PAPERS PRESENTED AT THE
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Statistiska centralbyrån Statistics Sweden

Yearbook on Productivity 2011

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Foreword

Growth is important. Today's growth is what we have to live on tomorrow. This is why we have focused on productivity and growth, and this is why Statistics Sweden has decided to create a yearbook on productivity. The yearbook is also an important part of our work on improving the economic statistics in Sweden. The objectives and priorities for this work were outlined by the Commission on the Review of Economic Statistics and this conference and yearbook is part of this program. Also this yearbook contains a number of productivity studies. The articles have been written by colleagues outside Statistics Sweden as well as people from our own organisation. This year's yearbook is the seventh and was presented at our yearly conference in Saltsjöbaden.

We want to especially thank Elif Köksal-Oudot at the OECD, Robert Inklaar University of Groningen, Matilde Mas, Instituto Valenciano de Investigationes Económicas Valencia, Michel Polder at Statistics Netherlands, Eva Alfredsson at Growth Analysis Jonas Månsson Linnaeus University Annette Nylund at Royal Institute of Technology and the Swedish Work Environment Authority. Our own contribution this time consists of a three development projects financed by the Riksbank with Sofie Lord, Barbro von Hofsten and Daniel Lennartsson as the authors.

Statistics Sweden, December 2011

Monica Nelson Edberg	Hans-Olof Hagén
Director National Accounts	Senior Advisor National Accounts

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Internalising external environmental effects in efficiency analysis

The Swedish pulp and paper industry 2000–2007

*Eva Alfredsson**
*Jonas Månsson***
*Peter Vikström**

Abstract

In this study we apply Data Envelopment Analysis (DEA) to analyse efficiency in presence of both desired and undesired outputs. We use register data from the Swedish national environmental accounts. The study concerns the Swedish pulp and paper industry. To compute efficiency, we use a directional distance function approach that allows scaling for different directions, both desired and undesired output directions under the assumption of equal importance. The analysis show that efficiency have increased over time, both in terms of desired output and in terms of environmental efficiency. The first analysis measure inefficiency if scaling is done with equal importance given to desired output and undesired output. This analysis shows an inefficiency of around 12 % meaning that there is a 12% potential to simultaneously reduce pollution and increase production of pulp and paper. In the second analysis scaling is only allowed in the direction of undesired outputs. This analysis shows that the average potential reduction in pollution is 22%. If, on the other hand, the potential is computed in terms of only desired output keeping undesired output constant, the average potential increase in desired output is 14%. In a forth analysis we discuss the potential to evaluate the costs of environmental regulations using the DEA methodology.

Keywords: Environmental efficiency, directional distance function, cost of environmental regulation

JEL:D24; Q25;Q28

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Östersund, November 2011

1 Introduction

In this study we use official Swedish environmental account data to explore various aspects of efficiency accounting for both desired and undesired output. The industry in the study is the Swedish pulp and paper industry. The desired outputs are pulp and paper and the undesired outputs that are included in this study are emissions of carbon dioxide and sulphur dioxide..

Incorporating the fact that production is related to negative external effects in terms of, for example pollution, has been on the research agenda for some time.[1]

The fundamental empirical problem is that we have *a mixed objective function*. In the presence of pollution it is reasonable to assume that firms would like to maximise the production of the desired outputs and at the same time minimise, or at least stay within regulated levels of undesired outputs. Early attempts to incorporate environmental factors in models of production mostly used a single output, the desired output, and treated pollution as an input (see for example Pittman, 1983; Keilback, 1995; Lovell etal, 1995).

One of the questions that have been put forward is whether pollution should be viewed from the input or the output side. Dyckhoff and Allen (2001) discuss this topic and conclude that there are advantages in treating pollution as input and there are a number of studies that use pollution as an input (see for example Hailu and Veeman 2000, 2001; Korhonen and Luptacik, 2004; Kousmanen and Kortelainen 2005; Kortelainen and Kuosmanen 2007; Zhang etal 2008; Larsson, 2008; Bye etal, 2009; Picazo-Tadeo etal 2011). Even if this solution solves the problem of how to handle pollution, it is a conceptually problematic view since pollution is a consequence of production not an input.

A way of incorporating pollution as an output was presented in Färe et al (1993). By using the distance functions, introduced by Shephard (1953, 1970), the authors compute a parametric distance function using data from pulp and paper mills in Michigan and Wisconsin. An alternative to the traditional distance function was first

[1] We use a production- theoretical framework and the measures in this study should not be confused with what in some literature is referred to as eco-efficiency (see for example Barba-Gutierrez et al, 2009; Lin et al, 2010; Fernandez-Viñé, 2010; Wang et al, 2010; van Caneghem et al, 2010; Whan and Côté, 2011; Wursthorn et al, 2011; Yang etal, 2011)

presented in Chung, Färe and Grosskopf (1997), who introduced the *directional* distance function for computing efficiency in the presence of both desired and undesired outputs.[2,3] The main advantage of the directional distance function is that it is not restricted to scaling in a model-wise pre-determined direction, as is the case with the traditional distance functions. This feature is especially convenient in situations where production is characterised by providing both desirable and undesirable outputs since we then have a mixed objective function, i.e. maximise desired production and minimise undesired production (see for example Picazo-Tadeo, 2005; Färe et al, 2007;Färe et al, 2010; Macpherson et al, 2010; Picazo-Tadeo, 2011).

This methodological advantage is however far from unproblematic. By using the directional distance function it is up to the researcher to choose in what direction efficiency should be evaluated. In absence of output prices, as is the normal case for pollution, it is theoretically far from clear how this should be done.

In this study, we follow Färe et al (2007) and Färe et al (2010) and explore three directions, all with different economic interpretations. In the first analysis, we include both desired and undesired outputs. In the second, we limit the analysis to only focus on the potential reduction in the undesired output, and finally we scale only in the direction of the desired output. The results indicate efficiency gains both in terms of pollution reduction and the production of pulp and paper during the studied period.

Finally we explore the possibility to calculate the potential cost of environmental regulation. Our conclusions is that the method needs to be further discussed and developed before it can be applied to evaluate environmental regulatory burden.

The last question relates to for example Färe et al (1989), Brännlund (1995), Hetemäki (1996), Bruvoll et al (2003) and Brännlund (2008). The results from these studies are somewhat mixed. Färe et al. (1989) found no significant impact from the introduction of environmental regulations. The impact was defined as changes in efficiency between 1969 and 1975, i.e. over the period when regulations were

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[2] The idea for this paper was however published in a working paper in 1995 (see Chung and Färe, 1995). See also Färe and Grosskopf (2000).

[3]Seiford and Zhu (2002) presented an alternative to using the undesired output as an inputbut problems with their approach were argued by Färe and Grosskopf (2004).

introduced in the electrical industry. Brännlund et al (1995) used a non-parametric framework and studied the relationship between profits and environmental regulations in the Swedish pulp and paper industry. The study found mixed results – greater environmental restrictions increased profits for some mills and decreased profits for others. Hetemäki (1996) studied the Finish pulp and paper industry using a stochastic frontier approach and found that productivity decreased with increased environmental regulations.[4] Brännlund (2008) also tried to find a relationship between productivity and the intensity of environmental regulation using a standard regression model with a Cobb-Douglas technology to estimate the productivity index. This index was then regressed on variables that capture regulation intensity. In contrast to Hetemäki (1996) this study found no such relationship.

In Färe et al (2007) and Färe et al (2010) an alternative is used where efficiency is evaluated towards an unregulated frontier and the question in that study was whether it was possible to identify the cost of environmental regulations in terms of foregone production, i.e. production unobtainable due to environmental regulations. The fourth analysis is also conceptually, but not methodologically, related to the work by Boyd and McClelland (1999). The result reported there is that the alternative cost of environmental regulations is approximately 9%.

The outline of the paper is as follows. In section 2 we give a short presentation of the Swedish pulp and paper industry. This is followed in section 3 by a presentation of the theoretical framework for the study. The data is presented in section 4. In section 5 the results are presented and discussed.

[4] See for example Green (2008) for a description of the stochastic frontier approach.

2 The Swedish pulp and paper industry – a short description

The Swedish pulp and paper industry accounts for about 6% of Sweden's gross domestic product and the industry is important to the trade balance since more than 85% of what is produced is exported. Sweden is the world's second largest exporter of paper, pulp and sawn timber combined. Sweden's pulp and paper industry is the third largest in Europe, after Germany and Finland (The Swedish Forest Industries Federation, 2010a p. 5f).

Even if the pulp and paper industry is rather small in terms of number of employees (around 27,500) the 41 paper mills and 41 pulp mills in Sweden accounts for about 50% of the aggregated domestic industrial energy use (Swedish Forest Industry 2007; Swedish Energy Agency, 2006). Further, a small number of mills dominate the industry; for example, the 12 largest paper mills account for 70% of the total paper capacity and the six largest pulp mills account for 65% of the pulp capacity (The Swedish Forest Industries Federation 2010b, p. 19).

The forest industry in general, and the pulp and paper industry in particular, is characterised by heavy capital-intensive production investments. According to Thollander and Ottosson(2008), a paper machine, for example, costs about 200–500 million USD to install. On average the forest industry's investments represent over 15% of total Swedish industrial investment (The Swedish Forest Industries Federation 2010a). In addition, production disruptions are very costly, and the few planned stops in the continuous production processes make any change in the process a high-risk project.

There are three basic means of producing pulp: mechanical, chemical, and chemical–mechanical. While the chemical pulp process mainly uses biomass as the primary energy source, the mechanical pulp process uses more electricity. The sector uses about 50 TWh biomass, 22.5 TWh electricity and 7.3 TWh fossil fuels. Since the 1970s, the sector has gradually grown less dependent on fossil fuels due to increased energy efficiency, while the use of electricity has increased (Statistics Sweden 2006). It should also be noted that the chemical pulp mills generate about 5 TWh electricity through the use of back pressure (The Swedish Forest Industries Federation 2007).

3 Theoretical framework

In this study we use a directional distance function approach, following Färe etal (2007). Before defining and discussing the directional distance function in presence of both desirable and undesirable outputs some notations are needed. Let x be a vector of inputs, DY a vector of desirable outputs and UDY a vector of undesirable outputs. The production technology *P(x)* is then defined as:

[1] $$P(x) = \{(DY, UDY) : x \text{ can/will produce } DY \text{ and } UDY\}$$

Given [1], the directional distance function is defined as:

[2]

$$D(x, DY, UDY; g_{DY}, g_{UDY}) = \max\{\beta : (DY + \beta g_{Dy}, UDY + \beta g_{UDY}) \in P(x)\}$$

where β is the value of the distance function and g_{DY} and g_{UDY} the direction of the scaling. Note in particular that in a traditional efficiency analysis the direction would have been determined by the origin and the observation itself. The relationship between the directional distance function and the traditional distance function is presented in Chung and Färe (1995) and can be expressed as:[5]

[3] $DDF = \frac{1}{D_o} - 1$, where D_o stands for the traditional output distance function.

Since technical efficiency (TE) in terms of the distance function is defined as $TE = 1/D_0$ technical efficiency in terms of directional distance functions is:

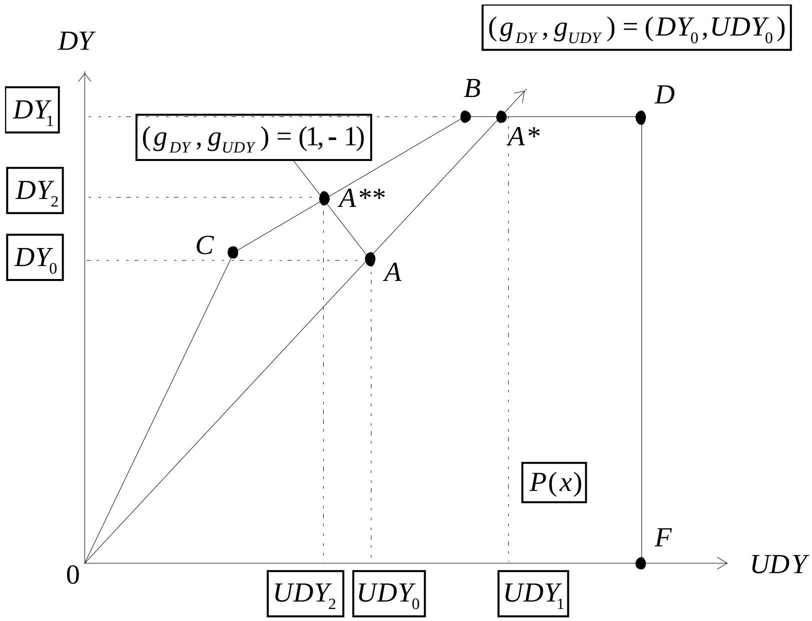
[4] $$DDF = \frac{1}{D_o} - 1 \Leftrightarrow D_o = \frac{1}{DDF + 1} \Leftrightarrow TE = DDF + 1$$

In Färe et al (2007), several directions and their interpretation is presented and we will use the same frame work as in their study.

A first direction is to use $(g_{DY}, g_{UDY}) = (1, -1)$. This situation is illustrated in Figure 1.

[5] A description of the traditional distance function can be found for example in Färe (1989).

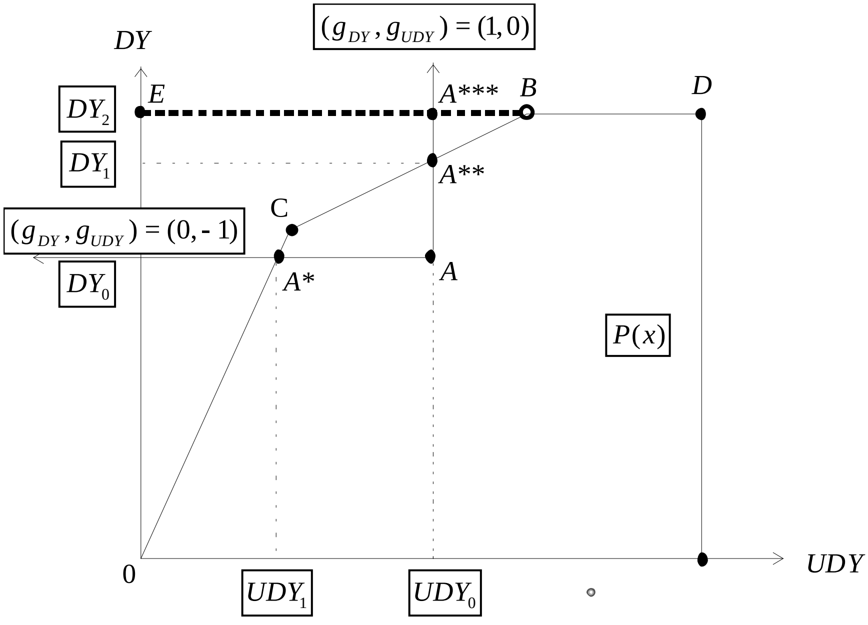
Figure 1
Illustration of directional distance function and traditional distance function



In Figure 1, 0 and observations *C*, *B*, *D* and *F* define the production technology while observation *A* is the observation to be evaluated. The corresponding production for observation *A* is DY_0 of the desired output and UDY_0 of the undesired output. Using the traditional approach, ignoring the fact that one of the outputs is undesirable, corresponds to choosing direction $(g_{DY}, g_{UDY}) = (DY_0, UDY_0)$ and is illustrated with the line from the origin, through point *A* and the reference on the production frontier *A**. The potential increase in desired output is therefore $DY_1 - DY_0$. However, this potential increase in *DY* is at the cost of increased production of undesired output, $UDY_1 - UDY_0$,i.e. an increase in production of desired outputs is associated with an increase in production of undesired outputs. However, since the objective of the policy is to maximise production of the desired output while minimising production of the undesirable output, the directional distance function (DDF) provides a tool to close in on that issue. By setting direction $(g_{DY}, g_{UDY}) = (1, -1)$ we are able to evaluate observation *A* from another perspective. It should be mentioned already at this point that the direction of the DDF is far from unambiguous. Using direction (1,-1) solves the problem of the different types of desirability but there are no theoretical arguments for this explicit direction. What is obtained by using the DDF in direction (1,-1) is a measure of how production of desired output can be increased at the same time as the production of the undesired output is decreased if both are considered equally important. In Figure 1, the potential increase in desired production equals $DY_2 - DY_0$, while at the same time production of the undesired output is reduced by $UDY_0 - UDY_2$, all at a given level of inputs and technology.

There are at least two other directions that are of policy interest. First, potential decrease in production of undesired output at a given use of production of the desired product, technology and input level. Secondly; potential increase in production of the desired output at a given level of undesired production, technology and input use. These two aspects are illustrated in Figure 2.

Figure 2
Illustration of (In)efficiency measured in the production of either only 'bad' (0, -1) or only 'good' (1, 0)



As in Figure 1 observation *A* is to be evaluated. The amount of undesired output that can be reduced while keeping desired output and input at a given level within the existing technology is illustrated by $UDY_0 - UDY_1$. *A** is here where observation *A* would be if this were done, i.e. in (DY_0, UDY_1). This is the potential pollution decrease, or inefficiency, expressed in pollution terms. The second question takes a more traditional, growth-oriented approach by asking how much it is possible to increase the production of desired outputs while keeping technology, undesired output, and input levels constant. This potential is illustrated by $DY_1 - DY_0$.

A final policy question is weather the existing framework can be used to measure the effect of current environmental regulations in terms of costs of foregone production of desired output.

Färe et al. (2007) argues that if we had free disposability of outputs, i.e. it was free and allowed to get rid of all undesired production without effort, the production technology would, in our illustration, be limited by the line segments *E-B-D-F*. In Färe et al. (2007) this is labelled the unregulated technology. The inefficiency measured in production loss of desired output would in this case be $DY_2 - DY_0$. Notice that this potential production increase consist of two parts; inefficiency ($DY_1 - DY_0$) and unobtainable production due to the fact that pollution is internalised ($DY_2 - DY_1$). Our conclusion is that this hypothesis needs to be discussed further and might require us to develop the model further in order to take into account also foregone potential reduction in undesired output.

To summarise: The analysis is intended to explore the following questions:

1) If desired and undesired output were considered equally important, how much inefficiency exists in the Swedish pulp and paper industry?
2) How large is the environmental inefficiency, i.e. potential reduction in undesired output while keeping technology, desired output and input levels constant?
3) How large is the production inefficiency, i.e. potential increase in desired output while keeping technology, undesired output and input levels constant?
4) Can the existing framework can be used to measure the effect of current environmental regulations in terms of costs of foregone production of desired output.

4 Data

The data used for this study has been compiled from different registers at Statistics Sweden and the data is on mill level. We have limited the data to only cover those mills that were active over the whole period. Further, the register data was far from perfect and contained information that was obviously incorrect. For example, mills that consumed zero energy and mills that did not have any registered pollution. This was especially so in the early part of the period. Mills with incomplete, or obviously incorrect, data have not been included in the sample. In all, we end up with 31 mills that we can follow for the whole period and that, as far as we can judge, are represented by realistic data. Descriptive statistics for these 31 mills are shown in Table 1.

Table 1
Descriptive statistics of outputs and inputs by year (n=31)

Year	Turnover, pulp and paper, Millions SEK y1	CO2, 100 tons y2	SO2, tons y3	Employed number x1	Capital, buildings and land, millions SEK x2	Machinery, Millions SEK x3	Energy TWH x4	Raw material Million SEK x5
2000								
Mean	2,119	556	115	674	329	1,299	1,846	900
Std. Deviation	2,284	736	150	617	685	1,675	2,341	975
2001								
Mean	2,025	518	103	653	347	1,274	1,932	820
Std. Deviation	2,230	632	125	605	735	1,665	2,218	946
2002								
Mean	2,067	529	99	638	333	1,294	1,930	861
Std. Deviation	2,260	662	119	595	7215	1,760	2,184	972
2003								
Mean	2,148	568	91	635	241	1,265	1,780	1,077
Std. Deviation	2,327	610	97	586	581	1,745	2,023	1,266
2004								
Mean	2,187	542	88	618	236	1,320	1,807	1,203
Std. Deviation	2,362	563	90	577	552	1,782	2,041	1,471
2005								
Mean	2,217	462	82	609	243	1,399	1,730	1,188
Std. Deviation	2,421	560	95	568	537	1,865	2,095	1,308
2006								
Mean	2,332	502	90	595	221	1,445	1,879	1,341
Std. Deviation	2,501	597	102	564	506	1,835	2,125	1,579
2007								
Mean	2,293	393	77	578	205	1,407	1,733	1,378
Std. Deviation	2,398	507	91	554	479	1,788	2,026	1,574
Total								
Mean	2,174	509	93	625	269	1,338	1,830	1,096
Std. Deviation	2,318	605	110	576	601	1,742	2,105	1,284

A first comment is that we use data that in most cases is in the form of values or costs. To be able to interpret this in terms of technical efficiency, we have to assume equal output and input prices. In the case of the pulp and paper industry, this assumption seems at least plausible due to the world market competition that the companies in the industry are exposed to.

