Research Memorandum

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Sectoral Labour Productivity Growth:
A growth accounting analysis of Dutch industries, 1973-1995

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1 Introduction[1]

Labour productivity growth in the Netherlands has slowed down since the mid-1970s. Moreover, Dutch productivity performance is quite disappointing compared to that of other OECD countries since the mid-1980s. Such a result prompts the question: does the Dutch economy face a productivity problem? Addressing the question is of major concern, because labour productivity growth together with higher labour input determine economic growth in the long run. Moreover, labour productivity contributes to the competitiveness of one's country.

Recently, Pomp (1998) put forward an explanation for the productivity slowdown in the Netherlands.[2] The latest slowdown is probably due in part to an increase of the employment share of employees with lower levels of productivity. The so-called 'Wassenaar agreement' between the social partners at the end of 1982 heralded a period of wage moderation in the Netherlands. Wage moderation has been associated with extraordinary job-creation growth in the Dutch economy. Even low-skilled people with low levels of productivity took advantage of this opportunity. Drawing the low-skilled people into the labour force has had a purely statistical effect, in the sense that it reduced average productivity. This effect, however, is no cause for concern, as a higher participation rate of low-skilled people is desirable from a social and political point of view. Nevertheless, if the labour force is adjusted for this composition effect, a major part of the productivity decline still remains unexplained.

To address the question whether or not the Dutch economy faces a real productivity problem, this research memorandum applies the extended growth accounting technique at an aggregated level and at the level of industry. The growth accounting technique provides a breakdown of observed output growth into components associated with changes in factor inputs and a residual that reflects technological progress and other elements. It allows us to explore whether a fall in the rate of technological progress or a drop in the growth of capital intensity explains the decline in labour productivity growth.

An international project for a large international comparison of economic growth, investment, employment creation, productivity and competitiveness is intended to start

[1] An abbreviated version of this research memorandum was published in CPB Report 1998/1. I am grateful to Kees Burk, Frans Suijker (all CPB), and Eric Bartelsman (Ministry of Economic Affairs) for their helpful comments on earlier versions of this paper. Thanks to Theo van Reijsen and Sjef Ederveen (both CPB) for statistical assistance.

[2] Pomp, M., 1998, Labour productivity growth and low-paid work, *CPB Report 1998/1*.

next year, depending on external funding. Using the growth accounting tool, supplemented by input-output analysis and econometric techniques to measure spillovers from tangible investment, ten research institutes (CPB among them) will analyse the sources of economic growth in eight countries in the European Union since 1970. However, the first results of the project (called the KLEMS project in this research memorandum) will not emerge before the end of 2001, as a large internationally consistent database needs to be developed.

This CPB research memorandum, mainly based on existing statistical material and an update of earlier work, thus serves as a preliminary contribution to the planned KLEMS project. As a large consistent database is available by the end of 2001, the results of the KLEMS project will probably provide additional insights into the relative performance of the Netherlands at a lower level of aggregation.

This research memorandum proceeds as follows. Section 2 describes the growth accounting technique in more detail. Section 3 presents the growth accounting results at an aggregated level and at the level of industry. Section 4 elaborates on the sources of the sluggish productivity growth in market services. It also compares the Dutch market services performance with that of several other industrialised countries. Finally, section 5 sums up, providing some conclusions and suggesting additional research.

2 Growth accounting methodology

Labour productivity growth contributes to an increase in GDP per capita, a rough-and-ready indicator of economic welfare. Moreover, labour productivity is an indicator of competitiveness and applied technology. Identifying the sources underlying the poor productivity performance in the Netherlands is therefore important.

Labour productivity is determined by the amount of available factor inputs, i.e. labour (including human capital), physical capital and intermediate inputs. It is, however, a single-input productivity concept. Employees can produce more without harder work or improved efficiency if additional machines and better equipment are at their disposal. In other words, labour productivity gains can be the result of increases in the capital-labour intensity without changes in underlying technology or inefficiency. Hence, labour productivity growth is difficult to compare among industries without elimination of the various inputs that might cause labour productivity to vary. Instead, Total Factor Productivity(TFP) growth measures the rate at which output increases if all inputs remain constant. In order to improve our understanding of sectoral productivity performance, we therefore also analyse the development of this productivity concept.

To measure labour productivity growth and TFP growth, I employ the extended growth accounting framework for measuring the contribution of different inputs to the growth process.[3] This framework is based on the neoclassical model of Solow (1957). It assumes that at the level of industry (=i) there exists a value added production function relating output to labour, capital, and time:[4]

(1) $$VA_i = F(K_i , L_i , t)$$

where	VA	Value added
	K	Capital input
	L	Labour input
	t	time

[3] See e.g. Jorgenson, D.W., F.M. Gollop and B.M. Fraumeni, 1987, *Productivity and US economic growth*, Cambridge, MA, Harvard University Press.

[4] In the main text of this research memorandum, I use the concept of value added only as a measure of industry's output. Appendix B also contains the decomposition results of the gross output-concept. Although shifts in use of intermediate inputs relative to capital or labour inputs over time may create differences in productivity measured with value added, trends of both output measures are more or less the same at a lower level of aggregation.

The key assumptions required to compute TFP growth directly from observable data are as follows: the production function is characterised by constant returns to scale, there is neutral technological progress, and producers are price takers in both output and input markets.

If firms maximise profits and act as price takers in both output and input markets, then the elasticity of output with respect to labour or capital is equal to, respectively, the share of labour cost in the value of total output and the share of capital cost in the value of total output. Both shares are directly observable. Moreover, constant returns to scale imply that the elasticities of the input factors add up to one. Hence, the labour share can replace the production elasticity of labour.

Now, if we assume that the production function is translog, then the contribution of factor inputs to output growth can be computed as their own growth rate weighted by their (mean)value share in total factor input.[5]

(2) $$\triangle \ln VA_i = tfp_i + W_i^k(\triangle \ln K_i) + W_i^l(\triangle \ln L_i)$$

Where W^j Average value shares of capital and labour

(3) $$W_i^j = 1/2[W_{i,\,t-1}{}^j - W_{i,\,t}{}^j]$$

As a preliminary step for the analysis of fundamental determinants of labour productivity growth, rewrite equation 2 as follows:

(4) $$\triangle \ln h_i = tfp_i + W_i^k \triangle \ln(K/L)_i$$

where h Labour productivity (=VA/L)

Given data on output, capital, labour and the share of labour in total factor inputs, TFP growth can easily be computed from (4). TFP growth is a residual that captures unmeasured factors such as disembodied technological progress, economies of scale, economies of scope, organisational improvements and other deviations from the

[5] In order to obtain a discrete Törnqvist index to measure growth in output and inputs, the value shares of inputs are measured as the average shares over two subsequent periods.

Notes on growth accounting

A number of methodological and data issues are associated with the growth accounting tool. This box briefly discusses some of them.

First, the assumptions on constant returns to scale and competition in both product and factor markets seem odd. If increasing returns to scale and spill overs exist, the estimated contribution of the residual, i.e. TFP, will be lower. The estimated value of TFP will also deviate from the true TFP, if factor prices do not coincide with social marginal products.

Growth accounting assumes the existence of a production function at either sectoral or industry level. This production function pretends to be representative for each firm within industries. Using comprehensive data sets of firms, various authors have found tremendous dispersions of productivity across firms (see, e.g. Baily et al., 1995, and van der Wiel, 1999). Therefore, the tremendous heterogeneity that exists across firms within industries indicts the centerpiece of the growth accounting literature. The elasticities of industry's production function capture some average of micro-level productivity technology over time and across firms, as well as the effects of past changes in composition within the industry.

An issue that already has been on the forefront of the discussion on growth accounting since decades is whether technology is embodied in capital or not. The debate between Jorgenson/ Griliches, and Denison /Kendrick boosted this discussion. The Jorgenson's stand assumes that one should capture adequately substitution among different types of capital inputs. Therefore, different types of capital are weighted by rental prices which are equal to the marginal product. On the other hand, the Denison's stand omits this 'correction' because embodied technology is based on dubious assumptions. They do not adjust the capital stock. Therefore, all technological progress should be included in the growth residual.

The final issue to be discussed are data availability and measurement problems. Following Jorgenson's approach, growth accounting requires disaggregated inputs in order to reflect the marginal productivity of each type of input. So, labour input should be differentiated by gender, age, occupation, etc., which is hardly feasible. Therefore, data availability is a severe bottleneck. Moreover, measurement problems with regard to output and quality changes can disturb the analysis. Quality improvements or innovations may be mistreated as pure price increases creating a downward bias in real output and labour productivity (see section 4.4).

assumptions mentioned above. It also reflects measurement errors that may arise due to measurement problems in output and input.

