# Productivity Growth in Denmark

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## 1. INTRODUCTION AND SUMMARY

Economic welfare is created by the production of goods and services. Production thus constitutes the basis for consumption of goods and services that satisfy the public's needs. The level of welfare in Denmark has grown substantially over the last many decades, mainly as a result of ongoing *productivity* growth in the Danish economy. Productivity refers to the efficiency of a production process. In simplified terms, it reflects value added generated by the production process relative to the amount of input. For example, *hourly productivity*, which is one of the most frequently used measures of productivity, is an expression of average output per hour worked.

An increase in hourly productivity implies more output for a given input of labour. Accordingly, higher hourly productivity enables a higher level of welfare and higher standards of living at the national level.

Higher levels of welfare can also be achieved by other means. For example, increasing the average number of hours worked per person may lead to more output per person. This can be achieved by increasing the share of the population in employment, e.g. via a fall in the structural level of unemployment, or by raising the average number of hours worked per employed person. Improved terms of trade will also lead to higher welfare, since higher relative prices of Danish export goods strengthen consumers' consumption opportunities. Rising investment income from abroad, e.g. by way of interest and return on investment in other countries, will also improve opportunities for consumption, thereby boosting welfare. In the long term, however, it is not realistic to achieve sustained improvements in welfare solely via increased hours worked, improved terms of trade or higher income from abroad. Sustained improvements in welfare require sustained productivity growth.

Productivity growth has been weak in recent years, however – not only in Denmark, but also in most other western countries, and especially in Western Europe. But the decline in productivity growth has been particularly pronounced in Denmark, and Denmark has seen weaker productivity growth than its neighbouring countries since the mid-1990s. If

this trend continues, it will contribute to lower standards of living in Denmark compared with its neighbouring countries.

In September 2011, Danmarks Nationalbank and the International Monetary Fund, IMF, held a conference on Danish productivity growth in an international perspective. A key objective of this article is to present and extend the insights obtained at the conference.[1]

Productivity is a complex issue that is affected by many factors. In this article we have chosen to focus on the subjects and perspectives considered at the above-mentioned conference, which are key to discussions of productivity growth in Denmark. They include research and development, education, the structure of the labour market, competition and the degree of openness of the economy.

The article begins by reviewing productivity growth in Denmark since 1975. The overall picture is that productivity growth in Denmark has been weak since the mid-1990s compared to previous years and relative to comparable countries. Denmark's modest productivity growth is primarily attributable to weak growth in the service sector.

It is difficult to pinpoint the exact reason why, since the mid-1990s, Denmark has seen weaker productivity growth than most of its neighbouring countries. In terms of structural parameters normally considered to be of importance to productivity and growth, Denmark is above average for advanced economies, cf. Darvas and Pisani-Ferry (2011). Considering the scope of research and development, which is often mentioned as a source of productivity growth, Denmark has a good position internationally, so this provides no obvious explanation. The same goes for the level of education and the structure of the Danish labour market.

Consequently, it is natural to focus on what it would take to improve productivity growth in Denmark in the future. Based on the conference held by Danmarks Nationalbank and the IMF as well as the existing economic literature, this article argues that stronger competition may be a means of improving productivity in Denmark, especially in the construction sector and retail trade. Stronger competition may be obtained e.g. by providing easier access for foreign firms to the Danish market. On the export side, there may also be reason to open up more to other countries. Empirical studies indicate that growing international trade in services may potentially boost productivity in the Danish service sector.

In terms of the education sector, added emphasis on specific disciplines, particularly in the social and natural sciences, may contribute to higher productivity. The tax system may also influence productivity

[1] The complete conference programme, including presentations by keynote speakers, can be seen at http://www.nationalbanken.dk/DNDK/OmNB.nsf/side/Konferencer_i_Nationalbanken!OpenDocument.

growth. Hence, empirical studies indicate that a reduction in corporate income taxes financed by higher taxes elsewhere may promote productivity via increased investment.

Finally, it is important to focus on the mobility and flexibility in the Danish economy. Much of the overall productivity growth may be attributed to the free mobility of economic resources, including labour, towards activities with high value added. It is therefore important to avoid measures devoting an undue amount of resources to less productive activities. This applies e.g. to the construction sector, which grew excessively during the overheating of the Danish economy in the years prior to the financial crisis.

## 2. GROWTH IN DANISH PRODUCTIVITY SINCE 1975

Value added per hour worked in the Danish economy, measured by the gross domestic product, GDP, at factor costs, nearly doubled in the period 1975-2010, equivalent to an average annual growth rate of 1.8 per cent for the period as a whole. However, this figure covers both the private and public sectors taken as one. This is problematic, since value added in the public sector is measured on a cost basis in the national accounts. Accordingly, productivity growth in the public sector is not taken into account.[1] If the market economy is instead considered by itself, the average annual growth rate for output per hour worked was 2.1 per cent in the period 1975-2010.

The average figure covers large fluctuations in annual productivity growth, cf. Chart 2.1. For example, hourly productivity in the market economy increased by 4.9 per cent from 2009 to 2010, while the two previous years saw negative productivity growth. Such annual fluctuations are caused by cyclical developments: Output tends to fall at the beginning of a downturn, whereas employment typically reacts with a lag. This entails a drop in productivity. Firms will gradually adjust their demand for labour to the new conditions, so the total input of labour will be reduced and productivity rises. This has been the pattern of productivity over the last three years. It is also worth noting that productivity growth was weak during the boom in the period 2005-07.

The evolution of productivity is also characterised by movements that are not directly attributable to the economic cycle. The average annual

[1] The cost-based calculation of value added in the public sector has led to underestimation of productivity growth in the health and education sectors in particular, cf. Statistics Denmark (2010). Statistics Denmark is currently developing methods to measure individual public consumption from the output side, cf. Graversen (2011). With such methods it will be possible to measure productivity development in parts of the public sector. Output-based measurement methods will be included in the calculation in the national accounts of value added in the public sector from 2014.

ANNUAL GROWTH IN HOURLY PRODUCTIVITY, 1975-2010 Chart 2.1


Note: The Chart shows the annual growth rates of GDP at factor cost per hour worked, 2005-prices, chained values. Market economy refers to the economy as a whole, excluding the general government sector.
Source: Statistics Denmark.

growth in labour productivity was markedly lower in the period 1995-2010 than in the preceding 20 years, regardless of the measure of labour productivity used, cf. Table 2.1. In terms of the market-based part of the economy, the average annual growth rate in GDP at factor cost per hour fell from 3.2 per cent in the period 1975-95 to a mere 0.7 per cent in 1995-2010. The difference between the two periods is slightly less pronounced in terms of GDP at factor cost per employed person. This reflects a decline in the average number of hours worked per employed

AVERAGE ANNUAL LABOUR PRODUCTIVITY GROWTH Table 2.1

| Per cent | 1975-95 | 1995-2010 | 1975-2010 |
|---|---|---|---|
| Market economy | | | |
| GDP at factor cost per hour | 3.2 | 0.7 | 2.1 |
| GDP at factor cost per employed person | 2.7 | 0.9 | 1.9 |
| Economy as a whole | | | |
| GDP at factor cost per hour | 2.7 | 0.7 | 1.8 |
| GVA per hour | 2.7 | 0.7 | 1.8 |
| GDP per hour | 2.6 | 0.8 | 1.8 |
| GDP at factor cost per employed person | 2.1 | 0.8 | 1.5 |
| GVA per employed person | 2.1 | 0.8 | 1.6 |
| GDP per employed person | 2.0 | 0.9 | 1.5 |

Note: Market economy refers to the economy as a whole, excluding the general government sector.
Source: Statistics Denmark and own calculations.

## MEASURING LABOUR PRODUCTIVITY Box 2.1

Labour productivity is calculated as value added in volume terms for a given input of labour.[1] The most common measure of value added is the gross domestic product, GDP, which is often used in calculations of productivity at the macro level and in international comparisons of productivity growth and economic welfare. However, as GDP cannot be broken down by industries, it is not well suited for more detailed analyses of productivity growth in individual countries. Consequently, gross value added, GVA, or GDP at factor cost is often used in such calculations.[2.]

Regardless of the concept of value added used, calculation of value added in volume terms poses considerable challenges. Since value added is given by gross output less use of intermediate inputs, double deflation is required for the calculation in volume terms. This is much more complicated than the standard single deflation method where the nominal value of output is divided by a single price index, cf. OECD (2001).

Quality improvements also pose a challenge to the calculation of value added in volume terms. Higher product quality makes it possible to sell products at a higher price. Statistically, it may be difficult to determine whether such an improvement is to be treated as a quantitative increase in value added, and thus in productivity, or as an increase in the price level. A similar problem applies in connection with the introduction of new product varieties. The strong improvement in the quality and supply of information and communication technology products in recent years represents a particular statistical challenge. One method to handle this challenge is to use hedonic price indices. The idea is to establish a linkage between product prices and various product characteristics at a given time. A new product variety can then be seen as a new combination of characteristics (rather than a new product), and the quality of the new product (defined as its price at an unchanged price level) can be calculated on the basis of the above-mentioned linkages. The growth in nominal value added can then be systematically broken down by quality-adjusted growth in volume terms and changes in the price level.[3]

The input of labour can also be calculated in several ways. A simple measure is the number of employed persons. The advantage of this measure is that it is relatively easy to calculate, so data on this is more frequently available than e.g. on the number of hours worked. However, the number of employed persons does not capture changes in the total input of labour that are due to changes in the average number of hours each employed person works. For example, a reduction in value added due to a higher share of part-time employment will be registered as reduced labour productivity when the productivity calculation is based on the number of employed persons. This may be misleading, so the total number of hours worked is usually preferred as a measure of the input of labour.

[1] Alternative productivity measures based on gross output in volume terms are also sometimes used. Unlike measures based on value added, the use of intermediate inputs is not subtracted from output when calculating such measures. This makes them less relevant for measuring economic welfare, so our focus is on value added-based measures alone in this article. See OECD (2001) for a more in-depth discussion.

[2] GVA equals GDP less net taxes on products, and GDP at factor cost is then computed by subtracting other net excise duties. For a basic introduction to value added concepts, see e.g. Thage and Thomsen (2009).

[3] See OECD (2001) for a more detailed description.

CYCLICALLY ADJUSTED GROWTH IN LABOUR PRODUCTIVITY Box 2.2

Labour productivity is defined as output per unit of labour input. A simple measure of this is GDP per employed person. However, GDP and the number of employed persons are both cyclical, and since the cyclical fluctuations in employment tend to lag GDP slightly, this will result in systematic cyclical fluctuations in calculated labour productivity.

This can be remedied by calculation of cyclically adjusted labour productivity, i.e. by replacing the actual figures for GDP and employment, respectively, with estimates of their respective *structural* levels. The structural level of GDP, also known as the potential level of output, is the level of output that is compatible with stable growth of wages and prices. It can be seen as the GDP level achieved under normal cyclical conditions. Structural employment is the equivalent level of employment. It can be calculated as the product of the size of the working age population and a structural participation rate less an estimate of structural unemployment.

Danmarks Nationalbank calculates estimates of potential output, structural participation rate and structural unemployment, cf. Andersen and Rasmussen (2011). Based on these estimates, a cyclically adjusted measure of labour productivity can be calculated as follows:

$$P^* = \frac{Y^*}{B \cdot E^* \cdot (1 - u^*)},$$

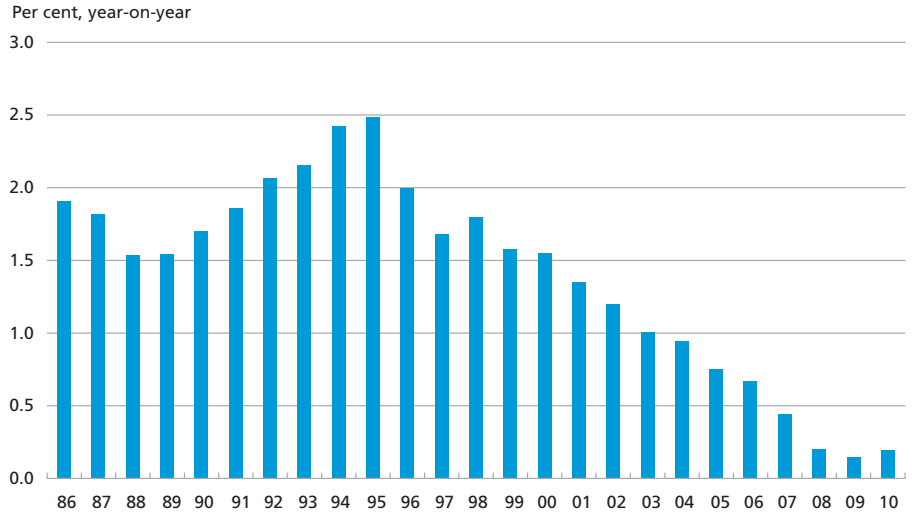
where $Y^*$ is potential output, $B$ is the number of persons in the population of working age, $E^*$ is the structural participation rate, and $u^*$ is structural unemployment.

person in the first period and an increase in the second period.[1] In Box 2.1 we discuss the pros and cons of various measures of labour productivity and the general challenges associated with the measurement of productivity.

The difference between the period 1995-2010 and the preceding years is not just the result of cyclical fluctuations. To illustrate this, we have calculated cyclically adjusted growth rates for labour productivity, measured by GDP per employed person since 1985, cf. Box 2.2. The calculations show that growth in cyclically adjusted labour productivity began to decline in the mid-1990s, cf. Chart 2.2. The slowdown has continued since then, and productivity growth has been very low in recent years,

[1] Using a number of statistical tests, Dalgaard and Hansen (2010) examine whether Danish trend growth in productivity has declined in recent decades. In contrast to the overall message of this article, the authors find no evidence of a statistically significant decline in trend growth in GDP per employed person in the period under review. On the other hand, a systematic decline in trend growth cannot be ruled out for GDP per hour worked, but the authors argue that any such decline would have set in as early as in the 1970s. The authors also demonstrate that the results for GDP per hour worked are dependent on the data source. Hence, the trend growth decline is much more pronounced when using data from Statistics Denmark than when using data from Penn World Tables.

GROWTH IN CYCLICALLY ADJUSTED GDP PER EMPLOYED PERSON Chart 2.2




Note: Cyclically adjusted labour productivity has been calculated as potential GDP divided by structural employment calculated as number of persons.
Source: Own calculations, cf. Box 2.2 and Andersen and Rasmussen (2011).

even when allowing for the strong downturn that hit the Danish economy in the wake of the financial crisis in 2008-09.[1]

**Danish productivity development in an international perspective**

The slowdown in Danish productivity growth is not unique. Since the mid-1990s, most other Western European countries have also seen much lower productivity growth than in the preceding 20 years, cf. Table 2.2. The US experience, on the other hand, contrasts with the European pattern. Productivity growth in the US economy took off in the mid-1990s and has remained at a higher level than in most Western European countries ever since. As a result, the productivity gap between the USA and Western Europe, which had narrowed considerably in the decades after World War II, widened again in the course of the last 15 years, cf. Timmer et al. (2011). Among the Western European countries, only Norway currently has higher productivity than the USA, cf. Chart 2.3.

[1] Changing the start and end years of the two periods compared may also be relevant. For example, the reason for the difference between the periods 1975-95 and 1995-2010 may be that the latter period starts close to a peak and ends close to a trough, thereby reducing the average productivity growth. This can be avoided by comparing the periods 1975-93 and 1993-2007 instead. The latest period then starts at a trough and ends at a peak, pointing, all other things being equal, to higher average productivity growth during that period. But even this breakdown results in a marked difference between the two periods, the average annual growth rates of GDP at factor cost per hour in the market economy now being 2.8 and 1.0 per cent, respectively. Thus, while slightly narrowing the difference, this alternative breakdown by no means changes the overall picture of substantially lower productivity growth since the mid-1990s than during the two preceding decades.