The model includes three outputs. As in Karvonen (2001) for example, the desired output is defined as the total real value of the production of pulp and paper. By dividing this number by a producer price index we obtain the real value of production.[6] Table 1 reveals that the production of pulp and paper fell in 2001, then increased until 2005, falling again in 2006 and 2007. We also have two undesired outputs – carbon dioxide (CO_2) measured in hundreds of tons and sulphur dioxide (SO_2) measured in tons of pollution. This information was compiled from the Swedish national environment account data. For the whole period, CO_2 pollution decreased by approximately 5,000 tons. The year with the highest CO_2 emissions was 2003, with56,800 tons and the lowest CO_2 emissions were in 2007, when they averaged 39,300 tons. With the exception of 2006, SO_2 emissions have declined and the reduction over the whole period is approximately 38 tons.

We use five inputs. The first is labour measured as the number of people employed at the mill in Sweden. Overall, the data shows a decline in the average number of people employed. In 2000, the average was 674 and in 2007 578. This means that the average mill has reduced the number of people employed by almost 100. Two variables are used to measure capital. The first is the capital stock of buildings and land, measured in millions SEK and the second is the stock of machinery, also measured in millions SEK. The first capital variable can be viewed as a more long-term capital stock while machinery is more of a medium-term capital stock. It is obvious from table 1 that the reduction in labour and long-term capital is to some extent replaced by capital in the form of machinery. While both labour and capital in the form of buildings and land have declined, capital in the form of machinery has increased. It is also noticeable that energy consumption decreased by 199 TWH between 2001 and 2007 while the use of raw materials increased from 820 units in 2001 to 1,378 units in 2007.

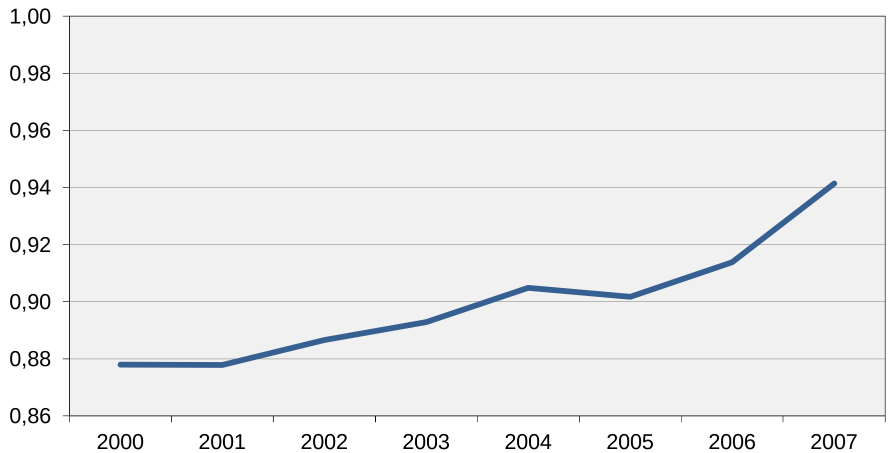
[6] Producer price indexes are presented in Appendix, Table A1.

5 Results

Before commenting on the results is has to notice that comparing efficiency between years is no straightforward matter. Efficiency in the meaning of the used framework is defined as‘ relative to others’ changed efficiency and can mean two things for a single unit; either the actual inefficiency has changed (increased or decreased) or those units that are in the reference technology have changed. Efficiency scores for a specific unit between years therefore need to be compared with a great deal of caution. For this reason, we only present the figures for the industry as a whole and deliberately avoid talking about individual units. Further, in addition to being an empirical application of environmental efficiency, this study constitutes a first important test of using the official Swedish environmental accounting data to conduct analyses.

The first analysis targets the question concerning environmental efficiency as expressed in the literature. The direction $(g_{DY}, g_{UDY}) = (1, -1)$ is used for the analysis which means that desired and undesired output is treated as equally important. Figure 3 shows the result of the analysis of environmental efficiency for the 2000–2007 period.

Figure 3
Efficiency accounting for both desired and undesired output. Swedish pulp and paper industry between 2000 and 2007

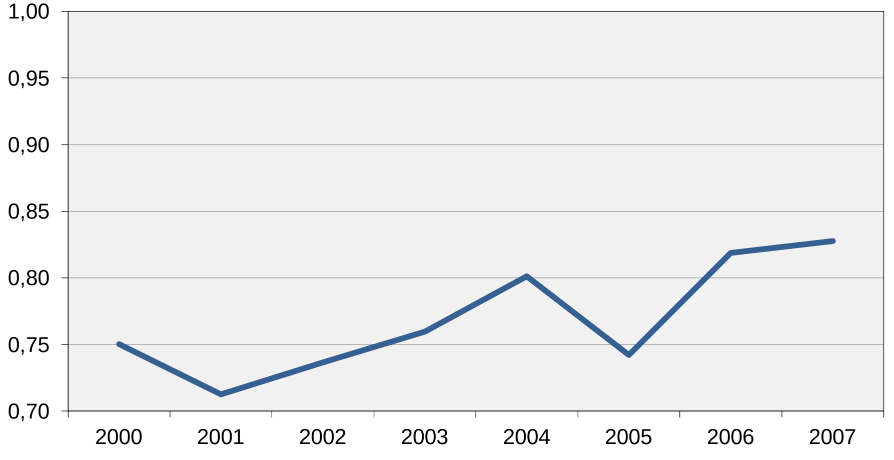


In 2000, average efficiency was approximately 0.88 or 12% inefficiency. These are interpreted as meaning that the industry could increase production of pulp and paper by 12% and at the same time reduce pollution by 12%. 2000 is the year that shows the largest potential but Figure 3 also indicates that some of this potential has been realised over the studied period since efficiency has increased. In 2007, efficiency was 94%, i.e. inefficiency was 6%. The result for 2007 seems logical, bearing in mind that the pulp and paper industry is exposed to world market competition and we would therefore, *in absence of large technological shifts*, expect a high degree of relative efficiency. In the same year, 18 out of the 31 units included in the analysis were efficient.

Analysis 2

In the second analysis, we explore the potential to reduce pollution while keeping technology, desired production and input levels fixed, i.e. $(g_{DY}, g_{UDY}) = (0,-1)$. The average potential pollution reduction is illustrated in Figure 4.

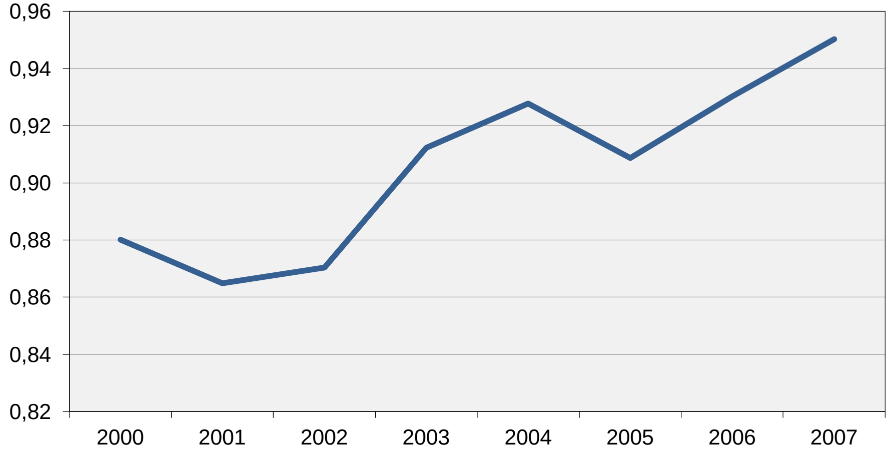
Figure 4
Average efficiency in terms of undesired output – Average potential pollution reduction. Swedish pulp and paper industry between 2000 and 2007



The average efficiency with respect to pollution is for the studied period around 0.78, i.e. a potential pollution reduction of 22%. As for analysis 1, the trend seems to be a decrease in this potential. One explanation might be that the industry to a large extent has adjusted to environmental regulations. The highest potential, i.e. the lowest efficiency score, is found in 2001. For that year, the potential pollution reduction was 29%. Since the industry's CO_2 emissions totalled 1,604,500 tons and SO_2 pollution 3,187 tons, this potential corresponds to a potential reduction of 465,305 tons of CO_2 and 924 tons of SO_2. For 2007, the potential pollution reduction is 17%. Since the production of CO_2 and SO_2 was then 1,218,500 and 2,379 tons respectively, the potential reduction in 2007 was 207,145 tons of CO_2 and 404 tons of SO_2.

Analysis 3
In the third analysis, we explore the potential to increase production of paper and pulp while keeping technology, pollution and input levels fixed, i.e. $(g_{DY}, g_{UDY}) = (1,0)$ in Figure 2. The result is shown in Figure 5.

Figure 5
Average efficiency in terms of desired output – Average potential increase in desired output. Swedish pulp and paper industry between 2000 and 2007



We are here looking at the potential increase in the production of pulp and paper which is measured as turnover divided by the producer price index. This can be therefore interpreted as the value expressed in fixed prices. The annual average inefficiency has decreased over time. In 2000, the average inefficiency was approximately 14%. In terms of pulp and paper production, this represents a potential increase worth around 9,2 million SEK. In 2004, the potential increase in pulp and paper had decreased to approximately 7%. However, there is a fall in efficiency in 2005 where inefficiency increased to approximately 9%. Already in 2006, inefficiency was almost the same as in 2004, i.e. approximately 7% and decreased even more in 2007. In the latest year for our data, 2007, inefficiency was 5%, corresponding to a potential increase of pulp and paper production worth around 3,6 million SEK at fixed prices.

Analysis 4

In this final analysis we investigate the cost of internalising environmental factors[7] using the same method and hypothesis as in Färe et al (2007).

The idea is to compare the frontier which include undesired output (pollution) with a model that does not include these factors. In technical terms the first model assumes weak disposability of outputs while the second model assumes strong disposability of outputs., By comparing the frontier of the first model with the maximum output produced by the industry with the highest output of "goods"[8] the costs of environmental regulations are calculated as the difference in output between the two measures ("models").

As illustrated in Figure 2, TE_{ToT} consists of two parts; the potential for the regulated industry (TE_R)(DY_1) and the part associated with the potential increase in pulp and paper production if pollution is unimportant (TE_{NR})(DY_2). The last part is not directly observed in the data, however. The relationship between the three measures is:

[3] $TE_{ToT} = TE_{NR} \cdot TE_R$,

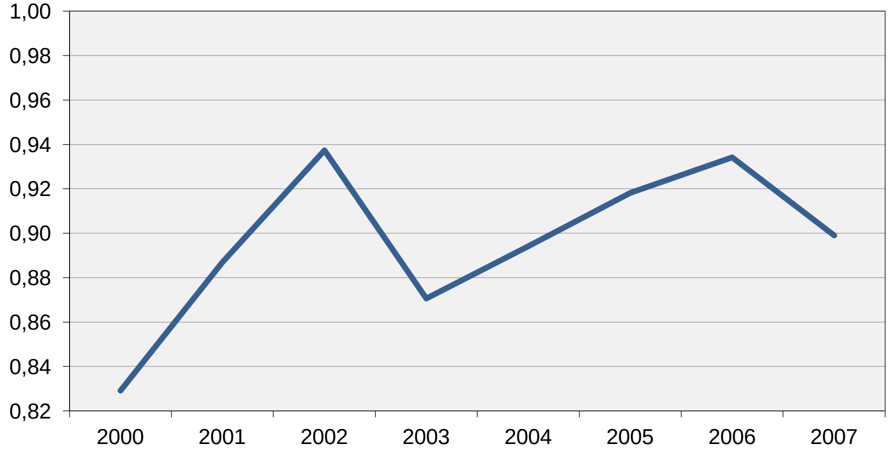
TE_{NR} is defined and computed as $TE_{NR} = TE_{ToT} / TE_R$

Figure 6 shows the "cost of internalise pollution" using this method.

[7] In Färe et.al (2007) this is labelled cost of environmental regulation, however what is done is that the researcher choose to include the environmental factors and declare them as bad output, i.e. internalising external effect into the production model.

[8] The total potential with respect to the "unregulated technology", denoted TE_{ToT}

Figure 6
Cost of internalising pollution measured in percentage of pulp and paper production



Given the assumption of strong disposability and the methodology given in the previous paragraph the costs in terms of foregone potential production of desired output has varied over the years. The trend seems however to be a decrease in inefficiency in terms of total potential of desired output.

In 2000, the total potential increase in pulp and paper production not realised was approximately 17%. Since the total production in our sample was worth 65,7 million SEK at fixed prices, this means that 1, 2 million SEK worth of pulp and paper was not produced.. In 2007 the in efficiency had decreased to approximately 10%.

If however weak disposability of outputs are assuming these results are not valid. The question is if we could still use a modified methodology in which foregone potential reduction in undesired output is equally analysed. This question would be interesting to explore in future analyses.

6 Conclusions and concluding remarks

In this study we have investigated different aspects of efficiency using official national environmental account data for the Swedish pulp and paper industry. In economic terms including pollution means that pollution is treated as an internal effect rather than an external effect. We have used a directional distance function approach and allowed for different directions for scaling, exploring different interpretations of efficiency. The most common way of choosing direction is to treat desired and undesired production as equally important. Using this approach shows a potential increase in the production of pulp and paper of 12% at the same time as CO_2 and SO_2 emissions can be reduced by the same amount. If we express inefficiency in terms of potential reduction of pollution, at a given level of pulp and paper production, this potential is on average 22%. If we measure efficiency in terms of potential output given unchanged levels of undesired output the average potential is 14% but decreased over time. In 2007, the potential was 5%, which corresponds to a real value of 3,6 million SEK.

We have further analysed the total potential loss in desired output assuming strong disposability of output. This analysis raised the question of whether the methodology could be developed to accommodate the assumption of weak disposability of output. This question will be explored further in future studies.

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Appendix

Table A1
Producer price index for year 2000 to 2007

Year	Producer price index
2000	1.074
2001	1.139
2002	1.069
2003	1.019
2004	0.99
2005	1
2006	1.031
2007	1.079

Source: Statistics Sweden

Table A2
Tax cost in SEK of CO_2 emission per ton

Year	Producer price index
2000	185
2001	185.5
2002	189
2003	190
2004	191.1
2005	191.1
2006	193.2
2007	195.3

Bundles of practices versus TQM principles and their prediction for productivity

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Abstract

The main objective in this study is to compare the traditional TQM management concept with contemporary used learning and work practices in firms in the business sector in Sweden. Will the use of one or both of the concepts predict higher value added per employee? The two management concepts are used as measurements of endogenous activities in the firm and are included in growth models. The concepts are based on new data from the Swedish Meadow Survey 2009/10 and matched with innovation data, ICT data and register data for the year 2008 from Statistics Sweden. The Meadow Survey is based on the new proposed guideline of how to harmonise the collection and interpretation of data concerning work organisation and competence development in the European Union countries.

Background

The need to further develop growth models and these model measurements are two important perspectives that are taken as starting points in this paper.

In general, traditional growth models are still more or less based and handled on assumptions that changes in the economy are exogenous, and that the main components are equal to all organisations. These equal components are capital, labour and technology. To estimate growth the components are estimated in an overall production function in the economy, which mainly is an aggregated mathematical input and output model. One of the grand economists that sharpened the theory is Solow, 1956, 1967. These traditional models of economic growth are concentrated to measurements of the quantity of inputs and the quantity of output, they do not provide information about what is happening in the actual performance. Therefore what is actually taking place is described as a "black box" by Rosenberg, 1983. He argues that knowledge of what is happening in the box will reveal differences in the rate of productivity improvement, the nature of learning processes underlying technological change itself, the speed of technology transfer, and the characteristics of newly emerging technologies. He argues that it is also helpful to understand the effectiveness of government policies that are intended to influence technologies.

Today's modern growth economists that have the ambition to understand growth and driving forces for growth strongly believe that researchers have to look into endogenous activities in the economy, including endogenous activities in the firm. These assumptions are also restricted because there is a huge lack of data, that are harmonised and continuously measured. Therefore the second perspective in this paper is the further need of estimates of endogenous activities that can be included into the model of the economy. Therefore, in this study it is important extend the growth model to also include what is also happening within organisations. This is achieved with the help of new data following the proposed Meadow guideline. The main goal of the guidelines is collecting and interpreting harmonised data on organisational change and work restructuring and their economic and social impacts at the EU level. These guidelines aim to constitute the first step towards implementing a harmonised European survey instrument. They will serve to promote comparative research through the development and diffusion of tools, methodologies and research designs for the development of large-scale data sets of wide applicability for comparative research and across disciplines. This overall goal will be realised through a series of interrelated tasks and objectives, starting with integrating the existing knowledge on organisational change and work restructuring and moving progressively towards the identification of a core set of indicators developed into survey questions that will be tested. User and stakeholder involvement and monitoring will assure the widest possible dissemination and exploitation of the project results (Meadow Consortium, 2010)[9]. The overall objective of the guideline is to contribute to the development of evidence based European growth policy (European Commission, 2008).

Objective

Even though there seems to be a broader understanding among scientists working with human resource management strategies there is surprisingly little research focusing on the relation between work and learning theories and used practices (Huselid, 1997; Huselid and Becker, 1997). Therefore, the main objective in this study is to contribute with some new aspects concerning the use of work and learning practise and work organisation in Swedish business sector, and some aspects concerning these practices and their relation to theory as well as their prediction to estimate higher economic values.

Methods

The frame of the study is the proposed Meadow guideline and specifically organisations' economics. For this purpose the statistical method regression analysis is used. The firm's economics is estimated with firm register data.

Two management concepts are studied with the help of data based on the Meadow guideline: one is an old management model aiming towards high economic performance in the organisation, the other is simply a measurement of how included learning and work practices are used without taking any stand in a specific management model. This is possible since the guideline does not take any stand between models. It is even argued in the guideline that the linkage between theory and data needs to be constructed ex post rather than be taken as something that has been structuring the original design of the guideline. Therefore, an explorative approach of used work and

[9] The Meadow project, Measuring the Dynamics of Organisations and Work, was a multi-disciplinary consortium of 14 partners, from universities in 9 European countries, supported by key institutions; OECD, Eurostat, and the European Foundation for the Improvement of Living and Working Conditions, the European Agency for Safety and Health at Work, and DG employment. Founded by the European Commission, DG Research, Priority Seven (Citizens & Governance) 6:e RTD Framework Programme (See, European Commission, 2008). The Swedish partner was University of Gothenburg with a team headed by Professor Annika Härenstam, Department of Work Science. http://www.meadow-project.eu

learning practices are possible and meaningful. The statistical methods' factor analysis is used to explore the homogeneity of the management concepts.

Observation unit

Observation unit is the firm that is defined after the corporate identity number. The majority of all these are defined as sole legal units that have a sole corporate identity number (it can also be a person's identity number, depending on the type of business). In statistics, this unit is the smallest economic entity with employees that produces goods or services. According to the registers' administrators the absolute majority of all firms in the register have a so-called one-to-one relationship between the legal and corporate identity number.[10]

Selection of firms

The analysis is based on about 880 firms in the business sector in Sweden. The selection frame of the survey consists of 1 395 firms that answered two other EU regulated and mandatory surveys: one collecting innovation data in Sweden, European Community Innovation Survey 2006–2008, CIS (Statistics Sweden, 2009a), and the other is the ICT Survey 2009 (Statistics Sweden, 2010a). The samples in these two surveys are stratified according to industry and size (Statistics Sweden, 2011a, Chapter 3 *Table 3.1 and 3.2*). The industries are defined according the Swedish Standard Industrial Classification, Nace 2007, based on the European Classification of Economic Activities, NACE, Rev 2.[11]. The included industries in the Swedish Meadow Survey represent about 55 percent of all employees working in the business sector[12]. Industries that are more likely to be using advanced technologies, due to their products and production techniques such as those within manufacturing industries and knowledge intensive service industries are included (OECD and Eurostat, 2005). The revised third OECD-manual covers

[10] Limited liability firms, or other types of enterprises or economic organisations, or sole proprietorship etc.