The assumption of neutral technological progress means that technological progress is independent of the size of capital and labour inputs. According to the neoclassical theory, the marginal product of capital is equal to zero in the long run. Then, labour productivity growth stems entirely from TFP growth. The latter rains down from heaven as manna, or is ‘a measure of our ignorance’, as Abramovitz (1956) called it, since TFP growth largely dominated among sources of growth in growth accounting studies at that time. In this theoretical neoclassical framework, labour as well as technological progress are exogenous.

Jorgenson and Griliches (1967), however, considerably broadened the concept of substitution of Solow’s growth accounting framework. The original framework does not incorporate substitution among different types of capital inputs, nor does it incorporate substitution among different types of labour input. Solow modeled only substitution between capital and labour inputs. However, as Jorgenson and Griliches showed, investment can be made endogenous within a neoclassical growth model, while productivity growth is exogenous, since capital goods and labour inputs differ substantially in marginal productivity (see also box).[6] The specific feature of investments in physical capital and human capital as a source of economic growth is that the investor can internalise the returns to these investments. Jorgenson and Griliches introduced constant quality indices of capital and labour inputs and a constant quality measure of capital goods output in allocating the sources of economic growth between investment and productivity. Growth accounting studies based on the broadened concept of substitution diminish the dominant position of TFP as a source of growth.

Therefore, in order to account properly for substitution among different types of capital inputs, I measure capital inputs as a flow of services in this research memorandum. Using the perpetual-inventory method and investment series over longer periods, I have constructed capital stocks for several types of assets at the level of industry. Then, each type of asset is separately weighted with a capital cost of services, since each type of capital input must be weighted by the corresponding marginal product.[7]

A similar issue as for capital substitution arises for labour input. Investments in human capital through education and training add to the supply of people with higher qualifications or skills. Labour inputs differ in marginal productivity. As a result, a rise

[6] Jorgenson, D.W., and Z. Griliches, 1967, The explanation of productivity change, Review of Economic Studies, volume 34, no. 99, July, pp. 249-280.

[7] See appendix A for more details.

in the supply of labour contributes to output growth in proportion to the marginal product. However, due to a lack of data on a lower level of aggregation, I have only adjusted labour inputs on a sectoral level. Initially, labour input is measured only by annual hours (i.e. full-time equivalents times annual contractual hours). The impact of changes in labour quality will be analysed in section 4.1.

The output concept: value added versus gross output

The concept of valued added, i.e. the value of output minus the value of intermediate inputs, is preferred as a measure of output on higher levels of aggregation. It avoids double counting of intermediate inputs by aggregation over industries: total output is the sum of industry-level measures of value added.

The value-added concept, however, creates a problem for productivity studies because intermediate inputs are transferred from a source of output to an explanation of output.[8] Therefore, many researchers prefer the use of gross output as a measure of products on lower levels of aggregation. Indeed, at the firm-level, this output concept looks more realistic. The outputs of a chemical firm are chemical products and not 'chemical valued added products'. Use of gross output as a measure ensures the connection between productivity and competitiveness, since measures of competitiveness are based on product prices.

Despite its advantages, the gross output concept has its drawbacks. Suppose a firm buys an almost-finished product and adds itself only a marginal element to the product. The value of gross output of this firm is high without almost any labour activity related to the product. Consequently, the odd result will be that the firm's labour productivity is relatively large. Moreover, if firms maximise profits, the value added concept points more directly to the firms' aim than does the gross output concept.

How is the KLEMS project related to the CPB research memorandum?

The planned KLEMS project of international comparison of the determinants of output and productivity will also apply the growth accounting methodology to the level of industries. Compared to the CPB research memorandum, this project further separates the intermediate inputs (V) into energy inputs (E), material inputs (M) and services inputs (S). Add to this capital (K) and labour (L), and it makes KLEMS. In addition, the KLEMS input concept will be amended by including important intangible capital components, or it could be expanded by including additional inputs, such as investment in research and development. Price indices will therefore be needed to convert input-

[8] See van Ark, B. 1996, Issues in productivity measurement: Statistical problems and policy links, in: *OECD, Industry productivity; International Comparison and measurement Issues*.

output (IO) tables into constant prices over long periods. At the moment, we have no IO-tables in constant prices for the Netherlands prior to the 1980s. This research memorandum circumvents this specific problem by considering the different intermediate inputs as one single input factor, which is already available in constant prices.

Finally, the KLEMS research project intends to analyse labour productivity developments at a lower level of industry than the CPB research memorandum. The aim of the KLEMS project is to focus on 36 industries. The available CPB database distinguishes fewer than 20 industries.

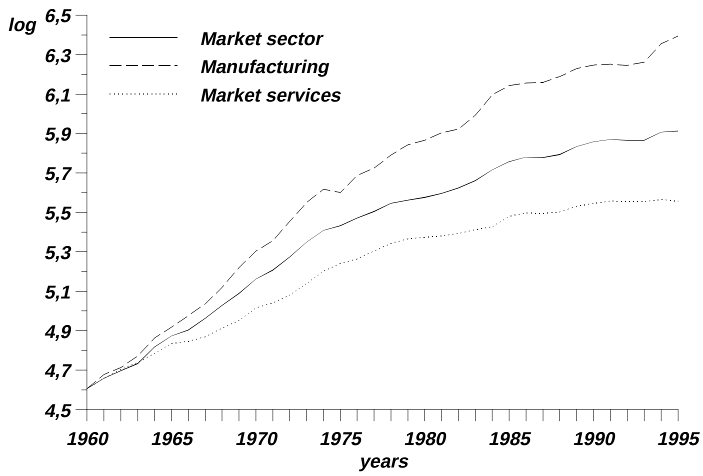
3 Decomposition of productivity growth

3.1 Productivity growth at the aggregated level

This section explores the results of the Dutch market sector as well as those of manufacturing and market services, which represent the bulk of the market sector. A simple means of exploring whether or not the character of development is different at the aggregated level is to examine visually the development of labour productivity, total factor productivity, capital intensity and employment.

Over the last twenty-five years, the growth rate of labour productivity in the Dutch market sector has gradually diminished (see figure 3.1). Note that it started to slow down around 1973, and it continued to decline in the mid-1980s and beyond. Whereas the first slowdown around 1973 was generally a global phenomenon, the second slowdown is definitely not (see box).

Figure 3.1 Labour productivity in the Netherlands (1960=100), 1960-1995



Looking at sectoral labour productivity trends in the post-war period, we see a similarity between manufacturing and market services. The trend in labour productivity growth in market services mirrors that of manufacturing over a long period. A general pattern of declining growth rates emerges in both sectors after 1973 through 1990. After 1992, the general pattern breaks down. Labour productivity growth in manufacturing accelerated, whereas it further worsened in market services. Over the entire period, labour productivity growth was much greater in manufacturing than in market services.

Poor productivity performance of the Netherlands in international perspective

Labour productivity growth flagged over time (see table). Growth rates are lower in the years after 1973 than before. However, the trends after 1980 show a mixed growth performance across the six countries. Japan, France and the Netherlands have failed to regain labour productivity growth rates into the 1990s, while growth rates in the US and the UK recovered. Britain's productivity growth rates are the highest in the first half of the 1990s.

The relative productivity performance of the Netherlands has worsened over time. In the period 1960-1973, growth rates of labour productivity were doing fine in an international setting. Since then, the Netherlands has lost ground. The relative decline does appear to have intensified considerably since 1990. Recent developments show that productivity growth rates in the Netherlands were the lowest compared with the other five countries.

Table *Labour productivity growth market sector, 1960-1995*

	1960/1973	1974/1979	1980/1990	1991/1995
	annual percentage changes			
Netherlands	6	3½	2¾	1
Germany	5¾	4	2¼	2¼
France	5¾	4	3¼	1½
United Kingdom	4	2¼	2½	3¼
Japan	8	3	3¾	2
United States	2¾	¾	1¼	1½

[a]Source: Netherlands: CPB Netherlands Bureau for Economic Policy Analysis; Other countries: O'Mahony (1999)

A cursory glance at the growth accounting ingredients, i.e. capital intensity and TFP, at the sectoral level shows that until the 1980s no marked difference in development emerges between both sectors and the market sector as a whole. Employment creation, however, definitely varied between both sectors. After 1985, market services' employment soared, while employment in manufacturing has been shrinking gradually since the early 1970s.

Over the entire period, growth rates of capital intensity have been substantially lower in market services than in manufacturing (see figure 3.3). In fact, capital growth rates have varied more widely than growth rates of TFP between both sectors (see figure 3.2).

Until 1980, TFP growth rates in market services kept almost on a par with those in market sector. From 1980, however, the performance of market services has, in this respect, worsened. The differences in growth rates increased considerably between manufacturing and market services.

