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Mind the gap!
International comparisons of productivity in services and goods production

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Abstract

In this paper, we make a comparison of industry output, inputs and productivity growth and levels between seven advanced economies (Australia, Canada, France, Germany, Netherlands, UK and U.S.). Our industry-level growth accounts go up to 2003, and make use of input data on labour quantity (hours) and quality (schooling levels), and distinguish between six different types of capital assets (including three ICT assets). The comparison of levels relies on multilateral, industry-specific purchasing power parities (PPPs) for output and inputs, within a consistent input-output framework for the year 1997. Our results show that differences in productivity growth and levels can mainly be traced to market services, not to goods-producing industries. Some of the strong productivity growth in market services in Anglo-Saxon countries may be related to relatively low productivity levels compared to the U.S. In contrast, services productivity levels in continental European countries were on par with the U.S. in 1997, but growth in Europe was much weaker since then. In terms of factor input use, the U.S. is very different from all other countries, mostly because of its more intensive use of ICT capital.

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1. *Introduction*

During the second half of the 1990s the comparative growth performance of many OECD countries has undergone a marked change. For the first time since World War II labour productivity growth in most countries that have been part of the European Union (EU) for a decade or more (the EU-15) has fallen behind the U.S. for a considerable length of time. Whereas average annual labour productivity growth in the U.S. accelerated from 1.1 percent during the period 1987-1995 to 2.4 percent during 1995-2005, EU-15 productivity growth declined from 2.3 to 1.4 percent. The downward trend in the EU-15 was rather continuous as growth slowed from 1.8 percent from 1995-2000 to 1.0 percent from 2000-2005. Just like the U.S., various other Anglo-Saxon countries, in particular Canada and Australia, experienced a significant improvement in productivity growth during the late 1990s (2.3 and 1.7 percent from 1995-2000 respectively), but since 2000 productivity in these countries slowed down again to growth rates comparable to the pre-1995 period (1.5 and 1.2 percent in 2000-2005 respectively). In contrast, U.S. productivity accelerated from 2.1 percent in 1995-2000 to 2.6 percent in 2000-2005.[1]

The striking acceleration in U.S. output and productivity growth since the mid 1990s has been much discussed in the literature. The role of information and communication technology (ICT) has been widely addressed (Oliner and Sichel 2000, 2002; Jorgenson and Stiroh 2000; Jorgenson, Ho and Stiroh, 2005; Gordon, 2003, 2004; Triplett and Bosworth, 2004). ICT had an impact on growth through a surge in ICT investment, strong productivity contributions from ICT-producing industries and a more productive use of ICT in the rest of the economy. Notably the market services sector of the U.S. economy seems to have strongly benefited from the increase in ICT use. Unfortunately, there is much less agreement on the reasons for the slower productivity growth in Europe. Compared to the U.S., ICT investment, ICT production and the productive use of ICT in Europe generated less productivity growth during the late 1990s (van Ark et al., 2003a, 2003b; Inklaar et al., 2005). But the reasons for the limited impact of new technology,

[1] Source: Groningen Growth and Development and The Conference Board, Total Economy Database (http://www.ggdc.net/dseries/totecon.shtml).

innovation and structural reforms on economic growth in Europe are still poorly understood. The acceleration and subsequent deceleration in Australia and Canada has also puzzled various scholars (Parham, 2005; Rao et al., 2005). Cyclical slowdown might be one reason, but there may be other reasons related to short term shocks, the innovation system and a possible slowdown in reforms in the labour and product markets.

This paper extends our previous studies in this research field by providing a combined analysis of productivity growth and levels by industry. The major novelty in this paper is the comparison of output, input and productivity levels in a comprehensive framework. Looking at growth and levels together enables one to better understand the differences in contributions of inputs (labour quality, ICT and non-ICT capital) to output performance.

In this paper we focus our analysis on a comparison of seven advanced economies (Australia, Canada, France, Germany, Netherlands, the United Kingdom and the United States). The growth accounts developed for this paper is a bridge between our earlier *60-Industry Database* and *Industry Growth Accounting Database* which we used in O'Mahony and van Ark (2003) and Inklaar et al. (2005) and our new *EU KLEMS Growth and Productivity Database* which will be published in early 2007. The level accounts are entirely new and are elaborated upon in more detail in Inklaar and Timmer (2006) and Timmer, Ypma and van Ark (2006).

While our present growth and level accounting dataset provides detail on 26 industries (of which 25 in the market economy), we focus the discussion in this paper on the comparative performance of three major sectors which constitute the market economy: the ICT production sector, which includes both ICT manufacturing (computer hardware and telecom equipment) and services (communications, software, etc.), 'other goods'-producing industries (excluding ICT producing manufacturing industries included in the first category) and market services (excluding ICT-related services).[2]

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[2] Our main analysis is focused on the market economy, because the measurement of output and productivity in the non-market part of the economy is still very problematic. Also our measures of total economy productivity, aggregated from the industry level, show some deviations from measures that are

In this paper, we show that in the Anglo-Saxon countries (Australia, Canada, UK and U.S.), market services have been contributing more to labour productivity growth since 1995 than before. Only part of the increase in labour productivity growth in market services can be traced to direct contributions from ICT investment. A large part of the acceleration of growth in this sector is due to higher total factor productivity growth. Strikingly, the continental European countries have not experienced this acceleration in TFP growth. Evidence from other studies suggests that this may be related to a more productive use of ICT in Anglo-Saxon economies, although this can be neither confirmed nor rejected on the basis of the industry-level data presented here.

Our comparison of productivity levels for 1997 suggests that TFP levels in goods production are relatively close between countries. In contrast, productivity levels in market services show relatively large gaps for Australia, Canada and the U.K. relative to the U.S., whereas the continental European countries are at or even above the U.S. TFP level in market services. This raises the possibility that the three Anglo-Saxon countries exhibit some kind of catching-up to the U.S. in particular in market services. But it also raises questions concerning the interpretation of the high productivity levels in continental Europe.

The paper proceeds as follows. In Section 2 we outline our basic growth accounting methodology. In Section 3, the data and results of our growth accounts are presented at the level of three major sectors of the economy (ICT production, other goods production and market services). Section 4 briefly introduces our level accounting methodology,[3] followed by results and discussion in Section 5. In the concluding section we summarize our main results, and indicate the areas for future research.

directly based on output and input measures for the total economy, such as published in our earlier work (Timmer and van Ark, 2005).

[3] For a more detailed discussion, see Inklaar and Timmer (2006).

2. Growth accounting methodology[4]

The productivity analysis in this study is rooted in the tradition of national accounting, input-output analysis and growth accounting, as pioneered by – among others – Simon Kuznets, Wassily Leontief, Moses Abramovitz, Robert Solow, Zvi Griliches and Dale Jorgenson. With these techniques macroeconomic and industry-specific measures of output, inputs and productivity can be developed. Broadly speaking, productivity measures can be classified as single factor productivity measures, relating a measure of output to a single measure of input (labour or capital), or as total (or multi-) factor productivity measures, relating a measure of output to a bundle of inputs. Labour productivity is the most widely used single factor productivity measure, and is mostly measured in terms of value added over employment or value added over total working hours. Total factor productivity (TFP) can be measured either as capital-labour TFP, based on a value-added concept of output, or as capital-labour-energy-materials-services TFP (KLEMS).[5] Due to the lack of comparable input-output tables on an annual basis, all measures of productivity are based on value added, and make only a distinction between the contribution of the quantity and quality of labour and capital to value added growth.[6] An important additional feature is the distinction of ICT capital assets (information technology equipment, communication equipment and software) and other types of capital (other non-ICT capital, transport equipment and structures).

