

# Productivity growth in Norway 1948–2008

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Growth in labour productivity in Norway has gone through a number of phases since the Second World War. From the post-war years through to the 1970s, it was generally high. Relatively low levels of productivity after the war and opportunities to import technology from abroad were probably important factors. From the mid-1970s until the late 1980s, productivity growth was low and variable. Unstable macroeconomic conditions contributed to this. Productivity growth picked up again in the early 1990s and accelerated further after the turn of the millennium. To some extent, this can be attributed to increased use of information and communication technology (ICT), partly in the service sectors. Productivity growth slowed again from 2005 and turned negative in 2008. Growth in capital intensity fell, and it has taken time for enterprises to adjust employment to the downturn in the Norwegian economy since 2007.

## 1. Introduction

Productivity developments are reported regularly in Statistics Norway's *Economic Survey* (Statistics Norway, 2009). Norges Bank has also discussed productivity growth previously in boxes in its *Inflation Report* (Norges Bank, 2006) and *Monetary Policy Report* (Norges Bank, 2007). Halvorsen (2006) provides an overview of productivity growth in the period 1981–2003. The present article analyses productivity growth over a longer period and attempts to date breaks in underlying productivity growth. As it has to be assumed that technological advances in Norway are associated with innovations abroad, there is also a comparison with productivity growth in other countries.

A country's productivity growth determines growth in standards of living over time. With productivity growth of 3 per cent, GDP can double in 25 years without needing any increase in the number of hours worked; with growth of 1 per cent, this will take 70 years.

The crucial importance of productivity growth for economic growth over time can also be illustrated as follows: In the period from 1948 to 2008, GDP for mainland Norway increased by an average of 3.3 per cent per year. Productivity growth contributed 3.1 percentage points of this, whereas the number of hours worked contributed, on average, just 0.2 percentage point. GDP growth since the war has therefore been driven primarily by growth in labour productivity.

Productivity is closely related to potential output – in other words, the maximum level of output compatible

with stable price and cost inflation. Estimates of productivity growth are therefore an important part of the basis for monetary policy. The high global inflation of the 1970s and early 1980s was probably a result of overly high estimates of growth in potential output, which illustrates the importance of quickly capturing changes in underlying productivity growth (see Orphanides et al., 2000). In theory, and over time, productivity growth will also affect the long-term equilibrium real interest rate (see, for example, Bernhardsen, 2005).<sup>2</sup> Changes in this interest rate are important for how expansionary or contractionary a given key policy rate will be for the economy. In isolation, higher productivity growth implies a higher long-term equilibrium rate, as the required rate of return in the economy increases.

Productivity growth is affected by factors such as the population's education, the size and quality of fixed capital, levels of research and development, infrastructure, the production and use of ICT, opportunities to trade with other countries, levels of state and foreign ownership, restructuring in the private and public sector, and how well legal and financial institutions are functioning. The design of the welfare state, the level of wage differentials, the population's age composition, labour force participation and workers' training and skills development, the degree of competition and macroeconomic conditions will also impact on productivity growth. In the light of all these factors that can influence productivity, it is not surprising that there is no generally accepted theory for

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<sup>2</sup> For a small, open economy like Norway, both the long-term equilibrium rate and trend productivity will be determined to a considerable extent by developments abroad.

what determines productivity or for how it should be measured.

Section 2 below provides a brief overview of different measures of productivity and the measurement problems associated with different concepts of productivity. Section 3 analyses productivity growth in Norway, while Section 4 compares it with that in other countries. The article concludes with some thoughts about how productivity growth may be affected by the financial crisis.

## 2. Different measures of productivity

For an enterprise, productivity expresses how efficiently it uses inputs such as labour and capital equipment to produce goods and services. If an enterprise produces more goods and services with the same inputs, or the same quantity of goods and services with fewer inputs, productivity has increased.

Productivity is typically defined as a ratio between a volume measure of output and a volume measure of inputs. Which measures are used will depend partly on the purpose of the analysis. Productivity can be defined relative to a single input (such as labour) or multiple inputs (such as labour and capital). As volume measures of output and inputs are associated with considerable uncertainty, calculations of productivity are subject to substantial measurement problems.

### *Labour productivity*

Labour productivity is used in many analyses. This is a relatively simple but important measure of productivity. It is also closely related to growth in real incomes. One key tenet of economic theory is that the rewards of labour are determined by labour productivity. Labour productivity depends on factors such as organisation, logistics, incentives, use of technology, qualifications and the quantity and quality of fixed capital. It is also influenced by how intensively capital and labour are used.

The simplest measure of labour productivity is output per worker. Output per worker increases if more is produced per hour worked, but also if more hours are worked. During an economic upswing, hours worked per worker normally rise. If productivity is measured as output per worker, one might mistakenly conclude that underlying productivity (and so potential growth) is changing over

the business cycle even if output per hour worked is constant. If productivity is measured as output per worker, we might therefore mistakenly register an upswing in productivity and possibly overestimate growth in potential output. In that case, we might subsequently be surprised by higher-than-expected inflation.