Figure 3.2 TFP in the Netherlands (1960=100), 1960-1995

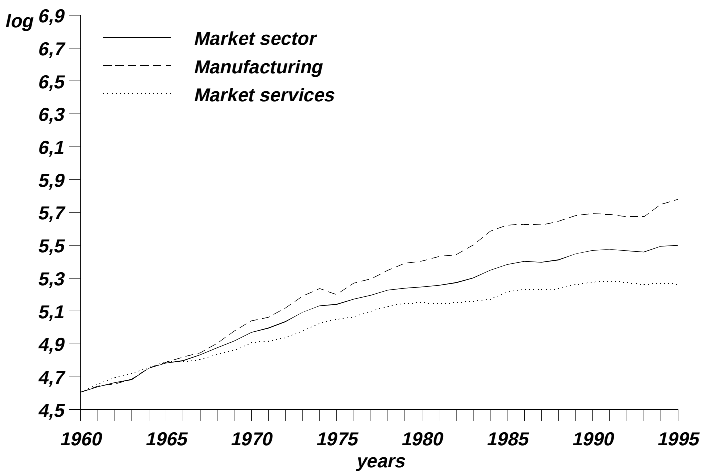


Figure 3.3 Capital intensity in the Netherlands (1960=100), 1960-1995

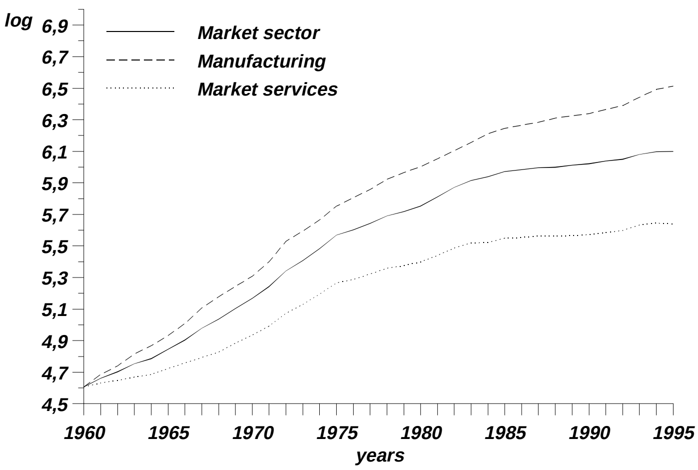
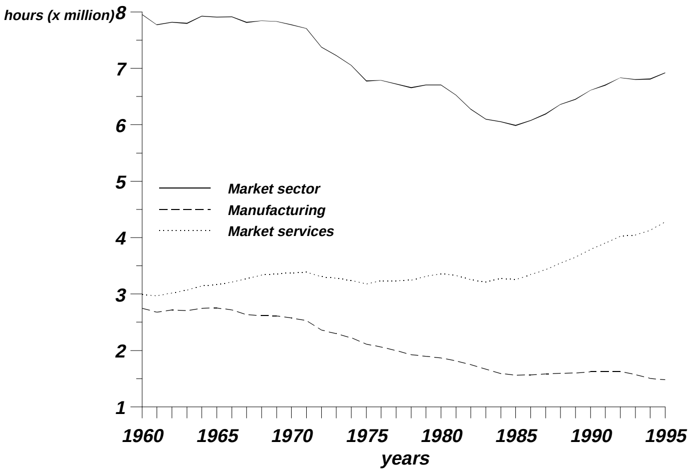


Figure 3.4 Employment in the Netherlands, 1960-1995



If we want to address the question of whether or not the Dutch economy faces a productivity problem, which was posed at the outset more precisely, then we need to examine more carefully at this time the figures that we gave earlier such a casual glance.

Therefore, table 3.1 decomposes labour productivity growth into the contribution of TFP growth and capital deepening for selected periods. At the macro level, the backsliding in TFP growth is stronger than that in capital intensity over time.

As stated before, prior to the early 1980s, productivity in manufacturing and market services showed almost the same pattern as productivity in the market sector at large. Afterwards, a different picture emerged; labour productivity growth in manufacturing recovered gradually, while growth rates in market services sharply slipped back in the 1990s.

The sudden productivity slowdown in *manufacturing* in the second half of the 1980s was due mainly to a reduced contribution of TFP growth. From the first half of the 1980s onwards, Dutch manufacturing has been forced to restructure. In connection with an economic downturn, profitability and investments were at the base, pushing the labour input out of the production process. In contrast, the upturn in the 1990s is due to TFP and capital deepening as well. Both an increase in investments, leading to higher growth rates of capital intensity, and a recovery of the value share of capital in total factor input contributed to the acceleration in labour productivity growth in manufacturing.

Table 3.1 Accounting for the growth of labour productivity, 1974-1995[a]

	labour productivity	contribution of TFP	capital intensity
	annual percentage changes	percentage points	
Market sector[b]			
1974-1979	3.6	2.5	1.1
1980-1985	3.2	2.6	0.8
1986-1990	2.0	1.9	0.3
1991-1995	1.1	0.7	0.4
Manufacturing			
1974-1979	4.9	3.4	1.5
1980-1985	5.0	4.0	1.0
1986-1990	2.1	1.4	0.7
1991-1995	2.9	1.8	1.1
Market services[c]			
1974-1979	3.8	2.9	0.9
1980-1985	1.9	1.2	0.7
1986-1990	1.3	1.2	0.1
1991-1995	0.2	-0.2	0.4

[a] Volume of gross value added per hour.

[b] Enterprises excluding mining and quarrying, operation of real estate, and medical- and other non-market services.

[c] Excluding operation of real estate.

The strong deterioration in TFP growth has largely caused the recent decline in productivity growth in Dutch *market services*, which actually vanished entirely in the 1990s. Although the contribution of capital has recently rebounded slightly, capital deepening still adds much less than it did during the first half of the 1980s.

As stated before, the flourishing employment creation in the Netherlands after the mid-1980s has especially been noticeable in the market services. This result seems to imply that employment growth has been associated with a substitution from capital to labour. It is feasible, therefore, that labour productivity growth in market services was held back due to wage moderation in the period after the Wassenaar agreement through the first half of the 1990s. Section 4.2 explores this possibility in further detail.

3.2 Productivity growth at the level of industry

Table 3.2 shows productivity growth at a more disaggregated level of industry within manufacturing and market services in the first half of the 1990s and the changes in growth rates compared to the previous period.

Table 3.2 Accounting for the growth of labour productivity by industry, 1991-1995[a]

	labour productivity	contribution of TFP	capital intensity
	annual percentage changes	percentage points	
Manufacturing	3 (¾)	1¾ (¼)	1¼ (½)
Food, beverage and tobacco industry	3¼ (-½)	2¼ (-½)	1 (0)
Chemical and rubber industry	4¼ (2¼)	2½ (1)	1½ (1¼)
Metal industry	3 (1½)	2¼ (1¼)	1 (¼)
Other industries	1½ (0)	¼ (-1)	1¼ (1)
Market services	¼ (-1)	-¼ (-1½)	½ (½)
Wholesale and retail trade	¼ (-1¼)	0 (-1½)	¼ (¼)
Transport, storage and communication	3 (½)	2½ (½)	½ (0)
Banking, finance and insurance	-1 (-1)	-2¼ (-2¼)	1¼ (1)
Other market services	-½ (-2)	-1½ (-2¼)	1 (¼)

[a]Volume of gross value added per hour; figures between brackets indicate differences in growth rates between 1991-1995 and 1986-1990.

First and foremost, an improved performance of the chemical industry accounts for the acceleration in labour productivity growth in *manufacturing*. This industry raised labour productivity growth due to a higher contribution of TFP and capital intensity. Upgrading of the product mix, in conjunction with process innovations, has undergirded this success. Both the shift towards goods with a high price per kilogram and the successful launches of several new products have contributed to additional value added.[9]

Besides the chemical industry, the metal industry also performed better in the first half of the 1990s than it did in the second half of the 1980s. However, based on the gross

[9]See CPB, 1997, *Economic outlook for the next cabinet period* (only in Dutch: *Economische Verkenning voor de volgende Kabinetsperiode*), Sdu Publishers, The Hague.

output concept, the industry’s productivity performance did not improve at all. The differences in development between both output concepts is due to an upgrading process that generated more value added per product.[10]

The marked fall in labour productivity growth in *market services* took place in almost every services industry except transport. The latter even slightly improved its relatively huge productivity growth rates after 1990. This improvement in productivity was accompanied by tremendous TFP growth that is even above the average growth rates in manufacturing. A closer look inside this industry shows that one of the most important sub-industries behind this outrageous performance is the air transport industry. The Dutch air transport industry took advantage of economies of scale, quality improvements, liberalisation, and tourism.

