5% in community, social and personal services. In addition, Table 1 shows that intermediate inputs from hotels and restaurants and other social services account for about 1% of total intermediate use per industry, while financial services account for around 7% and renting of machinery and equipment for 16% of total intermediate use per industry.

As a consequence, the adjustment of financial intermediation and renting of machinery and equipment may increase the growth rate of intermediate inputs in the industries where these intermediates are strongly used, thus reducing their growth rate of value added. The adjustment of output in hotels and restaurant and in other social and community services, however, may have only a small impact in other industries. The increase in the growth rate of intermediate inputs of these two services may be more than compensated by the increase in their gross output. This can be seen from the last block of results in Table 1 which presents the change in the growth rate of intermediate inputs per industry which is induced by setting negative productivity growth rates in services equal to zero. The growth rate of intermediate inputs changes significantly for all industries if the adjustment of productivity growth was undertaken in financial services or in renting of machinery and equipment. An adjustment of productivity growth in hotels and restaurant or in other social services only slightly affects the growth rate of intermediate inputs in the service using industries.

33. Additional estimations have shown that this second effect is quantitatively of minor importance.

Table 1. **Change in growth rate of intermediate inputs when negative service productivity growth rates are set to zero**[1]

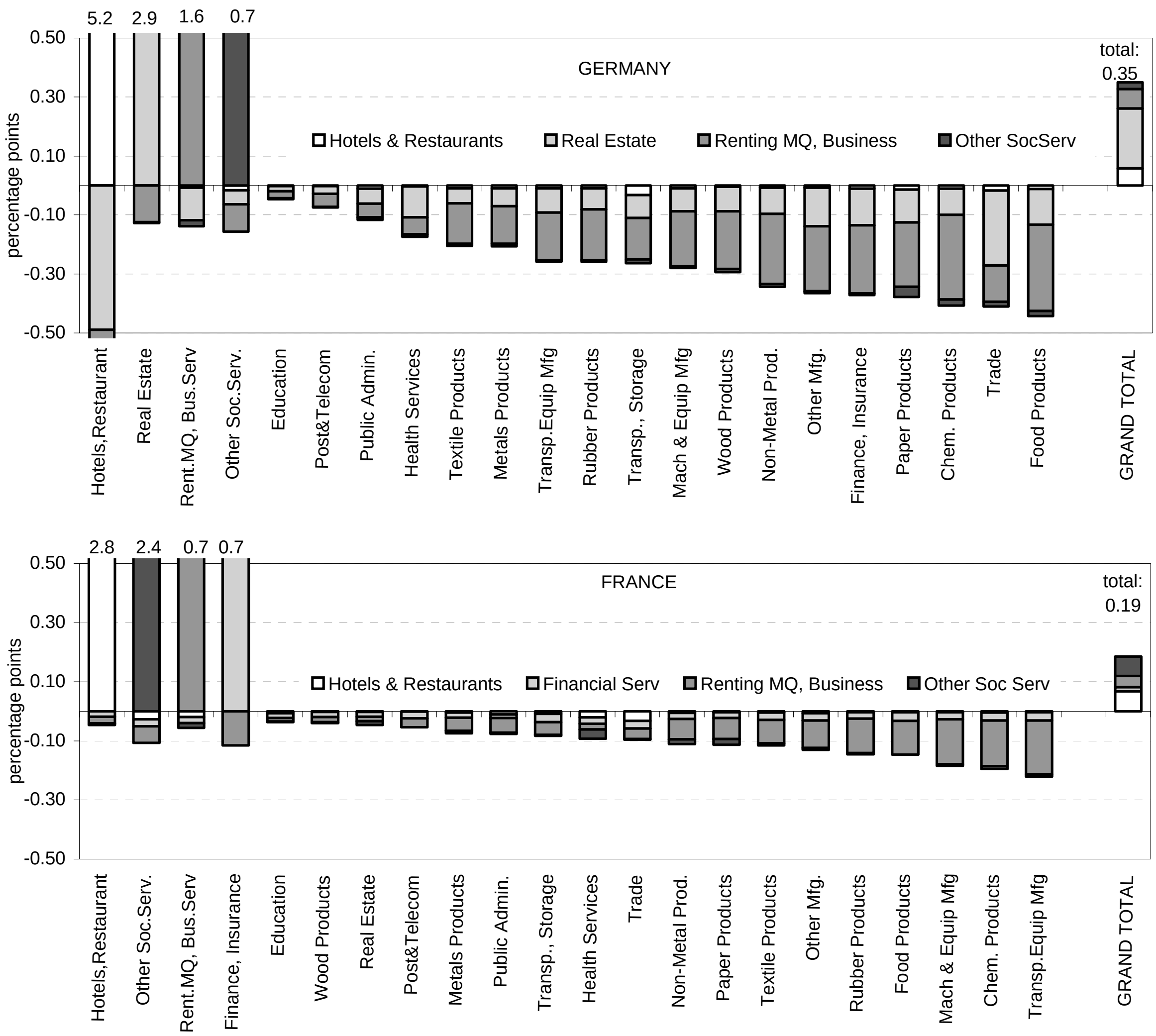
The example of France

FRANCE, 1991-99		Share of intermediate inputs in gross output	Actual use of inputs from industry shown as a share of total intermediate use per industry				Change in growth of intermediate inputs per industry due to adjustment of productivity in …			
	ISIC Rev.3		Hotels & Restau-rants [1.090]	Financial Inter-mediation [1.007]	Renting of Mach. & Equip. [1.009]	Other Social Services [1.054]	Hotels & Restau-rants [1.090]	Financial Inter-mediation [1.007]	Renting of Mach. & Equip. [1.009]	Other Social Services [1.054]
Sectors			in per cent				in percentage points			
MANUFACTURING	**15-37**	**72.48**	**0.10**	**2.65**	**11.21**	**0.21**	**0.001**	**0.008**	**0.033**	**0.003**
FOOD PRODUCTS, BEVERAGES	15-16	78.15	0.07	2.71	9.44	0.01	0.001	0.008	0.032	0.000
TEXTILE PRODUCTS, LEATHER & FOOTWEAR	17-19	72.98	0.14	2.95	8.47	0.22	0.002	0.008	0.027	0.002
PRODUCTS OF WOOD & CORK	20	66.69	0.09	2.37	2.09	0.14	0.001	0.006	0.006	0.001
PAPER PRODUCTS, PRINTING & PUBLISHING	21-22	65.50	0.10	2.88	9.56	0.75	0.001	0.007	0.027	0.007
CHEMICALS & CHEMICAL PRODUCTS	24	71.07	0.10	3.00	15.31	0.27	0.001	0.008	0.047	0.003
RUBBER & PLASTICS PRODUCTS	25	64.03	0.11	3.51	16.44	0.18	0.001	0.009	0.046	0.002
OTHER NON-METALLIC MINERAL PRODUCTS	26	60.88	0.23	3.69	11.31	0.82	0.002	0.009	0.030	0.007
METALS & METAL PRODUCTS	27-28	66.00	0.16	2.48	5.77	0.36	0.002	0.006	0.017	0.003
MACHINERY & EQUIPMENT	29-33	67.32	0.12	3.12	18.73	0.21	0.001	0.008	0.055	0.002
TRANSPORT EQUIPMENT	34-35	79.29	0.06	1.95	11.61	0.13	0.001	0.006	0.040	0.001
MANUFACTURING NEC; RECYCLING	36-37	57.81	0.27	4.38	14.64	0.32	0.003	0.010	0.037	0.003
SERVICES	**50-99**	**36.38**	**1.99**	**12.87**	**22.84**	**2.30**	**0.008**	**0.014**	**0.025**	**0.005**
WHOLESALE & RETAIL TRADE; REPAIRS	50-52	33.96	4.02	13.56	16.46	0.31	0.022	0.018	0.024	0.002
HOTELS & RESTAURANTS	55	52.50	6.48	5.03	5.74	0.45	ass. zero	0.010	0.013	0.003
TRANSPORT & STORAGE	60-63	47.78	0.55	7.98	11.08	0.26	0.004	0.015	0.023	0.002
POST & TELECOMMUNICATIONS	64	30.93	0.22	13.28	16.13	0.00	0.001	0.016	0.022	0.000
FINANCE & INSURANCE	65-67	48.90	0.01	34.77	29.10	0.00	0.000	ass. zero	0.062	0.000
REAL ESTATE ACTIVITIES	70	19.12	0.47	19.22	15.90	3.98	0.001	0.014	0.013	0.011
RENTING OF M&EQ & OTHER BUSINESS ACTIVITIES	71-74	50.51	1.37	6.31	36.52	1.29	0.011	0.012	ass. zero	0.009
PUBLIC ADMINISTRATION	75	21.80	2.29	9.07	37.86	1.02	0.008	0.008	0.036	0.003
EDUCATION	80	17.02	1.92	20.81	12.91	0.78	0.005	0.014	0.010	0.002
HEALTH & SOCIAL WORK	85	30.20	3.00	12.81	10.00	5.01	0.015	0.015	0.013	0.022
OTHER SOCIAL & PERSONAL SERVICES	90-93	49.07	2.07	7.25	15.77	16.93	0.016	0.014	0.034	ass. zero
OTHER SECTORS	**1-14,40-45**	**56.24**	**0.10**	**6.87**	**12.94**	**0.40**	**0.001**	**0.010**	**0.019**	**0.004**
ALL SECTORS	**01-99**	**50.74**	**0.84**	**7.24**	**16.00**	**1.05**	**0.004**	**0.011**	**0.027**	**0.004**

1. Simulation: negative service productivity growth rates are set to zero. Values in brackets represent the change in output growth due to the adjustment.
Source : OECD STAN Database 2002, input-output table 1995.

Figure 17 shows how these corrections affect productivity growth in other industries and the aggregate. Two main results prevail. First, the effect on industry and aggregate productivity growth depends on the extent of the measurement bias. In the case of Germany, output growth had to be adjusted more than in France in almost all industries with negative productivity growth; aggregate productivity growth would increase by about 0.35 percentage points in Germany as compared to 0.19 percentage points in France. Second, the effect depends on the share of production of the mismeasured service industry that is destined for intermediate demand. There seems to be almost no effect on measured productivity growth of other industries of a correction for hotels and restaurants, a service which produces primarily for final demand. In contrast, the effects of a correction in renting of machinery and equipment, financial intermediation or real estate, service industries which mainly produce for intermediate demand, would be spread across all industries. For instance, a correction in renting of machinery and equipment in Germany would reduce measured productivity growth in other industries by about 0.1 to 0.2 percentage points, since intermediate inputs would grow more rapidly than initially measured and output growth would thus be lower.

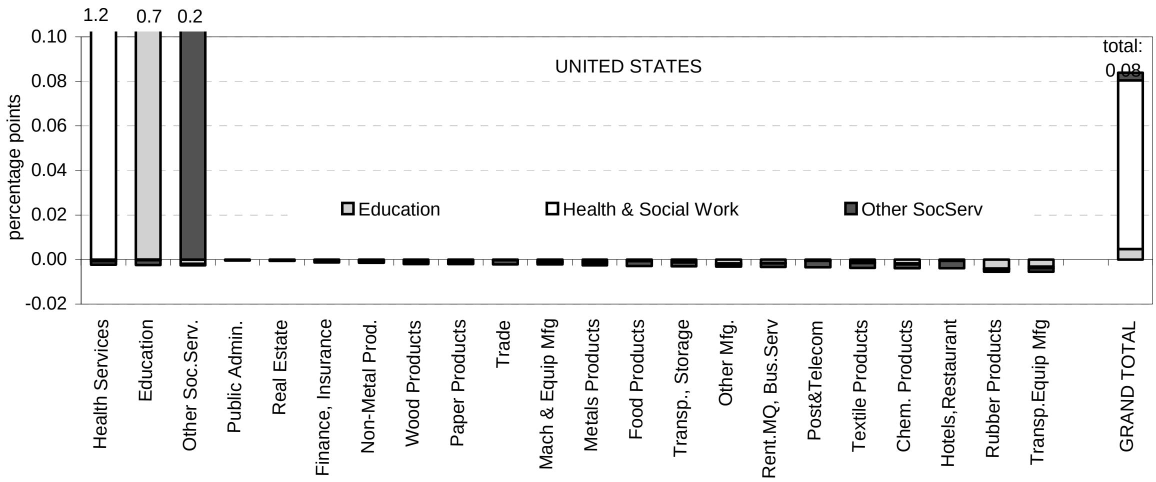
Figure 17. **Effect on industry and aggregate productivity growth when negative service productivity growth rates are set to zero**
The example of Germany and France



1. The industries are ranked according to the total effect if all negative service productivity growth rates are set to zero.
Source: OECD STAN Database 2002, input-output tables 1995, 1997.