To assess the contribution of the various inputs to aggregate growth, a growth accounting framework is applied as developed by Jorgenson and associates and used in, for example, Jorgenson, Ho and Stiroh (2005). For each industry gross value added (*Y*) is produced from an aggregate input *X*, consisting of ICT capital services (K^{ICT}), non-ICT capital services (K^{N}) and labour services (*L*). Productivity is represented as a Hicks-neutral

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[4] This section is largely derived from Inklaar, O'Mahony and Timmer (2005).

[5] See OECD (2001) for a more detailed exposition.

[6] Annual Input-output tables are used in the work for the U.S. by Jorgenson (1995) and his associates, and in a study for Japan, e.g. Jorgenson and Nomura (2005). Such tables are under development for the EU KLEMS project and scheduled for public release by the beginning of 2007. See www.euklems.net for further details.

augmentation of aggregate input (*A*). The industry production function (industry and time subscripts are omitted) takes the following form:[7]

$$Y = A\,X\left(L, K^{N}, K^{ICT}\right) \tag{1}$$

with superscript *N* indicating services from non-ICT capital and superscript *ICT* indicating services from ICT capital. Under the assumption of competitive factor markets, full input utilization and constant returns to scale, the growth of output can be expressed as the (compensation share) weighted growth of inputs and total factor productivity, denoted by *A*, which is derived as a residual:

$$\Delta \ln Y = \bar{v}^{L}\Delta \ln L + \bar{v}^{N}\Delta \ln K^{N} + \bar{v}^{ICT}\Delta \ln K^{ICT} + \Delta \ln A \tag{2}$$

where $\bar{v}^{i}$ denotes the two-period average share of input *i* in total factor income. Imposing constant returns to scale implies $\bar{v}^{L} + \bar{v}^{N} + \bar{v}^{ICT} = 1$. Capital services are defined in (3) as the aggregate of the individual capital stocks weighted by the capital compensation share:

$$\Delta \ln K_{t} = \sum_{j} \bar{v}^{K}_{j,t}\Delta \ln K_{j,t} \tag{3}$$

where $\bar{v}^{K}_{j,t}$ is the two-period average share of asset type *j* in total nominal capital compensation. For our growth accounts we use ICT capital services, which are calculated by weighting each of the ICT capital stocks by the share of the asset in total ICT capital compensation. Non-ICT capital services are calculated analogously.

As in Jorgenson *et al.* (2005), we define labour quality growth ($\Delta \ln q^{L}$) as the difference between the growth of labour input and the growth of total hours worked:

$$\Delta \ln q^{L} = \sum_{h} \bar{v}^{L}_{h}\Delta \ln L_{h} - \Delta \ln \sum_{h} L_{h} = \Delta \ln L - \Delta \ln H \tag{4}$$

[7] In equations (1) to (5) we drop industry subscripts *i* for sake of convenience

Here L is the labour input index, aggregated over the *h* labour types using labour compensation shares and H_t is total hours worked, summed over the different labour types. By rearranging equation (2) the results can be presented in terms of average labour productivity growth defined as the ratio of output to hours worked, $y = Y/H$, the ratio of capital services to hours worked, $k = K/H$, labour quality and TFP as follows:

$$\Delta \ln y = \bar{v}^{L} \Delta \ln q^{L} + \bar{v}^{N} \Delta \ln k^{N} + \bar{v}^{ICT} \Delta \ln k^{ICT} + \Delta \ln A \qquad (5)$$

We name the decomposition in equation (5), an “input decomposition” as compared to an “industry decomposition” which follows hereafter. As we also focus in this paper on the contribution of industries to aggregate labour productivity growth, the latter can be decomposed into industry contributions as follows (Stiroh, 2002a):

$$\Delta \ln y = \sum_{i} \bar{v}_i^{Y} \Delta \ln y_i + \left(\sum_{i} \bar{v}_i^{Y} \Delta \ln H_i - \Delta \ln H \right) = \sum_{i} \bar{v}_i^{Y} \Delta \ln y_i + R \qquad (6)$$

where $\bar{v}_i^{Y}$ is the two-period average share of industry *i* in aggregate value added. The term in brackets in equation (6) is the reallocation of hours and reflects differences in the share of an industry in aggregate value added and its share in aggregate hours worked. This term will be positive when industries with an above-average labour productivity level show positive employment growth or when industries with below average labour productivity have declining employment shares.

Finally, one can go one step further by combining the decomposition of industry labour productivity in (5) with equation (6), so that a full input and industry decomposition of aggregate labour productivity growth is obtained:

$$\Delta \ln y = \sum_{i} \bar{v}_i^{Y} \left(\bar{v}_i^{L} \Delta \ln q_i^{L} + \bar{v}_i^{ICT} \Delta \ln k_i^{ICT} + \bar{v}_i^{N} \Delta \ln k_i^{N} + \Delta \ln A_i \right) + R \qquad (7)$$

In this way, the contribution of input and TFP growth from each industry to aggregate labour productivity growth can be calculated. For example, the contribution of ICT-capital deepening in industry *i* to aggregate labour productivity growth is given by:

$$LPCON_i^{ICT} = \bar{v}_i^Y \left(\bar{v}_i^{ICT} \Delta \ln k_i^{ICT}\right) \tag{8}$$

which is the growth of ICT capital per hour worked in industry *i* weighted by the share of ICT capital compensation in industry *i* in aggregate nominal value added. The weight is the product of the share of industry *i* in aggregate value added ($\bar{v}_i^Y$) and the share of ICT capital compensation in industry value added ($\bar{v}_i^{ICT}$). Similar calculations can be carried out for the contributions of non-ICT capital and labour quality. The contribution of industry-level TFP to aggregate labour productivity growth is calculated as the product of industry TFP and the share of the industry in aggregate value added.

3. Data and results for growth accounting

Data

For the growth accounts in this paper we developed a database on output and labour and capital inputs for seven countries, including Australia, Canada, France, Germany, the Netherlands, the United Kingdom and the United States, covering the period 1987 to 2003.[8] Our output and labour input measures for France, Germany, the Netherlands and the UK are obtained from the Groningen Growth and Development Centre *60 Industry Database* at the level of 57 industries (GGDC, 2005), which were collapsed into 26 industries for the purpose of this study (see Table A.1). Data on labour quality and capital input were based on the *Industry Growth Accounting database* (GGDC, 2003) and updated to 2003. Data for the U.S. and Canada and Australia have been significantly revised since the last release of the *60 Industry Database*, and data for Australia have been added to the database for the first time.

[8] Together, the four European countries cover about 70 percent of output in the EU-15. See O'Mahony and van Ark (2003) and van Ark and Inklaar (2005) for figures for the aggregate EU-15. The Australian data covers fiscal years running from July to June. Following OECD convention, we allocate data for July 2000 to June 2001 to the year 2000.