Although the increase in capital intensity accelerated to some extent in the first half of the 1990s, a strong deceleration in the rise of TFP held back labour productivity growth in the remaining industries within market services. This was particularly relevant for other market services and banking and finance. Inefficient use of input factors and inadequate organisation of functions and tasks could have hampered productivity growth in these industries. These inefficiencies could be due to a lack of fierce competition, since these services are less exposed to international competitors than transport and trade. On the other hand, measurement problems regarding output and prices could be important, too (see section 4.4).

In summary, although overall labour productivity growth has continuously slowed down, the Dutch economy does not face an overall productivity slowdown if productivity trends in the first half of the 1990s are scrutinised on lower levels of aggregation. The productivity problem seems to be endemic to some market services. However, as the share of market services in total output and employment increases, the productivity problem could become evident in the near future. The next section therefore addresses proximate causes behind the sluggish productivity growth in Dutch market services.

[10] See appendix B.

4 Productivity slowdown in Dutch market services: a further analysis

4.1 The effect of low-skilled workers and fewer productive industries

Small negative productivity effect due to more low-skilled workers

Since the mid-1980s, employment growth in Dutch services has been accompanied by flagging productivity growth. This pattern suggests that new jobs in services feature low productivity. So far, only capital inputs have been adjusted for quality improvements. Due to a lack of sufficient data, the impact of quality changes in labour can be measured only indirectly. Following the methodology of Pomp (1998), I adjust sectoral labour productivity growth for labour quality changes. I hereby assume that wage variation among different types of workers reflects differences in quality.[11]

Table 4.1 illustrates the lack of evidence that measured employment composition effects have recently reduced labour productivity growth rates, especially in market services. In contrast, labour quality changes should have substantially raised labour productivity growth in the early 1990s, at least under the maintained assumption that changes in wages reflect changes in productivity. Therefore, if labour productivity growth is adjusted for labour quality changes, the productivity slowdown in Dutch market services becomes even more pronounced.

Table 4.1 Effects of quality-adjusted labour on Dutch labour productivity, 1980-1995

	1980-1985	1986-1990	1991-1995
	annual percentage changes		
Quality effect			
Manufacturing	½	¼	1
Market services	¾	– ¼	1¼
Quality adjusted productivity			
Manufacturing	4½	1¾	2
Market services	1	1½	– 1

[11] See appendix C for further details.

Small negative reallocation effect within sectors

As highlighted in the box *Notes on growth accounting*, it is important to distinguish between sources of changes in aggregates. Sectors might become more productive without productivity gains at the level of industry. If more productive industries gain market shares, while less productive industries lose market shares, aggregate productivity will improve. As is the case with other developed economies, the Dutch economy is shifting towards more services. Usually, labour productivity growth rates and labour productivity levels are lower in services than in manufacturing. Hence, de-industrialisation could explain the overall productivity slowdown.

To measure the sectoral composition effect on the overall labour productivity growth, the latter can be decomposed into a within-effect, shift-share effect and a cross-term:

$$(5)\quad \Delta \ln h = \frac{[\sum \Delta(\frac{VA_i}{L_i}) * \frac{L_i}{L}] + [\sum (\frac{VA_i}{L_i}) * \Delta(\frac{L_i}{L})] + [\sum \Delta(\frac{VA_i}{L_i}) * \Delta(\frac{L_i}{L})]}{\sum \frac{VA_i}{L_i}}$$

The within-effect expresses the change on productivity growth as a whole due to productivity growth within industries. The second term, i.e. the shift-share effect, measures the effect of changes in the employment shares of industries on overall productivity growth. If the impact on productivity turns out to be positive, then there has been a reallocation of inputs towards more productive industries. A negative result infers that resources have been transferred to industries with lower levels of productivity. Finally, the third term on the right-hand side represents the effect of both changes in productivity and changes in market shares. This effect is positive if industries raise their productivity as well as their market shares or, vice versa, reduce their productivity and their market shares simultaneously.

Table 4.2 presents the results of this decomposition method both on an aggregated level and at the level of market services. Remarkably, the shift-share effect appears to be negative in the market sector only in the last period. To some extent, the recent overall slowdown in productivity growth is associated with an increased employment share of the services sector, which typically features lower productivity levels. Nevertheless, approximately 75 percent of the slowdown is related to the languishing productivity growth within industries.

The shift of resources within service industries substantially reduced productivity growth in market services after 1985. Other market services increased their share in market services considerably. Nevertheless, their productivity growth performance was lower than that on average. After 1990, the productivity slowdown in market services became even more pronounced, due to lower growth rates across most service industries.

Table 4.2 Decomposition of labour productivity growth, 1974-1995

	1974-1979	1980-1985	1986-1990	1991-1995
	annual percentage changes			
Market sector	3¾	3¼	2	1
Within-effect	3¼	3	2	1¼
Shift-share effect	½	¼	0	– ¼
Cross-term	0	– ¼	0	– ¼
Market services	3¾	2	1¼	¼
Within-effect	3¾	1¾	1¾	½
Shift-share effect	¼	¼	– ¼	– ¼
Cross-term	0	0	0	0

4.2 The impact of wage moderation on labour productivity

Capital services currently available for productive use are one of the factor inputs that cause productivity to vary. The amount of available capital for productive use in each year depends on current investments and on the efficiency of the existing capital stock: older vintages are less productive than newer vintages. What has been the effect of wage moderation on this input factor?

One success of the ‘Dutch miracle’ has been without doubt wage moderation, which fostered employment creation. In order to regain economic growth and to curtail unemployment, the Dutch government urged the social partners to reduce the excessive wage growth in the early 1980s. The so-called ‘Wassenaar agreement’ between the social partners at the end of 1982 heralded a period in which the common policy goal became employment creation and wage moderation. The government encouraged this common policy by reducing the tax burden of both employers and employees.

However, some researchers, such as Kleinknecht (1996), believe that wage moderation has its drawbacks: it induces less product innovation and process innovation.[12] Such researchers believe that wage moderation will change the relationship of labour to capital. The relative decline in the price of labour will lead to substitution of capital for labour. The incentives for firms to invest in new capital are reduced, and they will delay scrapping of old capital. As a result, the capital stock ages. The production process will become less capital intensive, and labour productivity growth stagnates. Moreover, this wage policy protects ineffective firms, allowing them to survive when they would otherwise have been forced to exit due to a lack of incentives to launch new products or to adapt the production process.

To address the question whether or not wage moderation causes the stagnation of labour productivity growth, I will touch on three issues: capital intensity, capital costs of services, and mean service lives of capital assets. I will argue that wage moderation has fostered investments in services and that evidence of lacklustre productivity growth due to wage moderation is lacking.

First, sluggish aggregate capital intensity growth rates in market services conceal significant growth rates at the level of industry due to composition effects. The contribution of capital intensity to labour productivity growth recovered considerably in market services in the 1990s, but it is still below its contribution in the early 1980s. However, as table 4.3 illustrates, the development of capital deepening within market services does not generally point to a lack of process innovations and diffusion of new embodied technology. Both banking and finances, as well as other market services featured substantially higher growth rates of capital intensity than during the early 1980s.

Table 4.3 Growth of capital stock and intensity in Dutch market services, 1980-1995

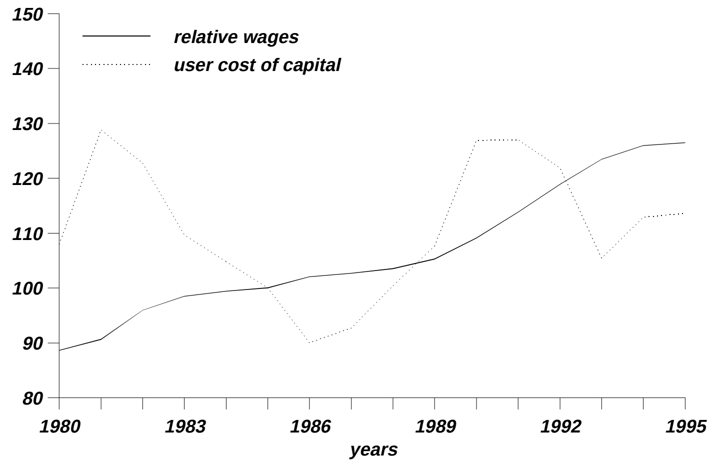
	Capital stock			Capital intensity		
	1980-1985	1986-1990	1991-1995	1980-1985	1986-1990	1991-1995
	annual percentage changes					
Market services	2¾	3½	3¾	3	½	1¼
Wholesale and retail trade	2	2½	3	4	0	1
Transport, storage and communication	3	2¾	2¾	3¼	1½	1¾
Banking, finance and insurance	1¾	2	3¼	1½	½	3
Other market services	3¼	8	7¾	2	3	3½

[12] Kleinknecht, A.,1996, Squander with wage moderation and flexibility (only in Dutch: Potverteren met loonmatiging en flexibilisering) Potverteren met loonmatiging en flexibilisering, *ESB*, 17 July, pp. 622-625.