The relevance of both, the extent of the measurement bias and the degree of production destined for intermediate demand, becomes particularly clear by comparing the results for France and Germany with the ones for the United States (Figure 18). First, the upward revision of the productivity growth rate for all services under consideration is lower in the case of the United States than in France or Germany. As a consequence, also the change in the productivity growth rate of all industries is lower. Second, the services where the United States showed negative productivity growth rates on this level of aggregation are education, health and social work as well as other social services. As could be seen above, these industries produce mainly for final demand and only to a small extent for intermediate production. Both factors together might explain the relatively small impact of a correction for measurement bias on productivity growth in other industries and on aggregate in the United States as compared to France or Germany.

Figure 18. **Effect on industry and aggregate productivity growth when negative service productivity growth rates are set to zero** *(continued)*
The example of the United States



1. The industries are ranked according to the overall effect if all negative service productivity growth rates are set to zero.
Source: OECD STAN Database 2002, input-output tables 1995, 1997.

Overall, the thought experiment presented here suggests that the principal impact of possible mismeasurement might be a shift in the attribution of productivity growth to specific sectors of the economy. This could imply a greater contribution of services sectors characterised by mismeasurement to total productivity growth, and a smaller contribution of other sectors, including manufacturing. The impact on aggregate productivity growth is not clear, *a priori*, but the result for Germany, France and the United States suggest that strong positive effects on service industries might be reduced by negative indirect effects on productivity growth of the industries that are using the adjusted services as intermediate inputs. The final effect on aggregate productivity growth might, therefore, be relatively small.

4. Conclusions

The question whether productivity growth performance in services might slow down aggregate growth can not unambiguously be answered. On a rather aggregate level, the productivity growth patterns indicate a large productivity growth differential between a progressive manufacturing sector on the one side and a rather stagnant service sector on the other side. However, the productivity growth patterns of the service sector do not fit into the traditional pattern that was underlying Baumol’s theory. Several services show productivity growth patterns that are typical for high-growth manufacturing industries, *e.g.* transport, storage and communications services, financial intermediation, and, to a lesser degree, wholesale and retail trade. There are also some – albeit weak – signs for positive indirect effects of ICT-related services and financial and business services on productivity growth in other industries and for aggregate productivity growth. Concerns about possibly negative consequences from unbalanced growth might however still be warranted. Productivity growth is low or negative in many service industries despite seemingly strong use of cost-reducing technologies and despite the fact that some market-related services produce in markets that are characterised by intensive competition.

There is substantial evidence that low or negative productivity growth rates in services are partly linked to problems in the adequate measurement of service productivity growth. The way, constant price value added of services is computed influences strongly the development of output or value added over time and, consequently, productivity growth by industry. In addition, weak changes in constant price value added over time can be observed when labour input-related indicators are used for deflation or extrapolation. There is also evidence that a potential under-estimation of service productivity growth leads eventually to an under-estimation of aggregate productivity growth via the flows of intermediate inputs.

There is, however, no clear evidence on which service industries are the most problematic from a measurement perspective. The extent of measurement bias seems to depend rather on the specific component of labour productivity growth where measurement bias arises. Firstly, general problems of definition and computation of the underlying price index seem to prevail mainly in social and personal services and in wholesale and retail trade. In particular in social services, several countries use labour-related indicators to derive constant price volumes of value added. In services such as post and telecommunications and financial intermediation, strong differences in the price developments across countries do not favour international comparability of constant price value added estimates.

Secondly, different definitions and data sources used for employment and hours worked might bias international comparisons of labour productivity growth. The empirical evidence shows that the difference between labour productivity growth per employment and per hour worked varies across industries and countries. It shows furthermore that hours worked per employment are relatively high in transport and communications services as well as in financial and business services, while they are relatively low in personal and social services. An adjustment for hours worked in productivity growth estimation might thus be desirable.

Finally, also the effect of a potential under-estimation of labour productivity growth in specific services on aggregate productivity growth depends on industry-specific factors. These are the type and extent of the measurement bias, the weight of the under-estimated services in the whole economy, and the degree to which the mismeasured service industry produces for intermediate demand. Significant impacts on other industries' productivities resulted from a potential under-estimation of productivity growth in financial and business services. The effects were particularly strong for manufacturing industries which illustrates the strong inter-relationship between business related services, such as financial and rental services, and manufacturing. In contrast, under-estimation of labour-productivity growth in social and personal services as well as in hotels and restaurants did not work through other industries, but contributed mainly through their stronger weights in the economy to the simulated upward shift of aggregate productivity growth.

The empirical evidence up to now can only give an initial picture of the extent of measurement bias and its effect on industry and aggregate productivity growth. It does not resolve the measurement problems that have become increasingly apparent in the services sector. Some countries have recently taken steps to improve output measurement and OECD is working with its member countries in several areas, including financial services, insurance and software. Nevertheless, further progress is required to improve productivity growth measures and enhance our understanding of the drivers of growth and the cross-country differences in productivity growth performance.

ANNEX A: TABLES

Annex Table 1. **Labour productivity growth by industry, 1995-2000/01**

		Austria	Belgium	Canada	Denmark	Finland	France	Germany	Italy	Japan	Korea	Nether-lands	Norway	Spain	Sweden	United Kingdom	United States
GRAND TOTAL	**01-99**	**2.21**	**1.40**	**0.82**	**1.48**	**2.44**	**1.22**	**1.34**	**0.74**	**0.83**	**4.11**	**0.89**	**1.55**	**0.41**	**2.38**	**0.66**	**2.06**
AGRICULTURE, HUNTING, FORESTRY AND FI	**01-05**	**3.93**	**4.11**	**3.09**	**5.63**	**4.05**	**4.89**	**4.75**	**3.62**	**0.09**	**3.33**	**1.31**	**2.51**	**3.30**	**2.10**	**1.27**	**6.46**
MINING AND QUARRYING	**10-14**	**4.42**	**-0.22**	**-1.25**	**17.32**	**-0.69**	**..**	**-2.73**	**-1.18**	**5.17**	**1.70**	**0.32**	**2.99**	**0.33**	**0.99**	**0.24**	**-1.83**
TOTAL MANUFACTURING	**15-37**	**5.18**	**3.96**	**1.10**	**2.29**	**5.03**	**3.61**	**1.51**	**1.07**	**2.60**	**11.33**	**2.35**	**0.43**	**0.19**	**4.37**	**0.32**	**4.54**
FOOD PRODUCTS, BEVERAGES & TOBACCO	15-16	2.44	-0.18	-0.69	3.16	3.08	-1.81	0.35	1.23	0.45	6.53	2.49	-1.32	-0.23	2.89	..	-4.42
TEXTILE PRODUCTS, LEATHER & FOOTWEAR	17-19	6.00	8.94	0.28	8.11	0.98	2.36	3.39	1.81	-2.85	1.22	4.37	-0.75	0.14	2.96	..	3.22
....TEXTILES & TEXTILE PRODUCTS	17-18	6.02	9.21	0.60	7.93	0.81	2.22	3.45	2.50	-2.98	..	7.30	3.03	0.20	..	..	3.43
....LEATHER, LEATHER PRODUCTS & FOOTWEA	19.00	5.96	1.80	-6.43	10.35	1.76	-0.81	2.86	-1.06	-0.95	..	4.11	-2.91	0.54	..	..	1.28
WOOD & PRODUCTS OF WOOD & CORK	20	5.60	5.33	-1.14	0.05	3.88	1.95	2.30	3.00	-6.44	4.27	6.12	3.06	0.95	5.82	..	0.28
PULP, PAPER PRODUCTS, PRINTING & PUBLISH	21-22	6.45	0.61	0.25	-0.01	2.24	1.64	3.54	1.98	1.51	3.01	2.96	-0.46	-0.75	2.79	..	-0.02
....PULP, PAPER & PAPER PRODUCTS	21.00	5.26	..	4.86	2.97	2.67	2.50	5.52	0.64	1.39	5.97	..	8.22	..	-0.20	..	0.21
....PRINTING & PUBLISHING	22.00	7.63	..	-3.23	-0.91	1.98	0.66	2.53	2.75	1.62	0.57	..	-2.15	..	5.89	..	-0.20
CHEMICAL, RUBBER, PLASTICS & FUEL PRODU	23-25	7.46	3.93	2.52	9.34	1.91	3.46	2.43	-0.75	2.71	8.35	3.13	4.85	0.16	3.30	..	3.68
....COKE, REF.PETROLEUM PRODUCTS & NUCLE	23	18.42	-9.19	10.60	38.52	-1.30	3.33	12.58	-5.64	4.03	..	-3.04	27.76	0.16	16.40	..	1.50
....CHEMICALS & CHEMICAL PRODUCTS	24	5.80	5.49	1.12	10.46	4.07	5.54	2.66	0.90	2.32	..	4.19	5.35	0.61	1.37	..	4.47
....RUBBER & PLASTICS PRODUCTS	25	7.44	2.32	5.27	5.59	0.14	3.39	1.35	-0.83	-0.80	..	3.12	-0.95	0.57	3.24	..	4.19
OTHER NON-METALLIC MINERAL PRODUCTS	26	4.50	-0.21	4.61	-0.48	1.78	3.71	0.91	0.53	-0.08	8.22	1.49	-2.25	0.56	-0.10	..	2.66
METALS, MACHINERY & EQUIPMENT	27-35	4.78	5.01	-1.07	-0.08	7.96	5.09	1.56	0.59	2.92	9.38	2.47	1.43	0.35	6.53	..	7.80
BASIC METALS & FABRICATED METAL PRODUC	27-28	4.93	3.43	-0.98	-0.51	0.30	1.51	1.37	0.15	-1.41	3.78	1.40	7.03	-1.32	-0.07	..	1.47
....BASIC METALS	27	9.19	..	3.10	-0.65	3.59	1.94	2.70	-2.52	-0.64	..	3.32	-2.07	-1.68	1.94	..	3.19
....FABRICATED METAL PRODUCTS, except mach	28	2.16	..	-3.14	-0.75	-0.52	1.43	0.98	1.18	-2.21	..	0.98	..	-0.65	-0.23	..	0.63
MACHINERY & EQUIPMENT	29-33	5.74	7.25	-1.99	0.21	11.27	7.16	3.68	0.67	6.29	14.47	2.56	-0.25	1.08	12.07	..	13.49
....MACHINERY & EQUIPMENT, N.E.C.	29	5.46	4.39	-3.79	-0.76	0.94	3.56	0.88	0.63	-1.22	-8.73	2.32	-0.64	1.32	1.90	..	..
....ELECTRICAL & OPTICAL EQUIPMENT	30-33	6.05	8.98	-0.55	1.60	16.40	9.51	6.44	0.69	9.69	19.56	2.84	0.14	1.00	21.74	..	..
........OFFICE, ACCOUNTING & COMPUTING MA	30	57.50	..	-1.31	12.70	-8.06	22.18	15.25	-2.42	..	19.18	..	..	2.55	12.71	..	..
........ELECTRICAL MACHINERY & APPARATUS,	31	8.03	..	10.16	-1.35	5.86	4.99	4.15	..	..	-13.45	..	..	2.78	0.47	..	..
........RADIO, TV & COMMUNICATION EQUIPME	32	3.00	..	-6.66	0.92	19.54	19.64	13.19	..	..	25.58	..	..	0.40	44.07	..	..
........MEDICAL, PRECISION & OPTICAL INSTRU	33	4.79	..	..	3.58	2.32	1.16	4.70	-0.12	5.51	-6.80	..	..	1.33	5.71	..	-1.75
TRANSPORT EQUIPMENT	34-35	-0.04	3.99	0.02	-1.06	1.22	7.82	-3.22	1.33	-4.19	4.54	4.74	2.71	1.57	2.89	..	1.59
....MOTOR VEHICLES, TRAILERS & SEMI-TRAIL	34	0.35	..	0.69	4.49	4.64	12.72	-5.11	1.51	..	1.12	..	..	2.20	4.11	..	1.42
....OTHER TRANSPORT EQUIPMENT	35	-1.08	..	-1.65	-6.00	-0.48	-3.13	9.37	1.00	..	15.86	..	..	0.65	-2.84	..	1.79
MANUFACTURING NEC; RECYCLING	36-37	3.79	4.23	0.93	-2.45	1.85	1.79	0.95	2.86	2.96	2.05	0.32	-2.46	0.24	6.63	..	2.40