Output per hour is therefore a better measure of productivity. The advantage of this measure is that it takes account of the fact that the number of hours worked per person can vary. One disadvantage is that the number of hours worked is harder to measure than the number of workers. In international comparisons, it is also normally easier to use the number of workers than hours worked, because statistics for the latter are not as standardised and are normally less accessible. As the number of hours worked per worker has changed considerably over time and also varies a great deal over the business cycle, however, we will be using output per hour in this article.

Labour productivity can change as a result of technological advances or an increase in capital equipment (or another input). One weakness of partial productivity measures such as labour productivity may be that allowance is made for increased inputs of labour but not for increased inputs of capital. This means that the measure does not necessarily reflect technological advances alone.

### *Total factor productivity*

It is usually said that an increase in output which is not attributable to an increase in the use of inputs such as labour and capital reflects a change in total factor productivity (TFP). TFP can, in principle, be calculated by taking growth in output and adjusting it for the contribution from specific inputs. Besides new, improved technology, an increase in TFP may be due to better logistics, more efficient utilisation of premises, or other changes in the organisation of production.

In practice, TFP cannot be observed and has to be calculated. There are various ways of doing this. In the calculations in this article, we impose an explicit production structure. We assume that the production structure in the mainland economy can be described by the following simple relationship between value added<sup>3</sup>, labour and capital services:<sup>4</sup>

<sup>3</sup> In this article, we use value added (gross output less inputs of goods and services other than labour and capital) because we are looking primarily at the whole economy or broad aggregates. See OECD (2001a) for a discussion of the use of value added and gross output in productivity calculations.

<sup>4</sup> This is based on the Solow growth model (Solow, 1957). We use a Cobb-Douglas production function often employed in analyses of this kind and assume that the production function has constant returns to scale. A similar percentage increase in all inputs will increase output by the same percentage. We also assume that the factors of production are paid their marginal productivity. The wage share can then be used as an estimate of  $\alpha$ .

$$(1) Y_t = A_t K_t^{(1-\alpha)} L_t^\alpha$$

$Y$  = Value added

$K$  = Capital services

$L$  = Labour, measured as number of hours worked

$\alpha$  = Wages paid as a proportion of value added

$A$  = Change in output not attributable to primary inputs (TFP)

As we are using value added, we can ignore factors of production other than capital and labour. We also assume that TFP is not linked to any of the factors of production but is Hicks-neutral. Increased TFP will not then affect the desired amount of capital per worker and will, in principle, represent “pure” (and cost-free) technological progress.

When decomposing growth in labour productivity into contribution from growth in capital intensity (the increase in capital services per hour worked) and contribution from growth in TFP ( $g_{ifp}$ ), we use equation (2), which is derived simply from equation (1).  $g_Y$ ,  $g_L$  and  $g_K$  are growth in value added, hours worked and capital services respectively.

$$(2) \underbrace{(g_Y - g_L)}_{\text{Growth in labour productivity}} = \underbrace{(1-\alpha)(g_K - g_L)}_{\text{Growth in contribution from capital intensity}} + g_{ifp}$$

Measuring fixed capital’s contribution to output is associated with significant challenges. In principle, it is the volume of the services that this capital contributes to output that is to be included. In the calculations performed here, we assume that the volume of capital services is proportional with the capital stock as estimated in the national accounts.

The quality of labour evolves over time. We measure labour input as hours worked regardless of quality. Changes in the quality of the labour force, such as higher standards of education, will therefore be captured as growth in TFP. As this is also captured in labour productivity, the relationship between labour productivity and TFP is unaffected.

Other factors that can make it difficult to identify technological advances are cyclical variations in productivity and the time it can take for technological advances to impact on output.

Despite these problems measuring TFP, the calculations presented in this article illustrate how important capital’s contribution to labour productivity has been.

## Measurement problems

The possibilities for measuring productivity vary between the different sectors of the economy. While it may be relatively easy to measure the production of standardised goods, it is relatively hard to measure productivity in many service sectors. Among other things, it is difficult to differentiate between volume and price components in the production of services. What is the volume of a legal service? How can we measure changes in the quality of such services? For example, technological advances may increase the speed at which letters are processed and distributed, but if the technology requires fewer delivery addresses or self-service, the quality of the service may fall.

In this article, as mentioned earlier, we use value added. Fixed price data for value added are obtained by deflating gross output and intermediate consumption individually. In industries with high intermediate consumption, such as manufacturing, minor errors in the deflation can result in major errors in value added and, therefore, the productivity growth measured. Even with more standardised goods, it may therefore be difficult to differentiate between volumes and prices for value added.<sup>5</sup>

In the national accounts, output in the public sector is calculated on the basis of inputs and a rough estimate of productivity, as for many public services there is no market for valuations. While this might indicate that it is most interesting to look at productivity growth outside the public sector, productivity measures for the whole economy will ensure consistency with GDP and the output gap. International comparisons are often made on the basis of aggregate productivity growth, partly because these figures are more readily available and because the size of the public sector varies from country to country.

The possibilities for measuring the individual inputs also vary. The number of workers can be measured with a relatively high level of certainty. There may be somewhat greater uncertainty about figures for the number of hours worked. Greater use of home offices, for example, may have increased the uncertainty about the number of hours worked. Even larger difficulties are associated with measuring changes in workers’ characteristics, such as the effects of longer and better education or increased experience. There are currently no productivity calculations in Norway that take account of these factors.<sup>6</sup>

Considerable problems are also associated with measuring capital equipment’s contribution to output and, therefore, the labour productivity measured. There are

<sup>5</sup> See Appendix 4 to Norwegian Official Report NOU 1996:4 for further information (in Norwegian only).

