The connection between IT investments, competition, organisational changes and productivity

Bengt Pettersson

The growth of productivity in Sweden was high from the early 1990s up to 2006. Studies of development in the USA indicate that previous IT investments, organisational changes and internal training have played a decisive role in the strong growth of productivity since the mid-1990s. This article addresses the preliminary main results of a project at the Riksbank on the factors behind the earlier strong growth in productivity in Sweden. The working hypothesis in the project – and the question that is posed in this article – is whether the productivity growth trend in Sweden can be explained by factors similar to those in the USA. The results support this view. They show that the spread of IT investments throughout the economy is not sufficient to increase the productivity growth trend. Complementary investments in organisations and human capital are also required. It is only then that the companies can gain the greatest possible benefit from the IT investments.

IT investments and productivity

Between 1992 and 2008, the labour productivity[1] trend increased more rapidly in Sweden than in most comparable countries. It also increased rapidly in the USA from and including the mid-1990s. Studies of development in the USA indicate that a combination of IT investments, organisational changes and internal training may explain the strong growth in productivity. An interesting question is to what extent there are similar

[1] Productivity aims to measure the amount of goods and services that can be produced for a given input of production factors. A higher level of productivity means that production is increasing more rapidly than the input of production factors, that is that the available resources in the form of capital and labour are being used more efficiently. There are different ways of doing this. The most common measure of productivity is labour productivity. Labour productivity is usually measured as production in relation to the number of employees or to the number of hours worked. In Europe, the measurement method based on the number of employees predominates. In the USA the predominant method is the one based on the number of hours worked. These two methods may provide different results.

factors behind the development in these two countries. This is also the question addressed in the Riksbank's productivity project, which was initiated in the autumn of 2005.

Investments in IT were considerable already in the 1970s and 1980s. This applies to both personal computers and fibre optics, as well as to wireless communication and the Internet.[2] The first computer was introduced as early as 1945. It was some time, however, before any effects on productivity were noted.[3] The turning point came in the USA in the mid-1990s. The productivity growth trend in the USA increased and between 1995 and 2007 averaged 1.8 per cent per year.[4] Between 1971 and 1994, it had averaged 1.1 per cent.

Studies of development in the USA indicate that it was IT investments in combination with organisational changes and internal training that lay behind this increase.[5] It is probable that these effects on productivity became possible thanks to the great flexibility, or adaptability, of the US economy. A flexible labour market makes it easier for companies to reorganise with the aim of drawing the greatest possible benefit from, for example, the IT investments made. Companies in the USA have probably been forced to make these changes in order to increase efficiency so that they can survive in the face of the fierce competition that prevails on the US market. Once these changes have been made and spread throughout the economy, they have had positive effects on trend productivity growth.

As used here, the term trend productivity growth refers to long-term, sustainable growth and not to short-term changes that can be explained by fluctuations in economic activity. If there is an upturn in economic activity, it often takes some time before the companies are sure that the increase in demand will last. They may then wait to expand their production capacity which – if production increases – means per definition that productivity will increase in the short term. The opposite often occurs in connection with downturns in economic activity, that is the companies are cautious about making employees redundant during a downturn before they are sure that the decrease in demand will last. These effects are, however, short term and do not reflect structural changes.

In Europe, productivity growth has long been significantly weaker than in the USA, even though there are some exceptions such as Sweden (see Figure 1).

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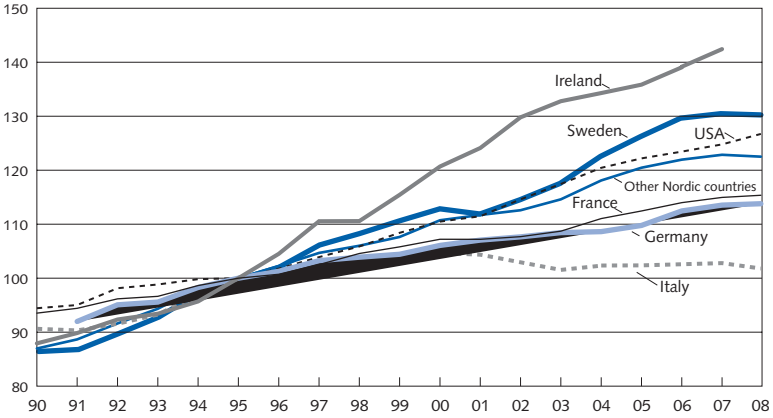
2 See Ferguson, BIS Review 1/2004.