Annex Table 1. **Labour productivity growth by industry, 1995-2000/01** *(continued)*

		Austria	Belgium	Canada	Denmark	Finland	France	Germany	Italy	Japan	Korea	Nether-lands	Norway	Spain	Sweden	United Kingdom	United States
ELECTRICITY, GAS & WATER SUPPLY	**40-41**	**5.12**	**..**	**1.25**	**1.19**	**5.40**	**4.66**	**5.71**	**3.94**	**4.21**	**11.99**	**4.51**	**3.28**	**6.19**	**-0.66**	**2.89**	**2.29**
CONSTRUCTION	**45**	**2.47**	**1.51**	**0.38**	**0.74**	**-0.77**	**-2.65**	**0.80**	**0.38**	**-4.15**	**3.53**	**-0.06**	**-3.34**	**-1.10**	**0.22**	**0.54**	**0.18**
TOTAL SERVICES	**50-99**	**0.52**	**0.57**	**0.83**	**1.08**	**1.38**	**0.60**	**1.05**	**0.36**	**0.60**	**1.18**	**0.84**	**2.11**	**0.13**	**2.01**	**0.79**	**2.47**
BUSINESS SECTOR SERVICES	**50-74**	**1.26**	**1.36**	**1.49**	**1.66**	**1.66**	**0.45**	**1.26**	**0.09**	**1.42**	**2.41**	**1.26**	**2.94**	**-0.14**	**2.34**	**1.01**	**3.36**
TRADE; RESTAURANTS & HOTELS	**50-55**	**1.91**	**-0.28**	**2.60**	**1.21**	**1.54**	**0.41**	**-0.92**	**0.23**	**-0.83**	**1.34**	**2.47**	**5.23**	**0.16**	**4.61**	**0.59**	**5.16**
WHOLESALE & RETAIL TRADE; REPAIRS	50-52	2.37	-0.43	2.91	1.57	1.99	0.62	-0.21	0.38	-0.83	2.30	2.67	5.62	0.69	3.98	..	5.47
HOTELS & RESTAURANTS	55	0.47	0.56	1.06	-1.65	-0.65	-0.41	-4.27	-0.17	..	-1.16	1.13	2.78	-0.62	3.10	..	-0.86
TRANSPORT, STORAGE & COMMUNICATION	**60-64**	**2.86**	**1.89**	**2.91**	**4.81**	**4.84**	**5.21**	**8.12**	**2.03**	**1.77**	**6.47**	**..**	**3.51**	**2.58**	**6.15**	**2.20**	**2.47**
TRANSPORT & STORAGE	60-63	2.55	..	1.19	3.86	1.60	3.06	3.13	-0.73	-0.69	..	2.34	2.20	0.36	3.51	..	1.65
POST & TELECOMMUNICATIONS	64.00	3.64	..	5.92	7.08	13.35	10.26	17.72	9.41	7.04	..	10.26	16.98	5.20	11.48	..	3.30
FINANCE, REAL ESTATE & BUSINESS SERVIC	**65-74**	**-1.42**	**1.23**	**-0.37**	**0.18**	**-0.68**	**-1.18**	**-0.91**	**-1.65**	**2.25**	**-0.05**	**-1.39**	**-0.96**	**-1.95**	**0.20**	**0.53**	**1.40**
FINANCIAL INTERMEDIATION	65-67	3.76	3.23	..	3.12	6.93	-1.06	4.68	2.00	1.70	4.53	-0.33	9.76	-0.45	4.38	..	5.52
....FINANCIAL INTERMEDIATION exc. insurance &	65.00	4.49	..	..	3.02	8.18	-1.34	8.65	3.14	..	..	..	..	0.74	..	..	2.87
….INSURANCE & PENSION FUNDING, exc.comp.s	66.00	4.14	..	..	8.57	-1.13	-2.52	-8.98	-1.30	..	..	..	..	-10.56	..	..	-0.96
….ACTIVITIES RELATED TO FINANCIAL INTERM	67.00	-5.73	..	..	-9.71	..	2.84	1.06	-1.40	..	..	..	..	6.19	..	..	16.57
REAL ESTATE, RENTING & BUSINESS ACTIVITI	70-74	-3.82	0.62	..	-0.81	-2.58	-1.48	-2.62	-2.76	2.02	-3.03	-1.63	-4.72	-2.50	-0.76	..	-0.13
….REAL ESTATE ACTIVITIES	70.00	-1.62	..	..	0.15	0.43	-0.46	-2.65	-0.85	1.74	..	..	-1.25	-6.15	4.03	..	1.70
….RENTING OF M&EQ & OTHER BUSINESS ACT	71-74	-2.81	..	..	1.60	-0.65	-0.40	-1.33	-0.04	3.32	..	..	0.73	-0.04	0.20	..	1.32
……..RENTING OF MACHINERY & EQUIPMENT	71.00	0.80	..	..	-1.22	3.01	-1.85	2.55	..	..	..	..	..	0.43	6.14	..	..
……..COMPUTER & RELATED ACTIVITIES	72.00	-9.33	..	..	7.63	-1.17	0.90	5.05	3.07	..	..	..	..	0.20	-0.61	..	..
……..RESEARCH & DEVELOPMENT	73.00	-2.15	..	..	2.04	-0.67	-0.83	6.51	..	..	..	..	..	-3.20	..	..	..
……..OTHER BUSINESS ACTIVITIES	74.00	-2.18	..	..	0.47	-1.21	-1.00	-3.34	-0.81	..	..	..	..	-0.30	-0.76	..	..
COMMUNITY, SOCIAL & PERSONAL SERVICE	**75-99**	**-1.09**	**-0.63**	**-0.73**	**-0.31**	**0.23**	**0.45**	**0.10**	**0.08**	**-0.48**	**-2.10**	**-0.43**	**0.27**	**0.28**	**0.70**	**0.12**	**-0.07**
PUBLIC ADMIN. & DEFENCE; COMPULSORY SO	75.00	0.13	0.06	0.73	0.99	1.04	1.25	1.12	0.90	1.82	-6.93	..	1.45	1.14	..	..	0.25
EDUCATION	80.00	-0.06	0.09	0.16	-0.15	-0.21	0.83	-0.02	-0.55	..	-0.98	..	1.16	0.40	..	..	-1.18
HEALTH & SOCIAL WORK	85.00	-3.42	-1.79	-1.17	-0.43	-0.10	0.31	0.01	0.68	..	-2.58	..	0.13	-0.18	..	..	-0.26
OTHER COMMUNITY, SOCIAL & PERSONAL SER	90-93	-0.99	0.88	-3.06	-1.42	0.64	-1.36	-0.40	-0.37	..	0.61	..	2.78	-0.28	..	..	-0.10
PRIVATE HOUSEHOLDS WITH EMPLOYED PERS	95.00	-3.01	-3.26	..	-1.56	-0.77	..	-0.27	-0.34	..	2.62	..	..	..	..	..	0.74

Source: OECD STAN Database 2002.

Annex Table 2. **Labour productivity growth by industry, 1990-2000/01**

		Austria	Belgium	Canada	Denmark	Finland	France	Germany	Italy	Japan	Korea	Nether-lands	Norway	Spain	Sweden	United Kingdom	United States
GRAND TOTAL	**01-99**	**2.20**	**1.59**	**1.12**	**1.76**	**2.87**	**1.15**	**1.66**	**1.25**	**0.78**	**4.59**	**1.03**	**2.33**	**0.96**	**2.72**	**2.21**	**1.65**
AGRICULTURE, HUNTING, FORESTRY AND FI	**01-05**	**5.49**	**5.30**	**2.04**	**6.55**	**4.58**	**4.69**	**7.07**	**5.31**	**0.30**	**5.90**	**2.65**	**4.89**	**2.55**	**2.05**	**2.45**	**2.66**
MINING AND QUARRYING	**10-14**	**1.57**	**5.54**	**1.42**	**12.77**	**2.11**	**..**	**2.52**	**2.00**	**1.35**	**14.43**	**1.41**	**5.50**	**5.43**	**2.95**	**14.28**	**1.78**
TOTAL MANUFACTURING	**15-37**	**4.34**	**3.25**	**2.23**	**2.64**	**5.73**	**3.86**	**2.48**	**2.02**	**1.83**	**9.99**	**2.96**	**0.67**	**1.65**	**5.71**	**2.42**	**4.15**
FOOD PRODUCTS, BEVERAGES & TOBACCO	15-16	3.12	0.78	1.03	3.15	4.43	0.44	1.83	1.61	-0.87	4.71	3.73	0.78	0.54	3.08	..	-0.50
TEXTILE PRODUCTS, LEATHER & FOOTWEAR	17-19	3.74	6.60	3.08	5.57	2.78	2.43	3.96	2.94	-2.59	1.40	2.37	0.72	2.10	3.95	..	3.25
….TEXTILES & TEXTILE PRODUCTS	17-18	3.75	7.08	3.32	5.57	2.82	2.95	3.77	3.38	-2.64	..	1.42	1.99	0.00	..	..	3.30
….LEATHER, LEATHER PRODUCTS & FOOTWEA	19.00	3.66	-2.21	-0.75	5.93	2.60	-1.42	5.40	1.13	-2.04	..	1.37	5.19	0.24	..	..	3.15
WOOD & PRODUCTS OF WOOD & CORK	20	3.37	2.11	-1.85	2.31	4.67	2.34	3.87	3.00	-4.09	1.23	2.89	0.33	0.42	4.61	..	-1.25
PULP, PAPER PRODUCTS, PRINTING & PUBLISH	21-22	4.97	2.63	-0.58	0.32	4.49	1.75	2.93	1.93	-1.03	4.11	2.76	0.56	0.01	3.23	..	-0.87
….PULP, PAPER & PAPER PRODUCTS	21.00	6.97	..	3.03	-0.29	5.02	3.50	3.33	1.84	-1.08	6.48	..	4.96	..	1.21	..	0.10
….PRINTING & PUBLISHING	22.00	3.39	..	-3.80	-3.18	2.80	0.65	2.62	1.83	-0.96	2.19	..	-1.27	..	5.37	..	-1.41
CHEMICAL, RUBBER, PLASTICS & FUEL PRODU	23-25	7.46	4.19	3.01	5.30	3.03	4.83	3.98	1.04	1.87	9.50	4.43	1.55	2.16	3.43	..	3.38
….COKE, REF.PETROLEUM PRODUCTS & NUCLE	23	40.80	-6.91	5.13	7.09	1.99	7.10	6.05	-0.57	-0.38	..	1.97	-4.28	0.07	11.05	..	3.31
….CHEMICALS & CHEMICAL PRODUCTS	24	4.61	5.55	3.25	7.87	4.28	5.92	5.29	2.12	2.40	..	5.65	2.89	0.27	2.36	..	3.94
….RUBBER & PLASTICS PRODUCTS	25	6.25	3.84	3.94	0.88	1.54	3.80	2.21	0.53	0.22	..	2.06	0.23	0.38	3.92	..	4.45
OTHER NON-METALLIC MINERAL PRODUCTS	26	1.88	1.68	0.72	0.62	2.78	2.55	3.52	0.95	0.02	7.38	1.83	2.69	1.70	1.54	..	2.74
METALS, MACHINERY & EQUIPMENT	27-35	4.34	2.96	3.66	2.06	7.43	5.89	2.43	1.82	2.89	9.91	3.14	1.15	1.87	7.79	..	6.85
BASIC METALS & FABRICATED METAL PRODUC	27-28	4.36	1.94	2.26	1.55	3.30	1.63	2.78	2.13	0.61	4.54	2.34	3.97	-0.59	2.50	..	2.47
….BASIC METALS	27	6.56	..	3.79	-6.11	5.65	3.12	6.41	1.40	0.82	..	5.08	0.22	-0.63	4.71	..	3.59
….FABRICATED METAL PRODUCTS, except mach	28	3.32	..	1.13	1.34	1.96	1.15	1.34	1.90	0.53	..	1.51	..	-0.24	1.95	..	1.94
MACHINERY & EQUIPMENT	29-33	4.47	3.59	4.58	2.35	9.44	8.25	3.75	1.87	5.00	13.90	3.78	1.22	0.48	11.78	..	10.80
….MACHINERY & EQUIPMENT, N.E.C.	29	3.68	4.39	1.58	0.92	2.55	4.38	2.58	1.81	-1.57	4.76	3.01	0.42	0.59	3.89	..	..
….ELECTRICAL & OPTICAL EQUIPMENT	30-33	5.23	8.98	6.30	4.64	13.68	10.77	4.86	1.94	8.61	16.02	4.42	2.04	0.44	19.22	..	..
……..OFFICE, ACCOUNTING & COMPUTING MA	30	24.14	..	19.19	17.31	-1.39	27.37	13.37	1.68	..	10.18	..	..	0.95	10.32	..	..
……..ELECTRICAL MACHINERY & APPARATUS,	31	6.26	..	3.14	4.54	5.85	5.87	2.69	..	..	-1.57	..	..	1.03	1.35	..	..
……..RADIO, TV & COMMUNICATION EQUIPME	32	3.84	..	3.45	1.53	19.29	22.49	10.52	..	..	20.33	..	..	0.15	38.86	..	..
……..MEDICAL, PRECISION & OPTICAL INSTRU	33	4.55	..	..	5.38	1.70	0.20	3.45	1.23	1.13	6.10	..	..	0.50	4.70	..	-1.98
TRANSPORT EQUIPMENT	34-35	3.78	3.54	3.82	1.56	2.34	5.64	-1.04	0.86	-1.63	7.43	2.67	1.92	0.75	5.64	..	2.50
….MOTOR VEHICLES, TRAILERS & SEMI-TRAIL	34	4.21	..	4.34	0.55	2.83	7.13	-1.84	3.04	..	7.32	..	..	0.82	7.70	..	3.22
….OTHER TRANSPORT EQUIPMENT	35	3.43	..	2.36	1.16	2.12	2.15	3.27	1.43	..	10.15	..	..	0.24	-2.67	..	0.32
MANUFACTURING NEC; RECYCLING	36-37	1.72	1.76	3.94	-0.85	2.42	1.96	0.22	3.36	-0.55	1.10	-0.15	-2.27	0.37	8.70	..	1.87