[11] The European Parliament and the Council regulate the definition of business and legal units that are used in common statistics, analyses and publications. Regulation of business and legal units (EG) Nr 696/93 and Regulation of Nace rev. 2 (Nace 2007) (EG) nr 1893/2006. Swedish Business Register, Statistics Sweden 2010b.

[12] Business sector is defined as the market producers and producers for own final use in Sweden.

innovation activities in less R&D-intensive industries, in both services and manufacturing. The manual regulates collection of data from the business sector but not the public sector. Collection from the public sector has to develop separately. Still, industries in Sweden with lower levels of technology that do not belong to manufacturing, such as agriculture, forestry, fishing and the construction industry together with parts of the service industries: hotels and restaurants, retail trade, real estate, education and healthcare as well as firms in culture are excluded from the selection frame, because they are excluded from the CIS Survey. Only some of these industries are also excluded from the ICT Survey.

The Swedish Meadow Survey

The Swedish Meadow Survey was collected the winter 2009/2010 from the employers in firms in the Swedish business sector. The response rate was 65 percent (Statistics Sweden, 2011a, Chapter 3 *Table 3.1 and 3.2*). In comparison with other surveys collecting European work organisation data, the response rate is high (Benders, Huijgen, Pekruhl, O'Kelly, 1999; Collin and Krieger, 1999).

The technique to match Swedish Meadow data with the data from the innovation survey and the ICT survey makes it possible to include all questions in the Meadow guideline and still reduce the Swedish Meadow Survey. The questions in the CIS Survey are standing model for the questions of innovation in the Meadow Guideline. The Meadow Guideline is complementary to other existing manuals that provide guidelines for internationally harmonised survey instruments. These include the Oslo Manual, which provides guidelines for collecting innovation data, the EU Continuing Vocational Training Manual, and the Methodological Manual for Statistics on the Information Society. Together, the three surveys and register data cover in principle all themes of questions in the Meadow Guidelines (Statistics Sweden, 2011a, Chapter 3 *Table 3.3*). The organisation of the Swedish Meadow Survey increases validity (quality of the questions) and reliability (the consistency of the measurement) considerably.

Match with register data

All three surveys are using corporate identity number (Statistics Sweden, 2010b) which makes it possible to match data between the included surveys and registers. Statistics Sweden's longitudinal integration database for health insurance and labour market studies, with the acronym LISA (Statistics Sweden, 2009b), complements the survey data with register data. The register included holds primary annual records from 1990 to 2008 for all individuals aged 16 and older who were registered in Sweden as of 31 December of each year. The individuals are connected to family, firms; places of employment etc.[13] Basic economic firm data are matched to this. Value added per employee for the finance and insurance industry Nace 64-65 is estimated on firm level specially for this study by Statistics Sweden. Official statistics on foreign controlled firms in Sweden are also used (The Swedish Agency for Growth Policy Analysis, 2010, in collaboration with Statistics Sweden) and matched with information of Swedish ownership from the LISA-dataset. For further information about data, restrictions and possibilities see (Statistics Sweden, 2011a).

Correlation analysis

The Pearson correlation coefficient method is used to study the relationship between the included practices when factor analysis is not applicable. This is the most common measuring of the degree of correlation. It is widely used as a measure of the strength of linear dependence between two variables. The correlation coefficient shows the degree of correlation, if it is very high it might indicate that two indicators provide overlapping information. If they are not highly related to each other they are seen as contributing with specific information, respectively.

Factor analysis

Factor analysis is used to study the two management concepts. The results of the analyses will show the patterns of the included practices, also latent or hidden patterns, in the two management concepts, respectively. Therefore the result provides information about the homogeneity of each management concept.

Factor analysis is a multi-variable statistical method. The patterns, called factors, are indirectly observed and measured as the variability of other variables. In other words, the variances from

[13] Statistics Sweden, 2009. *Longitudinell Integrationsdatabas för Sjukförsäkrings- och Arbetsmarknadsstudier (LISA) 1990-2007.* Arbetsmarknads- och utbildningsstatistik, 2009:1. The individual section includes: Age, Genus, Education, Employment, Unemployment, Income, Professional, Entrepreneurial activities, Illness, Parental leave, Rehabilitation, Retirement, Private pensions, etc. The firm section includes: Firms, Work places, Type of industry, Sector, Location, Number of employees and Salaries per year from 1990-2008.

variables that provide common patterns are called factor. The loadings between the variables (rows) and factors (columns) are the correlation coefficients (Garson, 2010).

In this study the specific model of Principal Component Analysis (PCA) is used. It reduces the complexity of the data by accounting the maximum variation in the dataset, one factor at the time. It looks at the total variance among the variables, so the solution generated will include as many factors as there are variables, although it is unlikely that they will all meet the criteria for retention. The mineigen criterion is used to retain factors, which means that only factors with an eigenvalue equal to or higher than one is included in the final model. If they are lower they are assumed not significantly contributing to the explanation. The percentage of the variances explained by the included factors and the measurement of the adequacy, MSA, are presented for each factor analysis model.

One way to obtain more interpretable results is to rotate the solution (Flynn, 2011). Varimax rotation is used; it serves to make the output more understandable and to facilitate the interpretation of the factors. The sum of eigenvalues is not affected by rotation, but rotation will alter the distribution of eigenvalues between particular factors, and it can change the factor loadings (Garson, 2010).

Regression model

Linear regression model is used to measure the strength of dependence between several independent variables including the two management concepts and value added per employee which is the dependent variable.

The linear regression model measures the strength of dependence between several independent variables (features) and one dependent variable. All variables are included simultaneously in each model. The dependence of one variable is measured while the model standardises for other dependence by holding the value of the other independent variables constant.

The dependent variable in the models used is value added per employee in each firm. The two different management concepts are included in each linear model as independent variables; management indexes that are measuring the characteristics of each of the two management model. The two management concepts are included in regression models, respectively. The difference between the two models is the type of management index which is used. The other variables that also are assumed to also have an impact on the value added are: the employees' education, size of the firm, type of production, etc.

The models are tested with help of stepwise selection procedures and C_p statistic, the latter which is including calculated for all possible combinations of variables in a general procedure to find an adequate model by means.

Finally, the regression model also provides information on if the included features, all of the independent variables, in the model suit the model. For example, the model tests how much of the variances in the dependent variable that can be explained by the non dependent variables. This test is commonly called R-Square (R^2); it can be between 0 and 1. If the test shows $R^2 = 1$ then the independent variables answer for all variances of the dependent variable; if the test shows $R^2 = 0$ the independent variables have no value in explaining the independent variable. A value of about 0.2 is not unusual in social science. If the test is low it can be interpreted as that the construction of the non dependent features can be altered and then better suited to predict the dependent variable. It can also mean that the dependent variable in the regression is nonlinear.

Five assumptions behind endogenous growth theory

Professor Romer, presents five basic facts or evidence about growth (Romer, 1994). At least some of them can be seen as growth arguments for learning in work and why it is of importance how work is organised (Statistics Sweden, 2011a).

The *first fact* is simply that there are many firms in a market but not perfect competition or the opposite: monopoly. The *second fact* is that there is an input beyond capital and labour and technology; it is discoveries or new ideas. The use of a discovery leads to changes and increases in technology. The use of this input by one firm will not exclude others from using it at the same time. The *third fact* is that it is possible to replicate physical activities. This implies a competitive market where inputs are rivals. The *fourth fact* is that discoveries are often accidental side effects of other activities and they are more likely to happen in activities with more people involved. This can be endogenous within an activity, not necessarily within a specific firm or organisation. The *fifth fact* is that discoveries in the long run do not exclude others from using them, but they can be controlled by people and firms, at least over a period of time, and during this period monopoly prices can be taken. This five facts are the assumptions behind endogenous growth theory, i.e. that high competence performing firms significantly predict higher value added per employee.

Not all of these growth facts are management practices. Some of them are included in basic growth assumptions but are not always measured. Still, in this study they are included in the basic model aiming to predict productivity. The first and third facts are due to assumptions concerning many firms in competitive markets. They are indirectly handled in the regression model by the fact that several firms are included from the business market in Sweden. The *second* growth fact has to be specifically included in a management concept. It is discoveries or new ideas. The *fourth* fact is that these discoveries or new ideas often are accidental side effects in activities with more people involved. The *fifth* fact is that these discoveries or new ideas are controlled by people and firms.

Bundles of practices

The first of the two management concept that are studied is an explorative perspective of used practices. The assumptions behind the studied practices are described, as well as their relations to the growth facts. All the practices are included in a factor analysis that aims to reveal a pattern of contemporary use of the practices, and even hidden latent patterns.

Human and structural competence

Investment in competence is not only focused on competence directly linked to human capital, even though it is important. The reason is that human capital is movable in a way that the organisation cannot control, at least not in the same way as it controls structure capital that is possible for the firm to own. Therefore the model includes information about competence that is directly related to people, called human capital, and competence that is owned by the firm, here called structural capital. The division of investment in human capital and structure capital is matching the fifth facts of growth – that discoveries or new ideas are controlled by both people and by firms. The firm’s structural capital has become more important since it is easier to create today, especially with help of ICT. At the same time more advanced structural capital often needs to be handled by more advanced human capital, and these can be seen as entangled. In the survey these are called individual and structural learning, respectively. The measurements of practices of both individual and structural learning within the work can also be seen as indicators of potential discoveries or new ideas as such, i.e. the second fact.

These two competence dimensions, human and structural capital, can also be divided into competences within or outside the firm.

In more detail, all practices that aim to increase the competence among the employees are included in the measurement of human capital. One measurement is the qualifications that are needed in the work, and how to match it with the employee's skills. Since there is no specific measurement of the actual matching process in the datasets there is not a specific measurement included in the management model. There is still a possibility to include the result of matching processes as the degree of employees with different levels of education. The result of the matching process is included in the final analyses of productivity as three measurements of the employees' level of education, but it is not included in the actual management concept. The qualities that the organisation can offer the employees, including work practices and learning practices at work, are also aspects of the competence related to humans in the firm.

Employees defined as being from outside the firm but who contribute with work in the organisation, such as temporary contractors, consultants and private employment agencies are also included in the definition of human competence. If consultant service is bought it is more likely that it belong to the definition of structural capital, i.e. used by the firm but not owned by the firm. The line between consultants and different temporary contractors is not equally clear in Sweden today as a few years back. There are temporary contractors and consultants that own their firms but with no other employees and they sell their work by hours or weeks. There are also private employment agencies that "sell" employees by hours or weeks but only if there is a buyer, otherwise the employee can be unemployed. These employees even work from a distance as traditional consultants. Many of these private agencies in Sweden have become large organisations that also can hire their own temporary contractors for their own work within the agency. A high percentage of temporary workers and the use of private employment agencies indicate the use of management practices including both pre-planning and higher need of a short term adjustment of the workforce.

The dimension concerning structural competence capital can also be divided into capital within the organisation that is owned by the organisation and the capital owned by others but available for the organisation to use, for example by collaboration or by outsourcing. In both cases this capital is today often depending on the use of ICT. Structural capital inside the organisation includes documenting work practices as well as systems for follow up on quality and customer demands. Structural capital also includes teamwork and other working groups. These later measurements catch aspects concerning the fourth growth fact that discoveries or new ideas often are accidental side effects in activities with more people involved.

Practices denoting earlier used composite indicators

In the first studies based on Swedish Meadow data and performed in the frame of Statistics Sweden's growth project (Statistics Sweden, 2010c; 2011) four composite indicators are composed including all the practices that are assumed to describe learning and work organisation as well as the organisation of flexibility to meet changes in the economy.

In this study of bundles of practices all the practices from the previous composite indicators are included. The study is performed by a factor analysis to reveal any hidden patterns of how the firms are using the included practices. The practices are describing *individual learning* such as the employees' formal and informal learning at work. Other practices are describing s*tructural learning* and provide information on whether the firm is building structural capital through organised work improvements, and by measuring production quality and customer satisfaction. The third group of indicators are *decentralisation:* measurements of the distribution of responsibilities such as the planning of daily work and quality control, as well as horizontal integration in teams. *Numerical flexibility* is the fourth indicator; it is providing information about the firm's possibility to change the size of the workforce on short notice, also including the workforce flexibility within the firm in terms of task rotation and part time work. This latter indicator might also indicate the use of an external workforce for knowledge transformation, at least in combination with the indicators of learning.

The result from correlation matrixes, in the formers study, including all practices from the four composite indicators shows that if they are partly rearranged they can reveal the contemporary use of learning and work practices. The result of these correlation analyses are presented in one of the first analyses using the Swedish Meadow data (Statistics Sweden, 2011a, Chapter 3 *Table 8–12*).

Contemporary pattern of practices

The first management concept studied here is the explorative approach that includes all but one question in the four composite indicators. The excluded question is concerning information about the amount of hierarchical organisational levels in the firm Q26 *How many organisational levels are there in your firm, including the top-management and the lowest level, for example, production staff?* The reason to exclude this question is that the information is assumed to characterise the size of the firm and not a work practice as such. Of course other information could also be included to meet the need of information concerning the growth facts. But since the four composite indicators have been used in several analyses concerning growth and innovation etc. it will be of interest to study how these included practices are used in the Swedish business sector.

The factor analysis retained seven factors. Together they explain 54 percent of all variances; this is over the norm, but not much more. On the other hand the measurement of the adequacy of the model MSA = 0.71 is high. Principal Component Analysis, PCA, is used with a rotation method to make the result clearer: Varimax. The method to reduce complexity of the data into fewer new components extracts the maximum total variance from all the variables to calculate the first factor, when calculating the second factor it extracts the remaining variances, and so forth with the third and fourth etc. until all variances are explained. For deeper mathematics see references (for example Garson D.G, 2010; or Darlington R.B; or SAS, 2010).

An alternative factor analysis model and rotation method has been tested: Principal Factor Analysis (PFA). This later model searches for joint variations in unobserved latent variables. It estimates how much of the variability is due to the common variance of the variables, called "communality", excluding unique variable-specific variance. The PFA model uses oblige rotation methods. The second model also results in seven factors, and these factors are identical with the result in the first PCA model.

The result of the PCA factor analysis in table 1 can be interpreted as that it supports the earlier composite indicators even thought it divides the measurements into seven bundles of practices. All variables are indexed and coloured after the original composite indicator presented in earlier analyses by Statistics Sweden.

Table 1
Seven bundles of practices

Variable label	1 Team & docu-menting Work practices	2 Customer & Quality focus	3 Flexible work contracts	4 Indivi-dual learning	5 Decentra-lisation & Flex-time	6 Business intelli-gence	7 ROT & Multi task
Percentage employees in improvements groups (TIS 44 M) STRU	0,71	-0,05	0,02	0,11	-0,07	0,03	-0,01
Documenting work practices (DU 57 M) STRU	0,51	0,33	0,18	0,11	0,01	0,10	0,08
Percentage employees in team with jointly decisions (DWT 40 M) DEC	0,50	-0,17	0,00	0,34	0,22	-0,02	-0,03
Frequency of team briefing meetings (FTM 104 M) STRU	0,48	0,09	-0,16	0,04	0,22	-0,37	0,34
Percentage flex-time (FW 48 M) DEC	0,47	0,30	-0,06	-0,14	0,42	0,14	-0,11
Measure customer satisfaction (CS 61 M) STRU	0,00	0,73	0,15	0,18	0,00	0,04	-0,03
Percentage of the employees with part-time? (PT 12) NUM	-0,21	0,53	0,08	-0,23	0,13	-0,39	-0,09
Follow up the quality in production (EPS 53 M) STRU	0,02	0,52	-0,05	0,22	-0,12	-0,05	0,40
Performance evaluation interviews (ET 94 M) STRU	0,32	0,52	0,06	0,02	-0,02	0,27	-0,02
Percentage of all employees from an employment agency? (RC 14) NUM	0,16	0,04	0,73	-0,18	0,00	0,02	-0,06
Percentage employees with temporary contract? (TW 11) NUM	-0,03	0,13	0,67	0,06	-0,15	-0,17	0,03
Percentage employees in training no salary (UPE100 M) IND	-0,07	0,04	0,62	0,22	0,14	0,11	0,14
Percentage employees on-the-job training (FB 102 M) IND	0,15	0,02	-0,03	0,73	0,02	-0,18	0,11
Organised competence dev, in normal every-day (DL 96 M) IND	0,07	0,21	0,09	0,59	0,11	0,28	-0,06
Percentage employees with paid training (PE 99 M) IND	0,32	0,22	0,10	0,40	-0,07	-0,05	-0,30
Decentralised quality control (QDE 34 M) DEC	-0,15	-0,09	0,09	0,23	0,77	0,06	0,14
Decentralised planning (TD 32 M) DEC	0,24	0,02	-0,10	-0,07	0,65	-0,08	-0,25
Monitoring ideas outside the firm (FEI 59 M) STRU	0,03	0,07	-0,06	-0,04	0,04	0,77	0,12
Training for rotating tasks (ROT 51 M) NUM	0,04	0,00	0,12	-0,03	-0,07	0,12	0,79
Variance Explained by Each Factor	*1,86*	*1,72*	*1,52*	*1,48*	*1,38*	*1,16*	*1,16*

Kaiser's Measure of Sampling Adequacy MSA = 0.71, and 54 percent of all variances are explained by the 7 factors. Generated by SAS. Rotation Method: Varimax. Variable label: The questions are numbered according to the Swedish questionnaire.

Results

The result of the factor analysis in table 1 indicates that the firm uses the 19 practices in seven bundles. The pattern is fairly clear with a clear result in seven factors. There are some double loadings, i.e. the coefficient value is high in more than one factor, but still the values between these double loadings differ so much that they indicate how the practices are mainly used. The high values are marked in colours and in some rows two values are marked, indicating double loadings.

Factor 1

The first factor is mainly comprised by firms building structural capital based on practices directly related to the organisation and documentation of work practices such as teamwork, improvement groups and documentation of good work practices. It also provides some information about horizontal integration in teams, which also can indicate the complexity of the organisation. The factor also includes information indication the employee’s possibilities to organise their own work.

In a forthcoming step in this study these practices are jointly included in a management index that will be tested if it contributes to explain productivity growth. The factor will be used as an indicator of whether the firm is organising to seize and endure discoveries and new ideas, even if these are accidental side effects in other activities, and it indicates if the work is organised so that more people are involved, and also if the discoveries and new ideas can be controlled by the firm.

Factor 2

Firms building structural capital based on practices with focus on customer satisfaction, follow up quality and performance evaluation interviews, is captured in the second factor. The measurements indicate if the firm aims to capture and meet the customer’s ideas and need of new discoveries. This factor will also be used as an indicator for productivity growth in a forthcoming step in this study.

Factor 3

Practices aiming to meet the firm’s need of flexibility concerning the number of employees is captured in the measurements, the percentage of all employees in the firm that are from an employment agency and percentage of others with temporary contracts or part time work. Firms using a higher percentage of these practices seem to use all three kinds of work contract practices. In addition, this factor might also indicate the use of an external workforce for knowledge transformation, at least in combination with the other indicators of learning and the employee's level of education. The factor will be included in the productivity growth model to see if it will endure new ideas and discoveries or not.

Higher frequency of temporary workers seems to be more closely related to training on non paid time. This can be interpreted as that firm with many temporary contractors does not to the same extent as other firms pay for the employees' training. The factor reveals firms that do not take full responsibility of the employees' training (see also Aronsson, 2004; Härenstam and the MOA Research Group, 2005). It can also be interpreted that non-paid training is a way to stay employed even if not paid. It might also be influenced by the fact that the Swedish legislation supports time off from work for training if it is planned in advance, but the employee cannot be expected to be paid at the same time (FINLEX, 2010). Other explainations might also be of importance, see further on in table 3 and related comments.