ANNUAL GROWTH RATES IN GDP PER HOUR WORKED, SELECTED COUNTRIES

Table 2.2

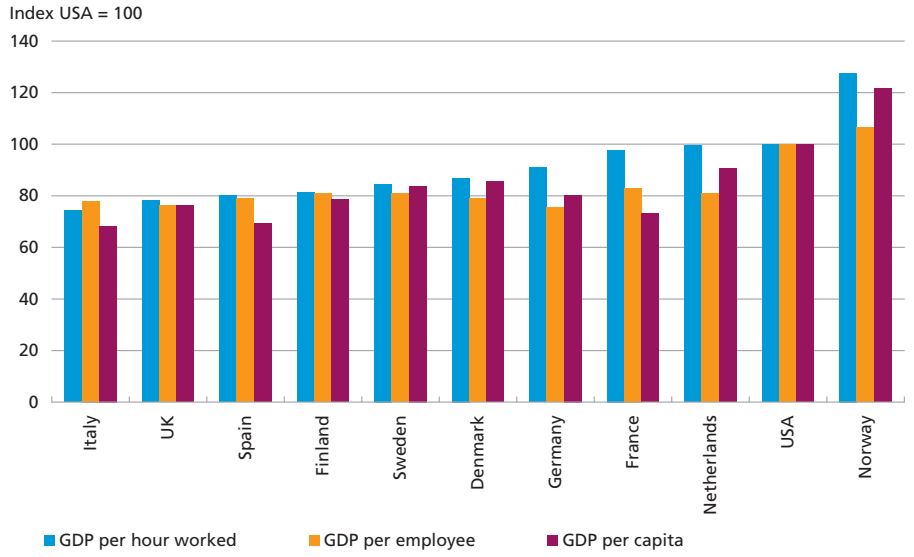
| Per cent | 1975-95 | 1995-2010 |
|---|---|---|
| Belgium | 2.7 | 1.0 |
| Denmark | 2.5 | 0.7 |
| Finland | 3.1 | 2.0 |
| France | 2.7 | 1.3 |
| Greece | - | 2.2 |
| Netherlands | 1.8 | 1.3 |
| Ireland | 3.9 | 3.4 |
| Italy | 2.4 | 0.3 |
| Luxembourg | - | 0.8 |
| Norway | 3.1 | 1.2 |
| Portugal | - | 1.9 |
| Spain | 3.1 | 0.8 |
| Sweden | 1.1 | 2.0 |
| UK | 2.5 | 1.6 |
| Germany | 2.6 | 1.3 |
| USA | 1.3 | 2.1 |
| Austria | - | 1.6 |

Note: The Table shows average annual growth rates in GDP per hour worked for the economy as a whole. Due to different sources and calculation methods, the figures for Denmark deviate slightly from the figures reported in Table 2.1.

Source: OECD.

GDP PER HOUR WORKED, PER EMPLOYED PERSON AND PER CAPITA RELATIVE TO THE USA, 2010

Chart 2.3




Note: The Chart is based on purchasing-power-adjusted GDP figures. Accordingly, changes over time relative to the USA may be due to differences in both productivity growth and price development.

Source: OECD.

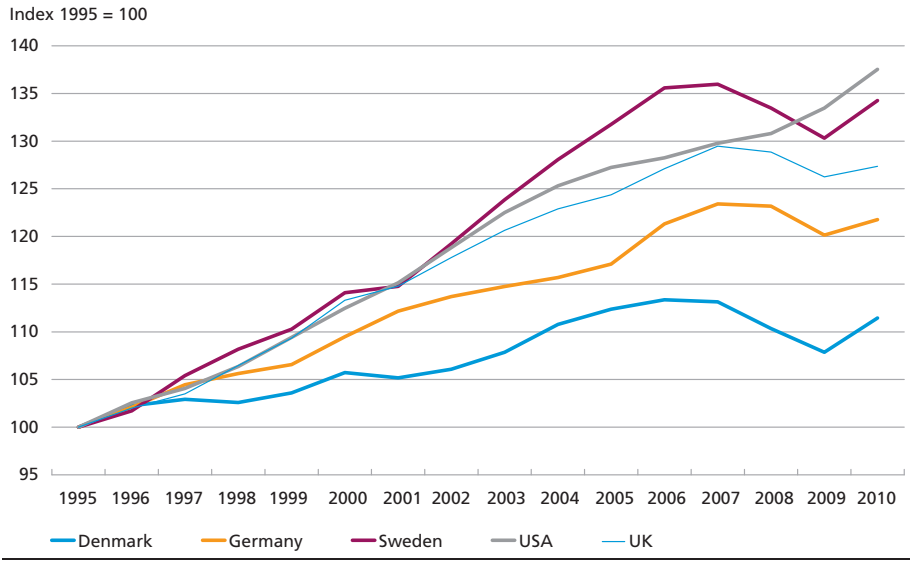
Hence, the decline in productivity growth in Denmark should be seen as part of a larger European phenomenon.

Even when compared with the other Western European countries, productivity growth in Denmark has been low since 1995. Among the 15 countries that made up the European Union until May 2004, only Italy and Spain have seen equivalent or lower growth in GDP per hour worked.

The significance of the relatively low level of productivity growth in Denmark is illustrated in Chart 2.4. Since 1995, labour productivity in Denmark, measured by GDP per hour worked has increased by 11 per cent in total. During the same period, productivity in Germany has risen by 22 per cent, while Sweden and the USA have seen productivity growth of 34 and 38 per cent, respectively. Obviously, these comparisons are affected by the choice of 1995 as the starting year, since, all other things being equal, the countries' different cyclical positions in the starting year result in different growth rates in the subsequent years. But the same overall pattern is seen when choosing another starting year, e.g. 1990, as productivity growth in Denmark has also been markedly weaker than in the above-mentioned countries when measured from that year.

Differences in productivity *growth* between various countries cannot be considered separately from differences in productivity *levels* – and thus the levels of welfare – of those countries. The hypothesis of *conditional convergence* predicts that countries with similar structural charac-

GDP PER HOUR WORKED, ECONOMY AS A WHOLE, 1995-2010 Chart 2.4




Source: OECD.

teristics (such as savings ratios and levels of education) will converge towards the same level of wealth. This means that countries with low initial levels of wealth will see higher growth rates than relatively more affluent countries. One explanation may be that, in terms of technology, the relatively poor countries are lagging behind the more affluent ones, making it potentially easier for them to boost productivity by adopting existing technology from the latter group.

There is solid empirical evidence for the hypothesis of conditional convergence, cf. e.g. Dalgaard and Hansen (2010). In view of this, it is not surprising that countries such as Portugal, Finland and the UK, where GDP per hour worked in 1995 was lower than in Denmark, have experienced stronger productivity growth since the mid-1990s. On the other hand, the hypothesis of conditional convergence cannot explain why Denmark's productivity growth has been lower than in countries where the level of productivity was already high. This is particularly true compared with the USA, but also compared with countries such as Germany, the Netherlands, Belgium and France, where GDP per hour worked was either higher or more or less the same as in Denmark in the mid-1990s, cf. Danish Economic Councils (2010).

In summary, we can conclude that productivity growth in Denmark has been weak since the mid-1990s, in relation to both the preceding years and to the development in a number of comparable countries. After many years of catching up with the USA, Denmark, like virtually all other Western European countries, has seen a widening of the gap between its productivity level and that of the USA. The slowdown in productivity growth has been particularly pronounced in Denmark, however, where growth in GDP per hour worked has been weaker since 1998 than in other countries with the same initial level of income. The weak productivity growth in Denmark has attracted considerable political attention, cf. Box 2.3.

**Productivity growth and welfare**

Productivity is not the only factor that impacts on the level of economic welfare in Denmark. As mentioned in the introduction, the number of hours worked per person, the terms of trade and income from abroad are also of key importance. The weak growth in productivity since the mid 1990s has coincided with a marked improvement of the terms of trade by approximately 10 per cent. This has expanded the opportunities for consumption in addition to what is shown by the growth in output. At the same time, while the average number of hours worked per employed person has increased slightly in Denmark, a number of other countries have seen a decline in the number of hours worked per em-

POLITICAL FOCUS ON PRODUCTIVITY GROWTH Box 2.3

Productivity growth has been high on the Danish political agenda for a number of years. In 2005, the government at the time set up the Globalisation Council comprising representatives of trade unions, business organisations and the education and research community. The objective of the Council was to discuss and provide advice on how to prepare Denmark for the challenges of an increasingly globalised world. Productivity growth plays an important role in this connection.

In 2006, the Globalisation Council published a range of recommendations.[1] Among other factors, the Council emphasised the importance of education and research. It also highlighted the conditions for business start-ups, outlining a strategy to promote entrepreneurship. The Globalisation Council stressed the importance of a more efficient public sector. In addition, competition and public-private collaboration on the performance of public tasks were identified as central instruments to enhance innovation in both the public and private sectors.

In 2009, the Danish Growth Forum was set up by the Danish government at the time with the objective of analysing and responding to the major challenges faced by the Danish economy now and in the coming many years, cf. the Danish Growth Forum (2011). Its members included representatives of the Danish government, trade unions, business organisations, the private sector and the research community.

The Growth Forum made a number of recommendations, many of which focused on productivity. The manufacturing sector's share of the overall economy has declined in recent years. According to the Growth Forum, manufacturing is of paramount importance to growth. The trend should thus be reversed so that manufacturing can gain a larger share of the economy in the coming years. To make this happen, competitiveness must be improved through wages that match productivity.

The Growth Forum also identified a number of areas in which the framework for high productivity in the construction and service sectors should be strengthened. This includes increased competition in the trade, service and construction sectors and intensified competition for services financed by the public sector. In addition, the Growth Forum recommended general promotion of productivity growth through education, innovation and investment in the capital stock. So, basically, the recommendations of the Globalisation Council and the Growth Forum are very much in line.

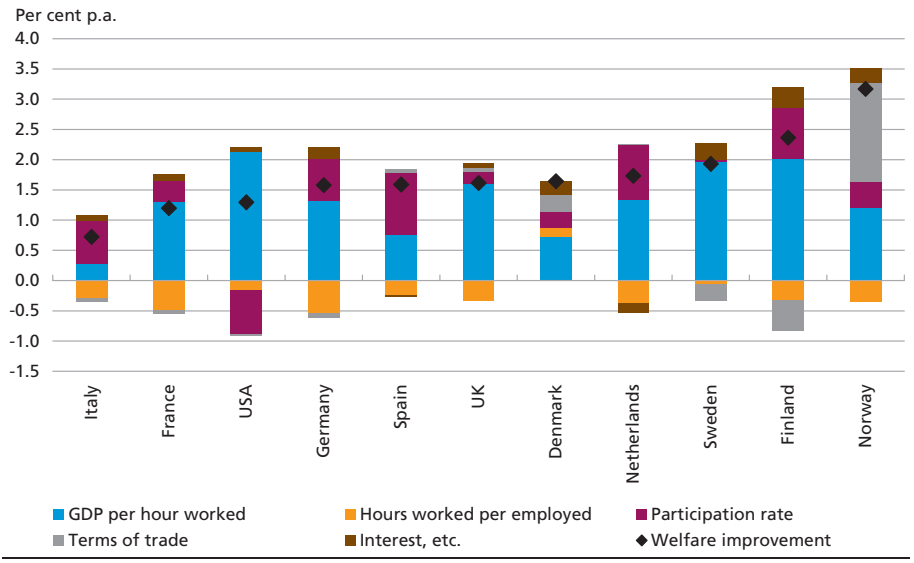
In the Danish Government Platform of 2011, the new Danish government states that it will set up a productivity commission.[2] The commission is to identify the causes of the low productivity growth since the mid-1990s and on this basis make specific recommendations to enhance productivity in Denmark.

[4] See Danish Government (2006).
[5] See Danish Government (2011).

ployed person. Finally, Denmark's external debt has given way to positive net wealth, resulting in positive net returns on foreign investments. As a consequence, the gross national product has increased more than the gross domestic product.

Allowing for these factors, the growth of economic welfare in Denmark since the mid-1990s appears less weak in an international context than implied by the growth of productivity. After an estimated adjust-

ECONOMIC WELFARE, AVERAGE ANNUAL INCREASE 1995-2010 Chart 2.5




Note: The growth rate of economic welfare has been calculated as the average annual growth rate for GNP per person of working age, adjusted for terms-of-trade effects. For a more detailed account of the adjustments made for terms of trade, see Ølgaard (2006).
Source: OECD, Eurostat, the IMF and own calculations.

ment for terms of trade, the average annual growth rate in the gross national product, GNP, per person in Denmark is on a par with the equivalent growth rates in countries such as Germany, Spain, the UK and the Netherlands, cf. Chart 2.5. On the other hand, Denmark is below Sweden, Finland and Norway. For Sweden and Finland, both of which went through economic crises in the early 1990s, this is a consequence of choosing 1995 as the starting year. If 1990 is chosen as the starting year instead, Denmark is at the same level as both Sweden and Finland, while Norway remains at a considerably higher level.

In principle, it cannot be ruled out that there is a causal link between Denmark's relatively weak productivity growth on the one hand and the improved terms of trade and higher income from abroad on the other. As established in economic theory, high productivity growth in a country's export sector may lead to a deterioration of the terms of trade, cf. Bhagwati (1958). The reason is that higher productivity will lead to a larger supply of the country's exports in the world market, causing the relative price of exports to drop. Conversely, low productivity growth may improve the terms of trade. In view of Denmark's small size relative to the world market, it is doubtful, however, whether this effect plays any role in the development in Denmark's terms of trade.

On the other hand, it cannot be ruled out that, to a greater extent than their foreign competitors, Danish exporters manufacture products

of a nature that makes it relatively difficult to achieve productivity enhancements. They may include designer products where capital inputs can only be substituted for labour inputs to a very limited extent. A high percentage of such products will result in relatively weak productivity growth. On the other hand, the terms of trade will improve over time, since the prices of products of the above type will typically go up relative to the prices of products for which it is easier to achieve productivity gains.[1]

With regard to the higher income from abroad, a causal link to the relatively weak development in productivity cannot be ruled out in advance either. If Danish firms and households choose to invest abroad rather than in Denmark, this will result in slower capital accumulation in Denmark – and thus weaker labour productivity growth – but at the same time it will result in higher income from abroad in the future.

However, there are no immediate indications that the improved terms of trade and higher income from abroad since the mid-1990s are attributable primarily to the weak productivity growth. Accordingly, as described in the next section, the analyses in this article show that Denmark's relatively low productivity growth is *not* attributable to slower capital accumulation than in the neighbouring countries. Furthermore, our analyses show that the weak growth of productivity is primarily attributable to weak productivity growth in the service sector where external trade is relatively limited, and where any terms-of-trade effects must therefore be assumed to be modest.

In any case, it is not likely that improved terms of trade and higher income from abroad will be able to fully compensate for continued weak productivity growth in future. If productivity growth in Denmark remains lower than in its neighbouring countries, this will cause the level of welfare in Denmark to decline relative to those countries.

## 3. DECOMPOSITION OF LABOUR PRODUCTIVITY: GROWTH ACCOUNTING

Productivity refers to the *efficiency* of a production process. Any productivity measure thus reflects how much is produced with a given amount of input. For example, labour productivity measures the output that is produced with a given amount of labour input, measured in e.g. hours or number of employed persons.

[1] A similar conclusion applies to the statistical challenge associated with product quality improvements described in Box 2.1. In terms of exports statistics, it may be difficult to determine the extent to which the higher price of an export article reflects a quality improvement (and thus higher real value added) or an increase in the price level. In the first case, the quality improvement would be recorded as higher productivity, while in the second it would be recorded as an improvement of the terms of trade.