Output is value added at constant prices and is primarily taken from national accounts complemented with measures from industrial and business surveys. Deflators for ICT producing manufacturing industries have been harmonised across countries as discussed by Inklaar et al. (2005). Labour input is measured as hours worked defined as the total number of persons employed (including self-employed) times the average number of hours worked. In addition, for each country we distinguish between three and seven different types of labour based on educational attainment. To construct our capital input measures we use data on investment in current and constant prices for six asset types. Three asets refer to ICT goods (computers, communication equipment and software) and three to non-ICT goods (transport equipment, other (non-ICT) machinery and equipment and non-residential structures).[9] To estimate capital stocks we use industry-specific geometric depreciation rates for detailed assets in the U.S., provided in Fraumeni (1997), in combination with industry shares of these assets from the BEA NIPA.

The series for the European countries were published earlier by Inklaar et al. (2005), but were revised and updated to 2003 using the same sources and methods as before (GGDC, 2003, 2005).[10] For the United States, we have developed an entirely new dataset, which is largely based on the latest releases by the Bureau of Economic Analysis (BEA) of GDP-by-Industry data that cover the period 1947-2004. These data are organized according to the NAICS 1997 classification system and are consistent with the *2003 Comprehensive Revision of the National Income and Product Accounts* (NIPA). In addition to the GDP by Industry data, we had to make use of numerous other sources, most notably industry output and employment data from the BLS, to obtain a complete set of growth accounts. For U.S. investment we used two main sources, namely the BEA *1997 Capital Flow Table* (CFT), showing the use of different types of investment goods by 123 NAICS

[9] Residential buildings are not taken into account to allow for a sharper focus on the productivity contribution of business-related assets. Since most of the outputs and inputs of the real estate industry consists of housing and imputed rents from housing we have to make an adjustment for this. However, it is hard to separate imputed rents only, so we decided to leave out the real estate industry from both outputs and inputs.
[10] Presently the *60 Industry Database* is largely rooted in the OECD STAN database, but additional information from industrial and business surveys was used to provide a greater industry breakdown. In the beginning of 2007, a new series of growth accounts for European countries will be published as part of the EU KLEMS project. See www.euklems.net for further details.

industries in 1997, and the BEA *Detailed Data for Fixed Assets* (DFA) with time series on purchases of different types of investment goods by 63 NAICS industries for the period 1901-2004. We also made substantive adjustments to the U.S. data to fit the ISIC rev. 3 industrial classification, which is the basis of our international comparative database.[11] A full explanation of our methods and procedures to build the U.S. growth accounts is available on request from the authors.

Data for Canada and Australia were developed specifically for the purpose of this paper. In the case of Canada the new NAICS-based use tables for the period 1961-2001 have been used for the output series. These data were extrapolated to 2003 using industry output series.[12] Employment data were drawn mostly from the OECD STAN database (2004 release). Detailed tables on investment by industry and asset tables from Statistics Canada were obtained for the purpose of a study for Industry Canada (van Ark and Inklaar, 2006). For manufacturing industries, we supplemented those tables with information from the final demand part of the input-output tables. Ho, Rao and Tang (2004, Tables 10-12) provide data on labour quality growth for Canada, which were compiled in a broadly comparable fashion to our methodology for the other countries.

Output series for Australia are mainly taken from the national accounts, supplemented by industry surveys, and data on employment are taken from the Australia's labour force statistics. Detailed investment by industry and asset tables are part of the Australian national accounts, and were supplemented with data from manufacturing surveys to distinguish investment by detailed manufacturing industries. Investment in communication equipment had to split off from the broader category of electrical and electronic equipment using data from input-output tables. For Australia we only had access to information about labour quality growth for the aggregate market sector from the national accounts. This rate was applied to each of the individual industries.

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[11] For the U.S., no educational attainment data has been collected for years after 2000, so labour quality growth is assumed to be zero for the latest three years.

[12] Industry output series for 2002 and 2003 are at constant prices. Current price data are estimated using producer price indices for most goods-producing industries and the GDP deflator for other industries. The 2002 input-output tables were released by Statistics Canada after we completed the dataset for this paper.

Industry contributions to labour productivity growth

On the basis of this dataset, measures of labour productivity growth and the contribution of individual industries and major industry groups to aggregate productivity growth can be calculated. **Table 1** shows the results of this decomposition for the 3 major industry groups that constitute the market sector of the economy for the 1987-1995 and 1995-2003 periods.[13] At the level of the market economy as a whole, the table shows a large acceleration in productivity growth in Australia, Canada and the U.S. since 1995. Labour productivity growth in France and Germany slowed down substantially, while growth in the Netherlands stagnated. In the UK, growth also slowed down somewhat, but it remained high compared to the continental European countries.

When decomposing the performance of the market economy into industry groups, we first distinguish the ICT production sector, which includes both ICT manufacturing and services (communications, software, etc.). The other sectors are 'other' goods-producing industries (excluding ICT producing manufacturing), market services (excluding ICT services) and the reallocation of hours.[14] A first point of interest is that the reallocation effects are generally negative, which supports the idea that industries with an above-average labour productivity level are declining in relative importance in terms of employment shares. A second important observation is that the contribution of ICT production differs between countries. The U.S. and the UK show rather high contributions from ICT-producers to productivity growth, whereas the continental European countries take an intermediate position and Australia and Canada show very

[13] The exact definition of the market economy (or business sector) differs by country and organization. We classify government (ISIC 75), education (ISIC 80) and health (ISIC 85) as non-market services, even though some or even most of education and health may be operated or owned by non-governmental organizations. Table 1 also shows the total economy aggregates, including non-market services. The reason for excluding these sectors from the analysis is mainly due to severe measurement problems in these industries. Moreover the international comparability of non-market output measures is very weak, which makes affects the interpretation of differences in growth performance at the total economy level. However, for the seven countries in this study the dynamics in growth performance for the market economy are largely reflected in those for the aggregate economy. Only in the case of France we find a bigger deceleration in productivity growth for the market economy compared to the total economy performance.

[14] In earlier work, such as van Ark et al. (2003a, b), we also distinguished between industries that used ICT intensive and those that did not – based on U.S. estimates of ICT investment relative to total investment. This approach necessitates a somewhat arbitrary distinction that has been criticized by, for example, Daveri (2004). More importantly though is the fact that it has become less important to make this distinction because we now have actual measures of ICT use for countries outside the U.S.

small contributions. Thirdly, in contrast to ICT production, the differences in average contributions of goods production (other than ICT) have been very small since 1995. Of course, there are differences between contributions of individual goods-producing industries which would be interesting to analyze in more detail, but mostly these contributions are positive and small and therefore matter relatively little for the aggregate.

Finally, and most importantly, the differences in contributions of market services are quite large between the countries. All Anglo-Saxon countries show accelerations in contributions from market services since 1995, ranging from 0.5 percentage point acceleration in the UK to 1.5 percentage points in Australia. In the U.S., labour productivity in market services increased by 0.9 percentage point from 0.9 per cent per year in 1987-1995 to 1.8 per cent per year from 1995-2003. In the Netherlands market services showed a slight increase in contribution of 0.2 percentage point, but France and Germany experienced a deceleration of 0.1 and 0.6 percentage points, respectively.