Factor 4
The factor is constituted by firms that include daily learning and on-the-job training and they are characterised by a high percentage of employees taking part in education and training on paid time. It is logical that if the daily work includes training a higher percentage of the employees take part in training. All learning practices in work except for training on non paid time are used as one common strategy. The factor is measuring human capital investments in the firm.

Factor 5
This factor gives information about the distribution of responsibilities concerning the planning of daily work and quality control. Decentralised authority in quality control and planning of one's own daily work are practices that are held together as one common strategy in the firms. The factor is measuring the distribution of authority between the management and the employees to use the employees' own human capital but also to plan and use structural capital in the firm.

Factor 6

This factor indicates the firm's awareness of knowledge outside the firm, and if it is monitored and used in the development of product etc. in the firm. This practice is it not intertwined with any of the other practices even though it can be assumed to be highly relevant for other practices in for example the building of structural capital. One reason can be that monitoring of activities outside the firm is assumed to require more developed activities than monitoring within the firm. The factor is measuring the use of structural capital outside the firm, and it is also an indication the firm's awareness of its importance.

Factor 7

The indicator of training for rotating task comprises a sole indicator 7. It gives information about workforce flexibility within the firm in terms of task rotation and part time work. The factor is measuring the organisation and flexibility of human capital in the firm.

Summary

In general the Swedish business sector uses the included management practices in seven different bundles; the firms do not use the practices as solely activities one by one. It is also indicated that these bundles of practices are almost to an equally high or low degree combined with each other. There is some double loading indicating that a certain practice contributes with information to more than one factor. There are some indications that the practices in the first bundle are used more flexibly than the rest of the practices: see factor 1, here summarised as a combination of team practices and documenting of work practices. This is the interpretation that the practices comprising factor 1 have some double loadings. Still the loading in the first factor is higher than in the second factor. Factor 2 and 4 also has one double loading each, but still with higher first than second values.

The loadings with minus, indicating negative loadings between variables and factors are few, which also indicate that the factors rarely exclude each other. Negative double loading can be interpreted as such that there is an indication of negative correlations between the factors. There are few such indications: for factor 1 (team briefing meetings) and factor 6; and factor 2 (part-time employees) and factor 6; and factor 4 (paid training) and factor 7.

The conclusion is that the absence of strong double loadings and absence of strong negative loadings indicate that all the bundles are used together in flexible mixes.

The development of management theory

The result in seven bundles with only a few weak negative double loadings can indicate that the practices are inter-related and internally consistent. It can be interpreted as that different management practices belonging to different management models exist at the same time in the business sector and sometimes even in the same firm, the later more likely if the firm is larger. This perspective on management can be compared with sediments of rocks created by erosion and changed into something else than it was from the beginning. It is a perspective argued to exist even in management (Shah and Ward, 2003). At the same time this approach it is argued not to be nearly so much studied and taken into account as the perspective of one single and dominant management approach at the time (Engwall, 2001).

Still, the definition of management strategies differs over time. During the 1960s and 70s management concepts were seen as intentional strategies and optimum could be reached by planning (Ansoffs, 1965). About two decades later the strategies were more related to value creation, coordination and cooperation (Porter, 1980; 1985). Total Quality Management, TQM, summarised by many researchers as the integration of several functions and processes within an organisation to achieve continuous improvement of the quality of goods and services (Ross, 1994). Atkinson developed theories concerning the flexible firm. The work force is divided into the core work force and combined with methods aiming towards functional flexibility in the firm, including work rotation. The second is the work force handling peripheral work the methods used is different kinds of short time work contracts, called numerical flexibility, and often in relation with financial flexibility, especially wage flexibility (Atkinson, 1985). During the 1990s the concept of core competence and access to competence, and not only ownership to competence, was further developed (Hamel and Prahalad, 1994). Some more recent approaches are: Business Process Re-engineering, also called process innovation, since it aims to redesign business processes with help of information technology (Davenport, 1993). Another is: Lean production focusing on efficiency in value chain processes based on customer focus (Womack and Jones, 2003). There is a growing interest on the combination of old existing models that are mixed with newly implemented practices. New practices can overlay old ones, some can be assumed to be substituted and others survived forming sediments of management practices in an organisation, argued already in the 1980s by Danielsson (1983).

Total quality management

The seven bundles of practices presented above can be including several of the presented management actions and procedures. It might be of interest to compare them with all of them but here there is only room for one comparison. The choice has fallen on Total Quality Management, TQM. There are several argument for the choice, one is that is an concept that is argued to integrate several functions and processes within an organisation (Pil & MacDuffie 1996) and that it is aiming to achieve continuous improvement of *quality* of goods and services (Ross, 1994).

The overall goal in TQM is to achieve greater organisational effectiveness, and lower cost and higher profitability, using several practices such as cross- and *inter functional problem solving teams*. The concept is based on the assumption that *employees* who are routinely performing the processes know best how to improve them. Therefore, the employees should be equipped and qualified with the necessary skills by training and education. All quality improvement shall be initiated by the *top management* (CEO), to create priority to the improvements and persistence in changes. More than a decade has passed since the core assumptions were first set forth by W. Edwards Deming et. al. (1982; 1986) It is argued to be spread in different businesses and sectors, in the US from industrial origins to health care, public agencies, non-profit organisations and education. It is derived and promoted by the US nation's public-private partnership award, dedicated to performance excellence[14]. Comparison between awarded performances in the US and practices used in Sweden are indeed of interest (Bloom and Van Reenen, 2007).

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[14] The Baldrige Program and the Malcolm Baldridge National Quality Award Consortium.

TQM is measured according to six principles in the US (Hackman and Wageman, 1995).

i. Problem solving teams

ii. Investment in training

iii. CEO's responsibility for changes throughout the organisation

iv. Supplier relation

v. Customer preferences

vi. Bench marking

The Swedish measurements of the principles are defined according to these six principles. First the homogeneity of the principles is analysed. Four out of six principles are analysed with the help of factor analysis. The remaining principles include too few variables for factor analysis. These two principles are iii and vi. Still, these two principles are included in the measurement of TQM that is included in the forthcoming analyse of productivity, see table 7 and related comments.

The Swedish measurements of TQM include data from three different surveys: the Swedish Meadow Survey, and the CIS Survey, and the ICT-use in firms. Each if these surveys has its own specific objective and construction of questions as well as choice of respondents. It might be argued that this circumstance can impact on the analyses[15]. At the same time the TQM concept is not in focus in any of the guidelines of the used data. This can contribute to a more objective presentation of used practices and at the same time it can make it more problematic to create the relevant measurements. When necessary, the match between the US and Swedish measurements are commented in relation to each principle. For further discussions according the Swedish measurements of TQM see Nylund; Hagén; Härenstam; Kaulio, 2011/12.

TQM is presented and studied with help of factor analysis.

[15] The circumstance relates to the discussion of self-reporting surveys and empirical evidence of correlations between variables i.e. common method variance (CMV). On the other hand a number of sources suggests that such problems are overstated. Instead it is suggested that the measurement bias, the product of the interplay of constructs and methods by which they are assessed should be in focus.

i. Problem solving teams

Problem solving team is a central principle in TQM that goes back to the basic assumption.

The measurement of cross-functional quality teams and task forces are described as the most common features of the organisations implementing TQM in US. The US measurements concerning the first principle are capturing the use of teams. About 90 percent of the US firms that are defined to have implemented TQM use teams as a way to solve problems. Less attention is given to the design of the work of front-line producers and the motivational structure of front-line jobs, it is argued to be unaltered in many cases. According to Graham (1993) there is in many organisations a chasm between front-line workers' involvement and their actual decision-making authority.

The measurement of teams in firms in the Swedish business sector are matched with four questions asking about the team or work groups, and three questions about employees' authority. The first four questions are: if the employees regularly up-date databases of good work practices (DU_57). This question indicates that the collecting of information is operationalised; otherwise it would be difficult to document the activities. This applies to the TQM approach called steering by facts. The second question is the percentage of employees in improvement groups (TIS_44); the third if teams are used where the employees jointly can decide how the work shall be done (DWT_40), and finally the frequency of meeting between managers and employees, including team briefings (FTM_104).

The three questions concerning the authority of employees are: if the authority is decentralised to individuals or teams concerning planning of the daily work (TD_32) and responsibility of daily quality control (QDE_34). A third question providing information about if the percentage of employees can adjust when to start and end the daily work i.e. flex-time (FW_48) is also included. This latter question is according to table 1 highly related to teamwork and decentralised responsibilities and therefore included. These questions concern authority as such and not specifically the authority concerning problem solving or front-line workers. This is true, even though the tasks, daily planning and quality control are argued to be important aspects of problem solving and improvement.

Table 2
Problem solving teams

Variables in TQM principle i	Factor 1	Factor 2
Employees regularly up-date databases that document good work practices or lessons learned (DU 57 M)	0,68	-0,19
Percentage employees in groups who meet regularly about improvements within the firm (TIS 44 M)	0,68	-0,03
Percentage employees working in a team, where the members jointly decide how work is done (DWT 40 M)	0,60	0,22
Frequency of meetings (briefing groups and team briefing) between responsible line managers/supervisors and employees (FTM 104 M)	0,46	0,26
Percentage of non-managerial employees that can choose when to begin or finish their daily work; flex-time (FW 48 M)	0,46	0,38
Do employees or managers decide on the planning of the daily work tasks of the non-managerial employees? (TD 32 M)	0,14	0,75
Are employee responsible for daily quality control (QDE 34 M)	-0,06	0,70
Rotated: Variance Explained by each factor (eigenvalue)	*1,73*	*1,37*
Cumulative percent of all variances explained	*0,28*	*0,44*

Kaiser's Measure of Sampling Adequacy MSA = 0.68. Generated by SAS. Rotation Method: Varimax. Variable label: The questions are numbered according to the Swedish questionnaire (M = Meadow).

Results

The result in table 2 is based on a common multi-variable factor analysis aiming to show if data reflects the principle. The result in table 1 shows two factors. Together these two factors explain 44 percent of all variances of the included variables, it is under the norm (50 percent), but the measurement of the adequacy of the model MSA = 0.68 is still rather high. The values are the correlation coefficients showing how much each variable contribute to a factor. If the value is close to or over 0.5 it is high correlated, and if it is below 0.3 it is low correlated.

The result indicates that the firms use team and authority as two separated strategies. Team is explained in factor 1 and the employee's authority is explained by factor 2.

The three first variables are highly correlated, and therefore it is indicated that these practices are often combined. The fourth variable, team briefing, has a lower value which can be explained by that it is also contributing to more than one factor. Factor 1 is measuring strategies concerning documentation of work practices and improvements groups, based on team work. The second, factor is focusing on authority of the employees to fulfil work tasks. It is measured as the decentralisation of daily planning and the responsibility of quality control, together with the employee's possibility to adjust when to start and finish their work during the day (flex-time). The two variables measuring decentralisation are highly correlated, which indicate that they are often combined.

It would have been a beautiful result if all the included variables would have constituted one homogenous factor that would have matched both the US measurement of team and the assumption about authority. But only two of the variables are explained by both factors and indicate that they are included in both strategies. These two are a measurement of the frequency of meeting between employees and managers (FTM_104) and of employees' flexible work time (FW_48). Their values indicate that they are mostly combined with the first factor. Since the measurements are not negatively correlated, it is indicated that the firms equally often use the two strategies together as separated.

The result seems logical and the variables are not divided into many several single factors. This TQM principle will be relevant when it comes to provide information about the growth facts that are not otherwise included in growth models. The practices in the principle can be argued to match both the second growth fact about discoveries and new ideas as such, and the fourth fact that predicts that these discoveries or new ideas often are accidental side effects in activities. It can also be argued to provide information about when more than a few employees are involved in an activity. It also provides information concerning the fifth fact that discoveries and new ideas are controlled by both people and firms, at least for a period of time, since it measures structure capital that is handled by employees i.e. human capital.

ii. Investment in training

The second principle is investment in training. Continuous improvement of quality is assumed to be supported by a thorough-going learning orientation, including substantial investments in training and other interpersonal techniques designed to promote individual and team learning. Investment in formal training is almost equally high as the use of teams in US firms (Conference Board, 1991). Interpersonal skills, training in quality-improvement and problem-solving, and team leading and training as well as other methods for problem-solving in US firms are also measured (Olian and Rynes, 1991). Arguments towards TQM say that there is a constraint on what is to be learned, who is to do the learning, and when learning should be set aside in favour of performing as well as once something has been discovered that improves work practices expected to be followed, according to Hackman and Wageman.

The measurements in firms in Sweden match both formal and informal learning. See table 3; percentage of employees' on-the-job training (FB_102); and with paid time-off for training (PE_99); and organised competence development in every-day work (DL_96); training for rotation of tasks (ROT_51); and employees' in non paid time-off training (UPE_100).

Table 3
Investment in training

Variables in TQM principle ii	Factor 1	Factor 2
Percentage employees received instructions or education while performing ordinary daily tasks (on-the-job-training FB 102 M)	0,73	-0,01
Percentage employees with paid time-off to undertake education/training (PE 99 M)	0,65	0,00
Organised competence development in normal day (DL 96 M)	0,64	0,18
Employees trained to rotate tasks (ROT 51 M)	-0,11	0,82
Percentage employees participated in education/training with no salary (UPE 100 M)	0,22	0,63
Rotated: Variance Explained by each factor (eigenvalue)	*1,42*	*1,11*
Cumulative percent of all variances explained	*0,30*	*0,51*

Kaiser's Measure of Sampling Adequacy MSA = 0.59. Generated by SAS. Rotation Method: Varimax. Variable label: The questions are numbered according to the Swedish questionnaire (M = Meadow).

Results

Table 3 reveals two factors indicating two parallel strategies of learning practices. Factor 1 is constituted by if the work includes organised learning in the daily job and a high percentage of employees that take part in it. It also includes high frequency of formal learning among employees. Factor 2 is based on strategies such as learning for multi-tasking and learning on non-paid spare time. These results indicate that it is the same firms that do not take responsibility for all employees' training that train employees to rotate among different tasks. When it comes to training to rotate tasks, it also occurs more often in larger firms than in smaller ones, maybe because of a greater need to organise training in larger than in smaller firms. The practices in factor 2 are more commonly used in larger firms, according to published results based on Meadow data (Statistics Sweden, 2011b, Chapter 9 *Table 9.4*). Results from that study also indicate that there also seems to be a relationship between un-paid training and larger firms and the percentage of employees with temporary contracts. There are several studies covering this subject (for example: Aronsson G., 2005; Härenstam A et al., 2005; Michael Quinlan M. Quinlan M, C. Mayhew and P. Bohle, 2001). Since the practices in factor two are known to be related to larger firms it can be an indication that larger firms go beyond smaller ones in investments in learning; they also include other form of learning practices.

The result implies that the firms use these practices as two different strategies, equally often together as separated. The learning practices in factor 1 are measuring human capital investments in the firm. Investment in multi-tasking in factor two is also investment in competence in the firm, and it can be argued to be an intertwined investment in both human and structure capital. This is because it aims to increase the flexibility in the work force as such but in practice it is an investment in actual training for employees.

iii. CEO's responsibilities throughout the organisation

Hackman and Wageman argue that consistent with basic theory, it is the management's job to create the systems within which employees do their work. Keeping authority centralised reduces the risk that chaos will develop as various teams and task forces simultaneously come up with potentially incompatible work processes. A clear, top-down chain of command makes it easier to secure the cooperation of middle managers when the concept itself is implemented, since they need not worry about their own authority being eroded. Senior managers make the initial decision and then manage changes throughout the organisation with help of middle managers. They also decide which of the ideas generated by teams or others will actually be adopted. According to the principle, improvements shall start at the top and then be carried throughout the organisation by each level of manager (Conference Board, 1991). In the referred article it is also critically argued that the distribution of authority in organisations does not change much when TQM is implemented.

The measurements in firms in the Swedish business sector are restricted to two questions from the Meadow Survey. The first is *How many separate departments or divisions reports directly to the head of the firm?* (BOSS_RAPP_31), and the second is *The percentage of employees that has a development or performance evaluation interview* *(talk) at least once a year*? (ET_94). The latter question is aiming to provide information about how changes are carried out in the organisation. It can be argued that the measurement might be complemented with the questions about decentralisation, see also table 2, since it indicates the distribution of authority in general between management and employees, and not the top management exclusively. This is also the argument for why it is not included in the principle of the top management, specifically.

Since the measurement consists of two variables, a traditional correlation analysis is used to study the relationship between them. The correlation is highly significant and the coefficient is 0.21. There is a correlation between them, but since the coefficient value is not so high the two practices still provide information about two different aspects concerning the management's role. This TQM principle might be relevant when it comes to providing information about the fifth fact concerning discoveries and new ideas and that they can be controlled by firm, or at least that the management tries to control it.

iv. Supplier relation

Continuous improvement of quality is argued to extend even beyond the organisation's boundaries in the model, as teaching quality practices to suppliers. The principle is concerning the measurements of the firm's relationships with suppliers, which aim to increase the supplier's quality (Sashkin, Kiser, 1993). It is often restricted to measure changes in the quality of the components parts from the suppliers (Lawler, Mohrman, Ledford, 1992). These learning activities occur in about half of the firms that implemented TQM in US.

In the Swedish business sector this principle can be measured with the help from different surveys, see table 4. The first three questions are from the innovation survey, CIS. They concern cooperation or other kind of relationships with other organisations concerning R&D. It is measured as expenditure on acquisition of external R&D from other organisations. The first variable is machinery and equipment for R&D (E11c). The second is external knowledge for R&D (E11d), and the third is general purchase of R&D (E11b).

The second part of measuring the principle includes cooperation or other kinds of relationships with suppliers. Here the focus is on if the firm electronically share information or not with suppliers with the help of ICT (D_siSuipde/f_18a and 18b). Both the information of supplier information itself and the use of ICT are in focus. Hard technologies are not directly expressed in the TQM concept, but systematic collecting of information is a fundamental feature in the basic theory. ICT is an advanced tool for systematisation and therefore its use is assumed to be in line with the concept. The use of ICT also provides a rich flow of information within the company, enabling either a more decentralised or a more centralised organisation. In both cases an organisation with more information. (See Statistics Sweden 2011, Chapter 5 *ICT, Organisation Flexibility and Productivity*).

Finally, two types of more general information concerning cooperation and outsourcing are included. The measured activities are if the firm cooperates with others or not in production, procurement and design (COOP_73 production; 75 procurement; and 71 design), and if the firm is outsourcing the same activities (OUTSOURC_81; 83; 85).

Table 4
Supplier relation, increasing supplier quality

Variables in TQM principle iv	Factor 1	Factor 2	Factor 3	Factor 4
Expenditure for: acquisition of machinery, equipment and software (E11c_CIS)	0,90	0,03	0,02	0,02
Expenditure: external R&D in general (E11b_CIS)	0,76	0,12	0,00	0,06
Expenditure: and acquisition of external knowledge (E11d_CIS)	0,76	-0,04	0,06	-0,01
Regularly shares information electronically with suppliers about; inventory, production plans, demand forecast (D_siSupde 18a_ICT)	0,06	0,91	0,00	0,04
and about: progress of deliveries (D_siSuipf 18b_ICT)	0,04	0,91	0,03	0,03
Cooperation with others; in production of goods or services (PROD_COOP 73 M)	0,03	-0,03	0,76	0,09
and in procurement of parts, components, services (BUYMATERIAL_COOP 75 M)	-0,04	0,10	0,73	0,00
and in design or development of new products or services (DESIGNDEV_COOP 71 M)	0,08	-0,04	0,66	0,16
Outsourcing; in design, development of new products or services (DESIGNDEV_OUTSOURC 81 M)	-0,08	-0,08	0,07	0,76
and production of goods or services (PROD_OUTSOURC 83 M)	0,05	0,05	0,09	0,73
and in procurement of parts, components, services (BUYMATERIAL_OUTSOURC 85 M)	0,08	0,08	0,08	0,58
Rotated: Variance Explained by each factor (eigenvalue)	*1,99*	*1,70*	*1,56*	*1,49*
Cumulative percent of all variances explained	*0,20*	*0,36*	*0,50*	*0,61*

Kaiser's Measure of Sampling Adequacy MSA = 0.58. Generated by SAS. Rotation Method: Varimax. Variable label: The questions are numbered according to the Swedish questionnaire (M = Meadow; CIS = Community Innovation Survey; ICT = Information Communication Survey).