3 Many economists wondered when the effects would become tangible. One example is Robert Solow, …"we see the computer age everywhere except in the productivity statistics"…, New York Times Book Review, 12 July 1987.

4 According to OECD statistics. Production per employee in the total economy.

5 See Bart Van Ark (2006), Brynjolfsson (2003).

Figure 1. Productivity in various regions 1990–2008
Index 1995=100



Note: The figure shows production per employee in the total economy according to internationally-comparable statistics. In the case of Ireland, no statistical outcomes are available for 2008.

Source: OECD.

It can be noted that productivity in Sweden increased more rapidly between 1992 and 2008 than in most other countries in the OECD area. According to OECD statistics, productivity in Sweden increased by an average of 2.4 per cent per year during the period.[6] At the same time, productivity also increased rapidly in the other Nordic countries and in the USA and Ireland. A common factor for these countries is that they have all invested heavily in IT. They have also implemented far-reaching structural reforms, including deregulation and privatisation processes that have increased competition. Studies conducted by the OECD indicate that there is a clear positive link between competition and productivity.[7] Greater competition forces companies to find new ways of retaining their market shares, which increases the likelihood that they will reorganise. The companies may thus have been forced to reorganise and train their personnel in order to draw the most benefit from the IT investments they have made.

Given this background, the question that can be asked is whether a combination of IT investments, organisational changes and internal training can, as in the case of the USA, explain the high growth in productivity in Sweden.[8] Here it is worth noting that productivity growth in the USA was strong both in the sectors that produce IT and in those that use it to a great extent, for example the retail and financial sectors. There are also

6 Here expressed as production in relation to the number of employees.
7 See, for example, various annual issues of "Economic Policy Reforms, Going for Growth".
8 The high growth in productivity in the 1990s may of course also be explained by the recovery process following the recession in the early 1990s. It is easier to increase productivity in an upturn than in a downturn. The interesting thing is, however, that the productivity growth trend was also strong during most of the previous decade.

studies that show that it has been possible to confirm similar effects in the UK.[9]

In contrast to the USA, the Nordic countries and Ireland, productivity growth in the major euro countries – Germany, Italy and France – has been weak over the last ten years. There is no real consensus in the research as to why the development of productivity in these countries has been so weak compared with development in the USA.[10] It can, however, be noted that factors common to these countries are that their IT investments as a percentage of GDP have not been as large as in those countries with higher productivity growth mentioned above and that deregulation and privatisation processes have not been as extensive.[11]

Research on the link between IT investments, work organisation and productivity has generally intensified over the last six to eight years. An increasing number of studies are reaching the conclusion that there are clear positive links between these factors.[12] Studies show that a strict labour market policy may be an obstacle to the positive effects of IT investments spreading throughout the economy.[13] This may explain the difference between the strong development of productivity in the USA and the weak development in the euro area. Strict labour market legislation makes it more difficult for the companies to adapt their organisations and may prevent the realisation of all the measures that would otherwise improve efficiency. It is interesting to note in this context that Swedish companies are rated highly with regard to the degree of decentralisation of decision-making and responsibility.[14] A decentralised structure may be a factor that makes it easier to conduct the change process in companies that have invested in advanced technology even in countries that have – at least on paper – a rigid labour market policy. [15]

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9 See Crespi, Criscuolo and Haskel (2007) and Caroli and Van Reenen (2001).

10 See Van Ark (2006).

11 See, for example, OECD's country reports and the European Commission's evaluations of countries in the Lisbon process.

12 Several studies indicate that there is a need for complementary investments in organisation and internal training in order for the companies' IT investments to achieve their full impact (see, for example, Bart Van Ark (2005), Brynjolfsson (2003)). Studies based on US data show that work routines, further training, and the use of IT are important determinants for productivity (see, for example, Björn Andersson and Martin Ådahl, Sveriges riksbank Economic Review 2005:1). The percentage of employees that use computers in their work and their level of education are factors that have a positive impact on productivity (see Black, Lynch (2001) data for the period 1987-1993). Studies also show that the greatest positive effects of reorganisation processes on productivity occur in companies with a high percentage of highly-educated labour (see Caroli, Van Reenen (2001). The level of education of the employees of a company is decisive not only in terms of making it possible to rapidly reap the benefits of new technology but also for reorganisation processes leading to positive effects (Aghion, Caroli and Garcia-Penalosa (1999). One study also shows that US multinational companies in the UK are more productive than British companies. The explanation may be that US companies export their organisational structures to subsidiaries in other countries (see Bloom, Sardun and Van Reenen (2007). Evidence of similar positive effects has been found in Sweden (see Karpaty (2007).