Labour productivity is an example of a *single-factor* productivity measure. Such measures express the amount of output per unit of a single input factor, in this case labour, without taking into account the contributions from other input factors, if any. Accordingly, the level of labour productivity is dependent on the intensity of capital, i.e. the amount of capital equipment such as machinery and buildings per unit of labour.

To account for this, labour productivity development is often analysed by means of growth accounting, cf. Box 3.1. In a growth accounting exercise, total output growth is decomposed into contributions from growth in measurable input factors (typically labour and capital) and

GROWTH ACCOUNTING — Box 3.1

Growth accounting decomposes economic growth into two components: The first component comprises contributions from growth in observable input factors such as labour and capital. The other component is growth in total factor productivity, TFP. Total factor productivity indicates the efficiency with which firms use the total input of observable production factors. It is assumed that the production side of the economy can be described by a specific production function. The standard example is a Cobb-Douglas function with constant returns to scale:

$$Y = TFP \cdot (Q \cdot H)^{\alpha} K^{1-\alpha}, \quad (1)$$

where $Y$ is GDP in volume terms, $K$ is capital in volume terms, $H$ is labour input measured in hours, $Q$ is an index of labour quality, and $TFP$ indicates total factor productivity. $Q$ will typically depend on the level of education of the labour force.

Key assumptions behind growth accounting are that firms maximise profits, and that product and factor markets are fully competitive. These assumptions mean that the parameter $\alpha$ can be approximated by the wage share. The amount of capital and (quality-adjusted) labour is typically measured using data from the national accounts. Since Y is observable, TFP can be estimated as a residual. By rewriting (1), growth in hourly productivity can be expressed as

$$\Delta y - \Delta h = \Delta tfp + (1-\alpha) \cdot (\Delta k - \Delta h) + \alpha \cdot \Delta q, \quad (2)$$

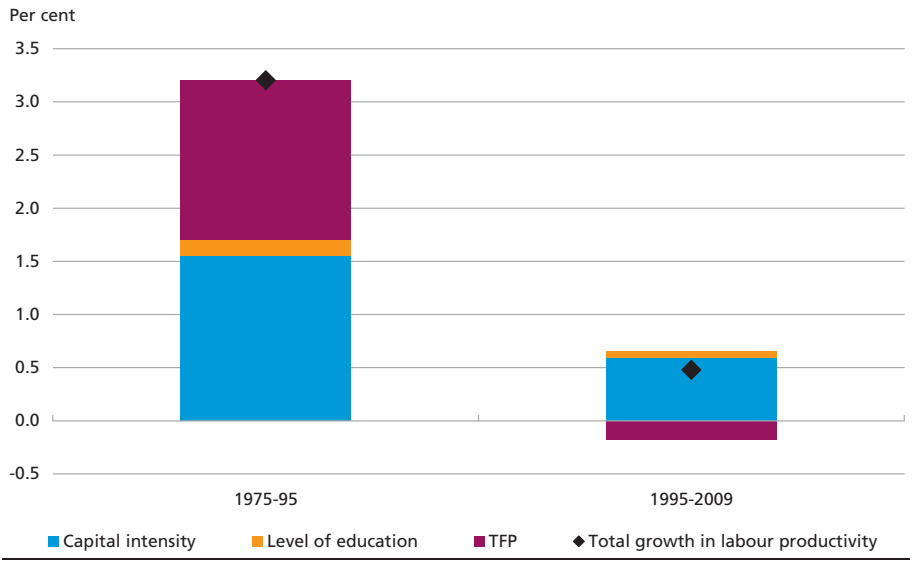
where lower-case letters indicate the natural logarithm of the variable in question. Growth in hourly productivity can thus be decomposed into contributions from growth in TFP, capital intensity and labour quality. While TFP growth is passed through on a one-to-one basis, the pass-through of growth in capital stock per hour worked and improvement in the quality of labour depend on the parameter $\alpha$. It should be borne in mind that the TFP level is calculated as a residual. This means that any improvement in hourly productivity that cannot be attributed to higher capital intensity or an increase in the level of education of labour will be registered as higher TFP. TFP growth is thus a measure of everything that increases hourly productivity and which is not directly attributable to developments in the capital stock or the level of education.

growth in *total factor productivity*, TFP. TFP indicates the possible level of output with a given amount of the measurable input factors. Unlike labour productivity, TFP is a *multi-factor* productivity measure that is unaffected by the amounts of measurable input factors. Growth in TFP thus indicates that part of labour productivity growth cannot be attributed to growth in the amount of other measurable input factors, including the capital stock. So TFP growth may reflect technological advances, among other factors, which cannot be attributed to increased capital, as well as efficiency gains from better organisation and planning of the production process.

Statistics Denmark and the EU KLEMS project under the European Commission carry out growth accounting for Denmark. One of the advantages of Statistics Denmark's figures is that they cover almost the entire period under review in this article, whereas the EU KLEMS figures cover only the period 1980-2007. On the other hand, EU KLEMS performs growth accounting for a large number of countries, thus enabling international comparisons. As a consequence, both types of growth accounting are used below.

The slowdown in labour productivity growth since the 1990s can be explained in part by a lower contribution from capital accumulation relative to the period 1975-95, cf. Chart 3.1. If capital intensity had in-

GROWTH ACCOUNTING FOR LABOUR PRODUCTIVITY, 1975-95 AND 1995-2009 Chart 3.1




Note: The Chart decomposes the average percentage annual growth in GDP at factor cost per hour worked in the market economy into contributions from growth in capital per hour, changes in the educational composition of the labour force and growth in TFP.
Source: Statistics Denmark and own calculations.

CONTRIBUTIONS TO GROWTH IN GVA PER HOUR, 1995-2007, SELECTED COUNTRIES

Table 3.1

| Per cent | Capital intensity | Education | TFP | Total growth in GVA per hour |
|---|---|---|---|---|
| Belgium | 1.3 | 0.2 | 0.1 | 1.7 |
| Denmark | 1.1 | 0.1 | -0.2 | 1.0 |
| Finland | 0.4 | 0.1 | 2.8 | 3.3 |
| France | 0.7 | 0.3 | 0.9 | 2.0 |
| Netherlands | 0.5 | 0.4 | 1.1 | 2.1 |
| Italy | 0.6 | 0.1 | -0.4 | 0.4 |
| Spain | 0.9 | 0.4 | -0.6 | 0.6 |
| Sweden | 1.6 | 0.3 | 1.4 | 3.3 |
| UK | 1.2 | 0.4 | 1.0 | 2.6 |
| Germany | 1.0 | 0.0 | 0.7 | 1.7 |
| USA | 1.2 | 0.3 | 1.2 | 2.6 |
| Austria | 0.5 | 0.1 | 1.5 | 2.2 |

Note: The Table decomposes the average percentage annual growth into GVA per hour in the market economy. Total growth in GVA per hour may deviate slightly from the sum of individual contributions due to rounding.
Source: Timmer et al. (2011) and own calculations based on the EU KLEMS database.

creased at the same rate in 1995-2009 as in 1975-95, the average annual growth in labour productivity in the former period would have been approximately 1 percentage point higher, all other things being equal. But the decline in productivity growth is primarily attributable to a lower contribution from TFP growth. So of the total decline of 2.7 percentage points per year in the period 1975-95, only approximately 1.1 percentage points can be explained by a smaller contribution from capital intensity growth and improved levels of education in the labour force.

A similar picture emerges if we compare the development since 1995 with the equivalent development in other countries. The relatively low productivity growth in Denmark is thus attributable to weak TFP development, cf. Table 3.1. In terms of growth in capital intensity, on the other hand, Denmark is well positioned compared with other western countries. The contribution from improvements in the educational composition of the labour force is slightly smaller in Denmark than in many of the other western countries, but the difference is minor. So the gap between Denmark and its neighbouring countries cannot be explained by weaker development in these observable factors, and the explanation must be found elsewhere.

Hence, the challenge is to examine the possible factors behind the weak Danish TFP growth since the mid-1990s. In sections 5-8 we take a closer look at some of the factors that are usually described as key to productivity development, and especially to TFP.

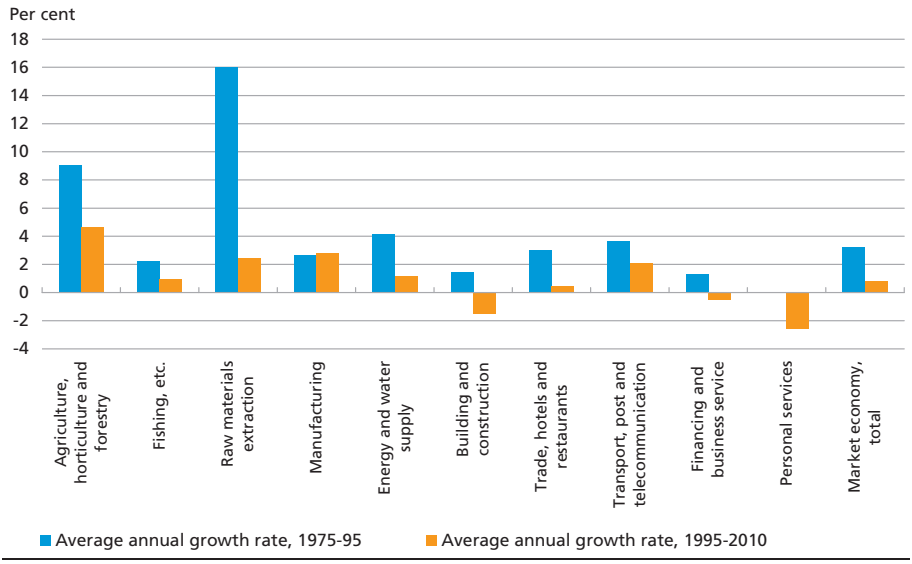
## 4. PRODUCTIVITY GROWTH BY INDUSTRY

In the preceding sections we have focused on productivity at the *aggregate* level. But aggregate productivity growth masks very different developments in productivity within the various industries, cf. Chart 4.1. For example, agriculture has seen high labour productivity growth since 1975 as a result of a marked increase in the capital intensity in this sector, among other factors. Conversely, labour productivity growth since 1975 has been very low, or even negative, in the construction sector and a number of service sectors.

For almost all industries, except manufacturing, the average annual growth in labour productivity was markedly lower in the period 1995-2010 compared to the preceding 20 years. Hence, the decline in productivity growth described in the previous section is a common phenomenon and cannot be attributed to a single industry.

Productivity growth in individual industries is obviously of importance to the growth rate of productivity for the economy as a whole. It is not a one-to-one relationship, however, since aggregate productivity growth is also dependent on the relative sizes and productivity *levels* of the in-

GROWTH IN LABOUR PRODUCTIVITY BY INDUSTRY, 1975-2010 Chart 4.1




Note: The Chart shows the average annual growth rates for GVA per hour worked, 2000-prices, chained values. The calculations are based on the market economy, i.e. the economy as a whole, excluding the general government sector. Comparisons of productivity growth across industries are complicated by the fact that it may be harder to measure productivity in some industries than in others. The difficulties related to quality improvements (as described in Box 2.1) are probably substantial in the service and construction sectors, whereas output in volume terms is easier to calculate in, say, the agricultural sector.

Source: Statistics Denmark and own calculations.

dividual industries. Aggregate productivity growth, whether measured by hourly productivity or TFP, can thus be obtained via two channels:

1) By productivity growth *within* individual industries.
2) By reallocation of resources *between* industries, transferring resources from low-productivity to high-productivity industries.

The first of these channels is often referred to as a *within* effect, while the second channel is referred to as a *between* effect. According to economic theory, production factors tend to gravitate towards the industries that provide the highest returns. For example, workers will have a financial incentive to seek employment in the industries with the highest real wages. Since, all other things being equal, firms in high-productivity industries will be able to pay higher wages than firms in low-productivity industries, this mechanism will tend to reallocate resources from less productive towards more productive industries, consequently having a positive between effect.

The distinction between *within* effects and *between* effects is often useful when analysing aggregate productivity growth. When assessing the potential impact of a specific policy measure on aggregate productivity, both channels should be taken into account. In principle, a policy measure may potentially lead to higher aggregate productivity without enhancing productivity in one single industry. This will be the case, e.g. if the measure facilitates reallocation of labour, thus enabling increased inflow into the most productive industries from less productive ones.

Growth in aggregate productivity can be decomposed into contributions from productivity growth by industry and reallocation of resources between industries, cf. Box 4.1. In this section, total growth in *labour productivity* in the economy as a whole, excluding public and personal services, is decomposed.[1] The calculated contributions from reallocation thus only reflect the effect of reallocating labour while the effect of reallocating capital is not explicitly taken into account.

Chart 4.3 focuses on the differences in productivity growth in the periods 1975-95 and 1995-2010. The reasons for the weaker productivity growth in the latter period are a smaller contribution from reallocation as well as lower productivity growth within each industry. As previously mentioned, the decline in productivity growth has been observed in practically all the key industries in the economy – illustrated here by the fact that the contributions from all categories are smaller in the period

[1] Ideally, calculations of productivity should be based on the market economy only. But it is not possible, on the basis of the available data, to break down the industry-specific data on gross value added and hours worked into a market part and a non-market part. We have consequently chosen to leave out the category of public and personal services, as it has a particularly high concentration of non-market output.

PRODUCTIVITY GROWTH AND REALLOCATION BETWEEN SECTORS Box 4.1

Aggregate labour productivity in a year $t$, $P_t$, is given as the ratio between aggregate gross value added in year $t$, $Y_t$, and the aggregate number of hours worked, $L_t$. Hence, aggregate productivity can be expressed as:

$$P_t = \frac{Y_t}{L_t} = \frac{\sum_j Y_t^j}{\sum_j L_t^j} = \sum_j s_t^j P_t^j ,$$

where $Y_t^j$ and $L_t^j$ are, respectively, gross value added and number of hours worked in industry $j$ in year $t$, $s_t^j \equiv L_t^j / L_t$ is industry $j$'s share of the total number of hours worked in year $t$, and $p_t^j \equiv Y_t^j / L_t^J$ is labour productivity in industry $j$ in year $t$. Accordingly, aggregate labour productivity can be calculated as the weighted sum of labour productivity by industry, where each industry is weighted by its share of the total input of labour.[1] Below, this share will be referred to as the industry's *employment share*.

The change in aggregate productivity from year $t$-1 to year $t$ can then be decomposed as follows:

$$\begin{aligned} \Delta P_t &= \sum_j s_t^j P_t^j - \sum_j s_{t-1}^j P_{t-1}^j \\ &= \sum_j s_{t-1}^j \cdot \Delta P_t^j + \sum_j (P_{t-1}^j - P_{t-1}) \cdot \Delta s_t^j + \sum_j \Delta P_j^t \cdot \Delta s_t^j \end{aligned} \qquad (4.1)$$

taking into account that $\sum P_{t-1} \cdot \Delta s_t^j = P_{t-1} \cdot \sum \Delta s_t^j = 0$.

The expression on the right-hand side of equation (4.1) consists of three terms, each of which has an economic interpretation, cf. Foster, Haltiwanger and Krizan (2001): The first term indicates the effect of productivity growth within industries, i.e. the *within* effect. This is the aggregate productivity growth that would have been achieved if there had been no reallocation of labour between industries. Here, the within effect is calculated as a weighted sum of productivity growth within industries, each industry being weighted by its employment share in the *starting year*.