<sup>6</sup> Calculations of this kind have been performed for many other countries in the EU KLEMS growth and productivity accounts (see [www.euklems.net](http://www.euklems.net)).

measurement problems when estimating both the amount of capital and how efficient it is.<sup>7</sup>

### 3. Productivity growth in Norway

We will look first at productivity measured as value added per hour worked.

Calculations of labour productivity are based on national accounts data. National accounts data are revised before the final figures are available. As labour productivity is a ratio, the productivity data may be revised significantly.

In our calculations, we use annual data. The quarterly figures for productivity are highly volatile, and official quarterly data for hours worked are available only from 1995 onwards.

There are major fluctuations in the productivity calculated, both from quarter to quarter and from year to year. There may be several reasons for this. First, it may be due to measurement error. Second, it may be due to variation in the utilisation of labour and capital during the year and in connection with cyclical fluctuations, as it is not profitable for enterprises to vary employment or capital equipment as much as demand and output vary. Third, changes in technology will be reflected in the productivity growth measured. These changes can, in principle, be permanent or temporary shifts in productivity levels or productivity growth. It is difficult to differentiate temporary shifts in underlying technology from other factors that may impact on productivity in the short term. More permanent productivity changes can eventually be identified

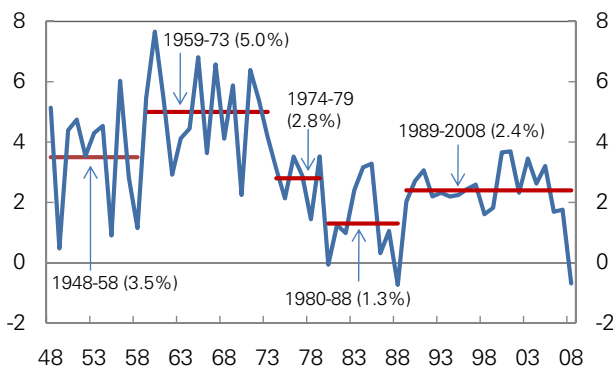
by, for example, studying whether there are statistically significant breaks in the time series for productivity growth. Permanent shifts in labour productivity may also be due to changes in enterprises' capital stock. These might result from a decrease in investment or parts of the capital stock become economically unviable.

In most productivity analyses, there will be a need to smooth the time series. How and how much productivity series are to be smoothed will depend partly on the purpose of the analysis. If it is the more long-term development in prosperity that is to be described, a relatively large amount of smoothing is required. If the focus is on movements in enterprises' costs, the more short-term movements in productivity will be more relevant.

Growth in value added per hour worked for mainland Norway since 1948 is shown in Chart 1. The figures before 1970 have to be considered relatively uncertain.<sup>8</sup> Productivity growth was relatively high until the mid-1970s. Relatively low productivity levels after the war, imports of technology from abroad and foreign direct investment were probably important factors. Commercial exploitation of technological advances made during the war may have been part of these technology imports. The figures show that average annual growth in productivity from 1948 to 1958 was 3.6 per cent. Productivity growth accelerated in the 1960s and early 1970s, averaging 5.0 per cent in the period 1959–73. This stronger growth in labour productivity can be attributed partly to the capital stock in the Norwegian economy growing rapidly during this period (see Chart 2).

From the mid-1970s, productivity growth fell sharply.

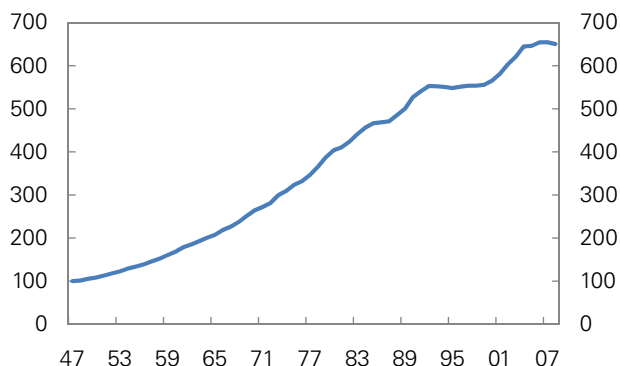
**Chart 1** Value added<sup>1</sup> per hour worked. Mainland-Norway  
Annual percentage growth. Actual and average. 1948-2008



<sup>1</sup> Measured in market value

Source: Statistics Norway, Norges Bank

**Chart 2** Capital stock per hour worked. Mainland Norway.  
Index: 1947=100. 1947-2008



Source: Statistics Norway, Norges Bank

<sup>7</sup> See OECD (2001b) for a more detailed discussion.

<sup>8</sup> The GDP figures before 1970 are based on the national accounts for 1865–1960 and 1954–1970. Hours worked before 1970 are based on Statistics Norway's historical statistics (see <http://www.ssb.no/histstat/aarbok/ht-0901-timeverk.html> (in Norwegian only)). GDP and hours worked for mainland Norway before 1970 have been calculated as GDP less shipping.