13 Bloom, Sadun and Van Reenen (2007).

14 See Bloom, Van Reenen (2007).

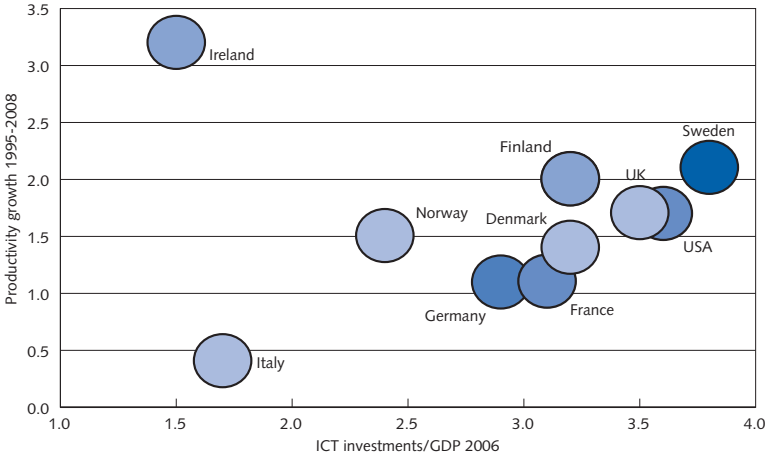
15 See Bresnahan, Brynjolfsson and Hitt (2002). Similar conclusions are drawn by Lindbäck and Snower (2000), Black and Lynch (2001) and Kling (1995).

So what is the relationship between IT investments and productivity on the one hand and between the flexibility of the companies and productivity on the other?

IT INVESTMENTS AND PRODUCTIVITY

Those countries that have invested a lot in Information and Communication Technologies (ICT) have also experienced high productivity growth over the last ten years. ICT investments as a percentage of GDP were high in Sweden in 2006 in comparison with other countries (see Figure 2). The difference was even greater, in Sweden's favour, in the early 2000s. The relative positions of the countries changed only marginally between 2002 and 2006 however. Those countries that had the highest percentage of ICT investments in 2002 were also those that had the highest percentage four years later.

Figure 2. ICT investments 2006 and annual average productivity growth



Note: Investments in ICT as a percentage of GDP. This statistic has served as an indicator for IT investments. Annual average productivity growth refers to labour productivity expressed as production in relation to the number of employees. The statistics are comparable between countries. In the case of Ireland, no statistical outcomes are available for 2008.
Source: Eurostat and the OECD.

Examples of countries with high IT investments and high productivity growth are the Nordic countries, the UK and the USA.

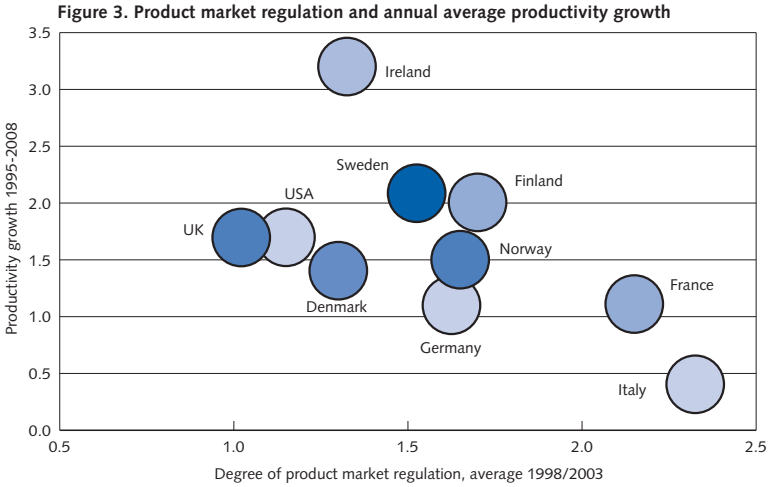
DEREGULATION AND PRODUCTIVITY

Those countries in which IT investments and productivity growth have been high have also implemented extensive deregulation processes and

economic reforms.[16] Some countries did this in the 1980s, some in the 1990s and some in the 2000s. Examples of countries that have done this and where the degree of regulation is low in international terms include the USA, the UK, Sweden, Finland and Denmark (see Figure 3).