Results

The result in table 4 is rather clear but not altogether expected even if it is not a total surprise. Nevertheless the results of the included variables comprise four factors. Several of the variables bundle themselves after how they are collected in different surveys. There are no double loadings and the coefficient values are high, partly very high.

The first factor 1 is comprised of three variables measuring the expenditure on acquisition of R&D. These variables are highly related to each other and they don't mingle with the other variables.

About half of the firms actually invest in innovations; it is also known that those who invest the most are the larger firms (Statistics Sweden 2011b, Chapter 9 *Table 9.3*). Factor 2 is comprised of the firms using ICT in sharing information with suppliers. Even if the variables in factors 1 and 2 are comprised after the source of information, it has to be remembered that their information is rather specific and therefore the results are still logical. The results indicate that firms that actually invest in R&D and use ICT to share information with suppliers do it regardless of other management strategies.

When it comes to cooperation and outsourcing in general, they are organised in two factors, 3 and 4 respectively. This result indicates that the firm does not use cooperation and outsourcing as one and the same strategy, because otherwise they would have been in the same factor. Still, these two strategies do not exclude each other, because if so they also have been negatively correlated in the same factor. The result indicates that firms equally often use both of the strategies as they use only one of them or in combination with the other factors 1 and 2, and still the result of this analysis seems logical. The innovation practices can be seen as discoveries or new ideas as such. The use of ICT as a way to both capture accidental side effects as well as control activities and people in the firm. Also the measurements of cooperation and outsourcing in the principle capture activities often involving many people and boosting new discoveries and ideas. Therefore the principle is argued to provide information to the growth facts that are not otherwise included in growth models.

v. Customer preferences

The continuous improvement of quality aims to meet customer requirements as a never-ending quest. In firms in the US the measurement of customer preferences are mainly based on complaint lines and market research and customer focus groups (Olian and Rynes, 1991).

The measurement in firms in the Swedish business sector includes the following kinds of variables. The first is measuring electronically shared information with customers (D_siCuipde/f_19b and 19a), this information is from the ICT survey. The second kind of information is if the firm follow up quality of products and processes (EPS_53) and if the firm measures customer satisfaction (CS_61), this information is from the Meadow Survey. The third kind of information is about if the firm reflects on changes in the value chain and related to new business practices (H16a) and the last question concerns if the firm has reduced time to respond to customers and suppliers (H17a). Both questions are from the innovation survey. The two latter questions do not divide the information between customer and supplier. Complementary analyses reveal that the other factors in the two models, in table 4 and 5, do not change regardless if these two specific questions are excluded or included (Nylund; Hagén; Härenstam; Kaulio, 2011/12)..

Table 5
Customer preferences

Variables in TQM principle v	Factor 1	Factor 2	Factor 3
Regularly shares information electronically with customers about; inventory, production plans, demand forecast (D_siCupde 19a_ICT)	0,91	0,02	0,02
and progress of deliveries (D_siCuipf 19bICT)	0,90	0,06	0,10
Reduce time to respond to customer or supplier (H17a CIS)	-0,03	0,80	-0,12
New business practice; supply chain/knowledge-/quality management, re-engineering, lean, etc (H16a CIS)	0,09	0,74	0,16
Follow up/evaluation of quality of production (EPS 53 M) processes or service delivery	0,01	0,03	0,77
Customer satisfaction; questionnaires, focus groups, analysis of complaints, other methods (CS 61 M)	0,09	0,01	0,71
Rotated: Variance Explained by each factor (eigenvalue)	*1,64*	*1,18*	*1,14*
Cumulative percent of all variances explained	*0,29*	*0,48*	*0,66*

Kaiser's Measure of Sampling Adequacy MSA = 0.53. Generated by SAS. Rotation Method: Varimax. Variable label: The questions are numbered according to the Swedish questionnaire (M = Meadow; CIS = Community Innovation Survey; ICT = Information Communication Survey).

Results

Three patterns of factors concerning customer preferences are revealed in table 5, their information is respectively rather specific and the result in three factors can therefore be logical. The variables comprise factors by how they are collected. The first factor is comprised of information from the ICT survey about electronically sharing information with customers. The second is comprised of the information from the CIS survey concerning new business practices (H16a) and reduced time to respond to customers and suppliers (H17a). New business strategies seem to be used in combination with reduced time to customer and supplier. The third factor is comprised by information about if the firm follow up products and processes (EPS_53) and if customer satisfaction is measured though questionnaires, focus groups, or other methods (CS_61).

The result indicates that the firms equally often use the three strategies together as separated. In the same way as argued above concerning ICT and customer focus, the principle can be argued to provide information to the growth facts. It complements the already disused measurement concerning ICT and adds a new perspective on capturing customer-related discoveries and new ideas about accidental or not accidental side effects and activities aiming towards building structural capital controlled by the firm.

vi. Benchmarking

Benchmarking, often of best practices, are not advocated by the founders but are associated with contemporary measurements of the management model. The principle is derived from the US Baldrige Quality Award criterion, see footnote 14**.** Still, the measurement of continuous improvement of quality extends to capture the best of other organisations' ideas and innovations. The final principle, benchmarking, is constituted by one single variable in the Swedish measurement, based on the question: *Does the firm monitor ideas or technological developments for new or improved products, processes or services outside the firm?* (FEI_59 from Meadow). In addition, see the result in table 1 where this variable constitutes a sole indicator. The last of the presented principles aims towards finding, capturing and controlling discoveries or new ideas outside the firm. It will provide highly relevant information that is not otherwise included in the growth model.

Summary

The analyses of the principles reveal that the TQM principles might still be a consistent model but its principles are not all together homogeneous. Some of the assumptions behind the principles might need to be adjusted. Still, one has to recall that it is more than a decade since the core assumptions first were set forth by W. Edwards Deming et. al. (1982; 1986) Most certainly time has had an impact on the contemporary status.

Prediction for productivity

Even though there is a broad understanding of the importance for the firms' use of human resource management strategies, there is surprisingly little measurement that focuses of the difference of theories and used practices (Huselid, 1997; Huselid and Becker, 1997).

Here the two management concepts will be studied according to productivity. Linear regression models are used to measure the strength of dependence between several independent variables and a dependent variable. The two different management concepts, the seven bundles and six TQM principles, are included in linear regressions models, respectively. The objective is to study their prediction on productivity, respectively. Value added per employee is the dependent variable measured as the labour productivity in each firm in 2008[16]. Together with all other features of the firm that are assumed to also have an impact on the value added the indexes are included as independent variables in two separated regression models. The other independent features are type of production, size of the firm, the employees education etc. The difference between the linear regression models are only the type of management model included.

The model is tested with the help of stepwise selection of independent variables. The first test is including the dependent variable (value added per all employees at the firm) and all the independent variables but not the two management indexes. The default p-value threshold for entry and for removal is 0.15. The model includes 9 different types of independent variables estimated for each firm. These are presented in table 6 as eight separated independent variables plus two measurements of industries: financial and all other industries. Six variables enters the final model in the test, two of them are industries. The test selection model without the management indexes only explain about R-Square (R^2) = 0.11 percent of all the variances. The full model without the management indexes explain about R-Square (R^2) = 0.14 percent of all the variances. The significance levels of each independent variable are presented below in table

[16] Data for year 2008 is used in this article in Yearbook of Productivity 2011. Data for year 2009 is available but problematic to use to describe a normal situation since it heavily reflects the financial crisis.

The p-values for each indicate the significance of the dependence in the model. High significance means that the correlation coefficient between the independent variables and economic output is significant at the 0.01 level (Pr >|t|), i.e. there is less than one percent chance that the result is a coincidence. Rather high significance means that the correlation is significant at the 0.05 level, and low significance level is when the correlation is significant at the 0.10 level, which means that there is less than a 10 percent chance that the result it is a coincidence. The regression model also provides information on if the included features, all of the non dependent variables, in the model suit the model.

Table 6
Regression model, without management indexes

Dependent variable:			
Value added per all employee at the firm year 2008		R-Square (R^2) = 0,14	
Independent variables:		**Significance level Pr > |t|**	
Gross fixed capital formation; SEK		< 0,0001	***
University educated (≥3years); versus all other educations, percentage		0,0002	***
Women employed, percentage	(neg coeff)	0,5610	#
Age 50+ employed; versus all other employees under 50 percentage		0,0351	**
Large firms; versus medium and small sized firms, dummy	(neg coeff)	0,2287	#
Foreign owned (if more than 50 percent of the voting value of the shares is held by shareholders abroad); versus Swedish owned, dummy		0,0341	**
Part of a group of firms; versus if not (not at all significant at 0,15 level), dummy		0,4035	#
Specialised vs. standardised products (not at all significant at 0,15 level), dummy		0,5867	#
Financial service NACE 66 compared with Financial service NACE 64 and 65, dummy	(neg coeff)	0,6746	#
All other industries compared with Financial service NACE 64 and 65, dummy	(neg coeff)	0,0346** to < 0,0001***	

Generated by SAS. Value added per all employees at the firm and Gross fixed capital formation is based on firm economic data; University educated and Women employed as well as the Age of the employees are based on individual register data the LISA-database, as well as the information of Firm size. Part of a group of firms is based on data from *The Swedish Agency for Growth Policy Analysis and* Statistics Sweden; Specialised vs. standardised products are from the Swedish Meadow survey; and the dummy for industries are based on Swedish Business Register FDB.

Results

It is not a surprise that firms with a larger amount of gross fixed capital and that is foreign owned predict higher productivity. Both features are traditionally good predictors for higher productivity. It is also known that a higher percentage of university educated employees also predict higher productivity. Different industries, identified by different NACE codes, also predict different productivity. Here all industries are compared with financial industries that in general have high productivity and therefore all comparisons are significantly negative-correlated. This is the case even in 2008, which had a dramatic drop in production levels during the last part of the year because of the financial crisis. Compared to the above features it is probably rather new information that a higher percentage of the employees who are over age 50 also predict higher productivity.

Altogether, firms with high values of the features marked with stars (*) are much more likely to predict higher productivity than firms with low values in these features. Firms with different values of the features marked with fences (#) are measured not to differently predict productivity.

In the next step the management indexes called "seven bundles of practices" and the index called TQM principles are included in the model, respectively. The value of each management concept is estimated as an index based on the values of its included variables.

The index of bundles is estimated as follows: All practices in the result in previous table 1 are summarised according to the result, i.e. the factors/bundles. For instance, the result of factor 4 "individual learning" is summarised in the following way: All practices comprising the bundle are summarised and divided according to the number of practices in the factor, there are three. The division is a way to standardise the use of different amount of practices in each factor in the index. All the values of the practices are summarised the same way for all the factors. Then, all the factors are multiplied with each other into a product = an index of bundles. The index is a product of all the values of each type of practices in the bundles. Each firm has a value of the multi-index; a higher index is compared to a lower index in the linear regressions model. This means that the difference of total values of the indicator between a firm that has a low value on one of the groups of practices compared to a firm that has a high value of the same group of practices will be greater with this model than compared to an additive model. A multiplicative index measures multiplication effects better than an additive model.

The variables in the TQM-model are summarised within each principle in the same way as the example above. All practices in the principles are summarised and divided according to the number of practices in the principles, and the principles are multiplied with each other. Each firm has a value of the index; a higher index is compared to a lower in the regressions model.

The results from the different linear models are presented in the same table, together with the other independent variables.

Table 7
Regression model, with management indexes

Dependent variable:	No index incl.	Bundles	TQM	TQM & WorkContr
Value added per all employee at the firm year 2008	R-Square (R^2) = 0,14	R-Square (R^2) = 0,30	R-Square (R^2) = 0,12	R-Square (R^2) = 0,14
Independent variables:	**Sign. level**	**Sign. level**	**Sign. level**	**Sign. level**
Management concept high compared to low values 2009/2010; percentage	—	**	**	*
Temporary workers 2008; percentage	—	In index	—	*
Gross fixed capital formation 2008; SEK	***	***	***	#
University educated ≥(3years) 2008; versus all other educations, percentage	***	**	***	***
Percentage women, 2008 (neg coeff)	#	***	#	**
Age 50+ employed 2008; versus age of all other employees, percentage	**	#	*	#
Large firms 2008; versus medium and small sized firms (neg coeff)	#	***	#	#
Foreign owned (>50 percent voting value abroad) 2008; versus Swedish	**	***	#	***
Part of a group of firms 2008; versus not	#	#	#	#
Specialised vs. standardised products (M)	#	#	#	#
Industries compared with Financial service NACE 64 and 65 *FDB* (neg coeff)	16 ind *** 1 ind ** 1 ind not sign #	2 ind *** 9 ** 1 ind * 6 ind not sign #	6 ind *** 9 ** 1 ind * 2 ind not sign #	1 ind * 17 ind not sign #
Industry NACE 66 (also incl. In above ind.)	*** neg	** pos	# neg	# neg

Generated by SAS. Value added per employee and Gross fixed capital formation is based on firm economic data 2008; University educated and Women percentage and the Age of the employees and Firm size are based on the LISA-database 2008. Foreign owned firms are based on data from *The Swedish Agency for Growth Policy Analysis and* Statistics Sweden; Specialised vs. standardised are from the Swedish Meadow survey. Industry dummies are based on Swedish Business Register FDB. Part of a group of firms is based on the ICT-survey.

Results

Comparison between the four regression models shows that the overall model of independent variables and their contribution to predict productivity is fairly stable. This is true even for the percentage of university educated employees. From other studies it is known that education is highly correlated with different management practices. This is also the case for the size of the firm. In the referred earlier studies ownership cannot predict any differences according to management practices, measured as four different composite indicators (Statistics Sweden, 2011a, Chapter 3 Figure 3.19). Here in this study, table 7, foreign ownership is positively and significantly estimated to predict productivity.

Both management indexes, Bundles (0.0170**) and TQM (0.0252**), are significantly predicting higher value added per employee. The first index at a slightly higher significance level but still at the same range of significance level as the second index: 0.05. In both cases it means that there is less than a five percent (two percent) chance that this result is a coincidence. The first index of Bundles gives a rather high degree of explanation R-Square (R^2) = 30, compared to other analyses in social science. The TQM concept provides a low degree of explanation (R^2) = 0.12, and it is even lower than the basic model without the index.

The differences between the indexes are the kinds of management practices they include. The first index of Bundles only includes one type of variable that is not included in the TQM-index. Because of this it is easy to test the importance of this particular practice – temporary contractors. Therefore an altered regression model for TQM is performed that is also controlling for temporary contractors as a sole feature since this practice is not included in the original assumption of TQM. The temporary contractors are significantly contributing to productivity within the 10 percent significance level, and the degree of explanation in the model increases a little; (R^2) = 0.14.

The TQM model includes more variables then the first concept of Bundles. These extra variables that are included in TQM are: Cooperation with others, and the use of ICT, and acquisition of external R&D, and an indication of the extent of the top-management responsibilities. These variables should increase the richness of the model; still this does not seem to be the case. The

TQM-model still does not explain the variances in value added per employee better.

The result of the different models indicate that temporary contractors as a sole indicator is not equally valuable for the firm as if it is included in a strategy with other practices, such as in seven bundles where it is used in parallel with the other practices (multiplied with the other practices).

A similar result as the Bundle represents is presented in earlier analyses based on the same practices but differently measured (Statistics Sweden, 2011d, Chapter 4 *Table 4.2 – OLS regression on MFP and the four composite indicators*). In the article the four composite indicators, as an additive index, are tested if it predicts innovation; the result indicates that it predicts innovation input but not innovation output Chapter 4 Table 4.8 and 4.9, respectively. This is interpreted as that since the additive index of the four work indicators positively influence the innovation input and do not influence at all in the further innovation steps, the initial influence will still contribute to output, i.e. productivity (Statistics Sweden, 2011e). For more nuances, definitions and results see the article.

The result and conclusion of the importance of temporary contractors can be compared with a study of long-term firm development including measurements of the four composite indicators based on a study performed in 1998 collecting data from the Swedish business sector – called flex 2 (The Swedish Growth Policy Studies, ITPS, 2001). One of the four indicators is numerical flexibility. It is including rotation of employees between tasks in the firm, if is used or not, the percentage of part-time workers, the percentage of employees with temporary contracts and the percentage of recruited employees in firms in 1998. The included variables comprising numerical flexibility differ slightly from the definition used in the four composite indicators and used in the regression model above in this study. The difference with the measurement used in this new paper is that the flex 2 indicator also includes rotation between tasks and the percentage of recruited employees.

The result of estimation of firms using numerical flexibility based on data from 1998 and value added data per employee from 1998 to 2008 is that the value added per employee is negatively correlated. The lower the value of the indicator numerical flexibility the higher is the value added per employee and vice versa in the firm. The measurement persists over time. It is the opposite with the indicators measuring decentralisation and learning, the higher the values of the indicator the higher the values of value added per employee (Statistics Sweden, 2011f, Chapter 8 *Figure 8.2*). The referred study is not measuring an index based on the combination of practices such as in this new study. Still, the former result is an indication that over a long period of time numerical flexibility at least as a sole practice is an indication of low and not high productivity.

The somewhat contradicting result could perhaps partly be explained by the very special situation in 2008 and to the difference in constructing the composite indicator versus the measurement of used temporary contractors.

Final reflections

This study aim to contribute in filling in some of the gaps of lack of measurement and theory concerning what is happening within the firm black box, or it will at least hopefully brightening up what is happening inside the firm and its importance.

Both the seven bundles and the TQM principles are argued to indicate information that is included in Romer's definition of the growth facts, but not otherwise included in growth models. Both the models are providing information concerning the second growth fact called discoveries or new ideas, and the fourth fact that predict that these discoveries or new ideas often are accidental side effects in activities with more people involved. The fifth fact is that these discoveries or new ideas are controlled by people and firms.

It is argued that the study contributes new aspects concerning the use of work and learning practice in the Swedish business sector as well as some understanding concerning the use of the practices versus theory. The conclusion is that in general firms in the Swedish business sector do not use the included practices as sole activities one by one – the practices are used in parallel bundles. The second conclusion is that the different bundles do not exclude each other, they are used in parallel.

The result concerning TQM deepens the information about the bundles of practices. Most of the practices seem to be used in general by all firms, and on top of this there seems to be some learning practices that mostly are used in larger firms. The analyses of TQM also reveal that the background assumptions concerning team and learning are still valid but the principles are not altogether homogeneous. Almost all of the principles included in factor analyses are divided into two, three or four factors per principle. Some of these factors are rather similar to the measurement of the seven bundles while others go beyond and create new patterns.

Both concepts, the Bundles and the TQM, are proven to predict productivity, in the Swedish business sector in 2008. The significance level of the result for TQM is almost as high as for the contemporary bundles. Both management approaches provide information about endogenous activities in the economy assumed to create growth. Both productivity analyses indicate that it matters if a firm uses one or two or several different learning and work practices in combination in the firm. But TQM cannot to the same degree explain the variances between the firms. Still, one has to remember that TQM is older than a decade. The TQM model does not include flexible work contracts but instead different strategies of cooperation and ICT Still, this two features cannot compensate for flexible work contracts, at least in the year 2008.

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Estimating R&D expenditures for small enterprises from subsidy data in the Netherlands

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Abstract

This paper presents a possible methodology for estimating R&D labour cost for micro-enterprises from R&D tax credit data. Linking information on R&D labour cost from the WBSO regulation in the Netherlands to R&D labour cost obtained from the R&D survey carried out by Statistics Netherlands, there is a strong statistical relationship between the two measures for each size class. Next, we use this relation for each size class to make a prediction for R&D labour cost in the size class below, based on the S&O data for the lower size class. This approach is found to lead to an underestimation of the corresponding aggregates by size class. However, since the underestimation is of approximately the same order for each size class, the reciprocal of the relative error can be used as a raising factor to scale up predicted aggregates. Using a lower and upper bound of such a raising factor, we showed that this strategy gives predictions that differ from the actual aggregates by about 7%.

1 Introduction

Despite the fact that new indicators are now seeing daylight (OECD, 2011), Research and Development (R&D) is still one of the main indicators of innovative activity. One of the reasons for this is that it is a variable that policy makers can affect, if they want to influence

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innovative behavior and economic growth. One of the well-known goals of the Lisbon Agenda for policy is that countries in the European Union should bring their expenditures on R&D to 3% of the national GDP. New insights, however, have shown that R&D does not provide the full picture when it comes to innovation, for example because it focuses on the input side while leaving innovation success out of the picture (Crépon et al. 1998). Moreover, the importance of R&D seems to be larger in the traditional industrial sectors, whereas the modern knowledge economies move to a more service oriented economy (Polder et al. 2010).