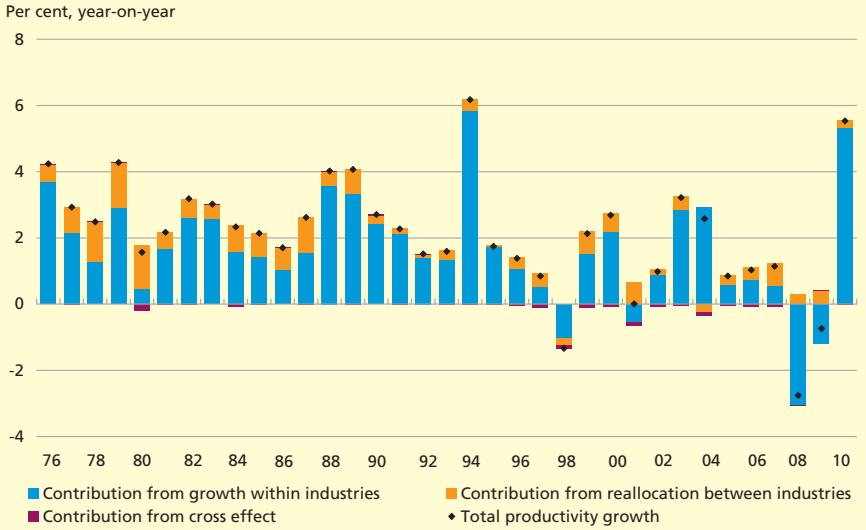
The second term on the right-hand side of equation (4.1) captures the contribution from reallocation between industries, i.e. the *between* effect. This term can be seen as a counterfactual expression of what the aggregate productivity growth would have amounted to if productivity growth within each industry had been zero. The contribution from reallocation is positive if the industries with higher-than-average productivity in the starting year have generally increased their employment share since the starting year, while industries with low productivity have seen a decline in their employment share.

The third and last term on the right-hand side of equation (4.1) is a *cross effect*, reflecting any interaction between productivity growth within individual industries and reallocation between industries. The cross effect will be positive if labour is reallocated to the industries with the highest productivity growth.[2] It is sometimes included as part of the overall reallocation effect, cf. e.g. Danish Economic Councils (2010). Consequently, the sum of the cross and between effects is often referred to as a total "gross effect" of reallocation while the between effect is referred to as a "net effect".

CONTINUED Box 4.1

Most of the growth in labour productivity since 1975 can be attributed to productivity growth within individual industries, but reallocation of labour between industries has also contributed significantly, cf. Chart 4.2.[3] The main reason is the sustained inflow of labour to financing and business services, where labour productivity has been above average for the economy in the period under review. Relocation of labour from the agricultural sector to the other sectors of the economy also contributed to higher aggregate productivity growth, especially in the first part of the period, as productivity in this sector was substantially below the average for the rest of the economy. But this contribution ceased as the agricultural sector caught up with the productivity level of the other industries. As a result, gains from reallocation between industries were reduced during the second half of the period under review.

CONTRIBUTIONS FROM WITHIN, BETWEEN AND CROSS EFFECTS Chart 4.2




Note: The Chart decomposes growth in labour productivity for the economy as a whole, excluding public and personal services. The decomposition has been calculated on the basis of the same breakdown by industries as shown in Chart 4.1, excluding personal services.

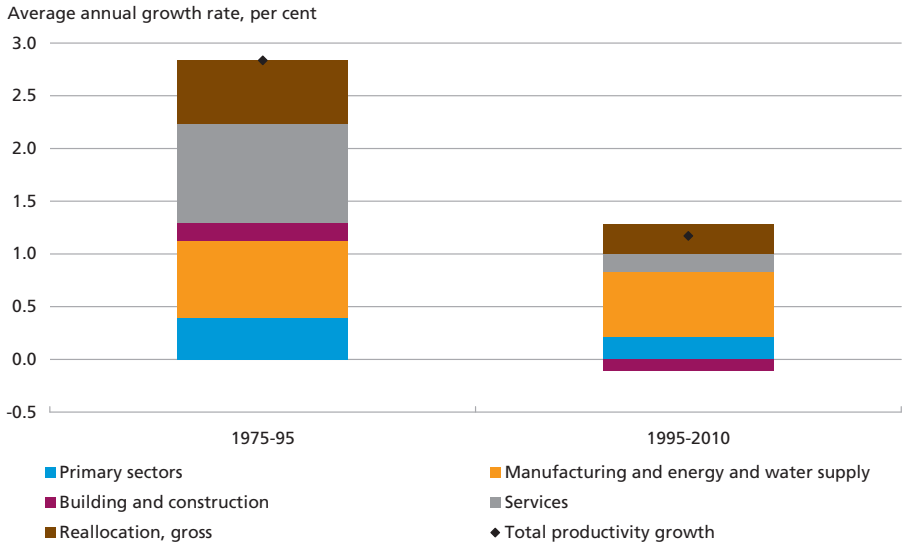
Source: Statistics Denmark and own calculations.

[1] It is assumed that aggregate gross value added can be calculated as the sum of gross value added within each industry. To ensure this, decomposition in this section is based on gross value added figures at constant prices. When this method is used, the calculation of productivity growth within each industry will deviate somewhat from the figures shown in Chart 4.1, since, in the latter case, the calculation of gross value added in volume terms is based on chained values.

[2] It should be noted that this differs from the pure reallocation effect captured by the between effect, which is positive, if labour is reallocated to the industries with the highest productivity *levels*.

[3] Here the decomposition illustrates solely the significance of reallocation between the key industries shown in Chart 4.1, excluding personal services. It only reflects part of the total effect of reallocation, however: Part of the productivity growth within the key industries may thus be attributed to reallocation of resources *within* the key industries, e.g. between individual firms in a given industry. Reallocation may thus be of much greater significance than suggested by Chart 4.2. Lentz and Mortensen (2008) find that 53 per cent of total productivity growth in Danish firms is attributable to a reallocation mechanism causing high-productivity firms to grow at a faster rate than low-productivity firms. According to Lentz and Mortensen, another 21 per cent can be attributed to the failure of existing low-productivity firms and their replacement by new, more productive firms.

DECOMPOSITION OF GROWTH IN AGGREGATE LABOUR PRODUCTIVITY, 1975-95 AND 1995-2010 Chart 4.3




Note: The Chart decomposes growth in labour productivity for the economy as a whole, excluding public and personal services. The decomposition has been calculated on the basis of the same breakdown by industries as shown in Chart 4.1, excluding personal services. Annual contributions to aggregate productivity growth are calculated for each industry as described in Box 4.1. The Chart shows the average of annual contributions. Contributions from primary sectors have been calculated as the sum of contributions from agriculture, horticulture and forestry, fishing, etc., and raw materials extraction. Contributions from services have been calculated as the sum of contributions from trade, hotels and restaurants, transport, post and telecommunications as well as financing and business service. The gross reallocation category refers to the sum of the between and cross effects, cf. Box 4.1.

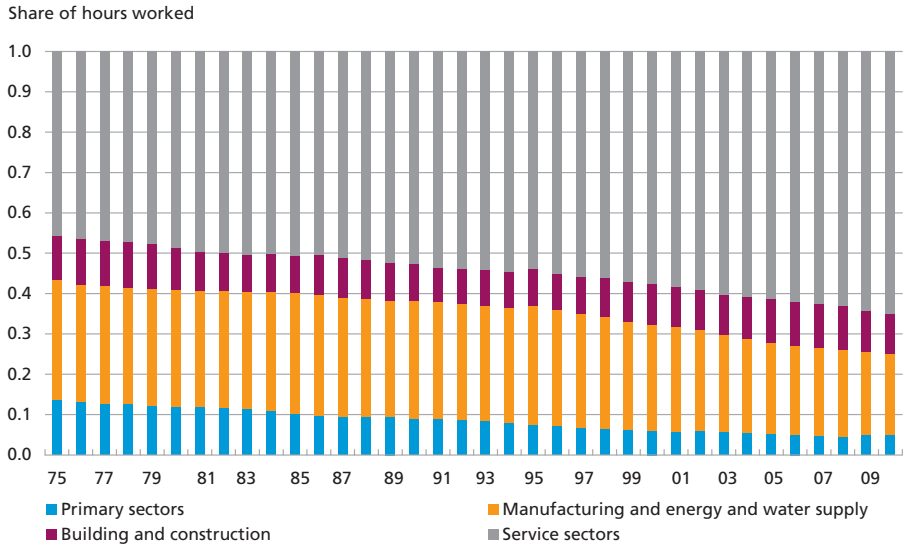
Source: Statistics Denmark and own calculations.

1995-2010 than in the preceding period.[1] This is particularly the case for the contribution from productivity growth in the service sector. The reduction in this contribution may thus explain almost half of the decline in the average annual productivity growth in relation to the period 1975-95.

The decline in the service sector's contribution to aggregate productivity growth occurred despite that sector's share of the total input of labour having increased throughout the period under review, cf. Chart 4.4. Viewed in isolation, the larger relative size of the service sector would indicate a larger contribution from that sector, but the increase in the sector's share of total employment is more than offset by the fact that productivity growth in the service sector has been considerably slower in the last 15 years than in the preceding 20-year period.

[1] As previously mentioned, the exception is manufacturing, where productivity growth in the period 1995-2010 remained largely unchanged compared with the period 1975-95. The reason for the lower contribution from manufacturing to aggregate productivity growth in 1995-2010 is that manufacturing accounted for a smaller share of total employment in that period compared with the previous one.

INPUT OF LABOUR BY INDUSTRY Chart 4.4




Note: The Chart shows the distribution of hours worked for the economy as a whole, excluding public and personal services.
Source: Statistics Denmark and own calculations.

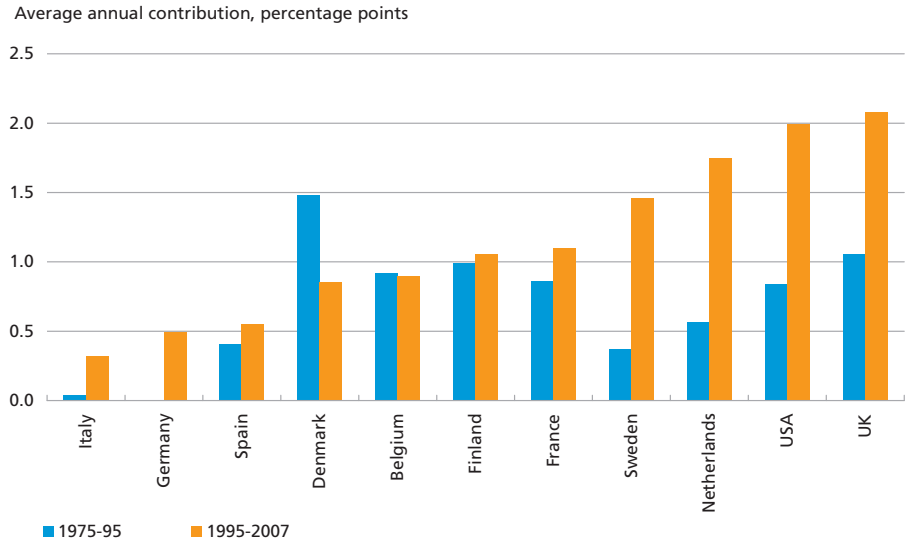
This raises the issue of whether the lower productivity growth is a structural phenomenon that can be attributed to the transition of the Danish economy from manufacturing to services. Baumol (1967) argues that the increased economic importance of the service sector will inevitably lead to a slowdown in productivity growth. The argument behind this hypothesis is that productivity enhancements are more difficult to obtain in the service sector than in manufacturing, because most services are produced with a high input of labour which can not easily be substituted by capital input.

It should be noted, however, that Baumol's hypothesis is *not* sufficient to explain the evolution of labour productivity in Denmark. The hypothesis is based on the assumption that productivity growth in the service sector is, by nature, lower than in manufacturing. Accordingly, the key assumption is that any increase in the contribution from the service sector that is attributable to a larger share of the total input of labour will be offset by a numerically larger decrease in the contribution from manufacturing, thereby reducing aggregate productivity growth. However, this cannot explain why productivity growth in the service sector has been weaker than before, resulting in a smaller contribution from this sector.

The Danish service sector's contribution to growth in aggregate labour productivity is also remarkable in an international perspective. Firstly,

SERVICE SECTOR CONTRIBUTION TO AGGREGATE PRODUCTIVITY GROWTH

Chart 4.5




Note: The Chart shows contributions from productivity growth in the service sector to labour productivity growth in the market economy as a whole. The contributions have been calculated as the sum of the average annual contributions from a total of eight market service sectors. Each contribution has been calculated as described in Box 4.1. Due to differences in the data sources, sector coverage and period of time, contributions from the Danish service sector are not directly comparable with the contributions shown in Chart 4.3. For the USA, the bars show the average annual contributions in 1977-95 and 1995-2007, respectively. For Germany, no comparable statistics are available before 1991, so contributions for the period 1975-95 have not been calculated.

Source: EU KLEMS database, cf. http://euklems.net/, and own calculations.

since the mid-1990s, the Danish service sector has contributed considerably less to aggregate productivity growth than the equivalent sectors in e.g. the USA and the UK, cf. Chart 4.5. This phenomenon is common in a number of European countries, however. Weak productivity growth in the European service sector is thus an important contributing factor behind the divergence between productivity levels in the USA and Europe in recent years, cf. also Timmer et al. (2011). It is even more remarkable that the Danish service sector's contribution to productivity growth was markedly higher in the period 1975-95 than in the subsequent years. This contrasts with the development in a number of other Western European countries and the USA where the growing size of the service sector has resulted in a higher contribution to aggregate productivity growth.

Overall, this indicates that weak productivity growth in the service sector has been the single most important reason why productivity growth in Denmark has been relatively low since the mid-1990s compared with other countries, especially the USA, and with the development in Denmark in the preceding 20 years. It is therefore natural to attach particu-

lar importance to this sector in analyses of the impact of various factors on productivity development. In sections 9 and 10, we focus on factors that may particularly impact productivity in the service sector.

## 5. RESEARCH AND DEVELOPMENT

Investment in research and development is often highlighted as a source of productivity growth. Research and development lead to the emergence of new knowledge that may enhance both labour and capital productivity. New knowledge may also be generated as a by-product of investment in new capital stock or through continuous learning by doing during the production process. Growth is driven by the accumulation of new knowledge according to many theoretical models, cf. e.g. Barro and Sala-i-Martin (1995).

The stock of knowledge is not included in the inputs of capital and labour in growth accounting, cf. Box 3.1. If more research leads to higher productivity, this will thus be reflected as higher TFP. Since weak growth in TFP is a significant factor behind Denmark's weak productivity growth, it is interesting to study whether Danish firms are sufficiently good at generating new knowledge and translating it into higher productivity.

In 2009, Danish firms' total expenditure for research and development constituted 2.08 per cent of GDP, cf. Table 5.1. This is considerably more than in the euro area. But there are considerable differences between the euro area member states, and research expenditure of firms in Germany is almost on a par with that of Danish firms. When including research otherwise conducted in the economy, Denmark's expenditure, at 3.06 per cent of GDP, is also considerably higher than that of the euro area.

EXPENDITURE FOR RESEARCH AND DEVELOPMENT AS A PERCENTAGE OF GDP, 2009 Table 5.1

| Unit | Private firms | Private non-profit sector | Education sector | Other public sector | Total |
|---|---|---|---|---|---|
| Denmark | 2.08 | 0.01 | 0.90 | 0.06 | 3.06 |
| France | 1.39 | 0.03 | 0.47 | 0.37 | 2.26 |
| Norway | 0.93 | - | 0.58 | 0.29 | 1.80 |
| Sweden | 2.54 | 0.00 | 0.91 | 0.16 | 3.61 |
| Germany | 1.91 | - | 0.50 | 0.42 | 2.82 |
| UK | 1.12 | 0.05 | 0.52 | 0.17 | 1.86 |
| USA | 2.02 | 0.11 | 0.36 | 0.30 | 2.79 |
| Euro area | 1.27 | 0.02 | 0.47 | 0.29 | 2.06 |

Note: The figure for other public-sector expenditure for research in the USA does not include military research. The figures for the USA relate to 2008.
Source: Eurostat.