Growth accounts for market services

Using data on capital services and labour quality, it is now also possible to decompose labour productivity growth rates for each industry and industry group into contributions from ICT capital deepening, non-ICT capital deepening, labour quality growth and TFP growth (see equation 5). Since market services are the most intensive users of ICT assets, a generic strategy is to analyze the role of ICT investment vis-à-vis total factor productivity (TFP) growth in this specific industry group. The results are given in **Table 2**. Here we focus exclusively on an input decomposition of labour productivity growth in market services. It is clear that ICT capital deepening plays an important role in labour productivity growth in market service industries. All countries in the table show a moderate to substantial acceleration in the contribution of ICT capital deepening in market services. Indeed the full decomposition tables in the appendix (Tables A1-A7) show that faster ICT capital deepening in the aggregate economy is almost exclusively due to market services. However, the most striking observation from Table 2 is the rapid acceleration in TFP growth in market services in the Anglo-Saxon countries (Australia, Canada, United Kingdom and United States). Before 1995, TFP growth in market services was negative in these countries, but turned positive after 1995. In contrast, all continental European countries (France, Germany and the Netherlands) showed deteriorating TFP growth in market services after 1995. Germany and the Netherlands experienced negative TFP growth in market services after 1995 and France shows only a small positive growth rate.

Table 3 zooms in on the contribution of individual service industries to total factor productivity growth in market services. The table focuses on the most recent period 1995-2003, with a breakdown for 1995-2000 and 2000-2003 The table shows a strong contribution from wholesale trade in the Netherlands and the U.S., even though it slowed down since 2000, in particular in the Netherlands. Retail trade showed a particularly strong performance in Australia and Canada from 1995-2000, but the retail sector's contribution to overall market services TFP growth slowed down almost everywhere since 2000. Financial intermediation was particularly strong in the United States since 2000, but not in other countries. A distinctive difference since 2000, however, is the strong improvement of productivity growth in business services in all four Anglo-Saxon economies. The category of "other market services" only showed a sizeable effect for Australia after 2000, which is primarily due to a productivity boom in construction.

The precise reasons for the differences in productivity dynamics of market services are difficult to generalize. One possible reason is that in some countries investments in ICT do not lead to faster TFP growth whereas in other countries they do. There may be many reasons for this, among which cyclical effects and the effects of unmeasured intangible investments stand out. Inklaar (2005) and van Ark and Inklaar (2005) investigate whether the output elasticity of ICT capital on TFP suggests productive returns which are above the marginal cost assumption, which would violate a basic assumption of the growth accounting methodology. However, in line with, for example, Stiroh (2002b) it appears that industry data do not exhibit supra-normal returns. There is even some evidence that it takes a number of years of below-normal returns before the productive returns of ICT become high enough to outweigh the cost.[15]

This also emerges from studies that take a more industry-specific orientation. For example, McGuckin, Spiegelman and van Ark (2005) analyze labour productivity growth in European and U.S. wholesale and retail trade in detail. They find that technology adoption in Europe lags the U.S. by several years, which has been holding back European productivity growth. They also find that this lag can be (partly) attributed to stricter regulations in European countries.[16] But the explanation for the slowdown since 2000 has so far remained unexplained, and more work in this area (for retail and other service industries) is therefore required.

Another missing piece of evidence which might shed new light on the reasons for large differences in the contribution of market services to productivity growth, is to focus not exclusively on comparisons of growth rates but also on comparative levels of productivity. For example, rapid TFP growth might point to catching-up and imitation when starting from a relatively low productivity level. Similarly, stagnating TFP growth at a relatively high level of TFP might be indicative of a lack of innovation. Therefore, we turn to level comparisons for the remainder of this paper.

4. Level accounting methodology

So far, a level accounting approach to output and productivity has not been applied very widely, which is primarily due to the lack of adequate industry-specific PPPs for output and inputs as well due to some important issues concerning the use of an index number methodology.

[15] An alternative approach is to directly estimate each of the output elasticities separately as done by, for example, O'Mahony and Vecchi (2005).They find super-normal returns on ICT, which they attribute (at least in part) to the returns to unmeasured intangible investment, such as organizational change or training programs. An advantage of their approach is that no assumptions about the other output elasticities have to be made, but disadvantage is that it requires a rather restrictive functional form for the production function (such as Cobb-Douglas) for the estimation (see van Ark and Inklaar, 2005).
[16] For a more detailed statistical analysis of growth differences in the trade sector, see Timmer and Inklaar (2005).

Measurement of industry-specific PPPs

Industry-specific PPPs are required in order to adjust comparative levels of output and productivity for differences in relative price levels between countries. There is little reason to assume that differences in relative price levels are negligible between countries and the same across industries. However, only few studies have attempted to measure industry specific PPPs. Jorgenson, Kuroda and Nishimizu (1987) make use of specific PPPs for expenditure categories from OECD to measure TFP for about 30 industries between Japan and the U.S. These expenditure PPPs are adjusted for differences in transport and distribution margins across countries. Other studies have aimed to directly measure producer-price based PPPs. Van Ark and Pilat (1993) provided TFP level measures for manufacturing industries in Germany, Japan and the United States using a unit value ratio approach which is based on quantities and values from production censuses in different countries. Similarly, Timmer (2000) measured TFP for manufacturing in Asian countries using a similar methodology. Pilat (1996), Mulder (1999), O'Mahony (1999), and O'Mahony and de Boer (2002) extended this approach to also measure output and productivity levels beyond manufacturing. But most studies had to rely on bilateral comparisons of pairs of countries. It has also turned out difficult to develop a consistent methodology across the various studies because of differences in data availability. In particular, value added is often deflated by gross output price relatives, without taking into account differences in prices of intermediate inputs (socalled single versus double deflation).

In this paper we make use of a new and comprehensive dataset of output PPPs for multilateral comparisons of output and productivity levels in 1997. Output PPPs are used to double deflate value added in a consistent input-output framework. In addition, relative prices for labour and capital input are developed. For a full discussion of the new output PPPs, the reader is referred to a separate study by Timmer, Ypma and van Ark (2006). For the integration of output PPPs and the derivation of input PPPs in a level accounting framework, details are spelled out in Inklaar and Timmer (2006). Here we only present the most important details.[17]

Output PPPs are defined from the producer's point of view and are at basic prices, which measures the amount received by the producer for a unit of a good or service produced. These PPPs have partly been constructed using unit value ratios for agricultural, mining, manufacturing and utilities products and transport and communication services. For the other industries, PPPs are based on specified expenditure prices from Eurostat and the OECD, which were adjusted to industry level by using relative transport and distribution margins and adjusting for differences in relative tax rates (derived from benchmark supply and use tables for 1997). This set of gross output PPPs for 1997, covering 45 industries at (roughly) 2-digit industry level, has been made transitive by applying the multilateral EKS-procedure for a total of 26 countries, which are mostly OECD countries (including Taiwan). For this study the gross output PPPs were then are allocated to the 26 industries in Input-Output tables for 1997.

Intermediate input PPPs are required in order to double deflate value added level as done in this study. These input PPPs should reflect the costs of acquiring intermediate deliveries, hence they need to be based on purchasers' prices. As we assume that the basic price of a good is independent of its use, we can use the same gross output PPP for a particular industry, after adjustment for margins and net taxes, to deflate all intermediate delivers from that industry to other industries. The aggregate intermediate input PPP for a particular industry can be derived by weighting intermediate inputs at the gross output PPP from the delivering industries. Imports are separately identified for which exchange rates are used as PPP, hence assuming no price differences across countries for imported commodities.

To obtain PPPs for capital and labour input, we follow the methodology outlined by Jorgenson and Nishimizu (1978). The PPP for capital services is based on the expenditure

[17] Both studies are part of the EU KLEMS project, and full details and industry level results will be released at the beginning of 2007.