Unstable macroeconomic conditions and high inflation probably contributed to low and variable productivity growth during this period. At the same time, some of the factors that had applied previously, such as technological catch-up with the USA and transfers of labour from less productive to more productive sectors, were less significant. Low profitability at enterprises resulted in low investment. Regulation of the credit market and the tax system probably contributed to inefficient investment.

A drop in productivity growth of this kind presents challenges for economic policy. A decrease in trend productivity which is not captured by analyses may result in price inflation gradually becoming unexpectedly high. However, it is not easy to identify a break in underlying productivity growth in real time. Are observed changes in productivity growth due primarily to cyclical fluctuations, or has there been a slowdown in trend productivity growth and, therefore, potential output? The relationships between cyclical fluctuations and productivity can evolve over time and make assessment difficult (see Box 1). Is the decrease in productivity levels temporary or permanent? Is it a break, or is the decrease more gradual? Box 2 presents various statistical methods that can be used for such an analysis. The test performed indicates that the fall in productivity growth in the 1970s was a statistically significant break in trend productivity. The test puts the break point in 1973. The test also indicates that there may be an additional fall in trend productivity in 1979, but this break is not statistically significant at normal test levels.

Productivity growth accelerated markedly from the late 1980s, despite growth in capital relative to hours worked having flattened out (see Chart 2). The internationalisation of product markets and liberalisation of trade, partly through the EEA Agreement, led to increased competition

in large areas of working life and to extensive restructuring and higher productivity and profitability requirements. The development of free capital markets, the phasing out of the low interest rate policy in the 1980s and the tax reform of 1992 probably contributed to increased productivity growth through more efficient investment. Rapid advances in computer technology, IT and the Internet have also had a positive effect on productivity. Norway has a small IT-producing sector, so the greatest contribution to labour productivity came from sectors that are users of this technology.<sup>9</sup> The tests performed in Box 2 show that this increase in productivity growth, dated to 1988, may also have been a break in trend productivity, but this break is not statistically significant.

Since 2005, growth in labour productivity has slowed from the high levels seen at the beginning of the decade. The contribution from capital intensity has decreased. In the period 2006–2008, capital intensity was largely unchanged. As the economic upswing continued, more marginal capital, which may have been slightly less efficient, was probably also brought into use. High employment growth and a shortage of qualified labour probably also led to high training costs and a decrease in efficiency. The downturn in the Norwegian economy since 2007 has contributed to a further drop in productivity growth. The downturn arrived suddenly, and it takes time for enterprises to consider redundancies. Experience from the acute shortage of labour towards the end of the upswing may also have caused enterprises to hold onto workers for longer than usual in an economic downturn. However, the test for breaks in trend productivity cannot identify a shift in productivity growth as yet.<sup>10</sup> This is a reflection of the time it normally takes for a break to be identified, especially in time series which fluctuate as much as productivity growth.

<sup>9</sup> Rybalka (2009) shows that there is a significant positive relationship between the use of ICT and productivity, and that the effect is greatest in the service sectors. The period analysed is 2002–2006.

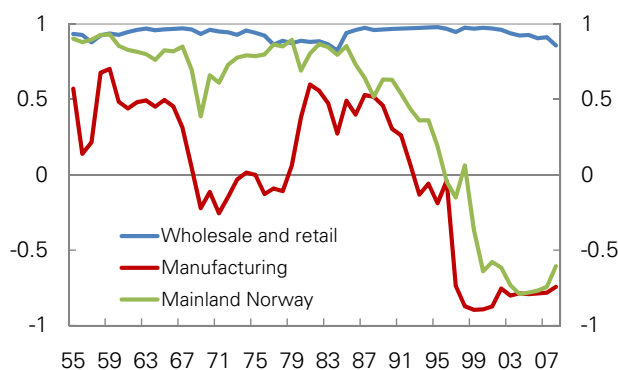
<sup>10</sup> If we impose a requirement of four breaks in the productivity series, the test suggests that these came in 1958, 1973, 1979 and 1988 (see Chart 1 and Table 1).

### Box 1: Productivity growth and cyclical fluctuations

One often observed phenomenon is that productivity growth leads and varies positively with the business cycle. This may reflect a number of factors. Procyclical productivity may reflect technological breakthroughs. These breakthroughs will gradually result in increased output through increased income opportunities. We will also be able to observe procyclical productivity if the production structure in the economy is characterised by increasing returns. Varying utilisation of the factors of production over the business cycle may also be recorded as procyclical productivity.<sup>1</sup>

In Norway, it appears that productivity growth and GDP growth were positively correlated until the early 1990s (see Chart 3). The corollary of this is that growth in hours worked varied relatively little. It seems that there was procyclical productivity in most sectors during this period. Since 1990, the positive correlation between GDP growth and productivity growth appears to have decreased and turned negative at times.<sup>2</sup> This may be related to the labour market becoming more flexible, making it easier (cheaper) for enterprises to vary labour input with changes in output.<sup>3</sup> Greater competition or greater required rates of return may also have led to enterprises increasingly having needed to quickly adjust labour input to output. Another reason may have been that the lift in trend productivity during this period dominated the cyclical movements in productivity. Countercyclical productivity during an economic upswing may be a reflection of the least efficient part of the capital stock having to be brought into use. It is also possible that workers become less efficient during an economic upswing, partly because it has to be assumed that training costs will rise with increasing utilisation of the labour force.<sup>4</sup> There are big differences between sectors. Manufacturing in particular contributed to the decrease in this correlation. In some service sectors, productivity was clearly procyclical also after 1990. The steep fall in productivity in 2007 and 2008, which coincided with a slowdown in GDP growth, may suggest that productivity is again in the process of becoming procyclical.