In addition to investment specifically targeted at research and development, investment in physical capital may also lead to the accumulation of new knowledge. The reason is that with new machinery, production typically has to be organised in a slightly different way, resulting in the creation of new ideas and know-how as part of the reorganisation. In terms of private gross investment, Denmark has more or less been on a par with Germany and the euro area as a whole since 1995. In other words, it is not evident that the weak Danish growth in TFP is caused by lack of investment.

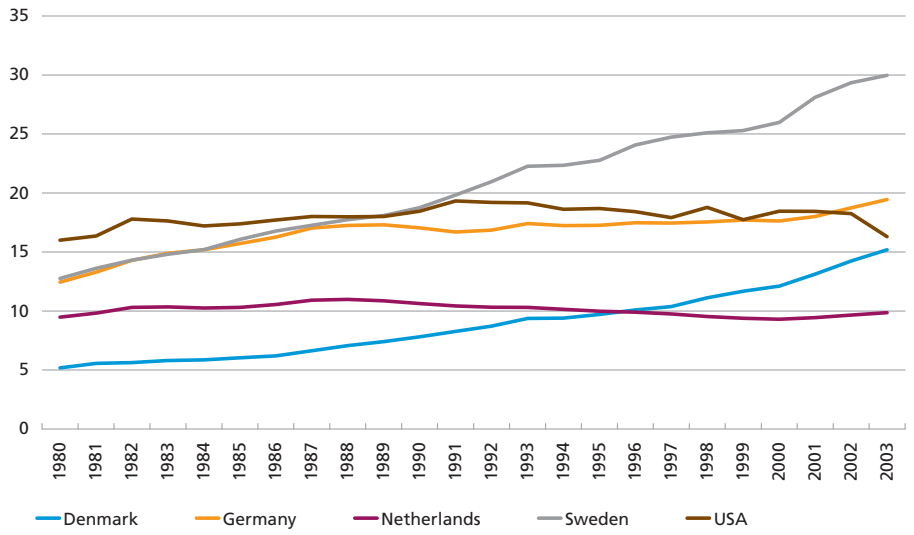
Generally, returns on investment in knowledge, whether in the form of research and development expenditure or investment in physical capital, will often not be generated until several years after the investment was made. So, in principle, it is possible that the weak Danish TFP growth is caused by failure to invest in research and development in previous years. This can be taken into account by looking at the *stock* of research and development capital (knowledge capital), the size of which depends on investments made in the preceding years. In connection with the EU KLEMS project, such stock time series have been constructed for a number of countries. Denmark has previously been at the low end relative to comparable countries, but it has, on the other hand, been among the countries experiencing the strongest growth in knowledge capital, cf. Chart 5.1. Against this backdrop, high Danish TFP growth might have been expected.

All things considered, there is no evidence that Denmark invests less in knowledge building than comparable countries. Together with the relatively weak productivity growth, this raises the question of whether Denmark gets less return on its investments than other countries. McMorrow (2011) argues that Denmark has had a low return on its investment in research and development compared with other countries. This may indicate that Danish firms have not been good enough at translating research and development efforts into marketable products.

But Denmark's limited size may also influence the return on investment in research and development. Ulku (2004) estimates the effect of research and development on productivity growth for 20 OECD countries and 10 developing countries. The premise is that research and development is translated into innovation, in this article calculated as a country's patent portfolio. According to the study, innovation has a positive effect on growth in GDP per capita, but investment in research and development only has a clear positive effect on innovation in large countries. In smaller countries, innovation is primarily promoted by using existing knowhow from other countries. This emphasises the importance of Danish firms' ability to implement technological advances generated abroad.

STOCK OF RESEARCH AND DEVELOPMENT RELATIVE TO GROSS VALUE ADDED

Chart 5.1




Note: The stock of research and development is only calculated at 2000-prices in EU KLEMS. Based on the GVA deflator in market service sectors, an expression for research and development has been constructed in current prices. The Chart shows that expression as a ratio of GVA for the market industries.

Source: Danish Economic Councils' EU KLEMS calculations, cf. Danish Economic Councils (2010).

However, Ulku's findings are to some extent contradicted by detailed micro studies for specific countries. For example, Doraszelski and Jaumandreu (2009) find that investment in research and development explains much of the productivity growth in Spanish firms. Hall and Mairesse (1995) reach a similar conclusion based on a study of French firms. The studies demonstrate that research and development have a direct effect on productivity in the firm where the research is conducted. If this is the case, research and development will also impact productivity in small countries although the effect cannot be measured in Ulku's study.[1]

This implies that simply expanding the research effort is not necessarily the answer to the productivity challenge, and there may be reason to look into whether research is given appropriate priority in Denmark. There may also be reason to examine whether Danish firms benefit sufficiently from knowledge generated outside Denmark. New knowledge and technology can spread to other countries especially via international trade and direct investment. These topics are discussed in more detail in section 10.

[1] A related issue concerns the link between the return on research and development and the size of the *firm* conducting the research. This issue will be discussed in section 9.

## 6. EDUCATION AND TRAINING

Education and training may make the labour force more productive, thus increasing output per hour worked. This is mainly due to the knowledge obtained by an individual, which enhances that individual's productivity. However, reinforced education initiatives may also raise the general level of knowledge in the firm and in society, thereby boosting productivity for others. The latter effect will typically be reflected as higher TFP.[1]

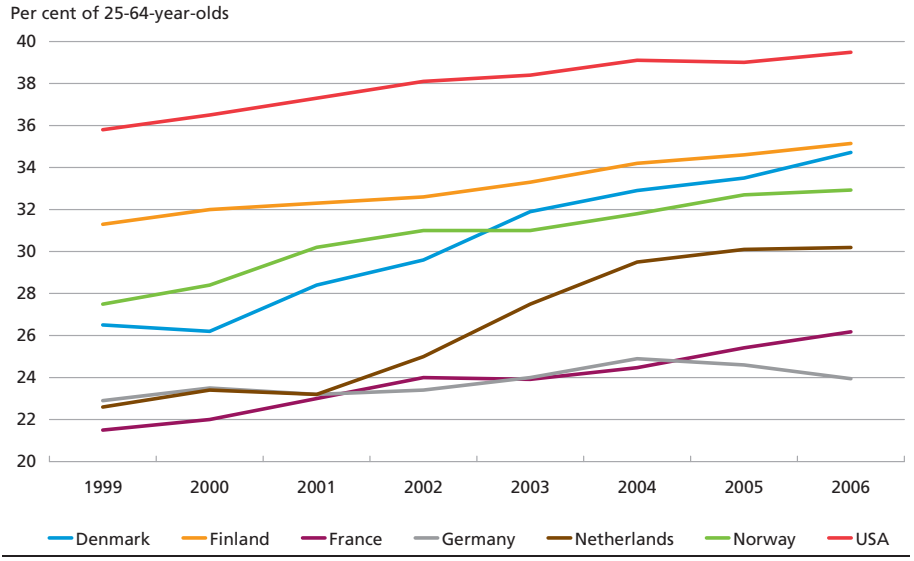
In terms of the proportion of the population of working age with tertiary education, Denmark is in line with most comparable countries, cf. Chart 6.1.

Although Denmark is not lagging behind in terms of the share of the population with tertiary education, the composition across educational fields may influence the significance of education to productivity. Junge and Skaksen (2010) find that an increase of one percentage point in the share of employed persons with higher education leads to an increase in GDP of approximately 1 per cent. However, the effect on TFP is much more pronounced for social and natural science education than for humanities education in the manufacturing and service sectors alike. Accordingly, focus on social and natural science programmes will potentially help to boost productivity.

The above discussion focused on the level of education in the *population*. In terms of productivity development, however, it is more relevant to examine the level of education among *employed persons.* Obviously, the latter is dependent on the former, but conditions in the labour market may also play a role. For some time, the general level of education among employed persons has thus tended to rise, cf. Chart 6.2, reflecting the generally increasing level of education in the population. But calculations made by the European Commission indicate that the contribution of improved educational standards to productivity growth has been significantly reduced since the mid-1990s, cf. McMorrow (2011). The reason may be the marked reduction in structural un-

[1] It should be noted that the educational level has already been taken into account in the growth accounting exercise where total input of labour has been adjusted for the labour quality, cf. Box 3.1. Ideally, a higher level of education should therefore be reflected as an increase in the quality-adjusted input of labour, while TFP should be unchanged. But growth accounting is based on a number of assumptions that are not necessarily met in practice. For example, it is assumed that labour is paid the value of its marginal product, and that the production function shows constant returns to scale. Under these assumptions, the amount of quality-adjusted labour can be measured on the basis of the firms' total payroll. In practice, wages are typically determined by negotiations between employers and employees, and for this reason, wages will not always be equivalent to the marginal product of labour. Hence, the calculation of labour quality is not necessarily correct, and part of the effect of increased education may be reflected as higher TFP. Besides, positive externalities of education may drive a wedge between the economic return on education and wages, and this may also cause part of the effect of a higher level of education to be captured by the TFP residual.

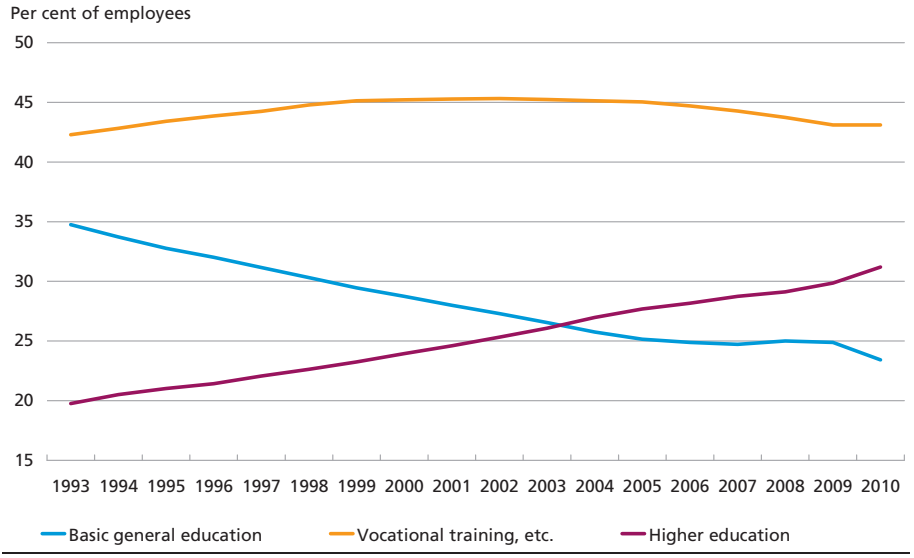
SHARE OF POPULATION WITH TERTIARY EDUCATION — Chart 6.1




Source: OECD.

employment during the same period. The decline in unemployment has led to groups of people with relatively little education gaining a foothold in the labour market and therefore constituting a larger share of those in employment than they would have if unemployment had remained unchanged. This trend was further reinforced by the shortage of

EDUCATIONAL COMPOSITION AMONG EMPLOYED PERSONS — Chart 6.2




Source: Statistics Denmark.

labour that occurred during the boom in the middle of the last decade. The proportion of employed persons with only basic general education thus flattened out during those years after having been falling for many years. This may have contributed to lower productivity growth.

The decline in structural unemployment is desirable for both the individual citizen and for society, and it should be emphasised that a reduction in productivity due to the inclusion of broader groups of the population in the labour market is not a problem in itself. On the contrary, the increase in employment will lead to considerable economic benefits, so it will be worth any negative knock-on effect on productivity. However, it is important to focus on whether the qualifications of the less productive part of the labour force can be upgraded to become more in line with those of other employed persons.

In a forward-looking perspective, structural unemployment will probably not be reduced much further than its present level. At the same time, there are no indications of a general decline in the level of education of the population. This means that productivity growth will not be permanently kept down as a result of further shifts in the composition of those in employment towards a larger share of employed persons with little education.

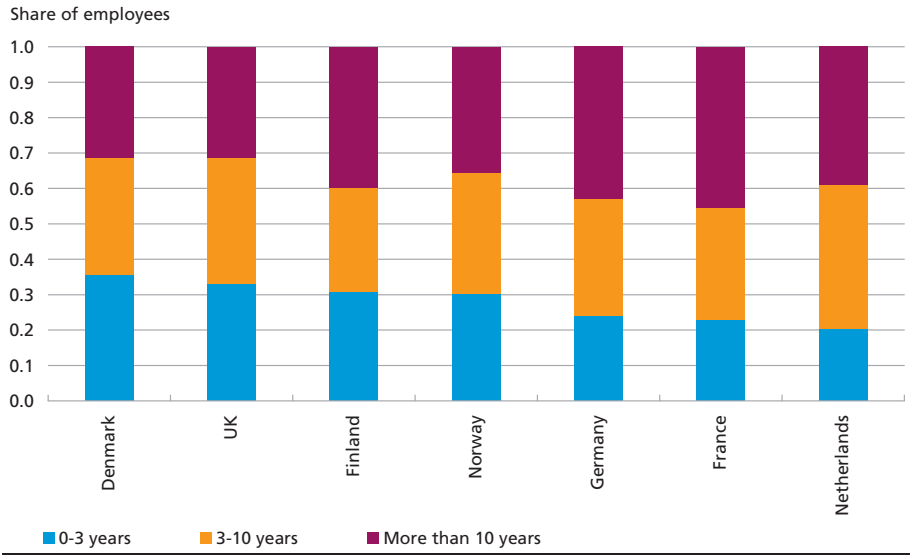
## 7. THE LABOUR MARKET

Labour is an important factor in the production of most goods and services. Accordingly, the structure of the labour market potentially has a considerable impact on productivity. The flexicurity model is often highlighted as a unique feature of the Danish labour market. The model combines flexible rules of hiring and firing with relatively generous unemployment benefits and active labour-market policy. This results in frequent job changes. Indeed, a larger percentage of Danish employees have relatively low seniority in their present jobs compared with a number of Continental European countries, cf. Chart 7.1.

In theory, the effect of the flexicurity model on productivity growth is ambiguous. On the one hand, high job turnover in the labour market may result in insufficient investment in human capital: If both firms and employees expect most employment relationships to be fairly short-term, this reduces the incentive to develop skills that are specific to the current job. Moreover, it will make firms less inclined to upgrade employee qualifications. Both of these factors will contribute to lower productivity growth.

On the other hand, the flexicurity model may facilitate reallocation of labour across firms and industries. This reallocation process is one of the

SENIORITY IN PRESENT JOBS, 2004 Chart 7.1




Source: OECD and own calculations.

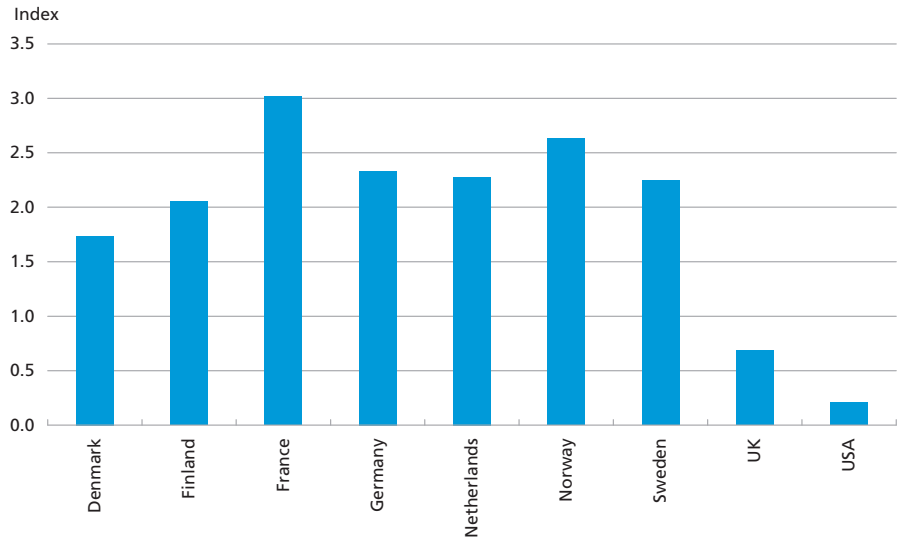
key sources of growth in Denmark, cf. Lentz and Mortensen (2008). It is therefore important to have a flexible labour market where firms are able to adjust employment to the current need, and where workers are not retained in less productive activities. The flexicurity model can, in fact, contribute to ensuring the most appropriate use of the labour force.