Annex Table 2. **Labour productivity growth by industry, 1990-2000/01** *(continued)*

		Austria	Belgium	Canada	Denmark	Finland	France	Germany	Italy	Japan	Korea	Nether-lands	Norway	Spain	Sweden	United Kingdom	United States
ELECTRICITY, GAS & WATER SUPPLY	**40-41**	**3.54**	**..**	**1.32**	**3.41**	**6.35**	**3.33**	**5.07**	**3.42**	**2.02**	**11.00**	**3.97**	**2.55**	**3.60**	**1.12**	**8.64**	**2.41**
CONSTRUCTION	**45**	**2.26**	**0.22**	**-0.54**	**0.15**	**-0.04**	**-0.70**	**0.04**	**-0.07**	**-2.74**	**1.53**	**-0.66**	**0.36**	**0.48**	**1.57**	**2.38**	**0.33**
TOTAL SERVICES	**50-99**	**0.71**	**1.13**	**0.97**	**1.27**	**1.59**	**0.26**	**1.10**	**0.66**	**0.60**	**1.66**	**0.66**	**2.04**	**0.33**	**2.05**	**2.02**	**1.57**
BUSINESS SECTOR SERVICES	**50-74**	**1.30**	**1.54**	**1.92**	**1.54**	**2.52**	**0.25**	**1.31**	**0.77**	**1.58**	**2.19**	**0.68**	**3.03**	**0.26**	**2.52**	**2.29**	**2.36**
TRADE; RESTAURANTS & HOTELS	**50-55**	**1.08**	**0.46**	**2.46**	**1.77**	**1.68**	**0.27**	**-0.58**	**0.96**	**0.50**	**0.90**	**1.11**	**5.04**	**0.66**	**4.24**	**1.85**	**3.54**
WHOLESALE & RETAIL TRADE; REPAIRS	50-52	1.54	0.58	2.79	2.01	1.85	1.04	0.18	1.41	0.50	2.19	1.30	5.56	0.89	3.90	..	3.68
HOTELS & RESTAURANTS	55	-0.27	0.02	0.64	0.20	1.07	-2.72	-4.58	-0.73	..	-1.22	0.01	1.90	0.06	2.56	..	0.67
TRANSPORT, STORAGE & COMMUNICATION	**60-64**	**2.15**	**1.53**	**2.51**	**3.97**	**4.78**	**3.04**	**7.31**	**3.50**	**0.43**	**5.77**	**..**	**3.57**	**3.12**	**4.82**	**4.80**	**2.71**
TRANSPORT & STORAGE	60-63	1.12	..	1.44	1.87	2.73	1.78	3.96	1.42	-1.57	..	2.73	1.32	1.97	2.98	..	1.88
POST & TELECOMMUNICATIONS	64.00	4.81	..	4.47	2.83	10.34	5.89	13.30	9.32	5.63	..	7.37	10.91	4.59	8.50	..	3.90
FINANCE, REAL ESTATE & BUSINESS SERVIC	**65-74**	**0.17**	**1.22**	**0.49**	**0.36**	**1.14**	**-0.86**	**-0.91**	**-1.06**	**2.17**	**-0.44**	**-1.27**	**-0.03**	**-1.65**	**0.84**	**1.19**	**0.79**
FINANCIAL INTERMEDIATION	65-67	3.77	3.23	..	-0.71	3.28	-1.08	3.34	1.61	0.64	5.17	-0.22	7.60	-2.32	3.69	..	3.74
....FINANCIAL INTERMEDIATION exc. insurance &	65.00	4.98	..	..	0.93	4.25	-1.74	5.37	3.20	..	..	..	..	0.28	..	..	2.08
….INSURANCE & PENSION FUNDING, exc.comp.s	66.00	1.85	..	..	0.85	-2.17	-0.78	-3.82	1.68	..	..	..	..	-4.10	..	..	1.03
….ACTIVITIES RELATED TO FINANCIAL INTERM	67.00	-4.38	..	..	-4.06	..	3.53	-0.40	0.66	..	..	..	..	2.28	..	..	9.71
REAL ESTATE, RENTING & BUSINESS ACTIVITI	70-74	-1.61	..	..	0.12	0.55	-1.01	-2.40	-1.91	2.37	-3.11	-1.49	-2.88	-1.17	0.18	..	-0.36
….REAL ESTATE ACTIVITIES	70.00	-0.99	..	..	3.73	3.41	0.57	-2.89	0.45	1.37	..	..	-0.69	0.03	2.83	..	1.65
….RENTING OF M&EQ & OTHER BUSINESS ACT	71-74	-0.05	..	..	0.04	0.45	-0.97	-1.57	0.60	4.51	..	..	0.54	0.37	0.47	..	0.32
……..RENTING OF MACHINERY & EQUIPMENT	71.00	3.40	..	..	15.71	1.83	-1.18	1.74	..	..	..	..	..	0.16	4.41	..	..
……..COMPUTER & RELATED ACTIVITIES	72.00	-4.15	..	..	10.33	-0.65	1.68	3.01	2.26	..	..	..	..	0.08	1.07	..	..
……..RESEARCH & DEVELOPMENT	73.00	5.86	..	..	-0.26	-0.32	-1.17	3.79	..	..	..	..	..	-1.21	..	..	..
……..OTHER BUSINESS ACTIVITIES	74.00	-0.32	..	..	-0.57	0.52	-1.05	-2.83	0.16	..	..	..	..	-0.11	-0.39	..	..
COMMUNITY, SOCIAL & PERSONAL SERVICE	**75-99**	**-0.47**	**0.39**	**-0.78**	**0.70**	**0.15**	**0.39**	**0.40**	**0.01**	**-0.81**	**0.26**	**0.18**	**0.37**	**0.48**	**0.82**	**1.34**	**-0.43**
PUBLIC ADMIN. & DEFENCE; COMPULSORY SO	75.00	0.65	0.06	1.25	1.42	0.47	1.24	1.58	1.64	0.90	-5.37	..	1.86	1.15	..	..	0.10
EDUCATION	80.00	-0.73	0.09	-1.14	0.77	0.06	0.57	0.16	-0.28	1.19	-0.86	..	0.65	0.58	..	..	-0.70
HEALTH & SOCIAL WORK	85.00	-1.36	-1.79	-0.71	0.49	-0.06	0.42	0.67	-0.25	1.38	0.09	..	0.01	0.84	..	..	-1.21
OTHER COMMUNITY, SOCIAL & PERSONAL SER	90-93	-0.60	0.88	-1.71	-0.08	0.36	-1.87	-0.67	-0.54	-1.63	2.54	..	1.14	-0.85	..	..	-0.20
PRIVATE HOUSEHOLDS WITH EMPLOYED PERS	95.00	-0.87	-3.26	..	-1.15	-0.12	..	-0.18	-0.81	..	8.19	..	..	..	..	..	1.48

Source: OECD STAN Database, 2002.

Annex Table 3. **Labour productivity growth by industry, 1980-90**

		Austria	Belgium	Canada	Denmark	Finland	France	Germany	Italy	Japan	Korea	Nether-lands	Norway	Spain	Sweden	United Kingdom	United States
GRAND TOTAL	**01-99**	**2.38**	**1.93**	**0.80**	**1.37**	**2.72**	**2.30**	**..**	**1.74**	**3.22**	**5.76**	**1.69**	**2.13**	**2.14**	**1.60**	**2.11**	**1.33**
AGRICULTURE, HUNTING, FORESTRY AND FI	**01-05**	**3.19**	**3.78**	**2.26**	**6.68**	**3.59**	**5.35**	**..**	**4.53**	**4.48**	**7.20**	**5.23**	**3.37**	**4.37**	**5.29**	**2.40**	**5.79**
MINING AND QUARRYING	**10-14**	**0.68**	**4.53**	**2.09**	**13.47**	**10.42**	**..**	**..**	**4.03**	**1.61**	**4.84**	**-2.94**	**5.37**	**1.80**	**3.28**	**8.05**	**5.25**
TOTAL MANUFACTURING	**15-37**	**3.82**	**4.83**	**2.60**	**1.11**	**4.57**	**2.67**	**..**	**2.76**	**3.90**	**5.74**	**3.07**	**2.15**	**4.12**	**2.86**	**4.57**	**3.56**
FOOD PRODUCTS, BEVERAGES AND TOBACCO	15-16	4.54	2.98	1.00	0.93	3.21	-0.02	..	2.23	-0.86	3.16	3.32	-2.17	0.59	..	..	0.95
TEXTILES, TEXTILE PRODUCTS, LEATHER AND	17-19	2.05	4.92	1.60	1.89	2.98	2.81	..	2.60	1.56	2.33	2.62	3.32	..	..	..	3.56
….TEXTILES AND TEXTILE PRODUCTS	17-18	1.87	5.39	1.52	1.62	2.99	..	..	2.33	1.21	..	3.07	2.93	..	..	..	3.60
….LEATHER, LEATHER PRODUCTS AND FOOTW	19.00	3.09	1.72	1.81	4.16	2.93	..	..	3.52	6.81	..	-0.47	7.93	..	..	..	3.57
WOOD AND PRODUCTS OF WOOD AND CORK	20	0.98	5.74	3.49	-0.53	4.58	..	..	4.01	3.21	6.17	1.94	2.22	..	..	..	2.70
PULP, PAPER, PAPER PRODUCTS, PRINTING AN	21-22	5.56	3.92	0.54	-0.51	4.08	..	..	3.36	2.55	7.77	2.37	1.94	-1.06	..	..	0.21
….PULP, PAPER AND PAPER PRODUCTS	21.00	6.39	..	1.79	0.29	5.29	..	..	..	3.61	9.27	..	..	..	..	..	2.25
….PRINTING AND PUBLISHING	22.00	5.01	..	-0.21	-0.63	3.11	0.77	..	..	1.98	6.27	..	..	..	..	..	-0.81
CHEMICAL, RUBBER, PLASTICS AND FUEL PRO	23-25	3.80	6.90	3.75	1.72	4.30	1.66	..	1.65	4.30	5.27	3.92	5.39	0.48	..	..	5.39
….COKE, REFINED PETROLEUM PRODUCTS AN	23	-13.36	5.58	7.69	-3.78	4.36	-12.46	..	-7.82	3.44	..	1.91	24.06	..	..	..	10.56
….CHEMICALS AND CHEMICAL PRODUCTS	24	5.38	8.26	4.25	1.25	3.55	..	..	8.77	9.36	..	4.63	4.46	..	..	..	4.94
….RUBBER AND PLASTICS PRODUCTS	25	4.20	9.24	1.57	2.95	5.41	..	..	0.98	0.74	..	3.32	2.95	..	..	..	4.25
OTHER NON-METALLIC MINERAL PRODUCTS	26	1.49	5.46	1.06	0.92	3.16	4.66	..	2.40	5.05	7.47	3.04	3.03	0.91	..	..	2.65
BASIC METALS, METAL PRODUCTS, MACHINER	27-35	4.23	4.58	3.61	1.33	5.00	..	..	3.40	5.13	8.91	2.85	2.31	1.37	..	..	4.34
BASIC METALS AND FABRICATED METAL PROD	27-28	4.59	5.50	2.35	1.33	5.07	..	..	3.29	2.13	7.89	2.09	3.35	..	..	..	1.62
….BASIC METALS	27	7.56	..	4.84	3.77	5.61	..	..	..	-0.25	..	1.48	..	..	..	..	0.97
….FABRICATED METAL PRODUCTS, except mach	28	2.42	..	0.47	0.76	5.46	..	..	..	6.03	..	2.54	..	..	..	..	2.39
MACHINERY AND EQUIPMENT	29-33	5.04	3.61	4.86	1.25	5.46	..	..	2.86	8.23	9.19	3.20	2.20	..	..	..	6.86
….MACHINERY AND EQUIPMENT, N.E.C.	29	4.73	..	0.04	0.21	4.53	..	..	1.03	5.43	6.49	2.29	3.63	..	..	..	..
….ELECTRICAL AND OPTICAL EQUIPMENT	30-33	5.42	..	7.70	3.78	7.61	..	..	5.83	11.69	10.34	3.86	0.84	..	..	..	..
……..OFFICE, ACCOUNTING AND COMPUTING M	30	9.37	..	28.02	13.67	16.98	..	..	..	..	17.05	..	..	..	..	..	..
……..ELECTRICAL MACHINERY AND APPARAT	31	0.85	..	2.02	2.45	6.06	..	..	..	..	7.36	..	..	..	..	..	..
……..RADIO, TELEVISION AND COMMUNICATIO	32	8.81	..	3.11	8.11	9.54	..	..	..	..	11.01	..	..	..	..	..	..
……..MEDICAL, PRECISION AND OPTICAL INST	33	6.12	..	..	0.58	8.65	..	..	..	7.15	6.77	..	..	..	..	..	..
TRANSPORT EQUIPMENT	34-35	-0.34	4.85	4.24	1.35	3.27	3.06	..	5.09	3.68	11.87	3.55	1.24	..	..	..	1.68
….MOTOR VEHICLES, TRAILERS AND SEMI-TRA	34	-1.19	..	5.94	2.15	3.10	2.65	..	..	..	12.09	..	..	..	..	..	1.17
….OTHER TRANSPORT EQUIPMENT	35	1.70	..	0.99	1.56	3.09	3.87	..	..	..	9.47	..	..	..	..	..	2.18
MANUFACTURING NEC; RECYCLING	36-37	4.13	1.76	-0.53	1.69	3.75	..	..	-0.81	3.30	9.08	1.58	0.26	..	..	..	3.35