**Chart 3** Correlation between value added and labour productivity.<sup>1</sup>Ten-year rolling windows. 1955-2008



<sup>1</sup> Correlation between the cyclical components of the series. The cyclical components are calculated using an HP filter with a smoothing parameter equal to 100

Source: Statistics Norway, Norges Bank

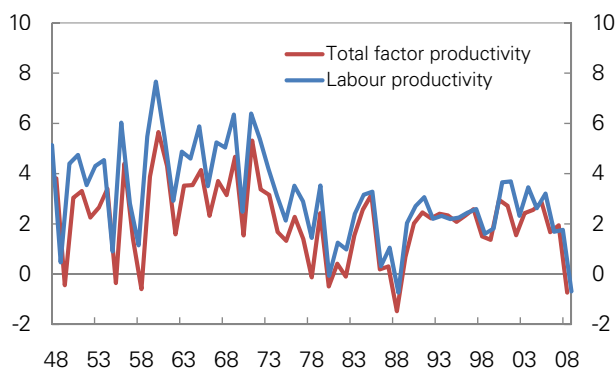
<sup>1</sup> For a more detailed explanation, see Basu and Fernald (2000).

<sup>2</sup> The analyses in Husebø and Wilhelmsen (2005) also show a decrease in the correlation between GDP and productivity in the 1990s. They use quarterly data.

<sup>3</sup> Flexibility in the labour market can be understood in a number of different ways. If enterprises can counter lower demand with lower wage growth or partial layoffs, employment can be kept up.

<sup>4</sup> Decreases in the positive correlation between productivity and GDP have also been recorded in the USA. Stiroh (2009), for example, links the changes to increased pressure on enterprises to raise productivity, changes in the labour market and measurement error.

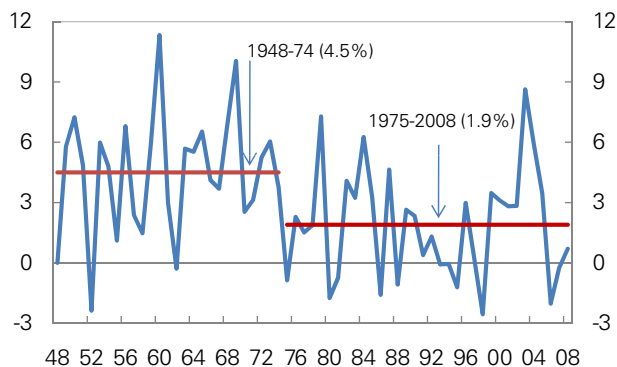
**Chart 4** Productivity.<sup>1</sup> Mainland Norway. Annual percentage growth. 1948-2008



<sup>1</sup> Measured in market value

Source: Statistics Norway, Norges Bank

**Chart 5** Productivity growth. Manufacturing. Annual percentage growth. Actual and average. 1948-2008



Source: Statistics Norway, Norges Bank

As mentioned above, growth in labour productivity can be decomposed into contributions from increased capital intensity and TFP. The capital stock has generally grown faster than the number of hours worked since 1948. In other words, workers have been equipped with more capital. Over the whole period from 1948 to 2008, growth in labour productivity averaged 3.1 per cent per year. The contribution from growth in capital intensity was 0.9 percentage point, while the contribution from TFP was 2.2 percentage points. However, it is uncertain how much of the growth in TFP was due to technological advances and how much reflects, say, an increase in the quality of the labour force.

From 1948 until the mid-1980s, increased capital intensity, as illustrated by the gap between the two curves in Chart 4, made a relatively large contribution to growth in labour productivity. Investment and growth in the capital stock were high relative to growth in hours worked. In the 1990s, growth in the capital stock fell markedly, but labour productivity rose nonetheless as a result of higher TFP.<sup>11</sup> This needs to be seen partly in the light of the tax reform of 1992, which contributed to a higher level of correspondence between the private and social profitability of investment and led to a marked increase in the average return on fixed capital. Part of the relatively strong rise in labour productivity in the early part of the 2000s was again related to increased capital intensity. Investment grew relatively strongly, while hours worked fell. We also see that capital intensity did not contribute to labour productivity in 2006–2008. This reflects the strong growth in employment, which meant that capital per worker fell despite high growth in investment. This was probably related to the time taken to adjust the capital stock to the increased supply of labour

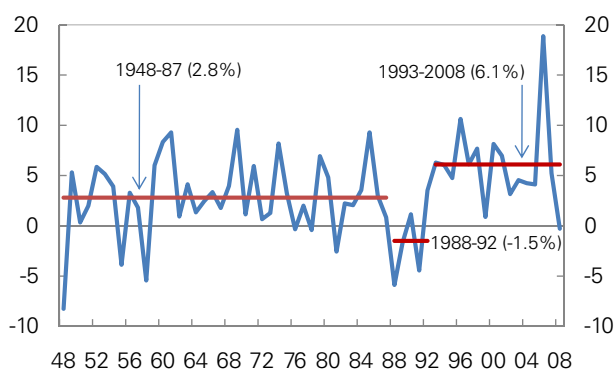
from the new EU member states and elsewhere. Low wage levels for parts of these groups may also have made it profitable to have slightly less capital per hour worked.