PPP for investment from the OECD, adjusted for differences in the user costs between countries. The user cost of capital input depends on the rate of return to capital, the depreciation rate and the investment price change. This data is taken from the growth accounts discussed in the previous section. The procedure to obtain a PPP for labour is more straightforward than for capital as it simply involves aggregating relative wages across different labour types using labour compensation for each type as weights. For this purpose we only distinguish between two labour categories: workers with a university degree or higher, and those without. This limited number of skill types is due to difficulties in matching schooling systems across the various countries.

The index number approach to level comparisons of output and productivity

Another major issue in TFP level comparisons is the choice of index number approach. The multilateral approach we adopt here originates from Caves, Christensen and Diewert (CCD, 1982) and is based on translog production functions. Importantly, in the CCD methodology the indices of relative inputs and output are transitive, which makes the indices base-country invariant.[18] It assumes a translog production function with constant returns to scale, price taking in factor markets and cost minimization for each industry. The parameters of this function are allowed to differ across countries. In addition, we specify aggregate output and inputs as constant returns to scale translog functions of their components.[19] Hence, translog multilateral indices of output in country c relative to the U.S. can be derived as follows:

$$\ln Y_c - \ln Y_{US} = \sum_i \bar{v}_i \left[\ln Y_{i,c} - \ln Y_{i,US} \right] \qquad (9)$$

with $\bar{v}_i = \frac{1}{2}\left[v_{i,c} + v_{i,US} \right]$. $v_{i,c}$ is the share of product i in total output of industry j, with *i* the components of Y.

[18] All binary pairs of comparisons pass the following test: $I_{ik}=I_{ij}\ I_{jk}$ where I_{ij} is an index comparing countries i and j.

[19] In fact our level comparisons are based on the so-called sectoral output and input measures, which net out intra-industry deliveries. See Inklaar and Timmer (2006).

Similarly, we can express differences in input levels for any country relative to the US. Analogously to output, translog multilateral indices of inputs, used in country c relative to the U.S. can be derived as follows:

$$\ln X_c - \ln X_{US} = \sum_j \bar{v}_j \left[\ln X_{j,c} - \ln X_{j,US}\right] \qquad (10)$$

with $\bar{v}_j = \frac{1}{2}\left[v_{j,c} + v_{j,US}\right]$

The translog multilateral productivity indices relative to the U.S. (A_c/A_{US}) can now be defined as follows :

$$\ln \frac{A_c}{A_{US}} = \ln \frac{Y_c}{Y_{US}} - \ln \frac{X_c}{X_{US}} \qquad (11)$$

Our approach deviates in two aspects from the general CCD-approach. First, we use implicit input and output quantity measures, based on aggregated relative prices, rather than direct measures, based on quantities. Second, our output measure is value added, rather than gross output, to keep in line with the growth accounts of the previous sections. These issues are discussed in turn.

First, it should be noted that the indices in equations (9) and (10) are discrete approximations to the underlying (continuous) translog production functions. In a time series context, this approximation generally does not pose any practical problems, since the shares in adjacent years are usually very similar. Hence, price and quantity measures will be consistent in aggregation (Diewert, 1978) However, this consistency is not guaranteed in a cross-country context where shares can vary widely. As a result, the approximation may be quite poor and price and quantity measures will no longer be consistent. To minimize the consistenty problem, we aggregate prices, and calculate relative quantities implicitly by the ratio of the nominal values and the relevant price indices. Define an aggregate relative price index for gross output PPP^{GO} as:

$$\ln PPP^{GO} = \sum_j \bar{v}_j \left[\ln P_{j,c}^{GO} - \ln P_{j,US}^{GO}\right]. \qquad (12)$$

The implicit relative gross output quantity index based on this relative price index (indicated by a tilde) can now be calculated as:

$$\ln \tilde{Y}_c^{GO} - \ln \tilde{Y}_{US}^{GO} = \left(\ln V_c^{GO} - \ln V_{US}^{GO}\right) - \left(\ln PPP^{GO}\right), \qquad (13)$$

where V is the value of output (in national currency), and similarly for inputs

As discussed above, our output measure is double deflated value added. Therefore, we need to adjust our gross output PPPs for differences in the prices of intermediate goods. Based on input-output tables, we can calculate an intermediate input PPP for each industry as in equation (12). The value added PPP can then be calculated implicitly from the following expression:

$$\ln PPP^{GO} = \bar{w} \ln PPP^{VA} + \left(1 - \bar{w}\right) \ln PPP^{II}\,, \qquad (14)$$

where $\bar{w} = \frac{1}{2}\left(\frac{VA^c}{GO^c} + \frac{VA^{US}}{GO^{US}}\right)$ and the superscripts *GO, VA* and *II* denote gross output, value added and intermediate inputs, respectively.

The final decomposition of the relative level of value added per hour worked into relative input levels per hour worked and relative TFP is as follows:

$$\ln \frac{y_c}{y_{US}} = \bar{v}^L \ln \frac{q_j^L}{q_{US}^L} + \bar{v}^{ICT} \ln \frac{k_c^{ICT}}{k_{US}^{ICT}} + \bar{v}^{ICT} \ln \frac{k_c^N}{k_{US}^N} + \ln \frac{A_c}{A_{US}} \qquad (15)$$

In equation (15), output per hour worked of country *c* relative to country *U.S.* is decomposed into a contribution from relative labour quality, ICT capital levels per hour worked, non-ICT capital levels per hour worked and relative TFP levels. The weights refer to average shares of each input in value added. For example, v^L refers the average of the labour shares in output for country c and the U.S. The other input shares are defined analogously and since we assume constant returns to scale, the shares sum to one.

5. Level accounting results

Labour productivity level results for 1997 and 2003

The first step in presenting our level results, it to focus on the comparative levels of labour productivity for the same major industry groups (ICT production, other goods production and market services) as in the first part of the paper. **Table 4** shows comparative levels of labour productivity, measured as value added per hour worked. The results for 1997 are for our benchmark year, and developed according to the methodology outlined above, so value added is double deflated.

Table 4 shows that, especially when it comes to productivity in the market economy, the U.S. shows a labour productivity level which is similar to that of the three continental European countries, ranging from France at 97 per cent of the U.S. level to the Netherlands at 106 per cent.[20] The other Anglo-Saxon countries show between 15 and 20 percent lower levels than the U.S, ranging from Australia at 73 per cent of the U.S. level to Canada at 85 per cent. Strikingly, the relative total economy levels are all higher relative to the U.S. than the market economy levels, signalling high relative TFP levels in non-market services in countries outside the U.S. These differences are largest in European countries, like France and the Netherlands. As before, when dealing with the growth, it is not clear how to interpret the results for the non-market sector given the substantial measurement problems that remain.

Table 4 also shows relative labour productivity levels in ICT production, other goods-producing industries and other market services in 1997. The relative productivity levels

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[20] Indeed the margin of error around level estimates is non-negligible. Although (formal) research on this issue is limited, Baldwin *et al.* (2005) argue that a confidence interval of (at least) 10 percent should be used. Schreyer (2005) arrives at a similar figure using a simulation exercise.

in market services correspond most closely to those at the level of the market economy, with productivity levels in France, Germany and the Netherlands relatively close to that of the United States, and Australia, Canada and the UK at a large distance from the other countries. Productivity levels in goods-producing industries are generally much closer together, with the exception of Canada which is doing much better in some resource-intensive and heavy manufacturing industries, like oil refining, metal products and machinery. The high productivity levels in ICT production in France, Germany and the UK can mostly be traced to high productivity level in communications services, with again smaller differences in ICT manufacturing.