Annex Table 3. **Labour productivity growth by industry, 1980-1990** *(continued)*

		Austria	Belgium	Canada	Denmark	Finland	France	Germany	Italy	Japan	Korea	Nether-lands	Norway	Spain	Sweden	United Kingdom	United States
ELECTRICITY, GAS AND WATER SUPPLY	**40-41**	**2.67**	**..**	**-0.48**	**1.32**	**3.66**	**5.14**	**..**	**-0.23**	**1.53**	**10.21**	**1.21**	**0.65**	**3.40**	**4.16**	**4.77**	**1.30**
CONSTRUCTION	**45**	**1.24**	**1.87**	**0.50**	**1.37**	**1.01**	**2.36**	**..**	**2.25**	**2.95**	**5.31**	**2.31**	**2.03**	**2.58**	**1.67**	**2.27**	**-0.22**
TOTAL SERVICES	**50-99**	**1.32**	**0.88**	**0.34**	**0.88**	**1.62**	**1.61**	**..**	**0.14**	**2.39**	**2.90**	**..**	**0.62**	**0.29**	**0.89**	**0.93**	**0.61**
BUSINESS SECTOR SERVICES	**50-74**	**2.18**	**1.48**	**0.44**	**1.29**	**2.35**	**2.02**	**..**	**0.62**	**4.44**	**4.69**	**..**	**1.13**	**0.74**	**0.95**	**1.33**	**0.75**
WHOLESALE AND RETAIL TRADE; RESTAUR	**50-55**	**1.87**	**-0.28**	**0.52**	**0.73**	**2.59**	**2.45**	**..**	**0.13**	**3.90**	**5.55**	**1.77**	**0.72**	**0.38**	**..**	**1.95**	**1.77**
WHOLESALE AND RETAIL TRADE; REPAIRS	50-52	2.55	-0.35	1.28	0.89	2.75	3.73	..	0.64	3.90	..	..	2.05	0.14	2.24	..	1.86
HOTELS AND RESTAURANTS	55	0.01	1.06	-2.28	-0.12	1.81	-3.02	..	-1.90	..	..	..	-6.07	0.26	..	..	-0.30
TRANSPORT AND STORAGE AND COMMUNIC	**60-64**	**2.58**	**3.31**	**2.32**	**2.73**	**2.88**	**4.05**	**..**	**3.18**	**3.77**	**3.97**	**..**	**3.02**	**2.73**	**..**	**3.27**	**1.72**
TRANSPORT AND STORAGE	60-63	1.96	3.15	1.62	2.38	2.29	2.63	..	2.56	2.87	..	..	..	2.54	..	..	1.63
POST AND TELECOMMUNICATIONS	64.00	4.20	3.96	3.08	3.85	5.92	6.77	..	6.18	7.96	..	..	..	2.27	..	..	2.10
FINANCE, INSURANCE, REAL ESTATE AND BU	**65-74**	**1.42**	**1.01**	**-0.92**	**0.29**	**0.44**	**0.36**	**..**	**-2.23**	**4.09**	**-0.35**	**..**	**-1.14**	**-0.22**	**-1.94**	**-0.63**	**-1.19**
FINANCIAL INTERMEDIATION	65-67	2.36	..	..	2.63	4.72	3.58	..	0.32	6.51	..	..	..	3.58	1.55	..	-1.06
....FINANCIAL INTERMEDIATION except insurance	65.00	2.86	..	..	1.70	4.60	5.17	..	..	..	..	..	..	..	..	..	-0.31
….INSURANCE AND PENSION FUNDING, except c	66.00	2.25	..	..	4.96	5.95	..	..	..	..	..	..	..	..	..	..	-5.13
….ACTIVITIES RELATED TO FINANCIAL INTERM	67.00	-8.99	..	..	10.10	..	..	..	..	..	..	..	..	..	..	..	1.08
REAL ESTATE, RENTING AND BUSINESS ACTIV	70-74	0.70	..	..	-0.64	-1.35	-0.69	..	-3.73	3.04	..	..	..	-2.68	-3.00	..	-1.65
….REAL ESTATE ACTIVITIES	70.00	3.06	..	..	-2.88	1.96	-1.51	..	..	-0.64	..	..	..	-1.06	..	..	0.76
….RENTING OF M&EQ AND OTHER BUSINESS A	71-74	1.16	..	..	2.36	-1.37	-0.24	..	..	6.77	..	..	..	-1.28	..	..	-0.31
……..RENTING OF MACHINERY AND EQUIPMEN	71.00	7.78	..	..	-13.45	-2.41	..	..	..	..	..	..	..	..	..	..	..
……..COMPUTER AND RELATED ACTIVITIES	72.00	1.52	..	..	5.07	-1.47	..	..	..	..	..	..	..	..	..	..	..
……..RESEARCH AND DEVELOPMENT	73.00	-3.67	..	..	1.31	1.07	..	..	..	..	..	..	..	..	..	..	..
……..OTHER BUSINESS ACTIVITIES	74.00	0.37	..	..	3.31	-1.30	..	..	..	..	..	..	..	..	..	..	..
COMMUNITY SOCIAL AND PERSONAL SERVI	**75-99**	**-0.19**	**0.02**	**0.07**	**0.29**	**0.52**	**0.77**	**..**	**-0.90**	**-0.71**	**-0.33**	**..**	**0.11**	**-0.05**	**0.42**	**0.05**	**0.05**
PUBLIC ADMIN. AND DEFENCE; COMPULSORY	75.00	1.07	..	2.85	0.24	0.84	1.24	..	1.77	1.82	..	..	0.34	0.07	..	..	0.60
EDUCATION	80.00	-0.77	..	-1.27	0.28	-0.06	-0.60	..	-1.23	1.44	..	..	0.06	0.28	..	..	-0.49
HEALTH AND SOCIAL WORK	85.00	-0.48	..	-0.75	-0.09	0.56	1.45	..	-0.15	2.39	..	..	-0.03	0.04	..	..	-1.78
OTHER COMMUNITY, SOCIAL AND PERSONAL S	90-93	-1.03	..	0.23	1.68	0.71	0.16	..	-1.81	-1.65	..	..	0.60	-0.62	..	..	0.88
PRIVATE HOUSEHOLDS WITH EMPLOYED PERS	95.00	4.08	..	..	-0.94	-0.63	..	..	-7.42	..	..	..	..	..	..	..	2.75

Source : OECD STAN Database, 2002.

Annex Table 4. **Time series available for labour productivity growth by industry**