Italy is an example of a country with low productivity growth, low ICT investments and a relatively high degree of regulation. France, on the other hand, has experienced relatively low productivity growth despite a relatively high percentage of ICT investments. A possible explanation of this is that the French economy is still relatively high regulated and that this prevents the companies from drawing the maximum benefit from their ICT investments. This is indicated in Figure 3. In Germany, productivity growth has been relatively low despite the fact that the economy is fairly deregulated compared to the average for the other countries and that ICT investments have been relatively high. The development of productivity in Germany has not, however, deviated very much from the links indicated in Figure 2.

Figure 3. Product market regulation and annual average productivity growth



Note: Product market regulation is presented using an average index for the years 1998 and 2003 in accordance with the OECD's "Going for Growth". The higher the index, the higher the degree of product market regulation there is assessed to be in the economy concerned. Here, product market regulation has been assumed to be a good indicator of the total degree of regulation in an economy. This statistic provides the same picture of the position of the countries in relation to each other as in the "World Economic Forum Global Competitiveness Index" 2001-2008 and the European Commission's annual evaluations of the Member States in the Lisbon process. Annual average productivity growth refers to labour productivity expressed as production in relation to the number of employees. The statistics are comparable between countries. In the case of Ireland, no statistical outcomes are available for 2008.

Source: OECD

[16] European politicians have noted the weak productivity growth trend in the EU and the negative effects on welfare. The propagation of the IT society and the promotion of research, innovation and deregulation with the aim of increasing competition are therefore central elements of the EU's Lisbon Strategy, which was adopted in 2000. The aim is to increase the potential for growth and employment in the Member States. Obviously, European politicians see a need to orient economic policy towards stimulating higher trend productivity growth.

The country where the link between ICT investments and productivity growth is not as clear as in other countries (at least according to official statistics) is Ireland. Despite low ICT investments (according to statistics from Eurostat), productivity growth in Ireland has been very high. This could possibly be explained by a "catching up" effect. At the end of the 1980s, Ireland was well down the OECD's world ranking in terms of GDP per capita. Overall, the Irish economy has since grown very rapidly from this low level. Structural reforms and a more effective economic policy have contributed to a situation in which average growth has been very high over a long period of time.[17] Economic policy has, among other things, aimed to attract foreign capital by offering very low levels of taxation for foreign companies. The Irish economy has become more open and foreign trade as a percentage of GDP has increased significantly. Ireland is thus competing more and more on the international market. The powers of the competition authority have been increased and competition has been strengthened.[18] Figure 3 also indicates that there is a positive link between deregulation and productivity growth in the case of Ireland.

It thus appears that there are positive links between IT investments, competition and productivity growth. The results of studies of other countries indicate that increased competition is a factor that forces the companies to implement organisational changes with the aim of drawing the greatest benefit from their investments. This appears to lead to increased long-term growth in productivity.

IT investments, flexibility and productivity in Sweden

Figures 2 and 3 above indicate that the high productivity growth trend in Sweden since the mid-1990s can at least in part be explained by the same factors as in the USA. The results of a recent Swedish study, funded by the Riksbank, show that there is a positive link between IT investments and organisational changes on the one hand and productivity in Sweden on the other, at least in the 2000s.[19] The study has used questionnaires to investigate how 120 companies have invested in IT during the 2000s, to what extent they have changed their organisation and, finally, the educational level of their employees. The study shows that productivity growth, with a certain time lag, was much higher in those companies that invested in IT above the median value and carried out reorganisations compared

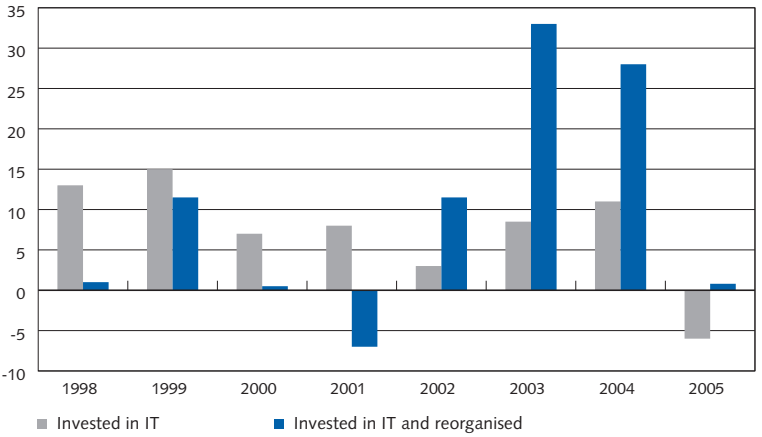
[17] See OECD Economic Surveys: Ireland 1999, pp 61–62.
[18] See OECD Economic Surveys: Ireland 2003, pp 84–85.
[19] Sveriges riksbank, June 2009, Working Paper No. 230, Christina Håkanson. This Working Paper is an important part of the Riksbank's productivity project which was initiated in the autumn of 2005 and has been underway since the spring of 2006. Bengt Pettersson at the Riksbank is responsible for the project.