Capital intensity in transport services, which features the highest capital intensity among market services, still grew significantly in the period 1991-1995. As I mentioned, however, this industry, faces no productivity problem at all. Due to their lower levels of capital intensity, banking and finance, as well as other market services, depressed the overall growth rate of capital intensity in market services in the period 1991-1995. Hence, the results at a lower level of aggregation do not directly suggest that there was a lack of process innovation or a substitution of capital for labour in those industries.

Second, although the wages have been moderated after 1982, wages have relatively increased compared to the costs of using capital in the aftermath of the Wassenaar agreement. Figure 4.1 explores the developments of wages and user cost of capital. Reductions in nominal interest rates and low rates of inflation put down the user cost of capital throughout the decade.

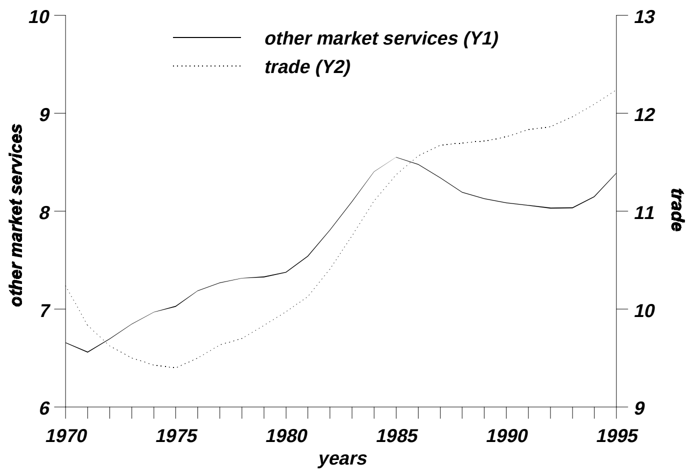
Figure 4.1 Relative wages and user cost of capital in other market services (1985=100), 1980-1995 [a]



[a] Wages and user cost of capital are both relative to the output deflator.

Finally, the mean service lives of assets have not changed remarkably in other market services after the Wassenaar agreement (see figure 4.2). This result also suggests that wage moderation has not widely depressed the accumulation of new capital.

Figure 4.2 Mean service lives of assets in trade and other market services, 1970-1995



To conclude, the negative impact of wage moderation on productivity growth seems to be absent. Besides many CPB studies, recent research by Bartelsman (1997) suggests that when one takes into account not only the specific production relationship between capital and labour, but also the problem associated with appropriability of quasi-rents on specific investments, one finds that institutionalised Dutch wage moderation could have boosted rather than depressed new investment and productivity.[13] Certainly, wage moderation in the Netherlands restored profitability in market services, thereby creating the room and incentive to boost investment. As a result, the investment ratio in services recovered.

4.3 Benchmarking Dutch market services performance

This paragraph presents an overview of Dutch relative market service productivity performance in the period after the first oil crises, which heralded a global slowdown in productivity. Data problems seriously hamper international comparisons in services,

[13] Bartelsman, E. J., 1997, Productivity and specificity in factor inputs, in *International workshop on the effects and policy implications of structural adjustment in small open economies, Amsterdam October 23-24, 1997.*

since measurement problems regarding output and quality changes are more severe in services than in manufacturing. An international comparison of growth accounting results is also limited due to differences in methodology in constructing the required capital stock or capital services estimates. Moreover, examining growth rates over different time periods in an international context is difficult, since the timings of business cycles vary across countries.

Despite these problems, using both the results of recent research at the National Institute of Economic and Social Research (NIESR)[14] and Groningen Growth and Development Centre (GGDC)[15], I have placed the results of the Research Memorandum in an international context. Although the industry groups within services in both studies are somewhat different from those employed in this study, the results reveal some general trends.

Table 4.4 Output per hour worked: an international comparison, 1991-1995

	US	UK	France	Germany	Japan	Netherlands
	annual percentage changes					
Total market sector	1½	3¼	1½	2¼	2	1¼
Manufacturing	3¼	3½	3	2½	3	3
Market services	1	2½	¼	1¾	2¾	¼
Distributive Trades	2¼	1½	¼	¾	2¾	¼
Transport & Communications	1¼	6	2¾	3¾	1½	3
Financial & business services	1½	1	−1	1½	2½	− 1
Other market services	−¾	4	−1	2½	3½	− ½

Source: US to Japan: NISEC, The National Institute Sectoral Productivity Data Set, NIESR, London; The Netherlands: CPB Netherlands Bureau for Economic Policy Analysis.

Table 4.4 shows that labour productivity growth was much lower in market services than in manufacturing in most countries (except Germany) in the period 1991-1995. Growth rates between both sectors vary the most in France, but differences in the Netherlands

[14] O'Mahony, M., 1999, Britain's productivity performance 1950-1996; An international perspective, National Institute of Economic and Social Research, London. This book compares productivity performance in Britain with five countries, the US, the UK, France, Germany and Japan for the postwar years.

[15] Over the years, GGDC have developed large data sets that also contain international sectoral data on output and employment. Series from the GGDC database are available on the internet site of the Groningen Growth and Development Centre (http://www.eco.rug.nl/ggdc.html).

are also substantial. Moreover, the Dutch overall growth rate in market services is the lowest in this international setting. Financial insurances, business services and other market services stand out as the worst-performing Dutch industries in this period.

Some results of the growth accounting exercises by GGDC are summarised in table 4.5 and figure 4.3. GGDC's results confirm poor productivity performance of the Dutch market services. Labour productivity growth during the period 1985-1996 is the lowest for services in the Netherlands. Growth rates have dropped in most selected countries (except the UK) during the period 1985-1996 compared to the period 1973-1985. Strikingly, the slowdown in growth rates is the highest in the Netherlands. In contrast, German performance in services is remarkably good. Germany's growth rates were already on the forefront in the period 1973-1985. Despite its flagging productivity growth rates in the 1990s, Germany is still among the highest ranking of European countries.

Again, the development in France shows similarity to the pattern in the Netherlands. Initially, labour productivity growth in services was relatively high in an international perspective. Yet, in the past ten years, French performance has been lacklustre. In the first half of the 1990s, average productivity in services grew by less than 1% a year.

The relative lower growth rates in the Netherlands go along with lower TFP growth (see figure 4.3).TFP growth rates in Dutch market services dropped by approximately 1½%-point between the two selected periods. TFP growth in Dutch market services declined further at the end of the 1980s, and vanished altogether in the 1990s. One reason for this might be the absence or exhaustion of the catch-up effect. The catch-up hypothesis assumes that the further an economy is from the technological frontier, usually the United States, the greater the possible rate of technological advance.

To what extent have Dutch services industries reached the technological frontier beyond which increased productivity is difficult to attain? Whereas productivity in the Dutch wholesale sector and transport sector does not appear to be lagging behind that in other industrialised countries beyond the US (see box), other Dutch market services, such as business services, seem to lag behind and could therefore still catch-up.[16] Nevertheless, this may not be the case so far. What is going on? Why has the relative position of the Dutch in services worsened over time?

[16] See CPB, 1997.

Table 4.5 Output per hour worked in services, 1973-1996

	1974/1985 (1)	1986/1996 (2)	slowdown (2)-(1)
	annual percentage changes		
France	2½	1	−1½
Wholesale and retail trade	2½	1	−1½
Transport and communication	3¾	3½	−¼
Finance, insurance, real estate&business services	1½	0	−1½
Community, social and personal services	2¼	½	−1¾
Germany	2½	2¼	−¼
Wholesale and retail trade	2	2	0
Transport and communication	4½	3½	-1
Finance, insurance, real estate&business services	3	2¼	−¾
Community, social and personal services	1¾	2¼	½
United Kingdom	1	1¼	¼
Wholesale and retail trade	½	2¼	1½
Transport and communication	2¾	4¼	1½
Finance, insurance, real estate&business services	1¼	0	−1¼
Community, social and personal services	¼	−½	−1
United States	1½	¾	−¾
Wholesale and retail trade	2¼	1¾	−½
Transport and communication	2½	1½	−¾
Finance, insurance, real estate&business services	−½	1¼	1½
Community, social and personal services	¾	−½	−1¼
Netherlands	2¾	¾	−2
Wholesale and retail trade	3½	1	−2½
Transport and communication	3	2¾	−¼
Finance, insurance, real estate&business services	3	−½	−3½
Community, social and personal services	1¼	¼	−1

Source: France up to United States: GGDC-sectoral database; Netherlands: CPB Netherlands Bureau for Economic Policy Analysis.

International comparison of productivity levels in services

An international comparison of labour productivity in services is difficult, partly because of measurement problems. Recently, van Ark et al. (1999) measured productivity differentials in some services for a few countries (see table). The estimates of productivity in transport and communication and distribution suggest that productivity relative to the US is generally lower in the selected countries. However, the distributive trade sector in France and the transport sector in the Netherlands are more productive than their counterparts in the US. In this international context, Dutch productivity does not appear to be lagging behind in these two sectors.