		Austria	Belgium	Canada	Denmark	Finland	France	Germany	Italy	Japan	Korea	Nether-lands	Norway	Spain	Sweden	United Kingdom	United States
GRAND TOTAL	**01-99**	**76-'00**	**70-'01**	**70-'99**	**70-'00**	**70-'01**	**78-'99**	**91-'01**	**70-'01**	**70-'98**	**70-'99**	**70-'00**	**70-'01**	**80-'00**	**80-'99**	**71-'99**	**77-'00**
AGRICULTURE, HUNTING, FORESTRY AND FI	**01-05**	**76-'00**	**70-'00**	**70-'99**	**70-'00**	**70-'01**	**78-'99**	**91-'01**	**70-'01**	**70-'98**	**70-'99**	**70-'00**	**70-'01**	**80-'00**	**80-'99**	**71-'99**	**77-'00**
MINING AND QUARRYING	**10-14**	**76-'00**	**75-'00**	**70-'99**	**70-'00**	**70-'01**	**78-'99**	**91-'01**	**70-'01**	**70-'98**	**70-'99**	**70-'00**	**70-'01**	**80-'99**	**80-'99**	**71-'99**	**77-'00**
TOTAL MANUFACTURING	**15-37**	**76-'00**	**70-'00**	**70-'99**	**70-'00**	**70-'01**	**78-'99**	**91-'01**	**70-'01**	**70-'98**	**70-'99**	**70-'00**	**70-'01**	**80-'99**	**80-'99**	**71-'99**	**77-'00**
FOOD PRODUCTS, BEVERAGES & TOBACCO	15-16	76-'00	70-'00	70-'96	70-'00	70-'01	78-'99	91-'00	70-'01	70-'98	70-'98	70-'00	70-'01	86-'99	93-'99	n.a.	77-'00
TEXTILES, TEXTILE PRODUCTS, LEATHER & FO	17-19	76-'00	70-'00	70-'96	70-'00	70-'01	78-'99	91-'00	70-'01	70-'98	70-'98	70-'00	70-'01	86-'99	93-'99	n.a.	77-'00
….TEXTILES & TEXTILE PRODUCTS	17-18	76-'00	80-'00	70-'96	70-'00	75-'01	91-'99	91-'00	70-'01	80-'98	n.a.	80-'96	80-'97	95-'99	n.a.	n.a.	77-'00
….LEATHER, LEATHER PRODUCTS & FOOTWEA	19.00	76-'00	80-'00	70-'96	70-'00	75-'01	91-'99	91-'00	70-'01	80-'98	n.a.	80-'96	80-'97	80-'99	n.a.	n.a.	77-'00
WOOD & PRODUCTS OF WOOD & CORK	20	76-'00	70-'00	70-'96	70-'00	70-'01	91-'99	91-'00	70-'01	70-'98	70-'98	70-'99	70-'01	80-'99	93-'99	n.a.	77-'00
PULP, PAPER, PAPER PRODUCTS, PRINTING & P	21-22	76-'00	70-'00	70-'96	70-'00	70-'01	91-'99	91-'00	70-'01	70-'98	70-'98	70-'00	70-'01	86-'99	93-'99	n.a.	77-'00
….PULP, PAPER & PAPER PRODUCTS	21.00	76-'00	n.a.	70-'96	70-'00	75-'01	91-'99	91-'00	92-'01	70-'98	80-'98	70-'00	91-'01	95-'98	93-'99	n.a.	77-'00
….PRINTING & PUBLISHING	22.00	76-'00	n.a.	70-'96	70-'00	75-'01	78-'99	91-'00	92-'01	80-'98	80-'98	70-'00	91-'01	95-'98	93-'99	n.a.	77-'00
CHEMICAL, RUBBER, PLASTICS & FUEL PRODU	23-25	76-'00	70-'00	70-'96	70-'00	70-'01	78-'99	91-'00	70-'01	70-'98	70-'98	70-'00	70-'97	86-'99	93-'99	n.a.	77-'00
….COKE, REFINED PETROLEUM PRODUCTS & N	23	76-'00	80-'00	70-'96	70-'00	75-'01	78-'99	91-'00	70-'01	70-'98	n.a.	80-'00	80-'97	95-'99	93-'99	n.a.	77-'00
….CHEMICALS & CHEMICAL PRODUCTS	24	76-'00	80-'00	70-'96	70-'00	75-'01	91-'99	91-'00	70-'01	70-'98	n.a.	80-'00	80-'97	95-'99	93-'99	n.a.	77-'00
….RUBBER & PLASTICS PRODUCTS	25	76-'00	80-'00	70-'96	70-'00	75-'01	91-'99	91-'00	70-'01	80-'98	n.a.	80-'00	80-'97	95-'99	93-'99	n.a.	77-'00
OTHER NON-METALLIC MINERAL PRODUCTS	26	76-'00	70-'00	70-'96	70-'00	70-'01	78-'99	91-'00	70-'01	70-'98	70-'98	70-'99	70-'97	86-'99	93-'99	n.a.	77-'00
BASIC METALS, METAL PRODUCTS, MACHINER	27-35	76-'00	70-'00	70-'96	70-'00	70-'01	91-'99	91-'00	70-'01	70-'98	70-'98	70-'00	70-'01	86-'99	93-'99	n.a.	77-'00
BASIC METALS & FABRICATED METAL PRODUC	27-28	76-'00	70-'00	70-'96	70-'00	70-'01	91-'99	91-'00	70-'01	70-'98	70-'98	70-'00	70-'97	95-'99	93-'99	n.a.	77-'00
….BASIC METALS	27	76-'00	n.a.	70-'96	70-'00	75-'01	91-'99	91-'00	92-'01	70-'98	n.a.	80-'00	91-'01	95-'98	93-'99	n.a.	77-'00
….FABRICATED METAL PRODUCTS, except mach	28	76-'00	n.a.	70-'96	70-'00	75-'01	91-'99	91-'00	92-'01	70-'98	n.a.	80-'00	n.a.	95-'98	93-'99	n.a.	77-'00
MACHINERY & EQUIPMENT	29-33	76-'00	70-'00	70-'96	70-'00	70-'01	91-'99	91-'00	70-'01	70-'98	70-'98	70-'00	70-'97	95-'99	93-'99	n.a.	77-'00
….MACHINERY & EQUIPMENT, N.E.C.	29	76-'00	95-'00	70-'96	70-'00	75-'01	91-'99	91-'00	70-'01	70-'98	80-'98	80-'00	80-'97	95-'99	93-'99	n.a.	n.a.
….ELECTRICAL & OPTICAL EQUIPMENT	30-33	76-'00	95-'00	70-'96	70-'00	75-'01	91-'99	91-'00	70-'01	70-'98	80-'98	80-'00	80-'97	95-'99	93-'99	n.a.	n.a.
……..OFFICE, ACCOUNTING & COMPUTING MA	30	76-'00	n.a.	70-'96	70-'00	75-'01	91-'99	91-'00	92-'01	n.a.	80-'98	n.a.	n.a.	95-'98	93-'99	n.a.	n.a.
……..ELECTRICAL MACHINERY & APPARATUS,	31	76-'00	n.a.	70-'96	70-'00	75-'01	91-'99	91-'00	n.a.	n.a.	80-'98	n.a.	n.a.	95-'98	93-'99	n.a.	n.a.
……..RADIO, TELEVISION & COMMUNICATION	32	76-'00	n.a.	70-'96	70-'00	75-'01	91-'99	91-'00	n.a.	n.a.	80-'98	n.a.	n.a.	95-'98	93-'99	n.a.	n.a.
……..MEDICAL, PRECISION & OPTICAL INSTRU	33	76-'00	n.a.	n.a.	70-'00	75-'01	91-'99	91-'00	92-'01	70-'98	80-'98	n.a.	n.a.	95-'98	93-'99	n.a.	87-'00
TRANSPORT EQUIPMENT	34-35	76-'00	70-'00	70-'96	70-'00	70-'01	78-'99	91-'00	70-'01	70-'98	70-'98	70-'00	70-'97	95-'99	93-'99	n.a.	77-'00
….MOTOR VEHICLES, TRAILERS & SEMI-TRAIL	34	76-'00	n.a.	70-'96	70-'00	75-'01	78-'99	91-'00	92-'01	n.a.	80-'97	n.a.	n.a.	95-'98	93-'99	n.a.	77-'00
….OTHER TRANSPORT EQUIPMENT	35	76-'00	n.a.	70-'96	70-'00	75-'01	78-'99	91-'00	92-'01	n.a.	80-'97	n.a.	n.a.	95-'98	93-'99	n.a.	77-'00
MANUFACTURING NEC; RECYCLING	36-37	76-'00	70-'00	70-'96	70-'00	70-'01	91-'99	91-'00	70-'01	70-'98	70-'98	70-'99	70-'01	95-'99	93-'99	n.a.	77-'00

Annex Table 4. **Time series available for labour productivity growth by industry** *(continued)*

		Austria	Belgium	Canada	Denmark	Finland	France	Germany	Italy	Japan	Korea	Nether-lands	Norway	Spain	Sweden	United Kingdom	United States
TOTAL SERVICES	**50-99**	**76-'00**	**70-'00**	**70-'99**	**70-'00**	**70-'01**	**78-'99**	**91-'00**	**70-'01**	**70-'98**	**70-'99**	**87-'00**	**70-'01**	**80-'99**	**80-'99**	**71-'99**	**77-'00**
BUSINESS SECTOR SERVICES	**50-74**	**76-'00**	**70-'00**	**70-'99**	**70-'00**	**70-'01**	**78-'99**	**91-'00**	**70-'01**	**70-'98**	**70-'99**	**87-'00**	**70-'01**	**80-'99**	**80-'99**	**71-'99**	**77-'00**
WHOLESALE & RETAIL TRADE; RESTAURAN	**50-55**	**76-'00**	**70-'00**	**70-'99**	**70-'00**	**70-'01**	**78-'99**	**91-'01**	**70-'01**	**70-'98**	**70-'99**	**70-'00**	**70-'01**	**80-'99**	**93-'99**	**71-'99**	**77-'00**
WHOLESALE & RETAIL TRADE; REPAIRS	**50-52**	**76-'00**	**80-'00**	**70-'99**	**70-'00**	**75-'01**	**78-'99**	**91-'01**	**70-'01**	**70-'98**	**92-'99**	**87-'00**	**80-'01**	**80-'99**	**80-'99**	**n.a.**	**77-'00**
HOTELS & RESTAURANTS	**55**	**76-'00**	**80-'00**	**70-'99**	**70-'00**	**75-'01**	**78-'99**	**91-'01**	**70-'01**	**n.a.**	**92-'99**	**87-'00**	**80-'01**	**80-'99**	**93-'99**	**n.a.**	**77-'00**
TRANSPORT & STORAGE & COMMUNICATIO	**60-64**	**76-'00**	**70-'00**	**70-'99**	**70-'00**	**70-'01**	**78-'99**	**91-'01**	**70-'01**	**70-'98**	**70-'99**	**70-'00**	**70-'01**	**80-'99**	**93-'99**	**71-'99**	**77-'00**
TRANSPORT & STORAGE	60-63	76-'00	80-'00	70-'99	70-'00	75-'01	78-'99	91-'00	80-'01	81-'98	n.a.	87-'00	91-'01	80-'98	93-'99	n.a.	77-'00
POST & TELECOMMUNICATIONS	64.00	76-'00	80-'00	70-'99	70-'00	75-'01	78-'99	91-'00	80-'01	81-'98	n.a.	87-'00	91-'01	80-'98	93-'99	n.a.	77-'00
FINANCE, INSURANCE, REAL ESTATE & BUSI	**65-74**	**76-'00**	**70-'00**	**70-'99**	**70-'00**	**70-'01**	**78-'99**	**91-'01**	**70-'01**	**81-'98**	**70-'99**	**87-'00**	**70-'01**	**80-'99**	**80-'99**	**71-'99**	**77-'00**
FINANCIAL INTERMEDIATION	65-67	76-'00	95-'00	n.a.	70-'00	70-'01	78-'99	91-'01	70-'01	70-'98	92-'99	87-'00	91-'01	80-'99	80-'99	n.a.	77-'00
....FINANCIAL INTERMEDIATION except insurance	65.00	76-'00	n.a.	n.a.	70-'00	75-'01	78-'99	91-'00	92-'01	n.a.	n.a.	95-'00	n.a.	95-'98	n.a.	n.a.	77-'00
….INSURANCE & PENSION FUNDING, except com	66.00	76-'00	n.a.	n.a.	70-'00	75-'01	91-'99	91-'00	92-'01	n.a.	n.a.	95-'00	n.a.	95-'98	n.a.	n.a.	77-'00
….ACTIVITIES RELATED TO FINANCIAL INTERM	67.00	76-'00	n.a.	n.a.	70-'00	75-'01	91-'99	91-'00	92-'01	n.a.	n.a.	95-'00	n.a.	95-'98	n.a.	n.a.	77-'00
REAL ESTATE, RENTING & BUSINESS ACTIVITI	70-74	76-'00	95-'00	n.a.	70-'00	75-'01	78-'99	91-'01	70-'01	81-'98	92-'99	87-'00	91-'01	80-'99	80-'99	n.a.	77-'00
….REAL ESTATE ACTIVITIES	70.00	76-'00	n.a.	n.a.	70-'00	75-'01	78-'99	91-'00	92-'01	70-'98	n.a.	95-'00	91-'01	80-'98	93-'99	n.a.	77-'00
….RENTING OF M&EQ & OTHER BUSINESS ACT	71-74	76-'00	n.a.	n.a.	70-'00	75-'01	91-'99	91-'00	92-'01	81-'98	n.a.	95-'00	91-'01	80-'98	93-'99	n.a.	77-'00
……..RENTING OF MACHINERY & EQUIPMENT	71.00	76-'00	n.a.	n.a.	70-'00	75-'01	91-'99	91-'00	n.a.	n.a.	n.a.	95-'00	n.a.	95-'98	93-'99	n.a.	n.a.
……..COMPUTER & RELATED ACTIVITIES	72.00	76-'00	n.a.	n.a.	70-'00	75-'01	91-'99	91-'00	92-'01	n.a.	n.a.	95-'00	n.a.	95-'98	93-'99	n.a.	n.a.
……..RESEARCH & DEVELOPMENT	73.00	76-'00	n.a.	n.a.	70-'00	75-'01	91-'99	91-'00	n.a.	n.a.	n.a.	95-'00	n.a.	95-'98	n.a.	n.a.	n.a.
……..OTHER BUSINESS ACTIVITIES	74.00	76-'00	n.a.	n.a.	70-'00	75-'01	91-'99	91-'00	92-'01	n.a.	n.a.	95-'00	n.a.	95-'98	93-'99	n.a.	n.a.
COMMUNITY SOCIAL & PERSONAL SERVICE	**75-99**	**76-'00**	**70-'00**	**70-'99**	**70-'00**	**70-'01**	**78-'99**	**91-'01**	**70-'01**	**81-'98**	**70-'99**	**87-'00**	**70-'01**	**80-'99**	**80-'99**	**71-'99**	**77-'00**
PUBLIC ADMIN. & DEFENCE; COMPULSORY SO	75.00	76-'00	95-'00	70-'96	70-'00	75-'01	78-'99	91-'01	70-'01	70-'98	92-'99	95-'00	80-'97	85-'99	n.a.	n.a.	77-'00
EDUCATION	80.00	76-'00	95-'00	70-'96	70-'00	75-'01	78-'99	91-'01	70-'01	81-'98	92-'99	95-'99	80-'97	85-'99	n.a.	n.a.	77-'00
HEALTH & SOCIAL WORK	85.00	76-'00	95-'00	70-'96	70-'00	75-'01	78-'99	91-'01	70-'01	81-'98	92-'99	95-'00	80-'97	85-'99	n.a.	n.a.	77-'00
OTHER COMMUNITY, SOCIAL & PERSONAL SER	90-93	76-'00	95-'00	70-'96	70-'00	75-'01	78-'99	91-'01	70-'01	81-'98	92-'99	95-'99	80-'97	85-'99	n.a.	n.a.	77-'00
PRIVATE HOUSEHOLDS WITH EMPLOYED PERS	95.00	76-'00	95-'00	70-'96	70-'00	75-'01	n.a.	91-'01	70-'01	n.a.	92-'99	95-'00	n.a.	n.a.	n.a.	n.a.	77-'00
EXTRA-TERRITORIAL ORGANIZATIONS & BODI	99.00	n.a.	n.a.	70-'96	n.a.	75-'01	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Source : OECD STAN Database, 2002.