Table 4 also shows an extrapolation of the benchmark results for labour productivity in 1997 to 2003. Starting from the relative labour productivity levels for 1997, we have applied the relative growth between 1997 and 2003 at the aggregate and industry group level (see Table 1).[21] The faster productivity growth in the U.S. since 1997 has resulted in lower productivity levels relative to the U.S. for the other countries, but the cumulative impact is still relatively modest over a period of only six years. Given the margin of uncertainty surrounding levels estimates, the analysis of the 1997 results more or less holds up for 2003.

Level accounts for market services

The relatively low productivity levels in market services in the Anglo-Saxon economies (except the U.S.) sheds new light on the possible reasons for rapid productivity growth in the market services sector for these countries, as was observed earlier. It might of course be possible that this rapid growth relates to typical catching up-effects as the industries start from low levels of productivity, and benefited from technological progress, innovation and institutional changes – more than the continental European countries

[21] The data requirements for a level comparison for one year are quite substantial, and in many cases these data only become available with a considerable lag. As a result, a fully consistent level accounting exercise cannot yet be done for a later year than our benchmark year 1997. Extrapolating the 1997 benchmark results forward is also not straightforward since ideally this should be done at most detailed level before re-aggregating using the CCD-method. As the data requirements for such an extrapolation would be comparable to that of a new benchmark, this is also not feasible at the moment.

which started from much higher levels. To explore this possibility further, an input decomposition of the differences in the level of productivity is useful.

Table 5 shows an input decomposition of the labour productivity gap in market services into the contributions of ICT capital intensity, non-ICT capital intensity, labour quality and TFP to the gap following equation (15). So for example, the (log) labour productivity gap between Australia and the U.S. is 37 percentage points, of which 9 percentage points are due to lower ICT intensity, 4 percentage points to lower non-ICT intensity and lower labour quality, and almost 20 percentage points due to lower TFP levels.[22]

A number of important observations stand out from Table 5. Firstly, ICT capital input per hour worked is higher in U.S. market services than anywhere else, and accounts for between 3.2 and 9.2 percentage points of the U.S. labour productivity level advantage. In contrast, non-ICT capital levels are higher in the continental European countries, and account for the bulk of the productivity advantage in market services for France and Germany. In Germany, higher capital intensity adds as much as 21.4 percentage points to Germany's advantage relative to the U.S., accounting for more than the total labour productivity gap. This is partly compensated by lower ICT capital intensity and lower labour quality.[23] In the Anglo-Saxon countries, non-ICT capital intensity in market services is lower than in the U.S. Labour quality levels in market services are also below the U.S. levels, with the exception of Canada and the Netherlands where it is relatively close to the U.S. level.

The major impact on the productivity gap relative to the U.S. for the Anglo-Saxon countries is due to lower TFP levels in market services. It accounts for between 19.8 percentage points of the Australian gap relative to the U.S. and 26.4 percentage points of the Canadian gap. In France and Germany, the TFP level is comparable to the U.S. Only

[22] The gap here is defined as the difference in the natural log of the levels, to stay consistent with the growth accounts and the decomposition formulae which are also in terms of logs. Hence the gaps given in Table 4 (which are based not based on logs) and Table 5 will be different

[23] The quality of data on investment by industry and asset as well as the investment PPPs are areas of potential improvement, but any adjustment would have to be implausibly large to account for the high non-ICT capital intensity level in Germany.

in the Netherlands, the higher productivity level in market services relative to the United States is largely due to a higher TFP level.

Finally, **Table 6** provides an industry decomposition of the labour productivity and TFP gaps in market services relative to the United States. In contrast to the input decomposition of market services in table 5, productivity gaps are now decomposed to the contribution of productivity gaps in the more detailed industries. So, for example, the almost 20 percentage point TFP gap between Australia and the U.S. in market services is mainly due to the gap in business services, contributing 14 percentage points, followed by other market services at 7 percentage points. In finance, TFP in Australia is higher than in the U.S., so its contribution to the overall gap is positive.

For labour productivity, there is clear evidence that the productivity level advantage of the continental European countries is primarily located in wholesale trade and – to a lesser extent – in retail trade. The Netherlands also shows a productivity level advantage in transport and storage and financial intermediation. Financial intermediation also shows positive contributions from high productivity levels in Australia and France. Strikingly, business services contribute negatively to the productivity gap relative to the U.S., for all countries except for Germany where the contribution is at par with the U.S.

Turning to total factor productivity, the gaps relative to the U.S. are reduced due to the lower contributions of ICT and non-ICT intensity and labour quality to labour productivity levels outside the U.S. But the distribution across industries is comparable to that for labour productivity. As for labour productivity, business services account for a large part of TFP gap relative to the U.S. But in all three continental European countries TFP levels in market services are still higher than in the U.S. due to higher TFP levels in wholesale trade, retail trade and financial intermediation (in particular in the Netherlands). In the Anglo-Saxon economies, most industries account for part of the TFP gap relative to the U.S., even though the contribution from business services is by far the largest. In the concluding section of this paper, we will briefly explore the possible explanations for these differences in productivity levels in services, as this also determines the direction for further research.

6. Summary and concluding remarks

In this paper we combined a growth and level accounting approach to compare productivity at industry level among seven advanced economies (Australia, Canada, France, Germany, Netherlands, the United Kingdom and the United States). Our analysis uses an industry decomposition for 26 industries, of which 25 are part of the market economy, and an input decomposition of labour productivity into the contributions from ICT capital intensity, non-ICT capital intensity, labour quality and total factor productivity. By looking at both growth and levels together, which is the major novelty of this paper, we may get a better view of the extent to which fast (or slow) growth rates may be due to catching-up effects.

Our analysis shows that market services play a key role in explaining the stronger productivity growth of the Anglo-Saxon economies (Australia, Canada, the UK and the U.S.). We also find that the continental European countries (France, Germany and the Netherlands) experienced a strong slowdown in market services. Our input decomposition shows that the differential growth performance is mostly strongly related to differences in TFP growth, whereas ICT capital deepening accelerated everywhere since 1995 – also in the countries with slow productivity growth.[24] An industry decomposition of market services attributes a large role to slower productivity growth in business services in Europe.

The level analysis in the second part of the reveals that productivity gaps at the aggregate level can also be largely traced to market services. Anglo-Saxon economies (other than

[24] An further decomposition of growth between 1995 and 2003 into the pre and post-2000 period, shows that the absolute contribution of ICT capital deepening after 2000 returned to pre-1995 levels in most countries.

the U.S.) show much larger productivity gaps relative to the U.S. than the continental European countries which are at or even substantially above the U.S. productivity level in market services. The advantage for France and Germany is in part related to higher levels of non-ICT capital intensity, but in the Netherlands higher TFP levels also play a role. For the Anglo-Saxon economies lower TFP levels in market services are the key explanation for lower aggregate labour productivity levels. An industry decomposition again points in the direction of the importance of business services accounting for a large part of the productivity shortfall relative to the U.S.