to those that did not change their organisation (see Figure 4). The reorganisations investigated in the study were implemented between 2000 and 2002, although the majority were carried out in 2001. IT investments have been measured for the same period. The fact that the positive impact of IT investments and reorganisations on productivity is not immediately evident in 2001 is probably because it takes time for the employees of the companies to adapt to and learn from the new situation.[20] In the short term – in this case this largely means within the same year – the impact on productivity may even be negative.

An interesting observation in the study is that those companies that have implemented reorganisations – but not invested so much in IT – do not exhibit any statistically significant effects on productivity.

However, the results of the study should be interpreted with a certain degree of caution. The number of companies included in the study is small and the period 2000-2002 was a period of low economic activity in Sweden in connection with the dotcom crash. It can not be ruled out that a number of companies, particularly in the IT sector, were forced to reorganise for this reason alone and not as a result of needs that arose in connection with IT investments. The companies analysed in the study

Figure 4. Productivity growth (TFP) for companies with high IT investments who have carried out organisational changes and those that have not reorganised respectively
Annual percentage change



Note: TFP stands for total factor productivity. The change in total factor productivity is usually calculated as the change in value added divided by the overall change in the number of hours worked and the capital stock. This provides a measure of the production increase that is not due to an increase in the input of labour or an increased supply of capital. Total factor productivity is used to analyse the entire economy or large aggregates. Here, the reorganisations have been measured during the period 2000-2002, although most were carried out in 2001.

Source: "Effects of Organisational Change on Firm Productivity", Christina Håkanson

[20] See Brynjolfsson (2003).

are, however, by no means concentrated to the IT sector but represent a broad spectrum of sectors in the Swedish economy.

It is, however, important to point out that the growth in productivity in Sweden since 1992 can also be explained by a number of other conceivable factors than those presented above. The IT sector grew rapidly in Sweden in the 1990s. It is therefore probable that it is productivity in the IT-producing sector rather than in the IT-using sector that accounts for the main part of the increase in productivity, at least in the 1990s. Another conceivable explanation may be that there was a natural recovery in the growth of productivity after unproductive companies went to the wall in connection with the financial crisis in the early 1990s.

It appears, however, that development in Sweden, the other Nordic countries and the USA differs from that in the euro area. There are clear similarities between development in Sweden and the USA. This may be surprising given the considerable differences that exist regarding the degree of regulation on the labour market. A flexible labour market has probably facilitated the restructuring of the companies in the USA. In the field of labour market legislation, the similarities are actually greater between Sweden and the euro area. One factor that could explain the ability of Swedish companies to also benefit substantially from IT investments by means of organisational changes may be that the organisational structure of Swedish companies differs from that in the euro area. International studies show that the structure in Sweden is much less hierarchical.[21] This could be a factor that makes it easier for company managements to get support for the organisational changes required to make the most of the IT investments made.

How long can the effects of the new technology last?

Following the long period of strong trend productivity growth in Sweden since the early 1990s, productivity declined in 2007. The development of productivity has been weak since then. It is difficult to say how long it will be before there is an upturn in productivity and to what extent the slowdown in Sweden is a sign of a decrease in trend productivity growth. It is still too early to determine whether the downturn in productivity in Sweden is only due to temporary variations in connection with short-term fluctuations in the economy. Companies do not always adapt immediately and completely to changes in demand as, for example, in connection with the most recent economic downturn.

[21] See Bloom, Van Reenen (2007).

Historically speaking, it has taken a long time for the positive effects of previous technological shifts on productivity to become apparent. For example, it took 20 to 30 years before the industrial revolution and electricity had an impact on productivity. One of the reasons for this may have been that the economic value of new technology and the possibility to benefit from it was underestimated.[22] There are several examples that illustrate that it takes a long time for new technology to have an impact on productivity. The steam engine was invented already in the 1700s, long before it had any tangible effect on the production process in, for example, the USA.[23] The construction of railways began in the USA in the 1840s, but it also took a long time before they had any effect on productivity.