Annex Table 5. **Overview of methods used in OECD countries for computation of constant price value added**

	Double indicators			Single Indicators											Other
				Output Related			Input Related								
	Double de-flation	Double extra-polation	Extrapo-lation/ De-flation	Defl. Value Added	Extrapolated Value Added		Deflated Value Added		Extrapolated Value Added						
					Volume	Physical Quantity	Interme-diate Cons. Price	Wage rate	Interme-diate Cons. Volume	Defl Wage bill	Input Physical Quantity	Number em-ployed	Hours worked		
Industries															
WHOLESALE & RETA 50-55															
WHOLESALE & RETAIL TRADE; REPAIRS 50-52	US, JA, FR, IT, DE, FI, NE, NO, CA		SE, FR (51, 52)	UK, AU, IC, PO	GE, LU, SP, NZ, SW, AL, NZ	AL, UK, NZ						PO			BE, IR, SE, TU
HOTELS & RESTAURAN 55	US, JA, GE, FR, IT, CA, DE, FI, NE, NO, SE			UK, AU, BE, IC, TU	LU, NZ, AL,	AU, SP, SW, AL						SP, IR (restau-rants)			IR
TRANSPORT & STORA60-64															
TRANSPORT & STORAG60-63	JA, GE, IT, CA, DE, NE, NO, SP, SE	NO(rail), BE (air)	US, FR, NO, SE, SP, CA	AU, FI, IC, TU, NZ	UK, LU, AL, NZ	UK, AU, BE, FI, IR, LU, PO, SP, SW, AL, NZ					IR	FI, US (sea & air)			TU, AL
POST & TELECOMMUN 64	GE, IT, AU, NE, SE; US, JA, DE, NO, SP (ICT)		FR, CA (CT)	IC, TU, BE; FI (CT)	AL, FI, SP, UK(ICT)	IR, LU, PO, AL, NZ (all ICT)		BE (Radio)			IR (priv)				

Annex Table 5. **Overview of methods used in OECD countries for computation of constant price value added** *(continued)*

		Double indicators			Single Indicators										Other
					Output Related			Input Related							
		Double de-flation	Double extra-polation	Extrapo-lation/ De-flation	Defl. Value Added	Extrapolated Value Added		Deflated Value Added		Extrapolated Value Added					
						Volume	Physical Quantity	Interm Cons. Price	Wage rate	Interm Cons. Volume	Defl Wage bill	Input Physical Quantity	Number em-ployed	Hours worked	
FINANCIAL INTERMED	65-67														
FINANCIAL INTERMEDIATION ex insurance	65	JA, GE, FR, IT, CA, DE, FI		LU, NO	BE, SP, PO	UK, AU, IR, LU, SW, NZ	UK			NE	IC, NE		US, UK, IC, TU	SE, AL	
INSURANCE & PENSION FUNDING,	66	US, JA, GE, FR, IT, CA, DE, FI		NO	UK, BE, SP; AU (non-life)	IR, SW, NZ; UK (non-life)	AU, IR (life), LU(non-			NE	IC, NE		IC, TU	SE, AL	
ACTIVITIES REL TO FIN. INT.	67	US (funds), JA, GE, FR, CA		US(securit y brokers)	AU, BE	UK, LU, NZ	UK			NE	IC, NE		US (holding), IC, TU	SE, AL	IR
REAL ESTATE, RENTIN	70-74														
REAL ESTATE ACTIVIT	70	US, GE, FR, IT, CA, AU, DE, NE, NO, SP		FI, SE	US, TU (dwell); BE, AU, IC (other)	UK, IC, IR, LU, Al, NZ	NZ				SW		UK, AL (others)		BE; UK, IR, TU (others)
RENTING OF M&EQ & O	71-74														
RENTING OF MACHINERY & EQUIPMENT	71	US, JA, GE, FR, IT, CA, FI, NE, NO, SE		SE	BE, IC, PO	UK, AU, LU	AU,						SP, NZ	AL, NZ	IR
COMPUTER & RELATED ACTIVITIES	72	JA, GE, FR, IT, CA, DE, FI, NO, SE			BE, IC, PO	UK, LU			NE				US, Au, IC, SP, NZ	AL,	IR
RESEARCH & DEVELOP	73	JA, GE, FR, IT, CA, FI		SE	BE	LU			US, NE				UK, AU, SP, NZ		IR
OTHER BUSINESS ACTI	74	JA, CA, GE, FR, IT, SE; US (legal)			BE, IC	LU			US, NE		SW		AU, SP, NZ; UK, IC, IR	AL,	IR, TU

Annex Table 5. **Overview of methods used in OECD countries for computation of constant price value added** *(continued)*

		Double indicators			Single Indicators: Output Related			Single Indicators: Input Related							Other
		Double deflation	Double extrapolation	Extrapolation/ Deflation	Defl. Value Added	Extrapolated Value Added		Deflated Value Added		Extrapolated Value Added					
						Volume	Physical Quantity	Intermediate Cons. Price	Wage rate	Intermediate Cons. Volume	Defl Wage bill	Input Physical Quantity	Number employed	Hours worked	
Industries															
COMMUNITY SOCIAL	**75-99**														
PUBLIC ADMIN. & DEFENCE;	75														
EDUCATION	80	US, JA, GE, FR, IT, CA, DE, NO, SE			BE; AU, SP (other edu)		SP		NE (other edu)		AL		UK, LU	AL	IR, NZ
HEALTH & SOCIAL WORK	85	US, JA, GE, FR, IT, CA, BE, DE, FI, NE, NO, SE, SP		NO (doctors), SE (priv)	AU, BE, IC	BE, LU, NZ; FI(vet)	NZ	NE	NE	AL	AL, SW		UK, AU, IC, IR, NZ	AL	SE
OTHER COMMUNITY, SOCIAL & PERSONAL SERVICES	90-93	US, JA, GE, FR, DE, FI, NO, SE; IT, CA, SP (cult all); NE (cultdis)	NO (Cult all)		AU, LU; BE, US (cultdis)	UK, FI, AL (all cult); AU, IR (cultdis)	AL (waste etc), FI (cultdis)		NE (waste etc.), US (cultdis)				UK, SP (waste etc); AU, NE, IC, IR (cultdis)		IR

1. The methods shown here only comprise market services. Non-Market Services are mainly measured by labour-input methods such as numbers employed and wage rates.
2. Countries may appear in two places. This is due to different methods used in sub-groups of industries.
3. Methods might have changed during recent years.

Source: OECD (1996).

ANNEX B – METHODOLOGICAL NOTES

B.1. Formal description of methods used to compute constant price value added

The following methods have been used within the analysis to calculate constant price value added:[34]

1) Double deflation

Current price series of gross output and of intermediate consumption are deflated using the respective price indices. Constant price value added is then attained as the residual.

This can be written as: $$VAR_t = \frac{Y_t}{IPY_t} - \frac{C_t}{IPC_t}, \qquad (1)$$

with: VAR_t := constant price value added in year t, Y_t := current price gross output in year t, IPY_t := price index of gross output in year t, C_t := current price intermediate consumption in year t, and IPC_t := price index of intermediate consumption in year t.

2) Double extrapolation:

Base year values of gross output and of intermediate consumption are extrapolated using the respective volume indices. Constant price value added is then attained as the residual.[35]

This can be written as: $$VAR_t = Y_0 IVY_t - C_0 IVC_t, \qquad (2)$$

with: VAR_t := constant price value added in year t, Y_0 := current price gross output of the base year, IVY_t := volume index of gross output in year t, C_0 := current price intermediate consumption of the base year, IVC_t := volume index of intermediate consumption in year t.

3) Extrapolation/deflation:

Constant price value added is derived by subtracting a deflated series of intermediate consumption, using a respective price index, from an extrapolated time series of base year estimates of gross output, using output volume indices.[36]

This can be written as: $$VAR_t = Y_0 IVY_t - \frac{C_t}{IPC_t}, \qquad (3)$$

with: VAR_t := constant price value added in year t, Y_0 := current price gross output of the base year, IVY_t := volume index of gross output in year t, C_t := current price intermediate consumption in year t, IPC_t := price index of intermediate consumption in year t.

34. These methods are taken from OECD (1997).

35. Since the actual constant price value-added in the case of Denmark has been calculated on the base of double deflation, and since we used for comparability reasons also 1995 as the base year, the resulting value added time series and consequently the compound growth rates are identical to the actual values.

36. As in the case of double extrapolation, this is more for illustration since the resulting constant price value added series is identical to the actual one.

4) Direct deflation of value added using gross output price index:

This can be written as: $$VAR_t = \frac{VAC_t}{IPY_t}, \quad (4)$$

with: VAR_t := constant price value added in year t, VAC_t := current price value added in year t, IPY_t := price index of gross output in year t.

5) Direct extrapolation of value added using gross output volume index:

This can be written as: $$VAR_t = VA_0 IVY_t, \quad (5)$$

with: VAR_t := constant price value added in year t, VA_0 := current price value added in the base year, IVY_t := volume index of gross output in year t.

6) Direct deflation of value added using a price index of intermediate consumption:

This can be written as: $$VAR_t = \frac{VAC_t}{IPC_t} \quad (6)$$

with: VAR_t := constant price value added in year t, VAC_t := current price value added in year t, IPC_t := price index of intermediate goods in year t.

7) Direct deflation of value added using a wage rate index:

This can be written as: $$VAR_t = \frac{VAC_t}{IW_t}, \quad (7)$$

with: VAR_t := constant price value added in year t, VAC_t := current price value added in year t, IW_t := wage rate index in year t.

8) Direct extrapolation of value added using an index of compensation of employees that is deflated by a wage rate index:

This can be written as: $$VAR_t = VA_0 \cdot \frac{SAL_t}{IW_t}, \quad (8)$$

with: VAR_t := constant price value added in year t, VA_0 := value added of the base year, SAL_t := index of employee compensation in year t, IW_t := wage rate index in year t.

9 and 10) Direct extrapolation of value added using an index of employment or employees:

This can be written as: $VAR_t = VA_0 IN_t$, or $VAR_t = VA_0 INE_t$, (9, 10)

with: VAR_t := constant price value added in year t, VA_0 := current price value added of the base year, IN_t := index of employment in year t, INE_t := index of employees in year t.

B.2. Calculating the effect of measurement bias on aggregate productivity growth

The role of measurement bias for aggregate productivity growth is examined by asking what would happen if negative productivity growth rates of services were set to zero. In general, the simulation is divided into three steps. The first step consists of deriving the change in output that would have occurred if negative productivity growth rates were set to zero. The second step consists of estimating the effect of this percentage change in gross output on growth of intermediate inputs for the other industries, using input-output-tables. The final step is to calculate the simulated growth rates of value added and productivity growth per industry and for the whole economy.