The combination of low productivity levels and high productivity growth in market services in the Anglo-Saxon economies (Australia, Canada and the United Kingdom), suggests a role for catching up on the U.S. productivity level. This catching up may be related to a rapid adoption of ICT, which is an input of major importance in market services, and TFP growth. Even though a direct relationship between ICT capital deepening and TFP growth cannot be derived from the industry data as used in this study (Inklaar, 2005; van Ark and Inklaar, 2005), other studies using firm level data or specific case studies show that the productive impact of ICT depends crucially on investments in intangible capital such as organizational change and employee training programs. But Brynjolfsson and Hitt (2003), for example, argue that it takes a substantial amount of time for these complementary intangible investments to have their full effect on productivity. Reforms in product and labour markets may also be needed to exploit the productivity potential of ICT (Nicoletti and Scarpetta, 2003).

These observations, however, raise a number of important questions. Firstly, if innovations and a conducive market environment in countries are so important, why is it then that the U.S. has exploited that potential much earlier than the other Anglo-Saxon economies? There are a wide range of possible explanations, but many seem related to the earlier impact of joint impact of technological change (in particular ICT), innovations within organizations and market reforms (in particular in product and labour markets) on U.S. productivity – compared to other countries. This may be due to a more competitive environment that revealed the need for structural transformation earlier than in other countries. The U.S. economy embarked on major reforms in labour and product markets in the 1970s when the economy showed clear signs of structural problems in particular in manufacturing. Australia, Canada and the United Kingdom only moved into serious reforms during the 1980s and 1990s, whereas most European countries only started on this by the end of the 1990s. For example, the launch of the Lisbon agenda for competitiveness is a clear recognition of the urgency of structural reforms in the European Union. Some of the early reforms in the U.S. (such as those in telecommunication) may have benefited service industries more than originally anticipated. Industry case studies, such as for retail (McGuckin et al., 2005) clearly showed how the effects of reforms in labour and land markets interact with technological and organizational renewals, and revealed the long lags involved. Economies of scale, demand effects and cultural preferences may also have raised the absorption capacity for these changes earlier and more easily in the U.S. than elsewhere.

A second question is how slow productivity growth in continental European countries can be linked to relatively high levels of productivity in market services. One possibility is that European service industries are at the frontier of technological and organizational change, but industry case studies (such as those reported in McGuckin et al., 2005; Baily and Kirkegaard, 2004 and Lewis, 2004) do not provide much support for that hypothesis. Alternatively, there may be an element of "perversity" in the high productivity levels in many European service industries which may be related to underutilization of the consumer market potential.. For example, if all the shopping needs to be done between 9 am and 6 pm instead of having access to retail facilities 24 hours per day, productivity may turn out higher in the former case. As a result of rigid markets a higher utilization of labour and capital (shop floor) capacity is realized. These observations raise new questions concerning an old debate on the need to adjust productivity measures for users' convenience, and the adjustment of inputs for utilisation rates, which goes beyond the scope of this paper.

Productivity levels in consumer services are not the only source of interest. Productivity differences in business services may be influenced by differences in trends in vertical integration of the value chain and outsourcing. As all countries in this paper show lower productivity levels in business services than the U.S., relative levels are seemingly unrelated to the productivity growth performance in this sector. However, there has been relatively little research on how the migration of employment from the manufacturing industry to business services an offshoring of business service activities has affected productivity growth across countries (Olson, 2006).

A final question is related to the issue of measurement of services output and productivity. The current methodology of splitting the change in output value into a quantity component and a price component is difficult to apply to many service activities, as often no clear quantity component can be distinguished. Moreover, possible changes in the quality of services are also difficult to measure. These problems are not new, and improvement in measurement of service output has been a topic on the agenda of statisticians and academics for a long time (Griliches, 1992; Wölfl, 2003; Triplett and Bosworth, 2004). However, the increased importance of ICT may have accelerated quality changes in services and raised the potential for productivity growth in services, which was previously not envisaged. An entirely new issue, which links the previous point on outsourcing with the issue of measurement, is the measurement of leasing in business services its impact on productivity. Even though such changes have not exclusively led to upward adjustments of real output, on balance the bias is probably towards an understatement of the growth in real service output (Triplett and Bosworth, 2004). There is no evidence, however, that this bias is in any way bigger in Europe than in the U.S.

Finally, we stress that at this stage of the research, caution is needed when drawing far-reaching conclusions from the integratied productivity growth and level comparisons. Some of the hypotheses about industry group and aggregate productivity differences are not necessarily borne out by the detailed industry results. Some of the detailed industry results suggest there is still room to improve the comparability and quality of the underlying data. This paper is based on a dataset that bridges our earlier datasets on industry and growth accounts with a more comprehensive growth and level accounts framework in the EU KLEMS project which will be published in 2007. The results from the latter project need to be awaited to find confirmation of the broader trends sketches here at the level of individual industries and for additional countries.

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Table 1: Industry Contributions to Market Economy Labour Productivity Growth, 1987-2003 (value added per hour worked, percentage growth and contributions)

	Australia	Canada	France	Germany	Nether-lands	United Kingdom	United States
1987-1995							
Market economy	1.1	1.2	2.7	2.8	1.7	2.9	1.9
contributions from:							
ICT production	0.3	0.3	0.4	0.6	0.2	0.7	0.6
Goods-producing industries	1.1	0.7	1.3	1.2	1.2	1.8	0.5
Market services	0.0	0.3	0.7	0.8	0.5	1.0	0.9
Reallocation of hours	-0.3	0.0	0.3	0.2	-0.2	-0.6	-0.2
Total economy	1.2	0.8	2.0	2.5	1.6	3.0	1.3
1995-2003							
Market economy	2.4	2.0	2.0	2.0	1.7	2.7	3.0
contributions from:							
ICT production	0.2	0.2	0.6	0.6	0.4	0.9	0.8
Goods-producing industries	0.7	0.7	0.8	0.9	0.8	0.6	0.7
Market services	1.5	1.3	0.6	0.2	0.7	1.5	1.8
Reallocation of hours	-0.1	-0.2	0.0	0.3	-0.2	-0.3	-0.2
Total economy	2.2	1.9	1.8	1.7	1.5	2.5	2.5

Source: GGDC Industry Growth Accounting Database, see www.ggdc.net for data. See Section 2 and Inklaar et al. (2005) for methods, and Section 3 and Appendix B for sources

Notes: Market economy includes all industries except real estate (ISIC70) government (ISIC75), education (ISIC80) and health (ISIC85). Labour productivity and TFP contributions are calculated using the share of industry value added in market economy value added. ICT/non-ICT capital contributions are calculated using the share of industry ICT/non-ICT capital compensation in aggregate value added. Labour quality contributions are calculated analogously based on industry labour compensation. Reallocation of hours is the difference between output-weighted industry growth in total hours worked and employment-weighted growth in total hours worked. ICT production includes electrical and optical equipment (ISIC30-33) and telecommunications (ISIC64). Goods-producing industries include all industries between ISIC01-41, except ICT production, market services includes all industries between ISIC45-74, except ICT production.