Nevertheless, the monitoring of R&D should not be discarded all together. Besides being the main indicator for innovation input and an important policy variable, R&D is also a measure for the absorptive capacity of a firm or sector. This means that the degree of R&D says something about, for example, how fast firms can adopt new technologies, and thereby how fast these new technologies can potentially diffuse (Griffith et al. 2000). Moreover, doing R&D evidently leads to the creation of knowledge and, additionally, to knowledge spillovers, which is the reason why public returns to R&D are considered to be larger than its private returns. The latter fact is the main rationale for stimulating R&D from the side of the government.

Recently, the Eurostat Working Group for Statistics on Science, Technology and Innovation (STI) identified various quality issues with respect to the measurement of R&D, see Eurostat (2010). One of the six quality issues identified is the 'Missing level of details of required breakdown of R&D by size classes'. In particular, this point refers to the exclusion of so-called 'micro-enterprises' (i.e. firms with less than 10 employees) by some member states. The Working Group requires details on the reasons for exclusion of such firms, a justification that their omission leads to a negligible bias of aggregate R&D statistics, and an assessment of the magnitude of such as bias. Moreover, the Working Group advises to use other information sources (such as data on tax incentives) and/or the possibility of sampling micro-enterprises at a lower rate than annually, for example once every four or five years. In the latter solution, estimates for the years in between could be obtained by using the information for the most recent year and estimating changes over time from other information sources.

The Netherlands is among those countries that do not include micro-enterprises in the regular R&D statistics. This is true for both R&D figures obtained from the biannual R&D survey (odd years) and those obtained from the likewise biannual Community Innovation Survey (even years), which contains a section on R&D expenditures and innovation expenditures in general. The alleged reasons for this exclusion are cost constraints and the disproportionate increase in administrative burden for small firms, relative to the additional information obtained. Earlier studies by Statistics Netherlands estimate the R&D expenditures of micro-enterprises to be less than 5% of total national R&D expenditures (see CBS, 2001, and CBS, 2003)

There are various reasons to reassess the magnitude of R&D expenditures of micro-enterprises. Firstly, the last assessment of its magnitude through primary sources has been done over ten years ago. It is worth to see if the share of micro-enterprises in the total of R&D has changed over time. Secondly, Statistics Netherlands by now has a valuable secondary source of information at its availability, namely data on a tax credit that firms can receive on wages of R&D personnel. A first peek at using these data to estimate the share in total R&D expenditures for small firms was carried out recently (CBS, 2010), but as it stands these estimates are quite conservative and seem to be a lower bound for the 'actual' share.

Lastly, the impact of R&D expenditures of micro-enterprises may very well go far beyond their actual magnitude relative to the expenditures of larger firms. Hence, the interest in policy circles for *fast growing innovative firms* (OECD, 2011). Innovative firms (like Google) typically start very small. But small firms combining innovativeness with entrepreneurship can grow into firms that have a major impact on economic growth. Even small firms that do not make it on their own, can make a huge profit from a breakthrough innovation. Larger firms are constantly on the hunt to take over and incorporate small firms that have valuable patents. It may well be fair to say that, indirectly, a large part of innovativeness, and thereby in the end economic growth, stems from R&D carried out at micro-enterprises. This justifies an interest in monitoring micro-enterprises, despite the fact that their contribution to total R&D in itself may initially not be very large.

This paper takes a first look at the feasibility of estimating firm-level R&D expenditures from data on an R&D tax incentive known as the WBSO (Wet Bevordering Speur- en Ontwikkelingswerk (Dutch), translated as Act Reduced Remittances Research and Development Work). Such a method could be used as part of the estimation procedure for R&D expenditures by micro-enterprises (the other part being the determination of a population of R&D micro-enterprises from the WBSO data).

The tax incentive and the corresponding data obtained from the administering entity NL Innovatie, are described in the next section. It also summarizes earlier research by Statistics Netherlands on the differences between the definition of R&D as maintained in international statistics (i.e. the Frascati Manual, see OECD, 2002), and the operational definition used by NL Innovatie to judge firms' requests for achieving a tax credit. Given these differences the administrative data cannot be used as a direct estimate of firm R&D expenditures conform to international statistical standards. Section 3 presents summary statistics and details on sample selection. In section 4 we outline a regression approach to explore whether despite the conceptual differences, there is a statistical relation between the two concepts of R&D. Section 5 presents results and uses them for prediction. Section 6 concludes and presents thoughts for further research.

2 WBSO: data from a Dutch R&D tax incentive

2.1 Description of the WBSO

The WBSO, or in full 'Wet Bevordering Speur- en Ontwikkelingswerk', is a tax incentive for Dutch firms to invest in Research and Development work.[18] It was introduced in 1994 by the Ministry of Economic Affairs as a means to stimulate private R&D expenditures, which were found to be lagging behind in the Netherlands. At the time, the Netherlands was one of the first countries to have such a tax incentive. At a later stage, it also served as an instrument to meet the innovation goals set by the Lisbon Agenda. Today it is the most important tax incentive instrument in innovation policy in the Netherlands. The WBSO applies to both firms and self-employed, as well as to knowledge institutes, and works as a contribution to R&D labour costs. Firms and knowledge institutes receive a tax reduction on wages and social security contributions with respect to R&D personnel. Self-employed receive

[18] This section draws on De Jong and Verhoeven (2007).

a (lump-sum) income tax credit. The regulation favours starting firms and self-employed with higher reductions.

Tax credits are granted based on a project proposal, which is judged by NL Innovatie, the administrative entity in charge of the implementation of the WBSO. If acknowledged, the proposal is considered as an application for WBSO. The determination of the actual amount of tax that a firm is allowed to deduct is ultimately the responsibility of NL Innovatie, and is determined *ex post* based on the actual labour cost, involving tax reports from the tax authorities (Dutch: Belastingdienst).

Despite the fact that the WBSO has a good target group reach, the coverage of small firms is quite low. In 2004, about 46% of R&D firms with between 1 and 9 employees used WBSO, against an overall 95% for firms up to 250 employees. Awaiting more recent data on the coverage of micro-enterprises from the currently ongoing evaluation of the WBSO, this potential undercoverage is something to take into account when estimating total R&D expenditures for this group from the WBSO data.

2.2 Description of the WBSO data

NL Innovatie has records with all project applications that were granted or not granted WBSO. These records contain, among other variables, information on the labour cost of R&D staff, and hours spend on R&D. The fact that Chamber of Commerce (Kamer van Koophandel, KvK, nummer) and Tax Registry numbers are included, makes it possible to find corresponding entities in the Business Register maintained by Statistics Netherlands. We followed the following strategy. For each year of the WBSO data (2006 to 2010) we linked the KvK numbers to a corresponding legal business entity (JE), which are the 'building blocks' of Dutch statistics. We used the December status of the Business Register for this, because it is the basis for the construction of samples for almost all regular surveys (like the R&D survey). Thus, for the sake of statistics, firms that do not exist in December do not matter. Linking was possible for the majority of the records: per year over 90% of the records could be linked.

Next, within the Business Register, we have information on the economic business entity (BE) corresponding to a particular JE. This relation is rather complex. It may be that several JE fall under one BE. In the analysis, these records are aggregated to one BE. In some rare cases, it can also occur that a JE belongs to two BE. These so-called ‘split cases’ have been discarded from the analysis. Finally, from a small number of JE there is no corresponding BE due to which also these records had to be discarded. However, for by far the majority of records there is a one-to-one relationship between a BE and a JE.

2.3 Differences between R&D and ‘S&O’

There are various reasons why R&D labour cost as reported to CBS, and R&D labour cost as reported to NL Innovatie are not the same. To make a clear distinction between the two concepts we will call R&D labour cost from the WBSO data ‘S&O’, rather than R&D (S&O is the Dutch abbreviation of ‘Speur- & Ontwikkelingswerk’ the literal translation of R&D). CBS (2010) has identified several differences between the concepts. At the firm-level, differences are that to qualify as an R&D firm for Statistics Netherlands, firms need to have employed at least 1 full time equivalent (fte) of own R&D personnel. In some services sectors this threshold is 3 fte. On the other hand, labour costs of supporting staff are part of R&D labour cost according to Statistics Netherlands, but firms cannot get a tax credit for this. Hence, this component of R&D labour cost is not present in the S&O data. In addition, applications for WBSO are subject to in-depth checking of the project description by NL Innovatie, whereas Statistics Netherlands checks mainly for consistency of answers in R&D survey. Finally, there is a difference in coverage due to the fact that some industries are precluded from doing R&D in the Statistics Netherlands definition, and Statistics Netherlands does not survey firms with less than 10 employees. All these differences make that S&O cannot be used as a direct estimate of R&D, and therefore we look at the alternative of identifying a statistical relation between the two concepts to be able to estimate one from the other.

2.4 Assembling the data

The original WBSO dataset contains 68,217 records, after dropping 5,086 records for rejected applications. In 2,133 (3.1%) cases the KvK number could not be linked to Business Register information. After dropping those, we end up with 66,084 records for the whole period with unique WBSO relation id’s (within one year). However, we want to link WBSO information to data from the R&D survey, which contains economic business identifiers (‘beid’). Therefore, KvK numbers falling under one beid are aggregated, resulting in a dataset with 56,798 records, with (annually) unique business identifiers.

Subsequently, we link the WBSO data to data from the R&D survey and CIS. In this paper, we will only look at 2007 and 2009 (the R&D survey years), because information on R&D labour costs is only available in these years. Since the WBSO data contains information on wages of R&D personnel, this seems a reasonable starting point. A translation of R&D labour cost to total R&D expenditures is planned for the future, but necessarily involves more assumptions on the distribution between labour and other types of R&D related costs. The two R&D years jointly contain 2,025 records, of which 1,513 (74.7%) can be linked to the WBSO data. Another 68 of these observations were dropped since the economic activity did not match the economic activities in the definition of R&D maintained by Statistics Netherlands.

Table 1 shows the observations by source. It is clear that the WBSO data covers far more firms than the R&D survey. One reason for this is the fact that the R&D survey does not cover firms smaller than 10 employees (size class 0 to 3). Moreover, firms below 100 employees (size class 6 and lower) are sampled, and since the survey is voluntary for all firms, there is also non-response, which amounts to around 30% each year. Tables 2a and 2b shows the overlap between the sources by size class ('sc'). Moreover, some firms only appear in the R&D survey. Reasons for the deviation in the coverage of R&D firms should be explored further, as well as an assessment of the quantitative importance of the firms that are not in the overlaps, in terms of R&D labour costs.

Ultimately, when estimating R&D expenditures for micro-enterprises, it is necessary to know which of the S&O micro-enterprises qualify as an R&D firm, and moreover what part of the population of R&D micro-enterprises is missed by the WBSO data due to a possibly limited reach of the regulation within this group. Although this exercise is necessary for our ultimate goal, it is beyond the scope of this paper. For the sake of our purposes, we shall act as if all R&D firms are captured by the overlap between WBSO and R&D survey data. For this group we can estimate R&D expenditures from S&O data, and compare estimates of the aggregate R&D to the sum of observed R&D expenditures.

3 Summary statistics and outliers

For the analysis we start by dropping firms smaller than 10 employees (up to size class 3). Moreover, we drop firms for which we do not have R&D labour costs from both sources. Table 3 shows how the observations are distributed over size classes, economic activity, and year. As a first way of confronting both measures of R&D labour costs, we calculate their ratio as R&D/S&O, where S&O is the R&D labour cost sourced from the WBSO data. This shows that there are sometimes quite substantial differences between the two concepts. However, for the majority of observations the difference seems within reasonable bounds. By way of controlling for outliers, we drop observations for which the ratio calculated is larger than 10 (# = 84) or smaller than 0.1 (# = 23), in other words where the deviation between the two concepts was larger than a factor 10. We then have 1390 observations for which we can determine a statistical relation between R&D and S&O.

Tables 4a to 4c show summary statistics for R&D, S&O, and the ratio of the two variables. For most observations, the R&D figures from the R&D survey are larger than the S&O. A reason for this could be that labour cost for supporting staff is included in the former but not in the latter. Moreover, this is in line with the finding that WBSO is effective in stimulating R&D, in the sense that in addition to the tax credit, firms invest in additional R&D (De Jong and Verhoeven, 2007). From Table 4c, we also see that the level of R&D labour cost increases by size class under both concepts. The ratio also increases, meaning that R&D labour costs in the R&D survey show a stronger increase than they do in the S&O data, even after controlling for extreme observations. This is consistent with the fact that there is a maximum on the amount of tax credit a firm can achieve, so that larger firms might not bother to apply for the whole of their R&D labour costs. The S&O data would in this case be more or less truncated for the larger size classes, while the R&D data is not. This leads to higher values of the ratios between the two variables.

4 Looking for a statistical relation between R&D and S&O

In general our aim is to determine whether there is a meaningful statistical relation between firm-level R&D figures, as collected by Statistics Netherlands, and wage information for R&D personnel as recorded by AgentschapNL, i.e. $RnD = f(SnO, \Omega)$, where Ω is potential additional information with predictive power. We will consider two common specifications for f, namely a linear and a log-linear function. The first specification leads to a simple linear regression:

$$(1) \quad RnD_i = \alpha + \beta SnO_i + u_i$$

where u is disturbance, which can be interpreted as measurement error plus a random error component. Thus, denoting measurement error by v_i, and letting ε_i be a normally distributed random error component with zero mean,

$$u_i = v_i + \varepsilon_i.$$

Moreover, the measurement error part may be parameterized further. That is, the difference between S&O could be related to other observable variables. In our specification, we allow for the possibility that it is related to firm size, L_i, and that it may vary per year and economic activity, i.e.

$$v_{it} = \gamma L_{it} + \sum_t \delta_t 1[year = t] + \sum_j \delta_j 1[industry = j],$$

where 1[ ] is the indicator function. Making the relevant substitutions in (1), we arrive at the estimating equation

$$(2) \quad RnD_{it} = \beta SnO_{it} + \gamma L_{it} + \sum_t \delta_t 1[year = t] + \\ + \sum_j \delta_j 1[industry = j] + \varepsilon_{it}.$$

Thus, if this specification is satisfactory, R&D is a linear function of S&O, and can be predicted by scaling S&O by a factor β and correcting it for possible measurement error.

Analogously, a log-linear specification starts from a multiplicative function

$$(3) \quad RnD_i = \alpha {SnO_i}^{\beta} u_i$$

$$\leftrightarrow \ln(RnD_i) = \ln(\alpha) + \beta \ln(SnO_i) + \ln(u_i)$$

$$= \alpha' + \beta \ln(SnO_i) + {u_i}',$$

and similarly when parameterizing u_i'

$$(4) \quad \ln(RnD_i) = \alpha' + \beta \ln(SnO_i) + \gamma \ln(L_{it}) + \sum_t \delta_t 1[year = t] \\ + \sum_j \delta_j 1[industry = j] + \varepsilon_{it}.$$

The goal of our exercise is ultimately to be able to predict R&D expenditures for micro-enterprises based on their S&O. We can determine this relation only from data for larger size classes, and then possibly extrapolate this relation to smaller firms. To be able to do so, a more or less 'stable' statistical relationship between R&D and S&O is required. That is, the extrapolation only makes sense if we can assume that the relation between R&D and S&O is approximately the same for microenterprises and for larger size classes. This assumption, in turn, seems justified if the relation estimated does not vary too much by size class in our results. We will test for equal coefficients by size class using an *F*-test.

5 Results

5.1 Estimation of the R&D/S&O relationship

Table 5 presents the OLS estimation results of the four specifications for the relation between R&D and S&O, corresponding to the equations (1) to (4) above:

specification I: linear relation without additional variables

specification II: linear relation, measurement error parameterized by firm size and economic activity

specification III: log-linear relation without additional variables

specification IV: log-linear relation, measurement error parameterized by firm size and economic activity

Standard errors reported are robust to heteroskedasticity.

Table 5a
OLS estimation results …for the linear specification (*N* = 1,390)

	specification (1)			specification (2)		
	Coeffient	std. error	*p*-value	coefficient	std. error	p-value
S&O (size class 4)	1.033	0.280	0.000	0.417	0.446	0.351
S&O (size class 5)	1.455	0.178	0.000	0.839	0.401	0.036
S&O (size class 6)	1.228	0.189	0.000	0.977	0.251	0.000
S&O (size class 7)	1.915	0.126	0.000	1.806	0.137	0.000
S&O (size class 8)	1.854	0.234	0.000	1.772	0.235	0.000
S&O (size class 9)	2.038	0.189	0.000	1.993	0.194	0.000
size class 4	91.387	136.641	0.008	-1617.219	353.888	0.000
size class 5	19.801	162.318	0.489	-1491.447	301.098	0.000
size class 6	102.430	134.955	0.029	-1375.964	271.736	0.000
size class 7	-72.296	154.589	0.121	-1609.549	297.092	0.000
size class 8	41.770	203.220	0.783	-1615.273	380.253	0.000
size class 9	2967.579	1445.198	0.054	-854.016	1321.483	0.518
employment				1.419	0.923	0.124
NACE 1				767.877	206.525	0.000
NACE 2				1183.504	200.877	0.000
NACE 3				677.490	421.044	0.108
NACE 4				220.723	516.704	0.669
NACE 5				1151.683	192.842	0.000
NACE 6				-612.815	784.601	0.435
NACE 7				1926.231	467.410	0.000
NACE 8				1318.393	340.024	0.000
NACE 9				357.025	823.718	0.665
1[year = 2007]				576.831	271.241	0.034
R^2	0.81			0.85		
F-test (*p*-values)	size class 4 to 9	size class 4 to 8		size class 4 to 9	size class 4 to 8	
α	0.016	0.036		0.075	0.080	
β	0.000	0.001		0.002	0.002	

Note: sno*i* = (S&O × 1[size class *i*]).

We see from Table 5a and 5b that there is a strong relation between R&D and S&O in all specifications. Moreover, the log-linear specifications meet our requirement of 'stable' coefficients over size classes. An *F*-test for the equality of coefficients on S&O (β), as well as of the size class specific constant (α) cannot be rejected when size class 9 (500 employees or more) is discarded. The latter size class is likely to be atypical in our context, since the tax credit is bounded and S&O information is therefore likely to underestimate R&D for very large firms, which is an explanation for the relatively high coefficient in this size class. For these reasons, this size class will be excluded from the prediction exercises as well. The *F*-tests for the size classes 4 to 8 shows that both the coefficients on S&O and the size class specific constants are comparable over size classes for the log-linear specification. This can be interpreted as evidence that the relation estimated for a particular size class may be extrapolated to another size class, in particular to the size classes 1 to 3 for which we do not have data.

However, the linear specification does not meet our requirement of 'stable' coefficients over size classes. An *F*-test shows that the equality of the coefficients should be rejected in these specifications, even when we exclude size class 9. The reason that the log-linear specification performs better is that both R&D and S&O are skewed even within size classes, which is also evident from the skewness of the ratio variable in Table 4c (i.e. relatively large means compared to the medians). In fact, this shows that the linear model is misspecified, and should be rejected. Since R&D is on average larger than S&O, the model gives estimates that are biased towards the firms with higher R&D/S&O ratios. Taking logs reduces the weight of the firms in the upper end of the distribution of this ratio.

Comparing the two log-linear specifications, it seems that parameterizing the measurement error does not add to the explanatory power of the model. The explanatory power of the model without additional variables is already very high with over 98%. Moreover, adding the variables we have at hand seems to disturb the significance of the size class specific constants, which could be due to the likely collinearity with the employment variable. All in all, specification (3) is our preferred one from these results. We shall use the results of this model with respect to size class c to predict both micro-level and aggregate R&D for size class c-1, for c = 5 to 8.