A clear picture is still lacking of the comparative labour performance of other market services, and little work has been done on this perspective. McKinsey (1997) found that the Dutch software sector was less productive than the software sector in countries like the US, Germany and France. Based on OECD statistics, the overall productivity level in market services seems to be rather low in the Netherlands. Taking into account the reasonable performance in transport and trade, this result suggests that the remaining Dutch services are underperforming in an international perspective.

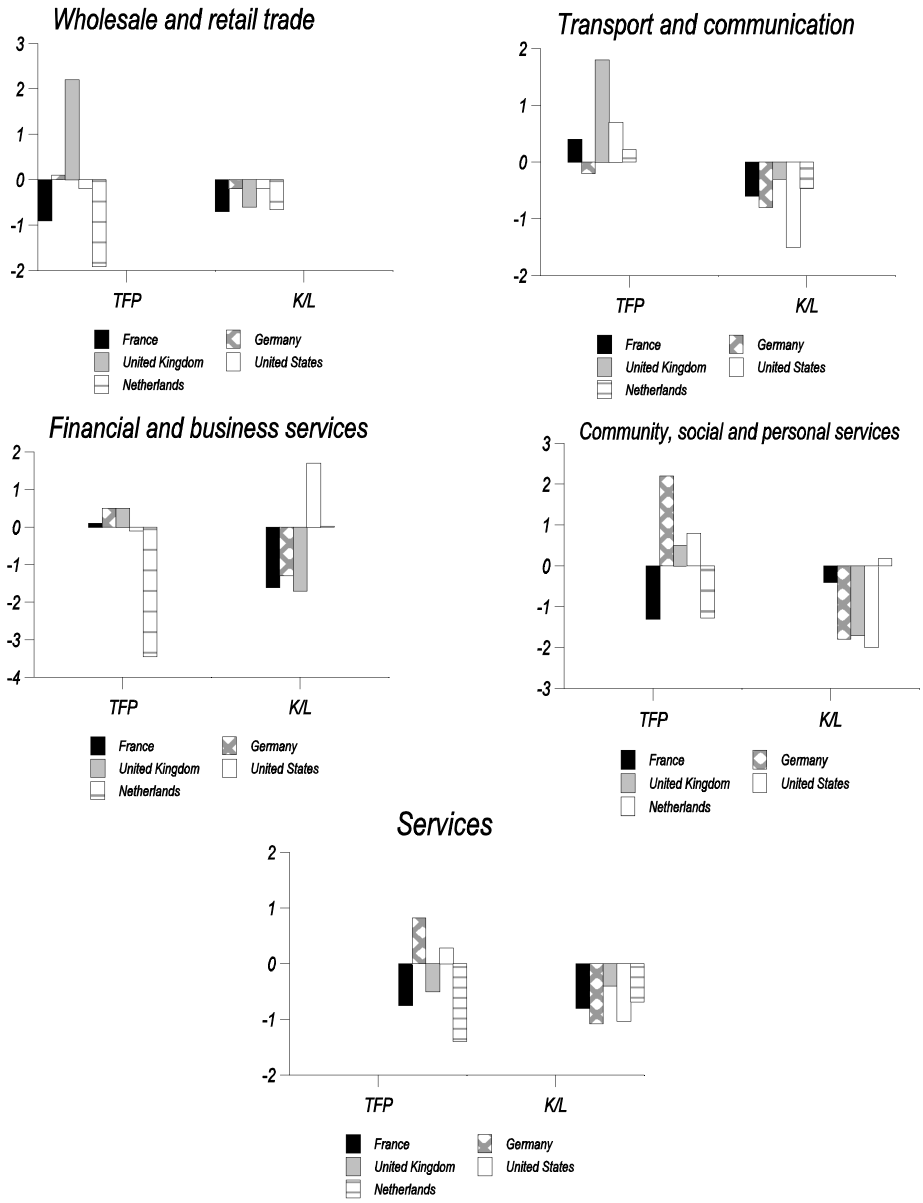
Table Comparative levels of labour productivity by sector, 1990

	Transport and Communication	Distributive trade
	United States=100	
Netherlands	112.5	69.6
Canada	74.1	51.1
Germany	64.0	70.1
Japan	31.3	55.1
United Kingdom	74.1	71.5
France	73.2	101.6

Source: Ark, B. van et al., 1999.

One of the possible reasons why Dutch services have not reached their potential output is a lack of adequate management and a suitable organisation of tasks. Several studies

Figure 4.3 *Changes in sources of labour productivity growth between 1973/85 and 1985/1995*



Source: van Ark et al. (1999).

have stressed the effect of deficient managerial abilities on productivity.[17] Since output in Dutch services has been booming since the 1980s, more than on average in an international perspective, firms in services had to expand and bring order to their organisations. Information technology (IT) offers firms the potential to improve corporate efficiency and to innovate new services. However, the use of IT also requires a new workplace organisation. Recent research showed that productivity gains cannot be attained simply by accumulating IT resources without transforming the way firms are run.[18] Perhaps, these required organisational changes have been set in motion too slowly in the Netherlands.

Additionally, low rates of productivity growth in Dutch services might also reflect a lack of competition. Both trade services and transport services are more exposed to international competitors than other market services. The productivity growth rates of the former are less lacklustre than those of the latter. According to McKinsey (1997), Dutch banks, although efficient, are far less innovative in savings and investment products than US financial institutions, which not only offer twice as many mutual funds per capita, but have also created over 60 percent more jobs in savings and investments services to date.[19]

Finally, recent CPB-research finds that even the Netherlands -a small open economy- can spur on technical change and raise productivity substantially by investing more in R&D.[20] The effect of domestic R&D is a rather important determinant of productivity in Dutch services sectors. Dutch R&D expenditures in services, however, are low by international standards.

4.4 Measurement problems in services: Productivity paradox?

Despite the increasingly use of IT and many new services, the productivity growth slowdown in services has apparently not been reversed. "You can see the computer age everywhere these days except in the productivity statistics", said Solow a couple of years ago. Why did not the explosion of the use of computers increase productivity growth in services? Do the figures simply fail to show it? Hitherto, three explanations

[17]Biema, M. van, and B. Greenwald, 1997, Managing our way to higher service-sector productivity, *Harvard Business Review*, July-August, pp. 87-95.

[18]Hoogeveen, D.,1997, The long and winding road; From IT investments to business performance, Ph d thesis.

[19]McKinsey & Company, 1997, Boosting Dutch Economic Performance, September 1997.

[20]Jacobs, B., R. Nahuis and P.J.G. Tang, 1999, Sectoral productivity growth and R&D spillovers in the Netherlands, *CPB Research Memorandum*, no.149, The Hague.

have been advanced to disentangle the so-called 'Solow paradox' or productivity paradox.

A first explanation focuses on the mismeasurement of output and quality in services. Measurement problems with regard to output and quality changes pose without doubt a severe problem in services, especially in banking and finance. What is the output of a bank? What is the impact of new services? It is believed that growth in output and productivity alike tends to be understated in many services because the benefits of new services are inadequately captured or uncountable in statistics.

In 1995, the Boskin committee concluded that the US consumer price index (CPI) was overestimating the true rate of inflation by about 1 percentage point per year due to new products and quality changes. The price effects of new products and quality changes are insufficiently captured in the CPI. As a result, US labour productivity growth is also understated. Unfortunately, it is unknown exactly to what extent the Dutch CPI is overestimated.

A switch to another output concept in Dutch banking would reveal greater productivity gains.[21] However, a measurement explanation of the productivity slowdown in services requires mismeasurement to extend over time. So, there must be an increase in the measurement bias regarding output and prices. This increase has not yet been proven. Gordon recently said that is difficult to argue that US current deflators understate quality changes and the benefits of new products to a greater extent than in previous decades.[22] Yet another question: has the rate of the number of new products and quality changes increased over time? In addition, in an international setting, it is hard to believe that Dutch performance in growth rates lagged behind that in other countries due merely to measurement problems.

A second explanation of the productivity slowdown highlights the aspect of lags in the adaptation of IT. This line of reasoning argues that IT offers enormous potential to improve productivity, but that the efficient use of IT requires time and effort. The lagged effect of electricity on productivity growth is a well-known example to support this view of long implementation lags of new technologies (David, 1991). Although the dynamo was introduced at the end of the 19th century, many factories continued to use the same organisation as they used during the steam engine age. Only in the 1920s were the production and organisation processes adapted efficiently to realise the productivity potential of electricity. As stated before, complementary changes and technologies are required to achieve gains in efficiency. The effective use of IT also requires personnel

[21] Hogenboom, R., and P. van de Ven, 1998, Does Dutch banking face a productivity problem? (only in Dutch: Heeft het Nederlandse bankwezen een productiviteits-probleem?), *Bank- en effectenbedrijf*, May.