There is no certain optimal turnover rate in the labour market. Based on a study of the labour markets of the OECD countries, Bassanini, Nunziata and Venn (2008) find that rules protecting employees against dismissal have a negative impact on productivity growth. The reason may be that they obstruct the process of the labour force seeking employment in more productive firms. In Denmark there is generally a low degree of protection against dismissal, cf. Chart 7.2. Against this background, there is no evidence that the flexicurity model is behind the weak productivity development.

Furthermore, the Danish labour market is characterised by a relatively high compensation rate in case of unemployment, especially for low-wage jobs, and by smaller wage differentials than in most other countries. Both of these factors may have both negative and positive effects on productivity.

A higher rate of compensation makes it less urgent to find a new job for people who become unemployed. On the one hand, this may lead to better resource utilisation and benefit productivity if it makes it easier

PROTECTION AGAINST DISMISSAL, AVERAGE 1990-2008 Chart 7.2




Note: The scale runs from 0 (lowest protection) to 6 (highest protection).
Source: OECD.

for people who are unemployed to find a job that matches their skills. On the other hand, it may also result in a loss of productivity if it leads to a longer period of unemployment during which the unemployed person's skills are not maintained.

One reason for the relatively small wage differentials in the Danish labour market is the high wage level for low-income brackets. Viewed in isolation, modest wage differentials will reduce the incentive to make an extra effort due to the limited potential gain. This contributes to lower productivity growth. Conversely, higher minimum wages will encourage firms to invest more in upgrading the qualifications of their employees or expanding the capital stock, thereby enhancing labour productivity. The reason is that it makes it more attractive to increase the hourly productivity of existing staff than to hire additional people. The price of higher minimum wages will be the disappearance of a number of jobs, however, e.g. because they are moved abroad.

Based on a study of the OECD countries, Bassanini and Venn (2008) find that higher minimum wages relative to the median wage have a positive influence on productivity. According to Bassanini and Venn, the effect of a higher rate of compensation on productivity is also positive.

It should be emphasised, however, that a high compensation rate and high minimum wages also influence a number of other labour-market conditions. For example, both factors will contribute to higher structural unemployment, which may help explain the positive effect on product-

ivity, cf. section 6. Higher productivity due to higher structural unemployment is not economically attractive.

Nevertheless, the empirical relations between the organisation of the labour market and productivity are relevant in the context of this article. The characteristics of the Danish labour market described above undoubtedly affect labour-market conditions such as unemployment and employment, but based on the literature available there is no clear evidence that they are responsible for the relatively weak productivity development in the Danish economy.

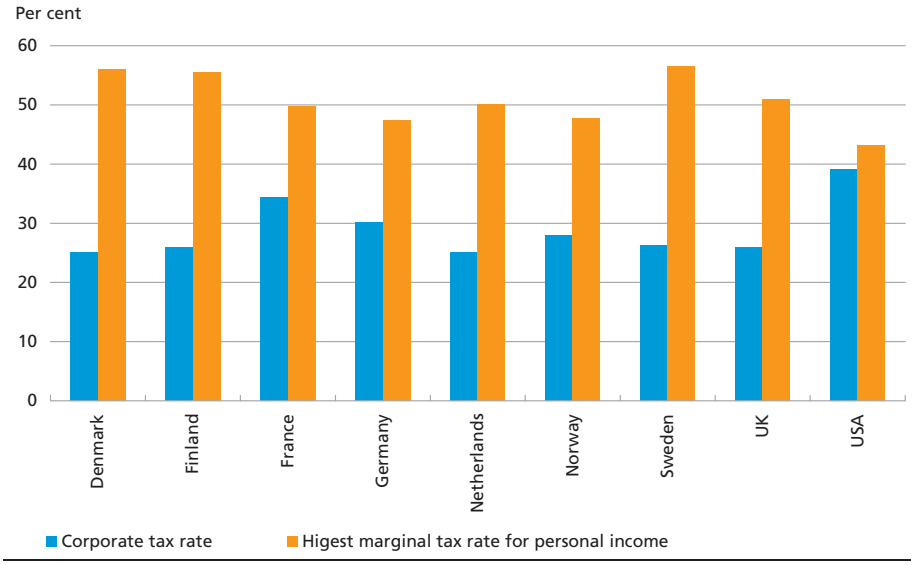
## 8. TAXATION

Collection of taxes is necessary to finance public expenditure, but there are many ways to obtain a given revenue. Depending on the structure of the tax system, it will have different effects on the incentives of households and firms and thus on their decisions regarding consumption, employment, investment, choice of education, etc. This means that the tax system may potentially affect a country's productivity.

In Denmark, the corporate income tax rate has gradually been lowered from 50 per cent in 1989 to 25 per cent today and is currently in line with those of a number of European countries, cf. Chart 8.1. On the other hand, Denmark's personal income taxes are at the high end internationally. This is primarily reflected in the fact that the top marginal tax rate is higher in Denmark than in most comparable countries. Furthermore, the top marginal tax rate is payable on income that is only slightly above the average. In countries such as Germany, the UK and the USA, on the other hand, the top marginal tax rate sets in at income levels four to nine times higher than the average income.

Based on data for 21 OECD countries in the period 1971-2004, Arnold et al. (2011) find that both personal and corporate income taxes have a dampening effect on productivity growth. According to the authors, the negative impacts of corporate and income taxes are primarily transmitted through weaker growth in TFP, the rationale being that higher taxes bring down the post-tax return on investment that may increase TFP. This reduces the incentive to make such investments. Arnold et al. (2011) argue that personal taxes in primarily affect productivity in industries with many new firms. The reason is that such firms are less secure and that they are often sole proprietorships and thus more dependent on the rules on personal taxes. But the extent to which this argument can be applied to Denmark – where retained profits are taxed at a rate equivalent to the corporate tax rate under the special Danish corporate taxation scheme – is not clear.

CORPORATE AND PERSONAL INCOME TAX RATES Chart 8.1




Note: Corporate income tax relates to 2011 and personal income tax to 2010. Personal income tax includes social contributions.
Source: OECD Tax Database.

Arnold et al. also argue that property taxation has a much smaller negative impact on productivity growth. Higher property taxation may thus lead to residential investment being channelled into more productivity-enhancing activities. Based on these arguments and supported by econometric analyses of data concerning the 21 OECD countries, the authors conclude that a revenue-neutral tax reform that reduces income taxes and raises property taxes will have a positive effect on productivity growth and economic growth in general.

## 9. COMPETITION AND BUSINESS STRUCTURE

Competition is a factor usually described as key to productivity growth – and rightly so. The relationship between competition and productivity is well documented in the economic literature.

Competition may raise the aggregate productivity level through both between and within effects, cf. section 4. The between effect operates via a selection mechanism among firms with different levels of productivity: Competition causes the most productive firms to gain market shares at the expense of less productive firms. As a result, the less productive firms will be reduced in size and in some cases cease to exist, thereby releasing resources for the more productive firms. On the other hand, the within effect of competition reflects higher productivity

within individual firms. Competitive pressures may cause firms to launch productivity-enhancing initiatives which, due to short-term costs, they might not otherwise have implemented.[1]

In contrast, lack of competition may lead to weaker productivity growth via lower productivity growth within firms and by impeding resource reallocation from the least productive to the most productive firms.[2] There are some indications of weak competition in parts of the Danish economy. This is exemplified by the fact that the price level in Denmark is substantially higher than in other EU countries, even when adjusting for differences in the level of wealth and in direct and indirect taxes, cf. Chart 9.1. While the difference is most pronounced for services, the prices of goods are closer to the level in other EU countries. The high price level for services indicates that service-related firms in Denmark are less exposed to competition than equivalent firms in other countries.

Denmark's relatively weak competition may be attributable to anti-competitive regulation in certain sectors, among other factors. This applies e.g. to the construction and retail sectors, which are troubled by weak competition, cf. Gaard (2011) and McKinsey & Company (2010). Both sectors are characterised by extensive anti-competitive regulation and weak productivity growth. In the construction sector, regulation is reflected in e.g. national standards for materials. Such standards make it less attractive for foreign firms to set up in the Danish market, thus limiting competition from those firms. Moreover, the organisation of the Danish construction sector with many small skilled-trade firms may have a negative impact on productivity because of the inability to exploit economies of scale. In the retail sector, according to McKinsey & Company (2010), competition is limited particularly by the Danish Planning Act, as it prevents the construction of so-called hypermarkets. This hampers the ability to exploit economies of scale and shields the market from competition from highly productive foreign chains.[3]

The link between productivity and size (measured by the number of employees) among firms in a given industry can be examined as an alternative indicator of competition in that industry. Strong competition should put the least productive firms out of business, concentrating employment in the most productive firms. Conversely, if the least productive firms account for a substantial part of total employment in the sector, this may be a sign of lack of competition. The Danish Economic

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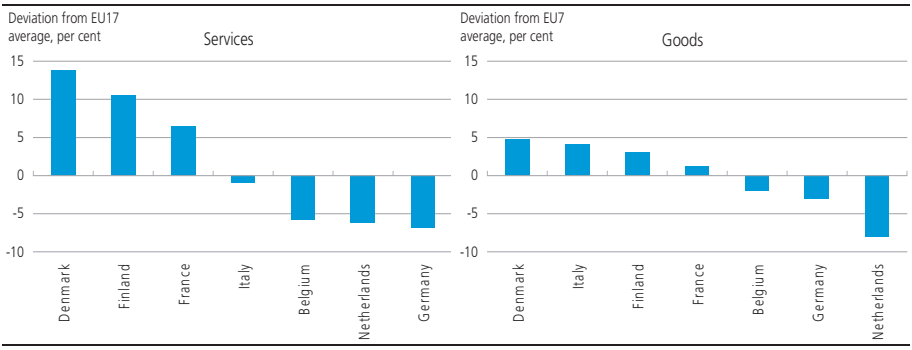
1 The theoretical basis of this effect is formalised in Holmes et al. (2011).

2 In some cases there may be sound arguments for restricting competition for the sake of productivity growth, among other factors. Patent protection is an example of an anti-competitive measure that may be required to give firms sufficient incentive to invest in the research and development necessary to generate productivity growth in the longer term.

3 The importance of competition from foreign firms is discussed in further detail in section 10.

PRICE DIFFERENTIALS IN EU7 MEMBER STATES, 2009 Chart 9.1




Note: The Chart shows Eurostat's Purchasing Power Parities less VAT and product-specific duties. Adjustment has also been made for differences in the countries' economic wealth. As far as goods are concerned, it cannot be ruled out that Eurostat's calculation of the price level in Denmark is slightly overestimated, the reason being that short-term sales are much more common in Denmark than in other countries. Without sufficient adjustment for such sales, the calculated price level will exceed the actual level. But the problem is probably less pronounced for services where short-term sales are less common.

Source: Danish Competition and Consumer Authority (2011).

Councils (2010) examine the breakdown of productivity and employment among firms in selected industries. They conclude that the potential for productivity gains from increased competition is particularly strong within wholesale trading.

Overall, there are clear signs that increased competition has the potential to enhance productivity in a number of Danish industries, including especially the construction and service sectors. Competition issues in these particular industries have attracted considerable attention, including from the Danish Growth Forum, cf. also Box 2.3.

Effective enforcement of the Danish Competition Act is a prerequisite for healthy competition in the economy. Such enforcement has been given higher priority by the Danish Competition Authority in recent years, cf. Gersing (2010), and the Authority has also been given new tools to achieve this. A new leniency programme was introduced in 2007, making it possible to reduce penalties for firms that cooperate with the authorities to disclose illegal cartel formation. In 2010, the competition authorities' scope for taking action against anti-competitive mergers was improved. These initiatives may contribute to enhanced competition and thus productivity in future. According to Gersing (2010), however, effective legislative enforcement continues to pose considerable challenges, especially as regards illegal cartel formation. In 2009, the Danish government at the time set up a competition legislation committee to assess whether the introduction of prison sentences in connection with cartel cases would contribute to better enforcement of the Competition Act. The committee is expected to complete its work in April.

A special aspect of the competition and business structure concerns the conditions for establishing new firms. New firms are often established because the founder has had a good idea for a product or service or has found a gap in the market. However, new ideas do not necessarily generate the highest productivity in new firms. It is easy to think of scenarios where the greatest profit of new ideas could be gained within existing firms. Established firms will typically be capable of much larger-scale production than start-ups, thus potentially gaining more from new knowledge. Besides, while an entrepreneur would inevitably have to spend resources on administrative and marketing tasks, a larger development department would typically be able to concentrate on generating new knowledge.

Based on a study of six OECD countries for the period 1992-97, the OECD (2002) finds that new manufacturing firms in four of the countries have contributed negatively to growth in labour productivity, while the contribution from new firms in the business service, auditing and information technology sectors has been positive in all the countries. On the other hand, the influence of new firms on productivity may also vary over the business cycle. It is easier to generate profit in good times than in bad. During an upswing, a number of relatively low-productivity firms may therefore be established which are not viable in a cyclical downturn. This may explain why, according to preliminary conclusions from the Danish Economic Councils, start-ups had a negative impact on Danish productivity development in the period 2002-07, cf. Pedersen (2011a).

According to the OECD (2008), entrepreneurship conditions are generally good in Denmark. High taxes reducing the return on risky investment are identified as the most significant negative factor in this connection. Besides, there is less focus on entrepreneurship in the Danish education system compared with some of the best-performing countries. But the general administrative and regulatory framework is good compared with other countries.

Productivity growth in the economy as a whole may also be dependent on the corporate structure in terms of firm size. Based on a study of a number of European countries, Pagano and Schivardi (2003) find a positive relationship between the average firm size and a country's productivity growth. According to the authors, this is because large firms gain more from research and development.[1] There are no indications,

[1] The relationship between firm size and return on investment in research and development has received much attention in the international literature. A number of studies find that the *innovative return* on research and development, in terms of e.g. the number of patents per Danish krone spent, is higher in small firms than in large ones, cf. e.g. Ortega-Argilés et al. (2009). Nonetheless, most studies find that large firms invest disproportionately more in research and development than small firms. The explanation given in Cohen and Klepper (1996) is that large firms are better able to profit by patents than small ones, and this is why the expected *financial return* on research and development is greater in large firms.