### *Which sectors drove productivity growth?*

The average rate of productivity growth in manufacturing in the period from 1948 to 2008 was 3.0 per cent, but there were considerable variations (see Chart 5). This needs to be seen in the light of parts of manufacturing being capital-intensive, and the utilisation of capital potentially varying considerably over the business cycle. Manufacturing will also be greatly affected by demand abroad, which was relatively volatile, especially in the 1970s and 1980s. Our test indicates a statistically significant break in productivity growth in manufacturing in 1974. This has also been observed in many other countries and has often been attributed to technological catch-up with the USA (see, for example, Englander and Mittelstadt, 1988). Sudden changes in oil prices during this period may also have made parts of the capital stock economically unviable and contributed to lower efficiency. If we test for further breaks, it appears that there was another permanent drop in productivity growth around 1990. This reflects weak growth in productivity in sectors that were shielded from foreign competition. Productivity growth was also slowed because productivity levels in the food, beverages and tobacco industry was approximately the same in the late 1990s as in the late 1980s. Productivity growth picked up after the millennium, however, as international competition grew. Greater competition and high cost levels have led to a scaling back of enterprises with low productivity, and to an

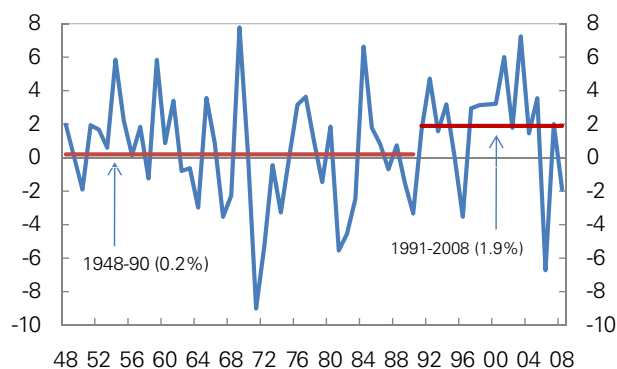
<sup>11</sup> For more about the increase in TFP growth in the 1990s, see Halvorsen (2006).

**Chart 6** Productivity growth. Wholesale and retail trade.  
Annual percentage growth. Actual and average. 1948-2008



Source: Statistics Norway, Norges Bank

**Chart 7** Productivity growth. Other private services.<sup>1</sup>  
Annual percentage growth. Actual and average. 1948-2008



<sup>1</sup> Financial and corporate services.

Source: Statistics Norway, Norges Bank

increase in the need, and opportunities, to outsource the production of internal inputs to Norwegian and foreign subcontractors. This increased specialisation has contributed to higher productivity growth. Our test indicates a further break in 1998, but this is not significant. Since 2005, productivity growth has slowed. This is related to a decrease in capital intensity of almost 6 per cent from 2005 to 2008. However, it appears that growth in TFP has also fallen somewhat.

There are major variations in productivity growth between service sectors. The wholesale and retail trade enjoyed relatively solid productivity growth from 1948 to 2008, but it was very variable (see Chart 6). On average, productivity grew by 3.3 per cent per year. The test for breaks in trend productivity reveals significant breaks in 1987 and 1992. The downturn in the Norwegian economy from the late 1980s, which led to a long period of low consumption growth, contributed to a decrease in productivity in the wholesale and retail trade in the period from 1988 to 1991. This was probably because the sector failed to adjust its workforce to the sharp drop in sales. However, efficiency then increased sharply and contributed significantly to the upswing in productivity growth in Norway from 1992. This is partly a reflection of structural changes due to the formation of chains and the introduction of ICT. Productivity growth in the wholesale and retail trade was no less than 6.1 per cent per year in the period from 1993 to 2008. Also in wholesale and retail trade, however, there was a drop in productivity growth towards the end of the period, probably due partly to reduced demand in this sector.

Other private services<sup>12</sup> had low productivity growth (see Chart 7), averaging 0.7 per cent per year during the period.

There are no significant breaks in productivity growth in this series. The test does, however, indicate that there was a break around 1990.<sup>13</sup> There was particularly low productivity growth in financial services up until then. According to national accounts data, productivity in financial services in the period from 1970 to 1988 fell by 2.3 per cent per year.<sup>14</sup> Since the beginning of the 1990s, productivity has increased. This can be attributed to efficiency improvements at banks in the wake of the banking crisis and increased use of new ICT for banking services and payments. There was a marked decrease in productivity growth towards the end of the period in this sector too.