For present purposes, the simulation is based on the following general relationships between growth of labour productivity growth, value added, output and intermediate inputs. First, a percentage change in labour productivity growth is defined as the volume change of value added (*dlnVA/dt*) minus the change in employment (*dlnL/dt*):

$$\frac{d\ln LP}{dt} = \frac{d\ln VA}{dt} - \frac{d\ln L}{dt}. \qquad (1)$$

Second, the volume change in value added is defined as the weighted difference of the volume change in gross output (*dlnQ/dt*) and the weighted volume change in intermediate inputs (*dlnM/dt*); the weights are given as the share of intermediate inputs (s_M) and the inverse share of current price value added on gross output ($1/s_{VA}$). The change in volume change of value added can thus be written as:

$$\frac{d\ln VA}{dt} = \frac{1}{s_{VA}}\left(\frac{d\ln Q}{dt} - s_M \frac{d\ln M}{dt}\right). \qquad (2)$$

This implies that, in general, a change in output growth of an individual industry i, γ_i, results from a change in the growth rate of value added, ε_i, weighted by the share of value added in output, s_{VA}^i, and a change in the growth rate of intermediate inputs, δ_i, weighted by the share of intermediate inputs in gross output, s_M^i :

$$\left(\frac{d\ln Q}{dt}\right)_i^k + \gamma_i^k = \left(s_{VA}^i\right)^k \cdot \left(\left(\frac{d\ln VA}{dt}\right)_i^k + \varepsilon_i^k\right) + \left(s_M^i\right)^k \cdot \left(\left(\frac{d\ln M}{dt}\right)_i^k + \delta_i^k\right), \; i := 1,\ldots,n, \; k := 1,2. \qquad (3)$$

In this formulation, the subscript *i* denotes an individual industry and the superscript *k* an industry group. There are two groups of industries that have to be distinguished in the simulation and, accordingly, there are two main steps in the simulation of the effect of measurement bias on productivity growth per industry:

Step 1: The first group consists of the service industries for which productivity growth has been set to zero. Since the effect of this adjustment influences the intermediate inputs of the other industries via the growth of output, the simulation must start with calculating the change in output growth of the adjusted service industries. This uses equations (1) to (3) where *k* becomes 1, indicating the first group of industries.

Due to data constraints, some assumptions have to be made, though:

1. Measurement bias is assumed to result from a bias in measuring production and value added, not from a bias in the measurement of employment.

2. Measurement bias in gross output is assumed to result from measurement bias in value added, not intermediate inputs.[37] This assumption is needed so as not to shift the measurement problem itself to other industries via intermediate inputs.

3. Measurement bias is assumed to concern the growth rate of value added only, not the level of current price value added.

4. Measurement bias is assumed to prevail only in time *t*, not in the base period. The true measurement bias of each year's output – which leads to an under-estimated productivity growth rate – is not known. At the same time, the necessary information concerning the change in output in the thought experiment concerns only the *change* in the growth rate of output or value added.

Under these assumptions, setting productivity growth of an individual service industry of industry group 1 equal to zero changes its growth rate of value added by ε_i^1. Since, for this group, intermediate inputs are assumed to stay constant, δ_i^1 is zero. The change in growth of value added translates thus into a change in output growth of each adjusted service industry as $\gamma_i^1 = \left(s_{VA}^i\right)^1 \cdot \varepsilon_i^1$. (4)

Step 2: The second group consists of industries that use the services for which productivity growth has been set to zero as intermediate inputs. Through input-output tables, it is possible to examine how a change in the growth rate of gross output of each adjusted service industry affects growth of intermediate inputs for the service using industries. Since for the service using industries, the rate of growth of output is assumed to be constant, γ_j^2 is zero. (For clarity reasons, the subscript indicating an individual industry in the second industry group is denoted as *j*.) The change in the growth of output of the adjusted service industries translates thus into the change of the growth rates of intermediate inputs that are delivered to an individual service using industry, δ_j^2. According to equation (3), this again changes the growth rate of value added of the service using industries by: $\varepsilon_j^2 = -\left(1 / \left(s_{VA}^j\right)^2\right) \cdot \left(s_M^j\right)^2 \cdot \delta_j^2$. (5)

Within equation (5), the change in the growth of intermediate inputs for each service using industry *j*, δ_j^2, results as the weighted sum of the changed growth of intermediate inputs that are produced by the service industries, for which productivity growth has been adjusted, and that are delivered to the service using industry *j*. The change of the growth rate of each individual intermediate input is, thereby, proportional to the change in growth of output of the respective service industry, γ_i^1; the weights are given as the share that each input produced by service industry *i* has in the total of all intermediate inputs that are delivered to the service using industry *j* of industry group 2, $\left(s_M^{ij}\right)^2$: $\delta_j^2 = \sum_i \left[\left(s_M^{ij}\right)^2 \cdot \gamma_i^1\right]$.[38] (6)

37. Since measurement bias in the output of one industry affects value added via intermediate inputs, assuming away the change in gross output from change of growth in intermediates might lead to biased results. Lack of time series on constant price intermediate inputs on a disaggregated level within the STAN Database, however, limits what can be done in this respect.

38. In principle, adjusting the intermediate input flows for the measurement bias may change the weight with which the growth rate of each individual intermediate input enters the growth rate of intermediate inputs per industry. Since, in this paper however, measurement bias is assumed to influence only the growth rate of value added and not its current price level (assumption 3), this effect does not occur.

Step 3 consists of calculating the final effect of measurement bias on the growth rate of value added per industry and for the whole economy. The simulated productivity growth rate per industry is calculated as the difference between the simulated growth of value added and the unchanged growth of employment. Finally, the "simulated" aggregate productivity growth rate is calculated as the weighted sum of growth rates of productivity growth across industries with the current price shares of value added as the weights.

REFERENCES

Baily, M.N. and R. Gordon (1988), "The Productivity Slowdown, Measurement Issues, and the Explosion of Computer Power", *Brookings Papers on Economic Activity*, Vol. 1988, Issue 2 (1988), 347-420.

Baumol, W.J. (1967), "Macroeconomics of Unbalanced Growth: the Anatomy of Urban Crisis", *American Economic Review*, Vol. 57, Issue 3 (Jun. 1967), 415-426.

Baumol, W.J., S.A. Batey Blackman and E. Wolff (1985), "Unbalanced Growth Revisited: Asymptotic Stagnancy and New Evidence", *American Economic Review*, Vol. 75, Issue 4 (Sepember 1985), 806-817.

Berndt, E. R., D.M. Cutler, R. G. Frank, Z. Griliches, J.P. Newhouse and J.E. Triplett (1998), "Price Indexes for Medical Care Goods and Services: an Overview of Measurement Issues", *NBER Working Paper*, No. 6817, Cambridge, MA, November.

Daffin, C., G. Reed, P. Vaze (2002): "Labour Productivity Measures for the Non-Production Industries", *Economics Trends*, No. 579, February 2002.

Dean, E. (1999), "The Accuracy of the BLS Productivity Measures", *Monthly Labor Review*, February 1999.

Eldridge, L. (1999): "How Price Indexes Affect BLS Productivity Measures", *Monthly Labor Review*, February 1999.

Fixler, D.J. and D. Siegel (1999), "Outsourcing and Productivity Growth in Services", *Structural Change and Economic Dynamics*, 10 (1999), 177-194.

Gullickson, W. and M.J. Harper (1999), "Possible Measurement Bias in Aggregate Productivity Growth", *Monthly Labor Review*, February 1999.

Gullickson, W. and M.J. Harper (2002), "Bias in Aggregate Productivity Trends Revisited", *Monthly Labor Review*, March 2002.

Johnston, A., D. Porter, T. Cobbold, R. Dolamore (2000), "Productivity in Australia's Wholesale and Retail Trade", *Productivity Commission Staff Research Paper*, Melbourne, October 2000.

Kendrick, J.W. (1985), "Measurement of Output and Productivity in the Service Sector", in: R.P. Inman (ed.): *Managing the Service Economy, Prospects and Problems*, Cambridge University Press, 1985, pp. 111-133.

Lebow, D.E. and J.B. Rudd (2001), "Measurement Error in the Consumer Price Index: Where Do We Stand?", Board of Governors of the Federal Reserve System, December 2001.

Lum, S.K.S., B.C. Moyer, R. E. Yuskavage (2000), "Improved Estimates of Gross Product by Industry for 1947-98", *Survey of Current Business of the BEA*, June 2000, pp.24-54.

Maclean, D. (1997), "Lagging Productivity Growth in the Service Sector: Mismeasurement, Mismanagement or Misinformation", *Working paper 97-6*, Bank of Canada, March 1997.

McKinsey (2002), *Reaching Higher Productivity Growth in France and Germany*, McKinsey Global Institute, Washington, D.C.

Moulton, B. (2000), "Measurement of Banking Services in the U.S. National Income and Product Accounts: Recent Changes and Outstanding Issues", Bureau of Economic Analysis, May 2000.

OECD (1996), *Measuring Value-Added in Services*, Paris, 1996.

OECD (1999), "A Volume Index for the Output of the Dutch Banking Industry Based on Quantity Indicators, a Pilot Study for the Period 1987-1995", STD/NA(99)21, Paris, 1999.

OECD (2000a), *The Service Economy*, STI Business and Industry Policy Forum Series, Paris, 2000.

OECD (2000b), "Employment in the Service Economy: a Reassessment", in: *OECD Employment Outlook 2000*, pp.79-128.

OECD (2001*a*), *Measuring Productivity – OECD Manual, Measurement of Aggregate and Industry-Level Productivity Growth*, Paris, 2001.

OECD (2001b), "What Services for What Society? How Should the Services Provided by Financial Intermediaries in a Modern Society be Measured?", STD/NA(2001)13, Paris 2001.

OECD (2001c), "The Characteristics and Quality of Service Sector Jobs", in *OECD Employment Outlook 2001*, Chapter 3, pp. 89-128.

OECD (2002a), "Measuring the Production of Financial Corporations, Progress Report by the OECD Task Force on Financial Services (Banking Services) in National Accounts, STD/NA(2002)19, Paris, September 2002.

OECD (2002b), "Report of the OECD Task Force on the Treatment of Non-Life Insurance in the National Accounts and Balance of Payments", STD/NA(2002)6, Paris, October 2002.

OECD (2002c), "Report of the OECD Task Force on Software Measurement in the National Accounts", STD/NA(2002)2, Paris, September 2002.

OECD (2002d), "Lessons from the Software Task Force", STD/NA(2002)3, Paris, September 2002.

OECD (2002e), *Measuring the Information Economy*.

OECD (2003a), "A Reader on Productivity Levels", OECD, Paris, forthcoming.

OECD (2003b), "Structural Change and Labour Productivity Growth", *STI Working Papers*, Paris, forthcoming.

OECD (2003c), Comparing Growth and Labour Productivity in the OECD Area – The Role of Measurement, STI/STD/ELS Working Paper, Paris, forthcoming.

Oulton, N. (1999), “Must the Growth Rate Decline? – Baumol’s Unbalanced Growth Revisited”, Bank of England, London, 1999.

Pike, R. and S. Drew (2002): “Experimental Monthly Index of Services”, *Economic Trends*, No. 583, June 2002.

Pilat, D., F. Lee, B. van Ark (2002), “Production and Use of ICT: A Sectoral Perspective on Productivity Growth in the OECD Area”, *OECD Economic Studies*, forthcoming.

Scarpetta, S., A. Bassanini, D. Pilat and P. Schreyer (2000), “Economic Growth in the OECD Area: Recent Trends at the Aggregate and Sectoral Level”, Economics Department Working Papers, No. 248, Paris, June 2000.

Schreyer, P. (1998), “Information and Communication Technology and the Measurement of Real Output, Final Demand and Productivity”, STI Working Papers 1998/2, Paris, July 1998.

Schreyer, P. (2001), “Computer Price Indices and International Growth and Productivity Comparisons”, Statistics Working Papers, STD/DOC(2001)1, Paris, OECD, April 2001.

Sharpe, A., S. Rao and J. Tang (2002), “Perspectives on Negative Productivity Growth in Service Sector Industries in Canada and the United States”, paper presented at Workshop on Service Sector Productivity, May, 2002, Brookings Institution, Washington, D.C.

Sichel, D.E. (1997), “The Productivity Slowdown: Is a Growing Unmeasurable Sector the Culprit?”, *The Review of Economics and Statistics*, Vol. 79, 3, pp. 367-370.

Slifman, L. and C. Corrado (1996), “Decomposition of Productivity and Unit Costs”, *Occasional Staff Studies*, OSS-1, Federal Reserve Board, Washington, D.C.

Triplett, J.E. and B.P. Bosworth (2000), "Productivity in the Services Sector", paper prepared for the American Economic Association, Brookings Institution, Washington, 2000.

Triplett, J.E. and B.B. Bosworth (2002), “‘Baumol's disease’ Has Been Cured: IT and Multifactor Productivity in U.S. Services Industries”, paper prepared for Brookings Workshop on Services Industry Productivity, Brookings Institution, Washington, D.C., September.

Vijselaar, F.W. (2003), “ICT and Productivity Growth in the Euro Area: Sectoral and Aggregate Perspectives”, forthcoming in the proceedings of the IVIE Workshop on “Growth, Capital Stock and New Technologies”, by the BBVA Foundation.

Yuskavage, R.E. (1999), “Measurement of Business and Professional Services in BEA’s Gross Product Originating Series”, paper prepared for a Workshop on Measuring the Output of Business Services in the Framework of the Brookings Program on Output and Productivity Measurement in the Service Sector, May 1999.