Table 5b
OLS estimation results for the log-linear specification (*N* = 1,390)

	specification (3)			specification (4)		
	Coeffient	std. error	*p*-value	coefficient	std. error	p-value
S&O (size class 4)	0.839	0.069	0.000	0.792	0.065	0.000
S&O (size class 5)	0.840	0.039	0.000	0.768	0.042	0.000
S&O (size class 6)	0.794	0.039	0.000	0.731	0.039	0.000
S&O (size class 7)	0.807	0.037	0.000	0.763	0.036	0.000
S&O (size class 8)	0.813	0.035	0.000	0.770	0.035	0.000
S&O (size class 9)	0.967	0.027	0.000	0.910	0.032	0.000
size class 4	1.095	0.361	0.002	-0.187	0.378	0.621
size class 5	1.126	0.206	0.000	-0.119	0.322	0.712
size class 6	1.428	0.202	0.000	0.005	0.353	0.989
size class 7	1.495	0.203	0.000	-0.105	0.395	0.790
size class 8	1.661	0.214	0.000	-0.106	0.435	0.808
size class 9	0.995	0.222	0.000	-0.945	0.418	0.024
employment				0.237	0.070	0.001
NACE 1				0.549	0.083	0.000
NACE 2				0.616	0.069	0.000
NACE 3				0.743	0.076	0.000
NACE 4				0.412	0.147	0.005
NACE 5				0.673	0.104	0.000
NACE 6				0.856	0.375	0.023
NACE 7				1.028	0.081	0.000
NACE 8				0.906	0.120	0.000
NACE 9				1.213	0.269	0.000
1[year = 2007]				0.029	0.043	0.499
R^2	0.98			0.98		
F-test (*p*-values)	size class 4 to 9	size class 4 to 8		size class 4 to 9	size class 4 to 8	
α	0.380	0.224		0.025	0.987	
β	0.000	0.926		0.002	0.921	

Note: sno*i* = (ln(S&O) × 1[size class *i*]).

5.2 Prediction

Based on the results in Table 5b, we now present a method to predict R&D labour cost based on S&O information. We base our predictions on our preferred specification (3). The initial strategy is as follows. Since we are looking for a way to predict R&D expenditures for size classes 1 to 3, we will investigate whether estimates can be derived from the statistical relation between R&D

and S&O in a higher size class.[19] In the end we want to predict size class 1 to 3 from size class 4. To evaluate if such a strategy works well, we will use the results from Table 5b for each size class c to predict the R&D labour costs in size class c-1. Thus, for example, we use the coefficients for size class 5 to predict R&D expenditures in size class 4 from S&O information for size class 4:

$$\ln \widehat{(RnD_i)} = 1.126 + 0.840 \times \ln (SnO_i) \qquad \text{for } i \text{ in size class} = 4.$$

To evaluate the predictive power for aggregate R&D, we aggregate the predictions by size class, and compare to the actual aggregates, that is for each size class we compare

$$\sum_i \exp (\ln \widehat{(RnD_i)})$$

to $\sum_i RnD_i$. Since size class 9 is found to be different from the other size classes using the F-test, we do not attempt to predict R&D labour cost for size class 8 from the results of size class 9. Note that we compare the aggregate predictions to the sum of R&D expenditures for those firms that are in the estimation sample, i.e. those firms for which we observe both R&D and S&O. As pointed out in section 2.4 two other important steps for estimating the R&D for micro-enterprises are 1. the determination of which firms in the WBSO data are R&D firms, and 2. which R&D firms are not in the WBSO data. This is not part of the current exercise.

Table 6a shows the mean, median and standard deviations of the relative errors of the predictions for R&D labour cost at the firm-level, i.e. $\exp (\widehat{\ln (RnD_i)}) / RnD_i$. From the table it is clear that while the median is fairly close to 1 for each size class, firm-level R&D is overestimated quite strongly on average using this approach. Moreover, the mean relative error increases with size class, thus the relative error is larger for larger firms.

Table 6b, on the other hand, shows that when we aggregate the predictions by size class, and compare it to actual aggregated R&D labour cost, the latter is underestimated. (Note that this contrasts with the overestimation on average at the firm-level; this is possible if within size classes, firms with smaller R&D amounts have a higher relative prediction error.) Predicted aggregated R&D seems to amount to an approximately constant share of 'actual' aggregate

[19] We do not consider size class 0 (i.e. self-employed without personnel) in the analysis, since the WBSO data do not contain wage information for this size class.

R&D, with around 80 to 85% for each size class. Thus, if this true, we could use the reciprocal of these shares as raising factors. Table 6c shows the degree of over- and underestimation when both raising factors (i.e. 1/0.8 and 1/0.85) are used to create a lower and higher bound for the prediction of the aggregates. Aggregate R&D in each size class is over- or underestimated by approximately 7% in this case.

We conclude that despite the fact that predicting R&D labour cost from S&O data using the statistical relation between R&D and S&O in the size class above leads to clear overestimation at the firm-level on average, and underestimation of the size class aggregates, the error in the predicted aggregates is quite constant over size classes. This allows to scale up the predicted aggregates, which results in a reasonable absolute prediction error of around 7%. Assuming that such a strategy can be followed for micro-enterprises as well, we could be able to estimate their aggregate R&D labour cost with a similar degree of error.

The conclusion applies if every S&O firm would be an R&D firm and vice versa. In this case we could just apply the S&O and R&D relationship from size class 4 to all S&O micro-enterprises, and scale up the aggregated prediction by the factors above to obtain a lower and upper bound for their total R&D labour cost. However, as we saw in Table 2a and 2b, there are R&D firms that are not S&O firms, and vice versa. To be able to estimate the actual amount of R&D labour cost of micro-enterprises, we need to be able to select those micro-enterprises from the WBSO data that are actually R&D firms. Moreover, in the light of the lower reach of the WBSO regulation in smaller size classes, we need to have an idea about how many R&D micro-enterprises are missing from the WBSO data, so that we can apply statistically meaningful raising factors to arrive at a corrected aggregate. This is the next step of our research.

6 Conclusions

This paper has presented a possible methodology for estimating R&D labour costs for micro-enterprises from R&D tax credit data. Linking information on R&D labour cost from the WBSO regulation in the Netherlands to R&D labour cost obtained from the R&D survey carried out by Statistics Netherlands, we have shown that there is a strong statistical relationship between these two concepts for each size class. Next, we used the results for each size class to make a prediction for R&D labour cost in a particular size class using the S&O data, and the statistical relation found for the size class above. On average, this approach leads to an overestimation of firm-level R&D. However, aggregating the predictions to obtain an estimate of aggregate R&D labour cost per size class, was found to lead to underestimation of the aggregates. Since the underestimation was found to be of a similar (relative) magnitude for each size class, however, we postulated that a raising factor could be used to scale up the predicted aggregates. Using a lower and upper estimate of such a raising factor, we found that such a strategy leads to an over- or underestimation of aggregate R&D labour cost by size class of about 7%.

Future research should focus on how to use our results for the actual estimation of R&D labour cost by micro-enterprises. The most important unresolved issue is how to determine which micro-enterprises from the WBSO data are R&D firms according to the definition maintained by Statistics Netherlands. Moreover, given that the reach of the WBSO regulation is lower among smaller firms, we also need to investigate how the results should be raised or weighted to obtain the aggregate. Finally, it is an open question whether the results for labour costs can be used to obtain estimates for total intramural R&D expenditures, including investment in machinery and hardware.

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Table 1
Coverage by source

in S&O, R&D or both	Freq.	Percent	Cum.
in S&O	20,074	91.05	91.05
in R&D	461	2.09	93.14
both	1,513	6.86	100.00
Total	22,048	100.00	

Table 2a
Coverage by size class and source (2007)

sc	in S&O, R&D or both		
	1	2	3
0	266	2	
1	1,276	2	
2	2,247	6	
3	1,365	11	7
4	1,359	22	56
5	1,457	54	121
6	672	43	114
7	389	47	176
8	223	46	150
9	132	39	79

Table 2b
Coverage by size class and source (2009)

sc	in S&O, R&D or both		
	1	2	3
0	347	4	1
1	2,214		1
2	2,014	1	1
3	1,376	7	6
4	1,435	17	78
5	1,529	35	127
6	861	35	158
7	471	36	202
8	280	31	162
9	161	23	74

Table 3a
Distribution by size class

sc	Freq.	Percent	Cum.
4	130	9.35	9.35
5	230	16.55	25.90
6	252	18.13	44.03
7	350	25.18	69.21
8	287	20.65	89.86
9	141	10.14	100.00
Total	1,39	100.00	

Table 3b
Distribution by economic activity

nace	Freq.	Percent	Cum.
0	1	0.07	0.07
1	160	11.51	11.58
2	563	40.50	52.09
3	205	14.75	66.83
4	34	2.45	69.28
5	84	6.04	75.32
6	13	0.94	76.26
7	324	23.31	99.57
8	1	0.07	99.64
9	5	0.36	100.00
Total	1,390	100.00	

Table 3c
Distribution by year

year	Freq.	Percent	Cum.
2007	644	46.33	46.33
2009	746	53.67	100.00
Total	1,390	100.00	

Table 4a
Summary statistics for R&D by size class

sc	mean(rnd)	sd(rnd)	med(rnd)
4	298.80503	295.4089	195.67599
5	402.96661	542.2384	200
6	509.67506	797.2686	220.5
7	990.98942	2229.854	372.5
8	1662.1264	3551.153	550
9	16994.416	35775.49	1943

Table 4b
Summary statistics for S&O by size class

sc	mean(sno)	sd(sno)	med(sno)
4	200.8515615	186.3108	138.82
5	263.4008	293.8125	144
6	331.5232341	477.7767	161
7	555.1720171	1034.255	232.9375
8	874.0262892	1652.546	304.5
9	6883.348915	15314.79	1051.5

Table 4c
Summary statistics for ratio R&D/S&O by size class

sc	mean(ratio)	sd(ratio)	med(ratio)
4	1.830306	1.645744	1.252359
5	1.812417	1.52041	1.350659
6	1.960735	1.69833	1.391746
7	2.094345	1.762738	1.555606
8	2.550451	2.14218	1.786376
9	4.669505	19.27945	2.251354

Table 6a
Mean relative prediction errors by size class

sc	mean(relerr)	sd(relerr)	med(relerr)
4	1.377437	1.282324	1.052868
5	1.432203	1.496357	1.050234
6	1.51308	1.372479	1.093684
7	1.696432	1.739881	1.170479

Table 6b
Prediction error of aggregate RnD by size class

sc	relative error
4	.8440385
5	.7964921
6	.8565363
7	.7965664

Table 6c
Lower and upper bound for error for aggregate RnD

sc	lower bound	upper bound
4	.9929865	1.055048
5	.9370495	.9956151
6	1.00769	1.07067
7	.9371368	.9957079

* Lower bound: prediction of aggregate was increased by a factor (1/0.85).
* Upper bound: prediction of aggregate was increased by a factor (1/0.80).
Lower and upper bounds are set in accordance to results in Table 6b.

Locations for Multinationals: Which role for the Skill Distribution of Employment?

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I. Introduction

This paper is focused on direct investments by multinationals and the skill distribution of employment in the host country. Its aim is two-fold: to highlight new challenges for assessing the skill levels and to analyse the role of the skill composition differences of host countries as a determinant of foreign direct investment (FDI) attractiveness across OECD countries.

Assessment of skills involves several dimensions. One component refers to the *educational attainment* and is developed widely since Schultz (1961). The concept of human capital takes a more comprehensive dimension referring to education, health and training of individuals (Becker 1964). In parallel, a number of analyses emphasized the *occupation* of individuals since many mechanisms of learning by doing take place once individuals are out of the educational system (e.g. Arrow 1962). Accordingly, in this study, we aim at better appreciating the relevancy of these two skill proxies testing the data as one of the location choice factors of multinationals in OECD countries over the (1997–2007) period.

Studies analysing the location factors have been carried out for long time since investment location decisions by multinational enterprises (MNEs) strongly affect the development dynamics at both the local and country levels. Host country's market size (mainly measured by population or GDP), incentives for

[*] Views expressed here are author's personal views and do not represent the official views of the OECD on the subject. The author is grateful to Hélène Dernis, Isabelle Desnoyers-James and Fabien Verger for their help in providing data from OECD Patents, AFA, FATS and STAN Databases.

investments (such as fiscal incentives), institutional environment (strong governance) and labour force characteristics are among the mostly cited elements for location choice factors.

However, as far as the FDI decisions-local skills linkages are concerned, empirical studies seem to suffer from weaknesses because they mainly focus on developing countries. This is notably the case for Root and Ahmed (1979), Schneider and Frey (1985) and Narula (1996). This study attempts to provide empirical evidence from OECD countries while investigating, at industry level, the relationship between inward FDIs and the skilled workers stock in the host country in order to analyse many policy recommendations given in the past (e.g. OECD 2002).

The remainder of this paper is organized as follows. A quick literature review on the importance of skill assessment, and its impact on MNEs' location decisions, is detailed in the Section II. Then the data used in this study as well as a set of descriptive statistics are shown in Section III. Section IV undertakes the empirical estimations, while section V discusses the results and concludes.

II. Literature review

The importance of human capital accumulation for economic development is explored by many economists since Becker (1964). An important number of endogenous growth contributions (e.g. Lucas (1988), Romer (1990), Aghion-Howitt (1992)…) strongly emphasize the role of education as a key determinant of technological progress and economic growth. At the firm level, today's knowledge-based economic context regards workers' educational attainment as a very significant signal with respect to his/her competencies and potential productivity.

Along with the OECD recommendation, human capital is regarded as being "the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being" (OECD, 2001 p.18). To asses human capital, past literature has either focused on educational attainment or on occupation of individuals[21]. While the human capital literature

[21] Another group of studies resorts to cost and income-based measures as proxy for human capital (see Le, Gibson and Oxley, 2003 for a survey), partly to account for difficulties in gathering data on education and qualification.

emphasizes education or training as determinants of skills, a broader conception of skills is now recognised, accounting notably for learning-by-doing and on-the-job training, which underlines the relevance of the occupational dimension as well.

Statistically, educational attainment is often measured through literacy rates (Summers and Heston, 1991), school enrolment ratios (Levine and Renelt, 1992), average years of schooling (Barro and Lee, 1993, 1996, 2001; Krueger and Lindhal, 2001), and direct tests of cognitive skills (Hanushek and Kimko, 2000; Gundlach, Rudman and Wöβmann, 2002), whereas on-the-job training is assessed as occupation requirements (Elias and McKnight, 2001).

However assessing skills is not an easy task since such quantification should ideally take into account many other subjective parameters. As a matter of fact, measurement of skills has been recognized as a major challenge for research on economic performance (see Borghans, Green and Mayhew, 2001; Le, Gibson and Oxley, 2003; and Wöβmann, 2003 for surveys on measurement issues). As of today, weaknesses and lacks in international comparable and reliable data prevent robust cross-country analyzes (de la Fuente and Domenech, 2001). This paper builds on and complements several previous attempts to assess skills of working population (Psacharapoulos and Ariagada, 1986; Nehru et al. 1995, Barro and Lee, 2001).

As regards the economic literature on determinants of FDI, the availability of some specific skills, often motivated by low-labour-cost-seeking, is pointed out among the intangible assets of a country and are fully considered by MNE's while making location decision at the present age of globalisation. Indeed, the supply of cheap labour in developing countries is traditionally seen as a main comparative advantage as regards the labour force intensive production, however analytical works on its linkages with FDI decisions dates back to the early 1970's.

One of the first quantitative works on economic determinants of FDI is realised by Dunning (1973) on the basis of surveys among entrepreneurs engaged in international production, where, together with the market size and investment climate, the availability of labour is analysed as an essential parameter. Similarly, Agarwal (1980) illustrates the attractiveness of the cheap labour availability in less developed countries, while putting a damper to its importance in case of increasing resistance that may potentially appear by the influence of trade unions or direct competition from local industries thanks to the technological progress.

More recently, Zhang and Markusen (1999) show in their model that locally available skills have an impact on FDI magnitudes and on MNEs production. Noorbakhsh, Paloni and Youssef (2001) argue that skilled labour has become more attractive to MNEs relative to the low labour cost per se.

As far as the determinants of investments in high-technology sectors (such as pharmaceuticals or ICT) and internationalisation of R&D activities are concerned, they are, not surprisingly, very sensitive to the availability of scientific infrastructure while cost factors and market size appear more secondary compared to other industries. Authors such as Jones and Teegen (2003) outline that even though the cost of labour has gained momentum, managers are more interested today in the skills and capabilities of the potential workforce, than in the mere costs of R&D conducted in this location. A survey carried by Thursby and Thursby (2006) shows that developed countries are still favoured by the higher quality of the academic research and by the possibility to collaborate with universities, especially in new sciences. But if respondent companies expect their overall R&D to grow in emerging countries and decline in developed economies, it is not only for reasons of cost, but also because of the large availability of skilled labour force, and for market issues.

III. Data and descriptive statistics

This empirical analysis of study is based on following three datasets: the OECD ANSKILL[22] (Skills by Industry) database, OECD AFA (Activities of Foreign Affiliates) and FATS (Foreign Affiliates' Trade in Services) databases. Industry level control variables are used from the OECD STAN Database for Structural Analysis.

In this paper, the skill assessment is realised through a new dataset (ANSKILL), that we have built in the OECD and which provides information on changing patterns of skilled labour force in OECD countries at industry level over the 1997–2008 period. The second dataset called AFA covers information on foreign affiliates in manufacturing industry whereas the third one, FATS database relates similar information on the services sectors. Both of these

[22] The ANSKILL data is currently for internal use only.

datasets provide data at ISIC Rev 3. at a 2-digit level of detail for all OECD countries. Time coverage differs depending on countries but the recent period (1997–2007) is mostly covered by the data, which enables us to proceed to the econometrical panel data analysis over this period after presenting the descriptive statistics.

3.1. Skill composition of employment in OECD countries

Although the complementarity of education and occupation variables have been strongly emphasized in the past (OECD 2001 for instance), only a few papers resort to both proxies to account for human capital. In this paper, skills are assessed through both the educational attainment (International Standard Classification of Education ISCED-97)[23] and occupations (International Standard Classification of Occupations ISCO-88) by industry (International Standard Classification of Industries ISIC Rev.3). This is the main difference between the ANSKILL database and the EU KLEMS database[24], which considers educational attainment exclusively as being the skill proxy.

While considering occupation as a proxy of skills, the following skills associations are established on the basis of the ISCO-88.

ISCO-88 one-digit (Occupation type)	Associated Skills
0 Armed forces	Not included in the analysis
1 Legislators, senior officials, managers	High skilled
2 Professionals	High skilled
3 Technicians and associate professionals	High skilled
4 Clerks	Medium skilled
5 Service workers and shop and market sale workers	Medium skilled
6 Skilled agricultural and fishery workers	Medium skilled
7 Craft and related trade workers	Medium skilled
8 Plant and machine operators and assemblers	Low skilled
9 Elementary occupations	Low skilled

[23] Resorting to the ISCED has been justified by Steedman and McIntosh (2001). Under some assumptions, these authors demonstrate the relevancy of the ISCED framework to assess low-skilled individuals. Here, their results are extended to medium and high-skilled individuals.

[24] EU KLEMS is a project funded by the European Commission's 6th Framework Programme (FP6) whose major output is a database for measuring and analyzing multifactor productivity by industry in EU and selected non-EU countries. One important aspect of measuring productivity is to take account of labour quality hence EU KLEMS provides estimates of labour input by skill levels.

While considering education as a proxy of skills, the following skills associations are established on the basis of the ISCED-97.