#### 4. Productivity growth in Norway compared with other countries

Comparing productivity growth in different countries is associated with significant problems. Although national accounts are in many respects standardised, there may be differences in the underlying data and methods. For example, there are different practices for how changes in quality are treated. This is very important when measuring productivity growth in sectors where there have been major technological advances. Differences in production structure from country to country may also lead to differences in productivity growth, even if productivity growth in each individual sector does not differ. Performing calculations adjusted for exchange rate movements and differences in price levels is also a challenge, but this is primarily an issue when it comes to comparisons of productivity levels. Here, we look solely at changes in productivity in each particular country. In the calculations below, we have used data from the OECD's productivity

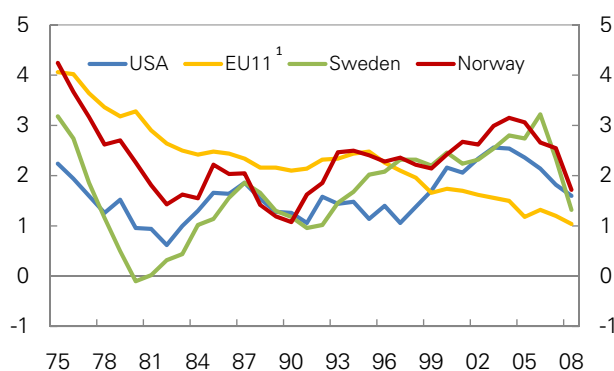
<sup>12</sup> Corporate and financial services.

<sup>13</sup> The test also suggests breaks in 1970 and 1975 (see Table 1).

<sup>14</sup> Measuring output in financial services is difficult. The productivity data for this sector are therefore particularly uncertain.



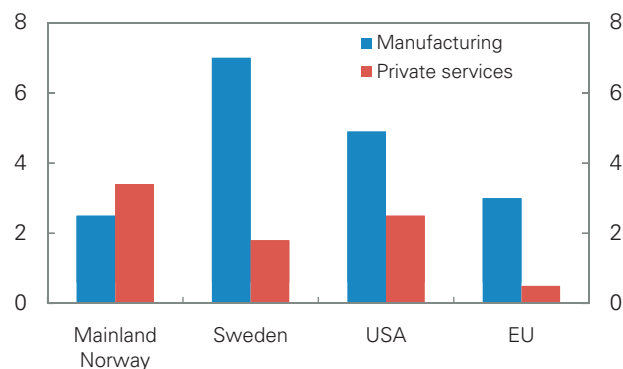
**Chart 8** Productivity growth. Five-year rolling average. Centred on last year. 1975-2008



<sup>1</sup> EU15 excluding Greece, Luxembourg, Portugal and Austria

Source: OECD, Statistics Norway, Norges Bank

**Chart 9** Average annual percentage growth in value added per worker. 1999-2007



Source: OECD

database. A great deal of work has been put into making these data comparable.

In the early 1970s, productivity growth was high in Norway, Sweden and the EU as these countries closed the technology gap to the USA (see Chart 8). In Europe, productivity growth has fallen gradually since the 1970s. This may be due partly to limited flexibility in the labour and product markets. The OECD (2009) cites factors such as entry barriers in product markets, limited competition in important markets, and limited mobility in the labour market. The OECD has also noted that high employment growth in the EU during this period may have pulled down productivity, because less productive workers were taken on (OECD, 2007). In the 1990s, productivity growth accelerated in the USA, Sweden and Norway. Labour productivity has generally grown slightly faster in Norway than in Sweden and the USA. These countries are often cited as countries with high productivity growth due to extensive use of ICT and relatively extensive production of ICT products. There seems to have been a decrease in productivity growth in all of the countries from around 2005.

Compared to other countries, Norway ranks relatively low when it comes to traditional indicators for research, technology and innovation.<sup>15</sup> It may therefore appear paradoxical that productivity growth has been quite high. The relatively low level of investment in research in industry can, to some extent, be explained by the industrial structure, which is dominated more by raw materials in Norway than in many other countries. Relatively low measurable innovation activity in these industries contributes to a low score in research indicators. Nor do

traditional indicators normally capture innovation which is not necessarily research-based, such as innovation in the service sectors and the development of new organisational models and business models.

It is in the service sectors that productivity growth in Norway has been higher than in many other countries since the mid-1990s (see Chart 9).<sup>16</sup> Productivity has been particularly high in the wholesale and retail trade, but it has also been relatively high in other services. The wholesale and retail trade probably increased its efficiency later in Norway than in many other countries. The productivity growth in the financial sector following the financial crisis in the 1990s was also relatively strong to Norway. In manufacturing, productivity growth in Norway has generally been relatively low compared with the USA and Sweden, and more in line with the EU countries. To some extent, this needs to be seen in the light of the structure of Norwegian manufacturing. Many countries have a larger share of industries with the potential for high productivity growth than Norway does.<sup>17</sup>

## 5. Concluding remarks

A small country like Norway must take account of the fact that a high proportion of technological advances will be made in other countries. Strong productivity growth and high productivity levels in the mainland economy suggest that the Norwegian economy has succeeded in exploiting existing technological possibilities. The incentives and ability to exploit existing technology may be related to high wage levels and a relatively well-qualified labour force.

<sup>15</sup> See, for example, Eurostat (2009).

<sup>16</sup> The OECD's productivity database broken down by industry gives productivity measured as GDP per worker.