[22] Gordon, R.J.,1999, Has the 'New Economy' rendered the productivity slowdown obsolete?, unpublished paper, available on the web (http://faculty-web.at.nwu.edu/economics/gordon).

equipped for the new demands of work. Is the effect of IT, therefore, still a question of time, or not? This issue has not yet been settled.

A final explanation focuses on the negative effect of IT due to the so called IT-maffia. Costs associated with the operation of IT systems are huge. Firms spent a fortune on PCs with few gains in productivity. Almost daily new versions of computers and software reduce the effective use of the computer on the workplace. There is a lack of standardisation, and computers have turned into increasingly complex machines, without any effective productivity gains at all. The production of computers has a high private rate of return, but they generate few spillovers. So far, returns to investment in IT equipments have been successfully internalised by computer producers.[23]

In summary, Dutch labour productivity performance in services is rather poor in an international setting. This result goes hand in hand with the relatively sluggish TFP growth rates in Dutch market services. The Dutch performance resembles the US performance: strong job creation in services coinciding with sluggish growth rates in labour productivity. Changes in the employment structure towards lower-skilled workers seem to be absent in Dutch market services. The growth accounting technique is, however, unable to disentangle the ultimate sources underlying the relative lack of TFP growth.

[23] A more banal hypothesis recently advanced to explain the productivity paradox argues that IT, such as the Internet, is not used for the production process at all. Rather, it is used as a toy to watch or to download, for instance, the latest version of formula 1; last but not least, it is used to curiously track job vacancies of competitors (see Bergen, A.,1998, The computer paradox, huge investments, few gains (only in Dutch: De computerparadox, hoge investeringen, weinig rendement), *Elsevier*, 22 August).

5 Conclusions and plans for additional research

Over the past three decades, Dutch labour productivity growth has slowed down. Although productivity flagged across the board in the aftermath of the first oil crises, Dutch performance has been rather poor in an international setting. This research memorandum concludes that the productivity problem is not endemic to the entire Dutch economy. Overall productivity figures hide widely different levels of performance within separate sectors and industries.

Recently, productivity performance in two basic sectors of the market sector, i.e. manufacturing and market services, has been markedly different. Manufacturing, in which labour productivity accelerated slightly during the first half of the 1990s, does not seem to be confronted with a productivity problem. In fact, a further acceleration of labour productivity growth could be expected because recent higher levels of investment boost capital intensity. On the other hand, the productivity performance in market services has deteriorated continuously over time. In fact, if adjusted for labour quality changes, productivity in market services is even lower in the 1990s than it was before.

After 1990, productivity growth in Dutch market services, which comprises nearly 65 percent of the Dutch market sector, has almost been absent. The instantaneous slowdown in market services has been accompanied by one particular factor: TFP. TFP growth has all but ceased. This could point to an inefficient use of factor inputs in the production process, or to a lack of disembodied technological change. The growth accounting tool is, however, unable to disentangle the ultimate sources underlying the poor productivity performance in Dutch market services. Therefore, no conclusive answers can be given, and additional and alternative research is required.

The planned KLEMS project aims to study the economic growth and innovation performance of eight countries and it will probably start next year. CPB Netherlands Bureau for Economic Policy Analysis is one of the ten research institutes that will carry out parts of the project. The KLEMS project is expected to provide additional insights into the relative international performance of the Netherlands at a lower level of aggregation.

CPB is also currently conducting research in business services in order to enhance our understanding of the factors behind the apparent poor performance of Dutch market services. Unique firm-level data are used to decompose labour productivity growth into the contributions of incumbents, entrants, and firms that exit. As far as the high entry- and exit rate of firms, and the noticeable increases in output and employment, are concerned, business services is really one of the most dynamic sectors in the Dutch economy in the recent past. The high rates of entry and exit suggest low entry barriers and, therefore, fierce competition stimulating efficient management. Nevertheless, labour productivity growth in Dutch business services has not yet improved. Since entering firms are less productive than incumbents, and since many new firms have entered the market of business services in the period investigated, negative reallocation effects largely determined the poor productivity performance in business services.[24] A follow-up of this micro-research will attempt to gain insight into the relationship between productivity, firm dynamics and competition.

[24] Wiel, van der H.P., 1999, Productivity in Dutch Business Services: the role of entry and exit, *CPB Report 1999/2*.

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Appendix A Data and measurement issues

Data

The industry data are sourced from the sectoral timeseries database of CPB. This database contains annual industry data series on a range of variables such as gross output, value added, employment, intermediate inputs, investments per type of asset from early postwar years onward. Recently, sectoral capital stock figures for the post-war period have been constructed to apply the growth accounting methodology. The latter are still preliminary, due to lack of sufficient information on a disaggregated level and further research plans by Statistics Netherlands.[25]

Capital stock and capital services per industry

Capital service is one of the variables that is used as an input in the production function, relating flows of input to flows of output. Capital is an aggregate of various types of fixed capital. Since capital goods differ substantially in marginal productivity, it is necessary to focus on the flows of capital services rather than the stock of capital. Unfortunately, capital services are usually not available directly. However, capital services can be generated by capital stocks.

Here, the estimates for total capital stock by industry are based on (a variant of) the perpetual inventory method (PIM) at the level of industry. The PIM requires time series on investment by asset and industry over a very long period and accurate price indexes to revalue past investments to current time series. This research memorandum distinguishes seventeen branches of industries (=i) and seven different types of capital assets (=j).

$$K_{ij}(t) = \sum_{b=0}^{b=t} S_{ij}(t,b)\ \Phi_{ij}(t,b)\ I_{ij}(b) \qquad \textbf{(6)}$$

Where
- S Proportion of investment at time b that survives to time t
- Φ Economic efficiency at time t
- I Original investments in real prices at time b

[25] Although Statistics Netherlands produces a yearly census of capital goods in manufacturing, agriculture and transport, the results of these censuses are doubtful, at the least (see van der Wiel, 1998). In the near future, Statistics Netherlands will carry out a project to construct new investment time-series for the past. They also aim to construct a sound capital stock.

Next, a truncated normal distribution is used with a stochastic mean service life centred about the mean life (see table A.1). The actual service life is assumed to be a random variable. This randomness is due to factors such as destruction, fire, theft and unanticipated obsolescence. The normal distribution is truncated, with a variance of one quarter the mean life, and truncated at 50 percent above and below the mean. Further, a beta-decay function, (β=0.90), is applied to the remaining stock to reflect efficiency loss by each type of asset as it ages.

$$\Phi_a = \frac{m_{ij} - a_{ij}}{m_{ij} - \beta a_{ij}} \qquad (7)$$

where
- a Asset's service life
- β Curvature parameter (β=0.90)
- m Mean service life
- Φ_a Proportion of asset's original productive efficiency remaining at age a

Table A.1 Mean service lives per type of asset

	mean service lives in years
Building	35-60
Machinery and equipment	10-25
Cars and road transport	10-15
Rail	40
Vessels	25-40
Aircraft	15
Civil engineering	35-45

Problems with constructed capital stock

The calculation of capital stocks based on PIM is fraught with difficulties. A comprehensive discussion of these difficulties is beyond the scope of the research memorandum, but some difficulties are briefly highlighted below.

First, the growth rates of the capital stock at the level of industry could be biased due to measurement problems with regard to the initial capital stock. Annual series on required investments are available from the year 1948 onwards. Since the mean service life for the longest-lived asset type goes back to before 1948, a capital stock per type of asset and industry has been constructed for 1948 in two ways. The first estimate is based on an old exclusive investigation of Statistics Netherlands. This investigation guesstimated the total capital stock of the Netherlands around the early 1950s.[26]

The second estimate uses the following formula to calculate a capital stock for 1948:

(8)

$$K_{ij}(0) = \frac{(\sum_{0}^{7} I_{ij}(t)) \ / \ 7}{(I_{ij}g7 \ + \ 1/m_{ij})}$$

Where $I_{ij}g7$ Average investments over seven years

Due to the long period after 1948, the differences in capital stock growth rates are modest between both methods. I have therefore applied the first estimate.

Second, the quality of the estimates of the capital stock also depends on the reliability and consistency over time of the required investment series. Unique investment series per type of asset do not exist due to several revisions and reclassifications in the period 1948 to 1995.

Further, based on limited empirical evidence, the shape of the decay function is supposed to be concave, implying that efficiency first declines slowly and then more rapidly as the asset ages. This pattern is consistent with two different assumptions concerning maintenance and repair practices: the decline in efficiency with any uniform level of maintenance and repair (output decay), the increasing costs of maintenance and repair required to maintain 100% of efficiency (input decay). However, the exact value of the beta-decay is unknown. Nevertheless, by setting different values for β, I have analysed the sensitivity of the results. The differences were very modest.