The reason that the lead times between technological shifts and productivity are so long is that complementary research is often needed to demonstrate the potential practical applications of the new technology. The dissemination of new technology has often been slow to start with as the initial investments have been expensive and it has taken time for them to provide a return. As mentioned earlier, in the short term these investments often have a negative effect on productivity as it takes time to learn to use the new technology in the right way.

A clear example is electrification in the USA at the end of the 1800s. It took several decades to determine the best way to use electricity in production. It took a long time before people realised that the factories had to be converted in order to able to exploit all the advantages of electricity. Instead of building multi-storey factories where the power source was centrally located, it was realised that flexibility would be improved by giving each workplace or production line access to its own power source when this was made possible by electricity.[24] This in turn made it possible to optimise the use of materials and to change the production process when necessary, and it also enabled the maintenance of separate parts of the production apparatus without needing to shutdown the entire process.[25]

However, once the companies have learned the best way to benefit from the new technology, the effects have often lasted for several decades. This could indicate that there is still potential for a continued high level of trend productivity growth. It is difficult, however, to draw any

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[22] Examples of this are: "What shall we do with a toy like that?" – Western Telegraph Company in response to Graham Bell's offer to sell his telephone patent for USD 100.000 in 1877. A few years later the company offered to pay USD 25 million for the patent but Bell rejected the offer. I think there is a world market for maybe five computers." – Thomas Watson, President of IBM in1943. "There is no reason anyone would want a computer in their home." – Head of Digital Equipment Corp. 1977.

[23] See Ferguson 2004.

[24] See, for example, Kroszner 2006.

[25] See David 1990.

clear conclusions. The long-term growth of productivity depends, among other things, on the scope available for companies to further increase the use of ICT in their production, how efficiently the ICT investments are used and how this efficiency spreads throughout the companies. There is also a lack of statistics for the last few years on what organisational changes the companies have made in order to gain the greatest possible benefit from their investments. It is therefore difficult to draw any far-reaching conclusions on the future prospects for long-term productivity growth.

Conclusions

There are signs that a combination of IT investments and organisational changes has had a positive impact on the growth of productivity in both the USA and Sweden. A recent study, funded by the Riksbank, indicates that these are important explanatory factors for the development of productivity in the 2000s. There are also certain common denominators for development in Sweden and the other Nordic countries. IT investments have been high, the economies have been deregulated and competition has been strengthened. Increased competition has probably forced the companies to make changes with the aim of improving efficiency in order to survive. It is also likely that the restructuring of the companies is an important factor that enables the companies to draw the greatest possible benefit from productive IT investments. In countries where the economic policies pursued help to increase competition, the growth of productivity is probably increased in the long term when the technology and infrastructure required is spread throughout the economy.

The extent to which other countries in Europe that have had a long period of low productivity growth will experience the same effects as the Nordic countries, Ireland and the USA is an interesting question. The countries with low productivity growth probably need to speed up the reform process. The European Commission's evaluations of the measures taken by the Member States indicate that there is more to be done in this respect, not least in the major EU countries.[26]

Trickier questions are when the growth of productivity will pick up speed in Sweden again and how high long-term, sustainable productivity growth will be. The positive effects on trend productivity growth of previous technological shifts have often lasted for several decades. Exactly how much and how long a period of time of the growth of productivity

[26] See the European Commission's evaluations of the countries' measures on the Commission's website (http://ec.europa.eu/economy_finance/analysis_structural_reforms/growth_and_jobs247_en.htm).

in Sweden can be explained by IT investments and organisational changes is, however, difficult to say with any degree of certainty. It is therefore difficult at present to draw any far-reaching conclusions about this for the Swedish economy. It is probable that there will be an upturn in productivity in Sweden when there is an upturn in the economy. It can not be ruled out that the main effects of previous IT investments and deregulation processes in the economy will continue to affect growth in the future. Nor can it be ruled out, however, that the main effects on trend productivity growth have begun to peter out. If this is the case, the level of trend productivity growth in the period ahead will probably be lower than it was from the early 1990s to the end of 2006.

Lower trend productivity growth means – all else being equal – that the level of potential growth in the economy will be lower than it has been for a decade. This would entail partly new preconditions for monetary policy in Sweden compared to the situation during the past ten years or so.

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