<sup>17</sup> See Boug and Naug (2001).

Productivity growth abroad will be affected by the financial crisis. This may result in reduced productivity growth through a number of channels.<sup>18</sup> The crisis may lead to reduced investment and reduced capital intensity, which will, in turn, have a negative effect on labour productivity. Structural changes as a result of the crisis may also lead to capital equipment becoming economically obsolete more quickly. Where there are factors preventing structural changes, labour and capital may be locked into unprofitable activities, and productivity growth may be inhibited.

How underlying technological developments will be affected is more uncertain. Reduced access to funding

as a result of the financial crisis may lead to reduced research and development, which could slow technological development in the longer term. On the other hand, the downturn may lead to the culling of the least productive enterprises and help press for increased efficiency at the survivors. Productivity growth will also be affected by the design of policy. The financial crises in the early 1990s in Norway, Sweden and Finland were followed by a clear upswing in productivity growth. Rapid resolution of the problems in the financial sector, combined with measures to improve the supply side, probably contributed to this.

## **Box 2:** Identifying breaks in productivity growth

There are many different statistical techniques that can be used to identify breaks in productivity growth.

Methods that identify discrete shifts in productivity growth:

- One simple method is to measure productivity between cyclical peaks. This provides a correction for cyclical factors, but cannot provide evidence of shifts in trend productivity between these peaks or after the final peak.
- Bai and Perron (2003) have developed a method which can determine the number of significant breaks in growth in a time series. The method identifies whether there are possible breaks, the number of breaks, and whether they are statistically significant.

A change in trend productivity may also be more gradual. It may then be better to estimate trend productivity using time-varying parameters. There are a number of possibilities here. One widely used method is the Hodrick-Prescott filter, which is easy to use and is available in many different statistical packages.

Economic theory can also be used to study breaks in trend productivity. For example, real wage growth and consumption per capita should correlate with underlying productivity growth. This can be exploited in tests which simultaneously look for breaks in multiple series.<sup>1</sup>

In this article, we have used the Bai-Perron method. Intuitively (and somewhat simplified), the version that we have used can be described as follows. Average productivity over the period as a whole is estimated using the following simple relationship:

$$(1) g = k + e_1$$

where  $g$  is productivity growth,  $k$  is a constant (estimated as equal to average productivity during the period) and  $e_1$  is a residual. The sum of the squared residuals (SSR) for this equation is saved.  
*(continue next page)*

<sup>1</sup> See, for example, Kahn and Rich (2007).

<sup>18</sup> For a more detailed discussion, see, for example, the European Commission (2009).

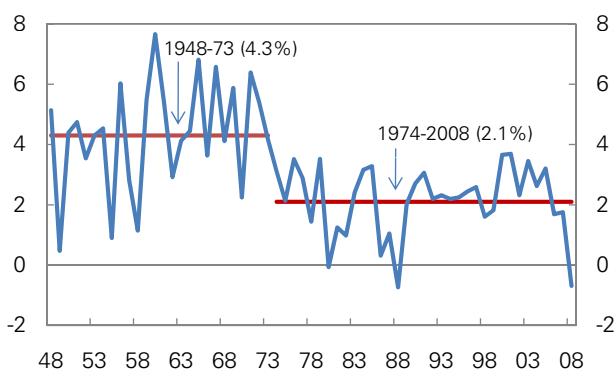
(continued from previous page)

Next, an equation is estimated which assumes one break:

$$(2) g = k_{1948-x} + k_{(x+1)-2008} + e_2$$

where  $x$  is the break point,  $g$  is growth in labour productivity,  $k_{1948-x}$  is average productivity growth in the period from 1948 until  $x$  and zero after  $x$ ,  $k_{(x+1)-2008}$  is average productivity growth from  $x+1$  until 2008 and otherwise zero, and  $e_2$  is a residual. The test varies  $x$  throughout the period, and the  $x$  that minimises the SSR is chosen as a possible (local) break point. If the SSR for (2) is significantly smaller than that for (1), it is concluded that  $x$  is a (global) break point. Next, it is assumed that there are two breaks, and the equivalent procedure is performed. We have tested for up to four breaks. The only significant break in productivity growth in mainland Norway is shown in Chart 10. The method also makes it possible to impose a given number of break points. In Chart 1, four break points are imposed. These are not (necessarily) significant break points, but the most likely given four breaks in the series. Table 1 shows the years of the break points in each productivity series.

**Chart 10** Value added<sup>1</sup> per hour worked. Mainland-Norway  
Annual percentage growth. Actual and average. 1948-2008



<sup>1</sup> Measured in market value

Source: Statistics Norway, Norges Bank

**Table 1** Break points for productivity

GDP mainland Norway	Manufacturing	Wholesale and retail trade	Other private services <sup>1</sup>
1958	1974***	1958	1970
1973****	1990	1963	1975
1979	1998	1987**	1990
1988	2003	1992**	

<sup>1</sup> In the case of other private services, only three breaks have been imposed, as we did not find any significant breaks.

\*\*\*\* Significant at a 1 per cent level

\*\*\* Significant at a 2½ per cent level

\*\* Significant at a 5 per cent level

\* Significant at a 10 per cent level

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