SMALL AND MEDIUM-SIZED ENTERPRISES IN THE NON-FINANCIAL SECTOR, 2006 Table 9.1

| Per cent of total number of firms | Micro (1-9 employees) | Small (10-49 employees) | Medium-sized (50-249 employees) | Small and medium-sized enterprises, SMEs (1-249 employees) | Large (More than 250 employees) |
|---|---|---|---|---|---|
| Denmark | 86.8 | 11.0 | 1.9 | 99.7 | 0.3 |
| Sweden | 94.2 | 4.8 | 0.8 | 99.8 | 0.2 |
| UK | 87.5 | 10.5 | 1.7 | 99.6 | 0.4 |
| Germany | 83.1 | 14.1 | 2.3 | 99.5 | 0.5 |
| France | 92.3 | 6.5 | 1 | 99.8 | 0.2 |
| Italy | 94.6 | 4.8 | 0.5 | 99.9 | 0.1 |
| Spain | 92.2 | 6.8 | 0.8 | 99.9 | 0.1 |
| EU27 | 91.8 | 6.9 | 1.1 | 99.8 | 0.2 |
| USA | 75.2 | - | - | - | - |

Note: The non-financial sector comprises manufacturing, building and construction as well as non-financial services. For the USA, the group "Micro" comprises firms with 0-9 employees. Comparable groupings for other firm sizes are not available. For the Netherlands, the data relates to 2005.
Source: Eurostat, European Business Economy Overview 2009 and U.S. Census Bureau.

however, that the corporate structure is a key explanatory factor behind Denmark's weak productivity growth. Overall, in terms of firm size, Denmark's corporate structure is comparable with that of the other European countries, cf. Table 9.1. Compared with the USA, the number of small firms with less than nine employees is substantially higher in Denmark.

## 10. INTERNATIONAL TRADE AND FOREIGN INVESTMENT

Globalisation and increased international trade in goods and financial assets are often highlighted as potential levers for higher productivity, and the economic literature has demonstrated strong correlations between productivity growth and various measures of international integration. The objective of this section is to assess the extent to which openness may contribute to enhanced productivity growth in Denmark, particularly within the service sector. We focus on two aspects of openness: barriers to international trade and the extent of foreign direct investment.[1]

[1] In Andersen and Dalgaard (2011), the focus is on a related, but separate aspect of openness to other countries, i.e. the scope of international travel activity. The authors' analysis points to a productivity-enhancing effect of increased travel activity. According to the authors, the reason may be that travel across borders leads to increased interaction between countries, thereby promoting the exchange of ideas and knowledge. Hence, the mechanism is closely related to one of the mechanisms often cited as an argument for productivity gains generated by international trade and foreign direct investment.

**International trade and productivity**

Denmark is a small, open economy with extensive external trade by international standards. While Denmark's external trade is comprised primarily of trade in goods, its trade in services is more limited, cf. Chart 10.1. This should be seen in conjunction with the fact that around two thirds of private employment is in the service sector. This raises the question of whether there is an unrealised potential for increased international trade in services, and, if so, whether the realisation of this potential may contribute to enhanced productivity development in the Danish service sector.

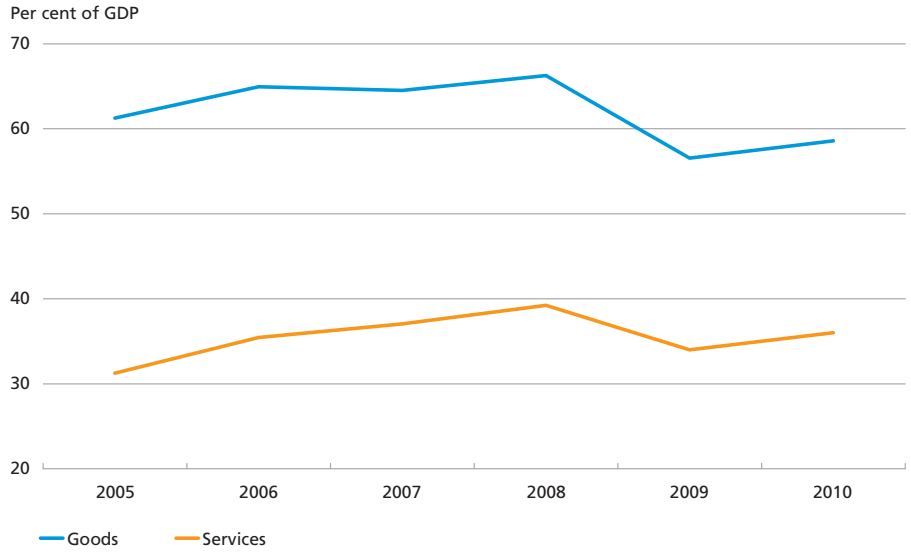
There may be many reasons why trade in services is less extensive than trade in goods. As far as a number of services are concerned, it is a precondition for trade that they are provided at the physical location where they are to be consumed. This means that, unlike goods, a number of services cannot be transported directly across borders, and international trade in this type of services consequently requires one of the trade partners to cross the border. This applies e.g. to services related to tourism, health and construction projects.

On the other hand, there are also many types of services where the supplier and the recipient do not have to be in the same place for the transaction to take place. As a result of technological advances, several services may be attributed to this category, as they can now be provided over the internet or by phone. They include financial services and various forms of consultancy services. Unlike trade in goods, international trade in this type of services does not necessarily require a physical product to be moved across borders, and, consequently, the transport costs of international trade will often be close to zero.

However, legislative restrictions may constitute a barrier to international trade in services, e.g. by way of a regulated number of providers in a particular sector, or requirements for national certification of providers.[1] In terms of more traditional trade-policy restrictions such as customs duties and import ratios, the extent and effects of such restrictions are very difficult to quantify. However, studies have been initiated by both the World Bank and the OECD with the objective of quantifying the extent to which existing policies of various countries constitute a barrier to international trade in services. According to the World Bank index, Denmark has more restrictive policies than many comparable

[1] The literature distinguishes between discriminatory and non-discriminatory regulation. Discriminatory regulation involves discrimination of foreign and domestic service providers, while non-discriminatory regulation limits market access to the same extent for all firms, regardless of the country of origin. The literature typically focuses on discriminatory legislation even though non-discriminatory regulation often constitutes an equally strong barrier to the market entry of foreign firms, cf. Francois and Hoekman (2010).

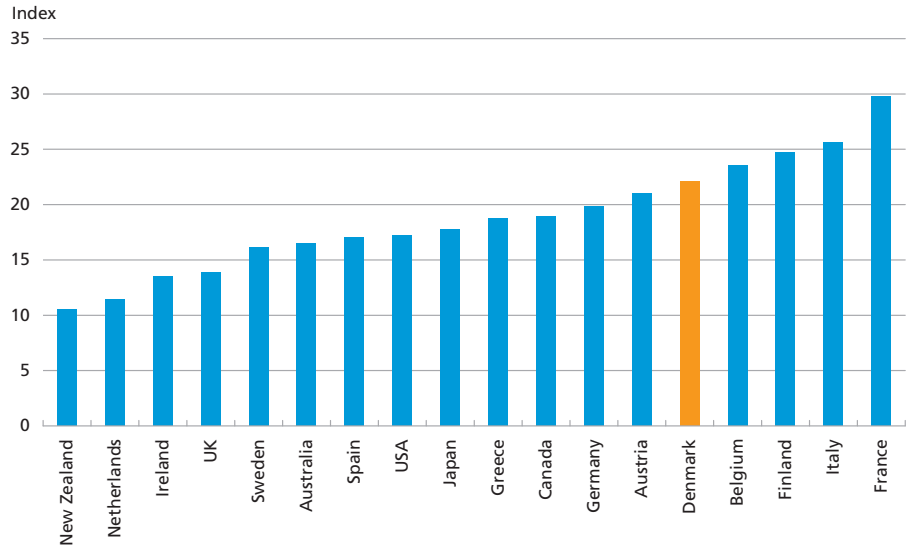
IMPORTS AND EXPORTS OF GOODS AND SERVICES — Chart 10.1




Source: Statistics Denmark.

countries, cf. Chart 10.2. A similar conclusion is reached by the OECD which finds that the policies of developing countries are generally more restrictive than those of OECD countries. According to the OECD, how

RESTRICTIONS ON INTERNATIONAL TRADE IN SERVICES, 2005 — Chart 10.2




Note: The Chart shows the World Bank's index of political restrictions on international trade in services. A higher value of the index indicates a more restrictive policy. The index is based on publicly available data on policies and covers the financial sector, telecommunications, retail trade, shipping, aviation (passenger transport) and business service.

Source: Borchert, Gootiiz and Mattoo (2011).

INTERNATIONAL STUDIES OF INTERNATIONAL TRADE AND PRODUCTIVITY — Box 10.1

The relationship between international trade and productivity at the macroeconomic level has been a major subject of discussion in the economic literature. Empirical studies across countries indicate that international trade has a considerable positive effect on the aggregate TFP level, cf. e.g. Frankel and Romer (1999) and Alcalá and Ciccone (2004). A similar result can be found in the literature on *growth accelerations*. Broadly speaking, a growth acceleration can be defined as a prolonged period, e.g. 8-10 years, during which productivity growth is significantly higher than in the preceding period. Experience from a number of countries shows that such long-term increases in productivity growth typically coincide with substantial increases in international trade, cf. e.g. Hausman et al. (2005) and Jones and Olken (2008).

The link between productivity and international trade is further substantiated by empirical studies at firm level. These studies focus on the relationship between the productivity of firms on the one hand and their exposure to international markets on the other.

On the import side, enhanced competition from foreign firms may lead to higher productivity growth in the sectors concerned, cf., among others, Pavcnik (2002) and Bloom et al. (2011).[1] Increased openness may also raise productivity via better access to importing commodities and intermediate inputs of high quality, cf. Amiti and Konings (2007). The classical infant industry argument speaks against openness on the import side. The core of the argument is that infant industries are rarely able to attain the same economies of scale as more mature industries and thus may need temporary protection against outside competition until they achieve competitive status. The infant industry argument has typically been used to justify trade protectionism in developing countries, although the validity of the argument is the subject of continued debate, cf. e.g. Sauré (2007).

A large number of studies examine the relation between exports and productivity. The studies show that exporters in the USA and a number of other countries are generally more productive than equivalent non-exporters, cf. e.g. Bernard and Jensen (1995, 1999, 2004) and Wagner (2007). A similar difference applies in Denmark, cf. Skaksen (2011).

There may be several reasons for such relation between exporter status and productivity. One possibility is that there is a causal link between exporting and productivity, known as *learning by exporting*. But the majority of the existing empirical studies indicate that the causality mainly goes in the other direction: The firms that *already* have the highest productivity become exporters, while the very act of exporting does not necessarily have any effect on the firm's subsequent productivity development, cf. Clerides, Lach and Tybout (1998), Bernard and Jensen (1999) and Wagner (2007), among others.[2]

This conclusion by no means precludes that international trade liberalisation may raise the *aggregate* productivity level. According to the above studies, access to foreign markets results in a faster growth rate for exporters than for non-exporters. Since exporters are more productive than non-exporters, this leads to reallocation of re-

CONTINUED Box 10.1

sources from less productive to more productive firms, thereby raising aggregate productivity. This reallocation process can be seen as part of the gain from increased international division of labour.

[1] Pavcnik (2002) demonstrates how the trade liberalisation in the 1970s led to productivity gains in manufacturing in Chile. Bloom et al. (2011) examine the impact of Chinese import competition in the period 1996-2007 on productivity development in more than half a million firms in 12 European countries, including Denmark. The authors find that firms in the most exposed sectors responded in two different ways: While the least productive firms tended to shrink or disappear altogether, the most productive firms tended to grow and achieve higher productivity growth. Overall productivity in the industries concerned increased via higher productivity within the surviving firms as well as by reallocation of resources from the least productive to the most productive firms.

[2] The most frequently mentioned explanation of this selection mechanism is that exporting a firm's products involves extra costs, including transportation, distribution or marketing costs, or costs of modifying the firm's domestic products for foreign consumption, cf. Wagner (2007). Such costs constitute a barrier that only the most productive firms can overcome.

ever, the policies of some OECD countries, including Denmark, are just as restrictive as the average policies of large developing countries, cf. Francois and Hoekman (2010).

The relationship between international trade and productivity is well documented in the international literature, cf. Box 10.1. Liberalisation of international trade in services may thus affect productivity growth in the Danish service sector through various channels. Increased openness will expose Danish firms to stronger competition via foreign imports, which may lead to higher productivity in the industries concerned.

Increased openness may also affect productivity via the export side. For example, by their presence in foreign markets, exporters may obtain valuable experience and knowledge of new technology that they can use in the production process (*learning by exporting*). Entry into foreign markets may also cause exporters to grow at the expense of other firms. If exporters are more productive than non-exporters, this will lead to a reallocation of resources from less to more productive firms, thereby increasing aggregate productivity.

Calculations based on Danish corporate data indicate that the latter channel has particular potential to raise Danish productivity through increased trade in services, cf. Skaksen (2011). Exporters of services are more productive than non-exporters, and firms that begin to export subsequently experience stronger growth than other firms. These factors indicate that increased trade in services will be able to raise aggregate productivity via reallocation of resources from non-exporters to more productive exporters.

Hence, in view of the findings of the economic literature, it is obvious to focus on increased international trade as a possible means of enhanced productivity growth in the service sector. But the challenge is to identify the barriers to trade and how to realise any unrealised potentials.

Borchsenius et al. (2010) give an indication of which Danish industries may have unrealised potential. The authors use a method that compares the geographical concentration in Denmark of production and consumption, respectively, of particular types of services. The idea is that if production of the service in question is concentrated in a particular area, while consumption is spread across the country, this means that the service can be traded across distances and that it can also be traded internationally.

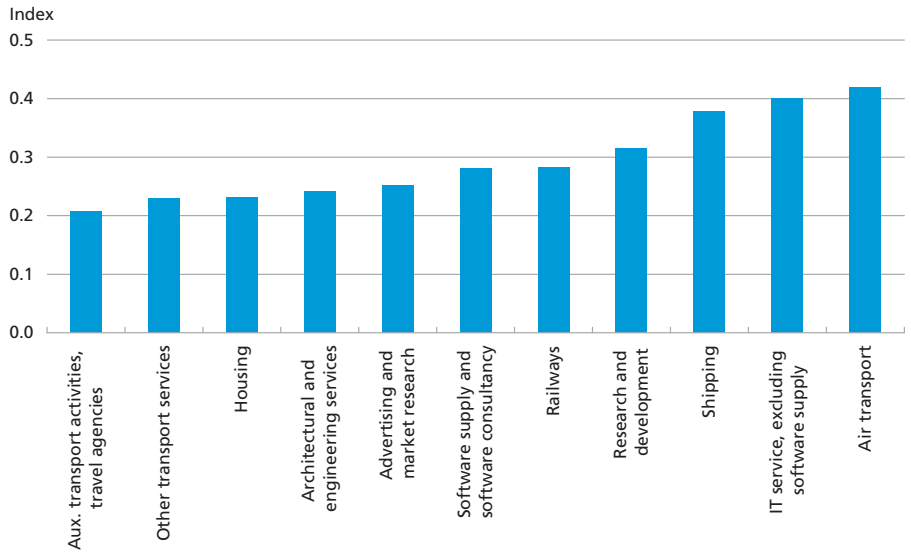
Based on this criterion, the greatest potential for international trade in services can be found in the transport, consultancy, IT service and research and development sectors, among others, cf. Chart 10.3.

Moreover, a clear positive relation can be seen between the applied measure of an industry's trade potential and the industry's actual export of services, cf. Chart 10.4. This relation can be used to identify the greatest barriers to international trade. For some industries with great trade potential, exports of services are substantially lower than warranted by the relation in general. This applies e.g. to services related to IT service, advertising and market research. The limited exports of these industries can be interpreted as an indication that they have unrealised potential for increased international trade and hence potential productivity gains.