Table 2: Input Contributions to Market Services Labour Productivity Growth, 1995-2003 (value added per hour worked, percentage growth and contributions)

	Australia	Canada	France	Germany	Nether-lands	United Kingdom	United States
1987-1995							
Market services (excl. ICT services)	0.0	0.5	1.2	1.9	0.8	1.7	1.5
contributions from:							
ICT capital deepening	0.7	0.4	0.3	0.4	0.6	0.6	0.9
Non-ICT capital deepening	-0.1	0.4	0.3	0.6	0.3	0.9	0.3
Labour quality growth	0.3	0.3	0.2	0.2	0.3	0.7	0.3
TFP growth	-0.8	-0.7	0.3	0.4	-0.3	-0.5	0.2
Reallocation of hours	0.0	0.0	0.1	0.4	0.0	0.0	0.0
1995-2003							
Market services (excl. ICT services)	2.3	2.4	0.9	0.9	1.1	2.2	2.7
contributions from:							
ICT capital deepening	1.0	0.5	0.5	0.6	0.9	0.9	1.3
Non-ICT capital deepening	0.0	0.2	0.0	0.3	0.4	0.6	0.4
Labour quality growth	0.2	0.1	0.2	0.0	0.1	0.2	0.1
TFP growth	1.2	1.4	0.1	-0.5	-0.4	0.5	0.9
Reallocation of hours	-0.1	0.1	0.0	0.5	0.0	0.0	-0.1

Sources and notes: see Table 1

Table 3: Industry Contributions to Total Factor Productivity Growth in Market Services, 1995-2003, (percentage growth and contributions)

	Australia	Canada	France	Germany	Nether-lands	United Kingdom	United States
1995-2000							
Market services (excl. ICT services)	0.3	1.3	0.3	-0.4	0.2	0.0	0.6
contributions from:							
Wholesale trade	0.2	0.0	0.3	0.4	0.7	0.0	0.9
Retail trade	0.6	0.7	0.0	0.1	0.1	-0.2	0.3
Transport & storage	-0.4	0.2	0.2	0.2	0.2	0.0	0.0
Financial intermediation	0.2	-0.3	0.2	0.0	-0.5	0.1	0.0
Business services	-0.2	0.4	-0.4	-1.0	-0.2	0.0	-0.4
Other market services(a)	0.0	0.3	-0.1	-0.1	-0.1	0.1	-0.2
2000-2003							
Market services (excl. ICT services)	2.6	1.7	-0.1	-0.7	-1.4	1.4	1.3
contributions from:							
Wholesale trade	0.5	0.4	0.2	0.2	-0.1	0.4	0.3
Retail trade	0.1	0.3	0.0	0.3	-0.1	0.2	0.2
Transport & storage	0.0	0.2	-0.2	-0.1	-0.1	0.0	0.2
Financial intermediation	0.1	0.1	-0.2	0.0	-0.1	0.0	0.4
Business services	0.8	0.5	-0.5	-0.8	-0.7	0.6	0.3
Other market services(a)	1.1	0.2	0.6	-0.2	-0.4	0.1	-0.1

(a) Other market services include construction, hotels and restaurants and social & personal services.

Sources and notes: See Table 1

Table 4: Labour Productivity Levels Relative to United States, 1987 and 2003 (value added per hour worked, US=100)

	Australia	Canada	France	Germany	Nether-lands	United Kingdom	United States
1997							
Market economy	73	85	97	104	106	74	100
ICT production	69	86	99	99	72	116	100
Goods-producing industries	82	124	95	90	101	81	100
Market services	69	64	96	113	115	66	100
Total economy	83	95	109	112	122	86	100
2003							
Market economy	69	80	90	93	98	73	100
ICT production	44	57	97	84	68	123	100
Goods-producing industries	77	121	95	87	100	83	100
Market services	68	64	88	102	106	64	100
Total economy	80	93	105	105	115	86	100

Source: 1997: Supply and Use tables for individual countries from Inklaar and Timmer (2006) and PPPs from Timmer, Ypma and van Ark (2006); 2003 updated from 1997 with time series underlying table 1.

Notes: For methodology, see Inklaar and Timmer (2006)

Table 5: Input Contributions to the Gap in Labour Productivity in Market Services, 1997 (value added per hour worked, gap measured as percentage productivity differential relative to the US)

	Australia	Canada	France	Germany	Nether-lands	United Kingdom
Market services (excl. ICT services)	-37.4	-44.1	-3.9	12.1	14.3	-41.4
contributions from:						
ICT capital per hour worked	-9.2	-9.1	-7.5	-3.2	-5.0	-10.0
Non-ICT capital per hour worked	-4.1	-7.0	8.8	21.4	4.0	-7.3
Labour quality	-4.3	-1.6	-6.7	-8.5	0.3	-4.0
TFP	-19.8	-26.4	1.6	2.4	15.0	-20.1

Sources and notes: see Table 4. The gap is defined as the natural log of the level. The contributions of the different inputs are calculated by multiplying the gap in input level by the share of each input in value added.

Table 6: Industry Contributions to the Gap in Labour Productivity and Total Factor Productivity in Market Services, 1997 (value added per hour worked, gap measured as percentage productivity differential relative to the US)

	Australia	Canada	France	Germany	Nether-lands	United Kingdom
Value Added per Hour Worked						
Market services (excl. ICT services)	-37.4	-44.1	-3.9	12.1	14.3	-41.4
contributions from:						
Wholesale trade	-8.0	-2.5	8.3	11.6	15.0	2.0
Retail trade	-5.4	-4.1	5.5	3.8	4.3	-3.1
Transport & storage	0.9	0.0	-1.0	-4.0	8.3	-5.2
Financial intermediation	3.3	-10.7	1.2	-2.1	3.3	-4.5
Business services	-28.3	-23.7	-19.7	0.6	-19.0	-21.4
Other market services(a)	0.1	-3.0	1.9	2.3	2.4	-9.2
Total Factor Productivity						
Market services (excl. ICT services)	-19.8	-26.4	1.6	2.4	15.0	-20.1
contributions from:						
Wholesale trade	-4.4	-1.8	5.3	6.7	7.8	0.8
Retail trade	-1.8	-2.0	3.2	2.8	2.3	-1.3
Transport & storage	-0.1	-0.5	-0.2	-1.6	4.4	-2.1
Financial intermediation	7.7	-2.0	4.5	2.0	6.4	4.2
Business services	-14.0	-13.3	-11.5	-7.9	-10.2	-10.6
Other market services(a)	-7.2	-6.9	0.3	0.4	4.2	-11.1

(a) Other market services include construction, hotels and restaurants and social & personal services.

Sources and notes: see Table 4. The gap is defined as the natural log of the level. The contributions of the different industries are calculated by multiplying the gap in productivity levels by the share of each industry in value added. Due to standard index number problems, the contributions have to be normalized by distributing the difference between the sum of the contributions and the aggregate according to each industry's share in value added.

Table A.1: Industry classifications

Industry	ISIC rev.3
Agriculture, forestry and fishing	01-05
Mining and quarrying	10-14
Food products	15-16
Textiles, clothing and leather	17-19
Wood products	20
Paper, printing and publishing	21-22
Petroleum and coal products	23
Chemical products	24
Rubber and plastics	25
Non-metalic mineral products	26
Metal products	27-28
Machinery	29
Electrical and optical equipment	30-33
Transport equipment	34-35
Furniture and miscellaneous manufacturing	36-37
Electricity, gas and water	40-41
Construction	45
Wholesale trade	50-51
Retail trade	52
Hotels and restaurants	55
Transport & storage	60-63
Communications	64
Financial intermediation	65-67
Business services	71-74
Social and personal services	90-99
Non-market services	75-85