Finally, the assumptions on service lives may very well be wrong. Overly long service lives will overstate the size of the capital stock, and too-short lives will understate it. However, a change in asset-life assumptions will have a more limited effect on growth rates than on the size of the capital stock. More serious could be the effect of changing asset lives over time, and changing the composition of capital stocks within the seven types of assets. In this respect, the composition of the capital stock could have been substantially changed by an increasing share of computers, whic have relatively shorter service lives. In this study, I assume that both effects are absent.

[26]See Verbiest, P., 1996, The capital stock in the Netherlands (only in Dutch: De kapitaalgoederenvoorraad in Nederland), CBS-Voorburg.

Capital services

The flow of capital services is a weighted sum of past investments, with weights given by the efficiency of each asset of different age. Each type of capital input must be weighted by its marginal product. To aggregate each type of asset to the total capital input, rental prices of capital are needed.

(9) $$\triangle \ln K_i = \sum_j W_{ij}^k (\triangle \ln K_{ij})$$

with

(10) $$W_{ij}^k = \frac{p_{ij}^k \, . \, K_{ij}}{\sum_j p_{ij}^k \, . \, K_{ij}}$$

where P^k User cost of capital

The user-cost of capital for each type of asset is based on long-bond and equity returns, as well as tax information from the CPB macro model FKSEC (1992) and sectoral information on tax deductibility, accelerated depreciation allowances, and investment tax credits:

(11) $$P_{ij}^k = T_{ij}[(1-u)r + d_{ij} + risk - P^e_{ij}]P_{ij}$$

with

(12) $$T_{ij} = \frac{(1 - wir_{ij} - uIA_{ij})}{(1 - u)}$$

where	d	Depreciation percentage
	IA	Fiscal investment facilities
	P$^{(e)}$	(expected) purchase price of asset
	r	Long-term interest
	risk	Mark-up for risk

u	Corporate tax rate
wir	Investment premiums

Capital services versus capital stock

As can be seen in table A.2, small differences in growth rates are found between capital stock, based on the PIM, and capital services on an aggregated level over time. However, at a lower level, differences are somewhat more pronounced.

Table A.2 Comparison of capital stock and capital services, 1974-1995

	capital stock	capital services
	annual percentage changes	
Manufacturing		
1974-1979	3.05	3.18
1980-1985	1.52	1.51
1986-1990	2.84	2.90
1991-1995	1.68	1.69
Market services		
1974-1979	4.37	4.41
1980-1985	2.65	2.57
1986-1990	3.53	3.55
1991-1995	3.83	3.85

Appendix B Growth accounting results: Gross output versus value added

As it is not settled which output concept should be preferred at the level of industry, this appendix presents the growth accounting results based on both concepts: gross output and value added. Table B.1 explores the results in manufacturing and table B.2 those of services. Labour productivity trends are generally similar between both output concepts. Differences in trends are noticeable in industries such as metal and banking.

Table B.1 Accounting for the growth of labour productivity in manufacturing, 1980-1995

	Gross output				Value added		
	labour productivity	TFP	K/L	V/L[a]	labour productivity	TFP	K/L
	annual percentage changes						
Food, beverage and tobacco							
1980-1985	5½	½	¼	4¾	4¼	2¾	1½
1986-1990	3	½	0	2½	3¾	2¾	1
1991-1995	2¾	½	¼	2	3¼	2¼	1
Chemical and rubber							
1980-1985	4¼	1½	¼	2½	7¼	6½	¾
1986-1990	3¼	½	¼	2½	1¾	1¼	½
1991-1995	4¼	¾	½	3	4¼	2½	1¾
Metal							
1980-1985	4¼	1½	¼	2½	4½	3¾	¾
1980-1990	3¼	½	¼	2½	1½	1	½
1991-1995	2¾	¾	½	1½	3	2	1
Other industries							
1980-1985	4	1¼	½	2¼	4¼	3	1¼
1986-1990	2½	½	0	2	1½	1¼	¼
1991-1995	2	¼	½	1½	1½	¼	1¼

[a] V is defined as intermediate inputs.

Table B.2 Accounting for the growth of labour productivity in market services, 1980-1995

	Gross output				Value added		
	labour productivity	TFP	K/L	V/L[a]	labour productivity	TFP	K/L
	annual percentage changes						
Trade							
1980-1985	3¼	1	¾	1½	3¼	2½	¾
1986-1990	2	¾	0	1¼	1½	1½	0
1991-1995	½	− ¼	¼	½	¼	0	¼
Transport							
1980-1985	2¾	1¼	½	1¼	2¾	1¾	1
1986-1990	3¼	1½	¼	1½	2½	2	½
1991-1995	3	1½	¼	1¼	3	2¼	½
Bank and insurance							
1980-1985	1¼	¼	½	½	1	½	½
1986-1990	1½	0	¼	1¼	¼	0	¼
1991-1995	¾	−1¼	¾	1¼	− 1	−2¼	1¼
Other market services							
1980-1985	0	− ½	¼	¼	− ¼	− ½	¼
1980-1990	1¼	½	½	¼	1½	¾	¾
1991-1995	− ¼	− 1	¾	0	− ½	−1½	1

[a] V is defined as intermediate inputs.

Appendix C Quality changes in labour input

As described in appendix A, capital input should be differentiated, with each type of capital input weighted properly according to its marginal product. The same applies to labour input. Total labour input is an aggregate that depends on its components, which differ in quality. In order to capture the heterogeneity of hours worked by different groups of workers, labour input in hours worked is defined as follows:

$$\triangle \ln L_i = \sum_j W_{ij}^{l} (\triangle \ln L_{ij}) \quad \textbf{(13)}$$

Where

$$W_{ij}^{l} = \frac{P_{ij}^{l} \cdot L_{ij}}{\sum_j P_{ij}^{l} \cdot L_{ij}} \quad \textbf{(14)}$$

where	L	Hours worked
	P^l	Wages per hour
	j	Labour characteristics (i.e. gender, age, education, etc.)

However, data availability constitutes a severe bottleneck to fulfill this approach. To calculate the impact of each labour characteristic separately, we would need an enormous disaggregated database. The data presently available do not allow such disaggregation. I therefore apply an alternative approach to measure the effect of changes in labour inputs. The starting point in the estimates of the composition effect is a standard semi-log wage equation (see Pomp, 1998):

$$Ln\ P_i^{l} = \alpha_i X_i + \varepsilon_i \quad \textbf{(15)}$$

where	α	vector of coefficients
	P	wages
	X	vector of dummies of labour characteristics
	ε	error term

If it is assumed that wages reflect marginal productivity, and that production is characterised by constant return to scale, then the change in the average wage rate equals the change in labour productivity. Therefore, labour productivity growth can be attributed to changes in the composition of employment:

(16)
$$\Delta\left(\frac{Y_j}{L_j}\right) = \Sigma\alpha_i \ \Delta S_i$$

where S_i Share of labour characteristic i (gender, working time, education, age and sector of employment)

The wage equation (formula 15) is estimated by using micro-level data from two datasets (the LSO79 and the AVO93).

The sectoral data on the employment structure along the four dimensions of labour characteristics, i.e. S_i, are based on several different sources of labour accounts (see table C.1).

Table C.1 Sources of labour accounts

	Source
Gender	CPB, database Sectoral Analysis
Working time	CPB, database Sectoral Analysis
Age	CBS, Arbeidskrachtentelling
Education	CPB, database Sectoral Analysis

Using the estimated α_i, and the changes in S_i, we are able to calculate labour productivity changes. Table C.2, for instance, shows the productivity effect of changes in the structure of employment in the early 1990s. The changes in the level of education and age appear to be the driving forces, especially the aging of the labour force pushes productivity upwards.

Table C.2 Effect of changes in employment composition on productivity in services, 1991-1995[a]

	1991-1995
	annual percentage changes
Gender	– 0.04
Working time	– 0.03
Age	0.91
Education	0.48
Total	1.31

[a] Based on the average of the two estimated wage equations.

Abstract

This research memorandum analyses Dutch labour productivity performance by industry over time. While labour productivity growth in the Dutch manufacturing industry gradually improved in the 1990s compared to the second half of the 1980s, it dropped back sharply in market services. As a result, overall labour productivity growth of the market sector is still slowing down. In an international perspective, the relative position of Dutch services has worsened over time.

The growth accounting tool can be used to decompose labour productivity growth into the contribution of factor inputs, such as physical and human capital, and total factor productivity growth. The sharp slowdown of productivity growth in Dutch market services has been accompanied by a drop in total factor productivity growth in the 1990s. While this suggests that the efficiency of the production process can be enhanced, further research is needed to improve understanding.