The analysis does not specify exactly what factors prevent the realisation of that potential. As mentioned, there may be legislative restrictions, but e.g. language-related and other cultural differences may also

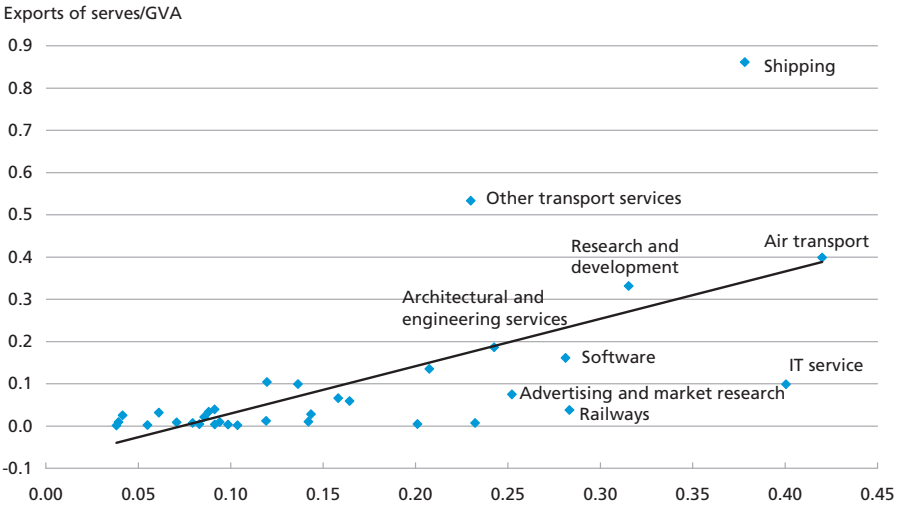
SERVICE SECTORS IN DENMARK WITH THE GREATEST POTENTIAL FOR INTERNATIONAL TRADE

Chart 10.3




Source: Borchsenius et al. (2010).

TRADE POTENTIAL AND EXPORTS OF SERVICES IN DANISH SECTORS Chart 10.4




Source: Borchsenius et al. (2010).

constitute a barrier to cross-border trade. Further analyses to illustrate how to increase the extent of international trade in the above industries would therefore be useful.

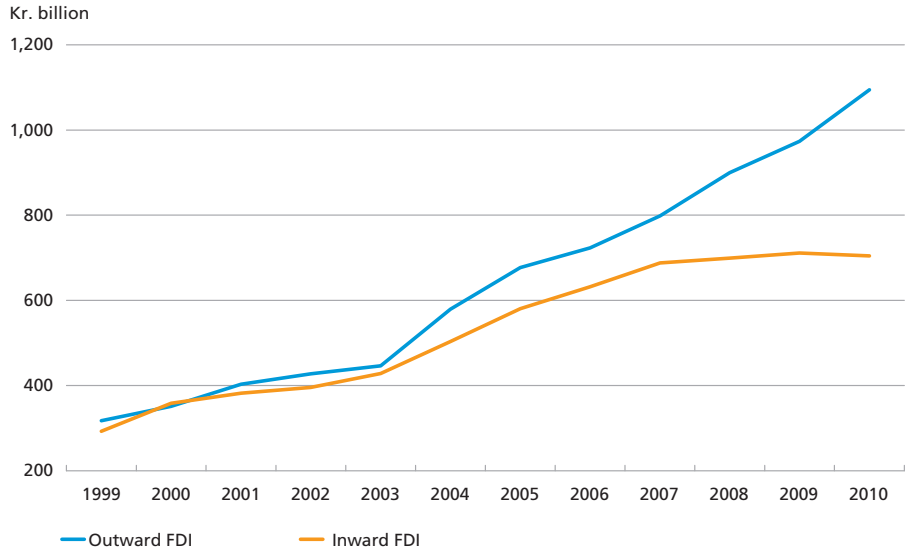
**Foreign direct investment**

Economic interaction with other countries may also take the form of inward and outward foreign direct investment. Direct investment leads to ownership and influence in foreign firms and is consequently a potential source of cross-border capital, knowledge and technology transfers. Hence, the extent of inward and outward foreign direct investment may be essential to productivity development.

Until the beginning of the new millennium, the value of Danish investment abroad was more or less offset by the value of foreign investment in Denmark, cf. Chart 10.5. A gap has subsequently developed between inward and outward foreign direct investment. This reflects the current-account surpluses in recent years, as such surpluses are offset by rising net external assets. It should be noted that, following many years of increases, the value of foreign investment in Denmark has stagnated in recent years. Against this backdrop, it is relevant to examine how the presence of firms that are wholly or partially foreign-owned affects productivity development in Denmark.

Foreign-owned firms operating in Denmark are generally more productive than purely Danish-owned firms, cf. Table 10.1. Part of this dif-

INWARD AND OUTWARD FOREIGN DIRECT INVESTMENT — Chart 10.5




Note: Direct investment, excluding pass-through investment.
Source: Danmarks Nationalbank.

ference can be attributed to differences in e.g. size and the educational composition of the employees. But even when adjusted for such factors, the productivity of foreign-owned firms is 17-19 per cent higher than that of Danish-owned firms, cf. Pedersen (2011b) and the Ministry of Economic and Business Affairs (2011).

There may be many reasons for the positive correlation between foreign ownership and productivity level. In this connection it is relevant to distinguish between foreign acquisitions of existing Danish firms, also known as *brownfield investment*, on the one hand, and foreign owners starting up new firms in Denmark (e.g. in the form of subsidiaries of foreign firms), i.e. *greenfield investment*, on the other.

CHARACTERISTICS OF FIRMS IN DENMARK, 2008 — Table 10.1

| Average | Foreign-owned firms | Danish-owned firms |
|---|---|---|
| Number of employees (FTEs) | 86 | 11 |
| Value added (DKK million) | 58 | 6 |
| Labour productivity (DKK 1,000) | 683 | 540 |
| Share with higher education (%) | 27 | 15 |
| Share with long-cycle higher education (%) | 8 | 5 |
| Share with PhD degree (%) | 0.4 | 0.2 |
| Capital intensity (DKK 1,000) | 267 | 325 |

Note: The statistics include firms with minimum 0.5 full-time equivalents (FTEs), excluding firms in agriculture, fishing and raw materials extraction, energy and water supply, public and personal services, real estate letting and administration as well as unspecified sectors. Labour productivity and capital intensity are calculated as value added and capital stock per FTE, respectively.
Source: Ministry of Economic and Business Affairs (2011).

In the former case, covariation between foreign ownership and productivity is attributable to the fact that foreign ownership has a direct beneficial effect on productivity, e.g. via economies of scale or international experience in management and organisation. But the causality can also be the opposite. So the reason for the acquisition of foreign-owned firms that used to be purely Danish-owned may just as well be that they were already highly productive. If this is the reason for the positive correlation, increased foreign ownership of Danish firms will not necessarily lead to higher productivity.

As regards greenfield investment, foreign studies indicate that the selection mechanism causing exporters to be more productive than non-exporters also applies here: The least productive firms serve the domestic market; then come exporters, and finally the most productive firms are the ones that establish subsidiaries abroad and become multinational, cf. Helpman, Melitz and Yeaple (2004). All things being equal, the presence of such multinationals will raise average productivity in society, and foreign direct investment such as greenfield investment should therefore be expected to benefit Danish productivity.[1]

In addition to the direct effects on the productivity of the firms concerned, foreign investment may impact the productivity level in Denmark via *spillover* effects on domestic Danish firms. Such effects may occur e.g. by imitation of the technology, management and organisation of the foreign firms. Knowledge may also be transferred by employees in foreign firms building up new competences which they bring with them if they are later employed in a Danish firm. Finally, the presence of foreign firms may intensify competition, forcing domestic firms to launch productivity-enhancing measures. However, intensified competition may also have a negative impact in that foreign firms breaking into domestic markets must be expected to reduce the market shares of domestic firms. This may cause domestic firms to lose benefits of scale and lead to lower productivity, cf. Aitken and Harrison (1999) and Konings (2001).[2]

The empirical literature provides no firm conclusions on the importance of spillover effects. Damgaard (2011) is the only existing study of spillover effects of foreign direct investment using microdata from Dan-

[1] An empirical study based on data on German firms shows that foreign-owned firms are generally more productive than German-owned firms, but that the difference disappears on comparison with only the German-owned firms that have achieved multinational status, cf. Temouri et al. (2008). This suggests that the multinational status, rather than foreign ownership, is the best indicator of a high productivity level. When applied to a Danish context, this indicates that retaining high-productivity Danish firms with multinational status is just as important as attracting foreign multinational firms.

[2] It may also have a negative impact if foreign firms are able to attract the most skilled and productive employees at the expense of Danish firms, cf. Javorcik (2008). If that happens, such a mechanism may also help to explain the correlation between productivity and foreign ownership.

ish firms. The study generally finds the largest number of *negative* spillover effects on the short-term productivity of domestic Danish firms. This result differs from most recent empirical studies of spillover effects in developed countries, however. The majority of those studies find small positive spillover effects, if any, of foreign direct investment, cf. e.g. Görg and Greenaway (2004) and Smeets (2008).

Overall, there are some indications that foreign direct investment enhances the productivity level in Denmark. The strong positive correlation between productivity and foreign ownership indicates positive productivity gains from the presence of foreign firms, but it would be useful to clarify the extent to which this correlation is driven by greenfield and brownfield investment, respectively. In addition, further evidence is needed on the impact of foreign direct investment on the productivity level in Danish firms via spillover effects, including in the longer term.

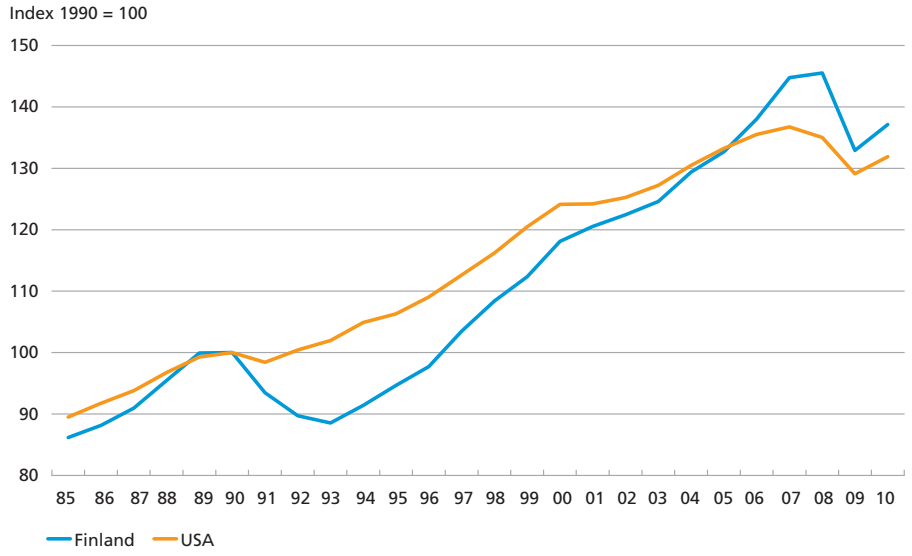
## 11. PRODUCTIVITY GROWTH AFTER THE FINANCIAL CRISIS: CREATIVE DESTRUCTION OR A LOST DECADE?

The international financial crisis led to a steep decline in economic activity in Denmark in 2008-09. Labour productivity also fell sharply. As previously mentioned, this is a normal cyclical phenomenon: When demand decreases at the beginning of a downturn, it will typically take firms a while to adjust their demand for labour to the new conditions. As a result, output declines faster than employment, leading to lower labour productivity.

Adjusted for cyclical developments, it turns out that productivity growth in Denmark was already weak before the onset of the financial crisis. Structural growth in both labour productivity and TFP thus began to decline in the mid-1990s and was very subdued during the boom before the crisis, cf. Chart 2.2 and Andersen and Rasmussen (2011).

It is hard to say how the crisis will affect future productivity growth. Experience from a number of other countries shows that a major financial crisis often has long-term consequences, cf. Reinhart and Rogoff (2009) and Reinhart and Reinhart (2010). As a notable exception, experience from Finland shows that a financial crisis can be overcome in the course of a few years. The Finnish economy saw strong growth and overheating in the late 1980s. But this trend came to a sudden stop in the early 1990s when Finland went through a financial and economic crisis resulting in a plunge in GDP per capita, cf. Chart 11.1. Finland quickly got back on track, however, and from the mid-1990s Finland experienced a long period of rapid growth in GDP per capita. As a result, GDP

GDP PER CAPITA IN FINLAND AND THE USA, PPP-ADJUSTED Chart 11.1




Source: OECD.

growth in Finland, viewed over the entire period 1990-2010, was higher than in e.g. the USA.

The key to Finland's renewed economic growth after the crisis in the early 1990s was strong growth in labour productivity, particularly in the manufacturing sector, cf. Maliranta et al. (2010). The high productivity growth was very much the result of *creative destruction*, i.e. the microeconomic process that generates new products and ideas and leads to increased activity and employment in the firms launching them. But the new ideas and products also lead to earlier products and technologies becoming obsolete and being discontinued, thereby causing existing jobs to disappear. Creative destruction manifests itself partly by the establishment of new firms and the closing down of old ones and partly by the reallocation of labour and capital between existing firms.

Maliranta et al. (2010) demonstrate that just under one fourth of total labour productivity growth in the Finnish manufacturing sector since the early 1990s can be explained by creative destruction. According to the authors, the factors behind the successful creative destruction in Finland were the extensive deregulation and liberalisation of the economy, and the opening up of Finland to other countries, especially in the West. This intensified competition and provided new opportunities for the business sector. According to Maliranta et al., Finland's ability to make the most of the new opportunities was based on its sustained investment in re-

search and upgrading of the labour force through increased education since World War II.[1]

It is still too early to determine whether the Danish economy may experience a productivity scenario similar to the Finnish one. While productivity growth in the Danish economy was high in 2010, this may, as previously mentioned, be attributable to a normal cyclical pattern. In the following, we will highlight parallels and differences in relation to the Finnish experience, but because it is still early days, the discussion will have to be somewhat speculative.

Denmark's relatively high level of investment in education and research, cf. sections 5 and 6, can be singled out as a factor conducive to creating a scenario similar to the Finnish one. Stronger efforts in these areas will naturally tend to foster productivity growth, but at the same time it is important to be aware that the return on such investment will only manifest itself in the very long term. On the upside is also the flexible Danish labour market which facilitates reallocation of labour between firms, cf. section 7. It is a key aspect of the process related to creative destruction.

On the other hand, it could be argued that the current conditions of the Danish economy are different from those of Finland in the early 1990s. Productivity in Finland was at a much lower *level* than the leading countries at the time (GDP per hour was approximately 75 per cent of the US level in 1990), whereas the current difference in levels between Denmark and the leading countries is somewhat smaller. In the early 1990s, Finland thus had more potential for growth by catching-up compared with the leading countries than Denmark has today, cf. also the discussion on conditional convergence in section 2.

It is also worth noting that productivity growth in the Finnish economy was already high *before* the crisis in the early 1990s, cf. Maliranta et al. (2010), while Denmark has seen weak productivity growth in recent years as described above. Indeed, calculations by the Danish Economic Councils indicate that the lack of creative destruction may help to explain Denmark's weak productivity growth, especially in the boom years 2005-07. The contribution from reallocation of resources between firms in the same sector was thus negative in those years, cf. Pedersen (2011a). One possible reason for this development may be that firms whose productivity would normally have been too low for them to remain in business were kept temporarily alive by the general overheating of the Danish economy in those years.

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[1] According to Maliranta et al. (2010), Nokia's success from the mid-1990s is also an key explanatory factor behind Finland's high growth, but the authors demonstrate that creative destruction also contributed considerably to productivity growth in other parts of the Finnish economy.

Of the measures that may contribute to creating a scenario similar to the Finnish one, it would be natural to focus on the areas that have already been discussed in this article and singled out as especially important in the Finnish context, cf. above. In the long run, the primary objective is to continue investing in research and development as well as education. In the shorter term, there may be something to be gained from abolishing anti-competitive regulation and taking steps to increase international trade in the service sector. At the same time it is important to avoid measures that may impede creative destruction by tying up resources in less productive activities.

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