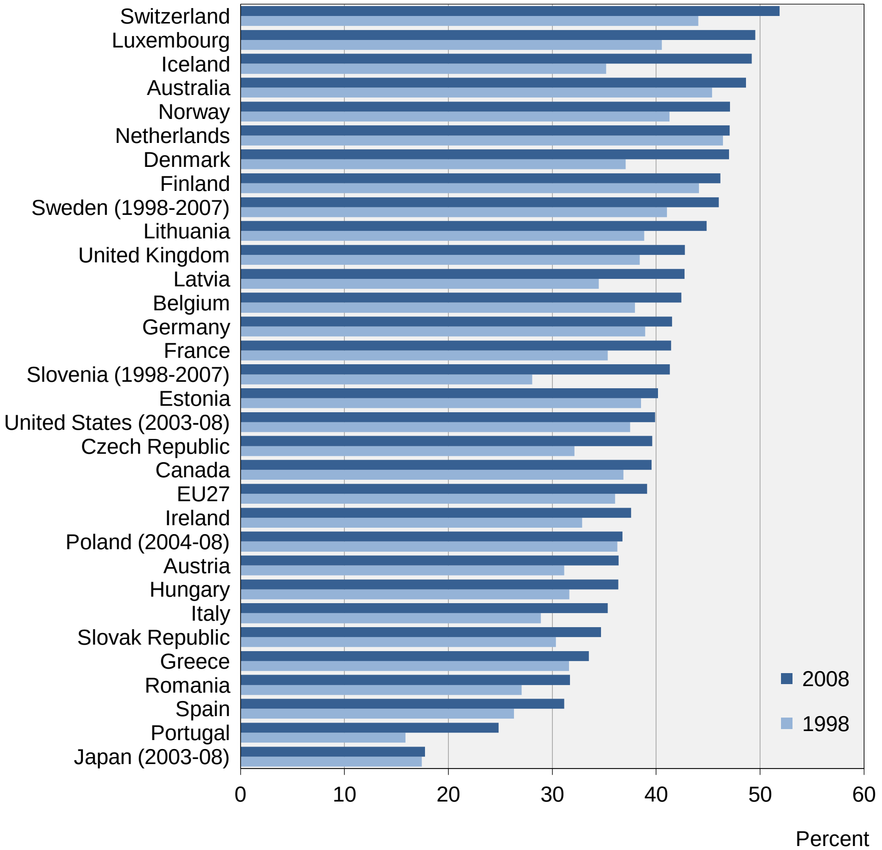
ISCED-97 (Educational attainment)	Associated Skills
1 Primary education	Low skilled
2 Lower secondary /second stage of basic education	Low skilled
3 Upper secondary education	Medium skilled
4 Post secondary non-tertiary education	Medium skilled
5 First stage of tertiary education	High skilled
6 Second stage of tertiary education	High skilled

Both proxies are assessed on the labour force, not on the adult population, neither on students. In this way, this dataset may fill a gap in current data sets (see Wößmann, 2003). Resorting to both proxies would allow us undertaking robust cross-country analyses at industry level and testing for robustness of results with each of them.

3.1.1 High skilled workers: occupation and education definitions

Figures 1 and 2 show the evolution of the number of high skilled workers defined with the occupation proxy on the one hand, and with the education proxy on the other hand.

Figure 1.
High-skilled workers (occupation definition), 1998–2008



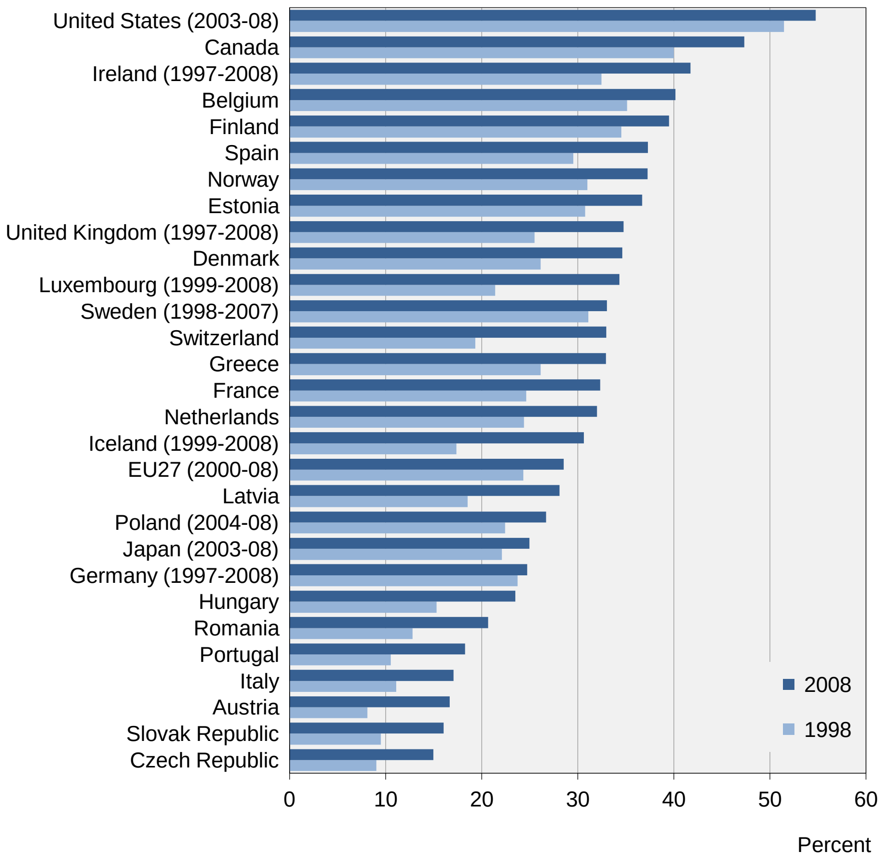
Source: OECD, ANSKILL database, September 2011.

In all countries a net increase in the share of the high skilled employees is observed through the 1998–2008 period (Figures 1 and 2). The occupation proxy plots show that the most significant catch-up occurred in Iceland and Slovenia, whereas the shift was less than 1 percentage point in countries such as Japan, Poland and the Netherlands. The share of the highly-skilled defined by their occupation was the highest in Switzerland and Luxembourg at the end of the period; mainly due to the important size of the business services sectors.

Variations over the 1998–2008 period are more important when skills are assessed with the education proxy (Figure 2). Assessed by their educational attainment, the share of high-skilled employees increased by 7% on average across countries. Switzerland and

Iceland registered the highest increase between 1998 and 2008, as opposed to Germany where the increase was less than 1 percentage point.

Figure 2.
High-skilled workers (education definition), 1998–2008



Source: OECD, ANSKILL database, September 2011.

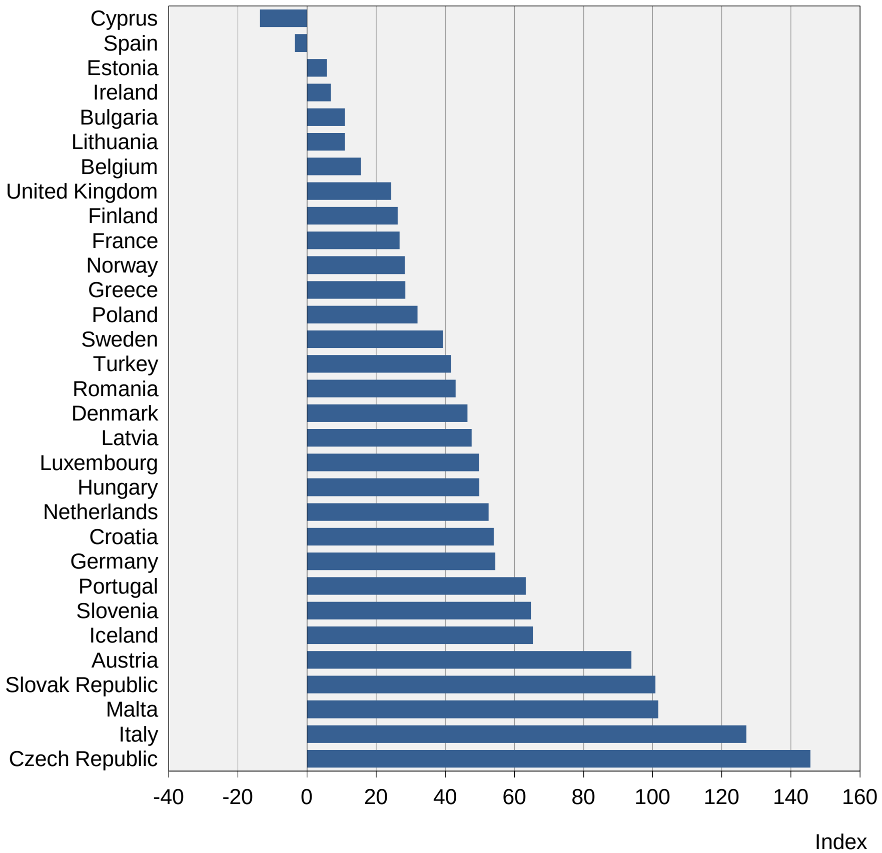
Another type of comparative analysis of the occupation and the education proxies is presented in Figure 3. For countries for which both of the skill proxies are available, we calculate the following ratio on the basis of the 2009 data:

$$\left(\frac{\text{Number of the HS (occupation definition)}}{\text{Number of the HS (education definition)}} \text{ x } 100\right) - 100$$

The Figure 3 shows that in the Slovak Republic, there are two times (100%) more high skilled workers when we use the occupation definition compared to the education definition. This ratio is even higher for countries such as the Czech Republic (145%) or Italy (127%).

According to the classical economic literature, human capital accumulation has high economic returns and the more individuals invest in their education, the more likely they are to be employed in highly-skilled occupations. Although the indicator presented here is not based on individuals' data at the micro level, it provides insights on a certain mismatch between the educational attainment and occupations in most of the countries; drawing attention to the importance of the proxy chosen to assess the skill composition of employment.

Figure 3.
Supply of and demand for highly skilled employees, 2009. Employees in high-skill occupations as a percentage of those with at least a university degree



Source: OECD (2010), *Measuring Innovation: A New Perspective*.

3.1.2 Industry-level focus[25] on the growth of the highly skilled (occupation definition)

In this section, the EU-15 area (Figure 4) is compared with the United States (Figure 5), Canada (Figure 6) and Japan (Figure 7) as regards the growth of the high skilled workers in medium-high and high technology industries (ISIC 24, 29t33 and 34t35[26]) on the one

[25] The industry detail level provided here depends on the availability of the data in the ANSKILL database.

[26] Includes shipbuilding.

hand[27], and in the knowledge intensive business services (ISIC 64, 65t67, 71 to 74) on the other hand[28]. The complete STAN industry list is presented in the Annex 1 of this document.

In all countries, the most important increase is observed in business services sectors. In the European Union, computer and related activities (ISIC 72) registered an average annual growth rate of 7.5% over the 1998–2008 period. The rate was almost 11.7% for the broader category of renting and other business activities (ISIC 71t74) in the United States, 6.6% in Canada (72t74) and 4.4% in Japan (ISIC 72).

The second highest growth rates are observed in insurance and pension funding sectors (ISIC 67) in the EU-15 area (5.3%) and in financial intermediation related activities (ISIC 65 and 67) in the United States (3.7%).

In Canada, the second most important increase (4.0%) is observed in the manufacturing of transport equipment (ISIC 34t35), followed by chemicals and chemical products (ISIC 24).

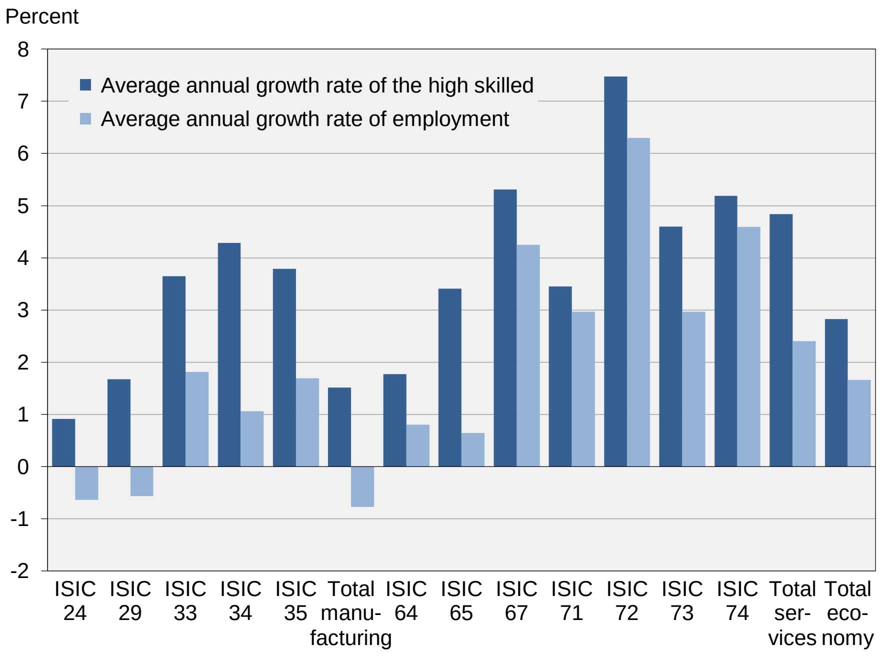
In all countries, increases in the high skilled workers in total economy are mainly driven by the services sectors.

Japan and the United States have a similar pattern in terms of decrease in the share of high-skilled workers. In Japan, the decrease is generalised in all the high and medium-high technology industries as for the total manufacturing. In the United States, a strong decrease is observed in the machinery and equipment not elsewhere classified (ISIC 29) and in total manufacturing to a lesser extent. In both countries, post and telecommunications sector (ISIC 64) is a knowledge-intensive sector where the share of high-skilled employees decreased as well over the 1998–2008 period.

[27] For further reading on classification of economic activities according to their technology intensity, see Hatzichronoglou, T. (1997).

[28] For further reading on knowledge intensive business services, see OECD (2006).

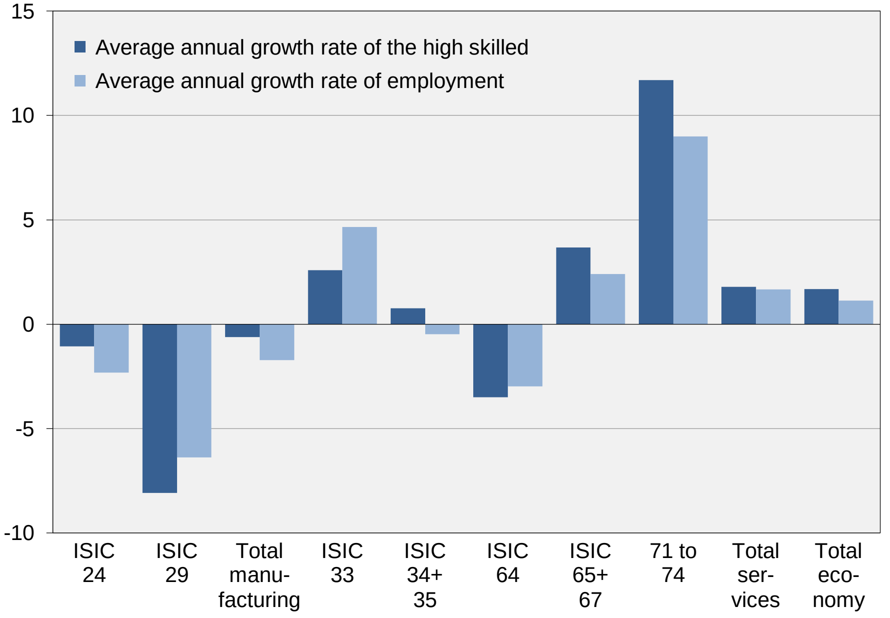
Figure 4.
Growth of high skilled workers in the EU-15 area, medium-high and high tech industries and in knowledge intensive business services, (1998–2008)



Source: OECD, ANSKILL database, April 2010.

Figure 5.
Growth of high skilled workers in the United States, medium-high and high technology industries and in knowledge intensive business services, (1997–2007)

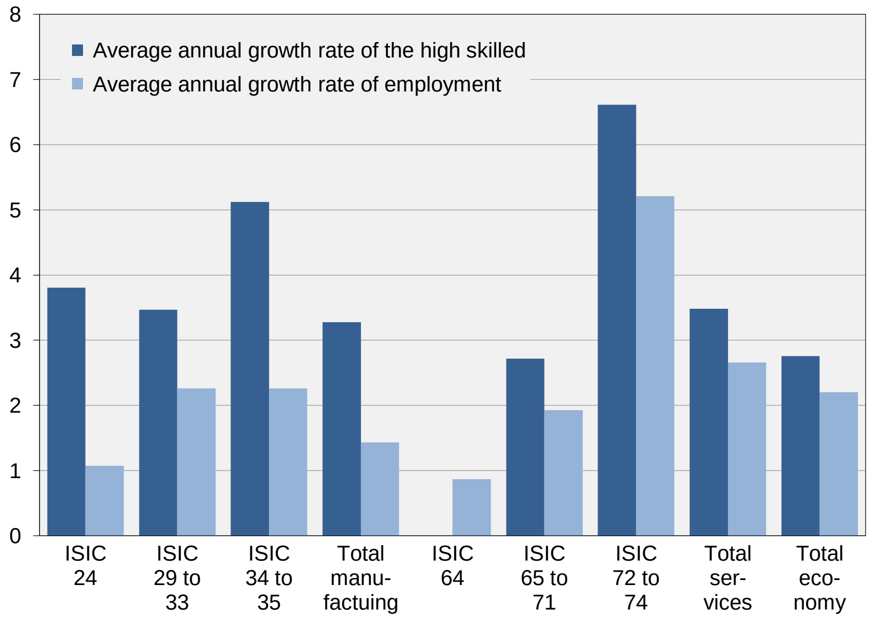
Percent



Source: OECD, ANSKILL database, April 2010.

Figure 6.
Growth of high skilled workers in Canada, medium-high and high tech industries and in knowledge intensive business services, (1997–2007)

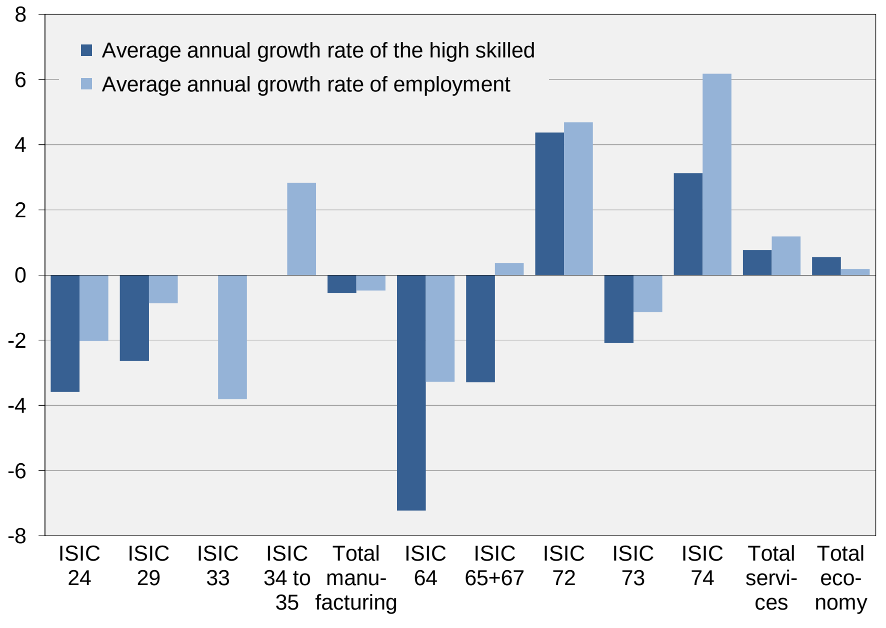
Percent



Source: OECD, ANSKILL database, April 2010.

Figure 7.
Growth of high skilled workers in Japan, medium-high and high tech industries and in knowledge intensive business services, (2003–2008)

Percent



Source: OECD, ANSKILL database, April 2010.

3.2. Foreign direct investment trends in OECD countries

For quite some time in most countries the only data available on foreign direct investment were data on capital flows and stocks. Investment is considered to be direct investment when the investor's objective is to establish a lasting interest in a foreign company for the purpose of influencing the management of that company. In order to reflect such influence in statistical terms, the convention is that any investment of more than 10 per cent of the value of the voting shares of a company must be treated as a direct investment, while any investment below 10% is considered to be a portfolio investment.

Over the past 20 years, the accelerating pace of economic globalisation, in which multinationals play a lead role, has raised new questions which conventional statistics on direct investment have only been able to answer indirectly through econometric estimates. For instance, job creation and R&D expenditure, linked directly to international investment, were difficult to evaluate. In order to respond better to this new demand, a new category of data on the activities of

multinational firms was developed. This category was based non on the concept influence over a company, but on the concept of control. The concept of control assumes that a company is controlled if an investor holds more than 50% of the company's ordinary shares or voting rights. Consequently, when a company is under foreign control (foreign affiliate) or when a national company controls a company abroad (affiliate abroad), all of the activities of those affiliates are deemed to be under foreign or national control, respectively[29].

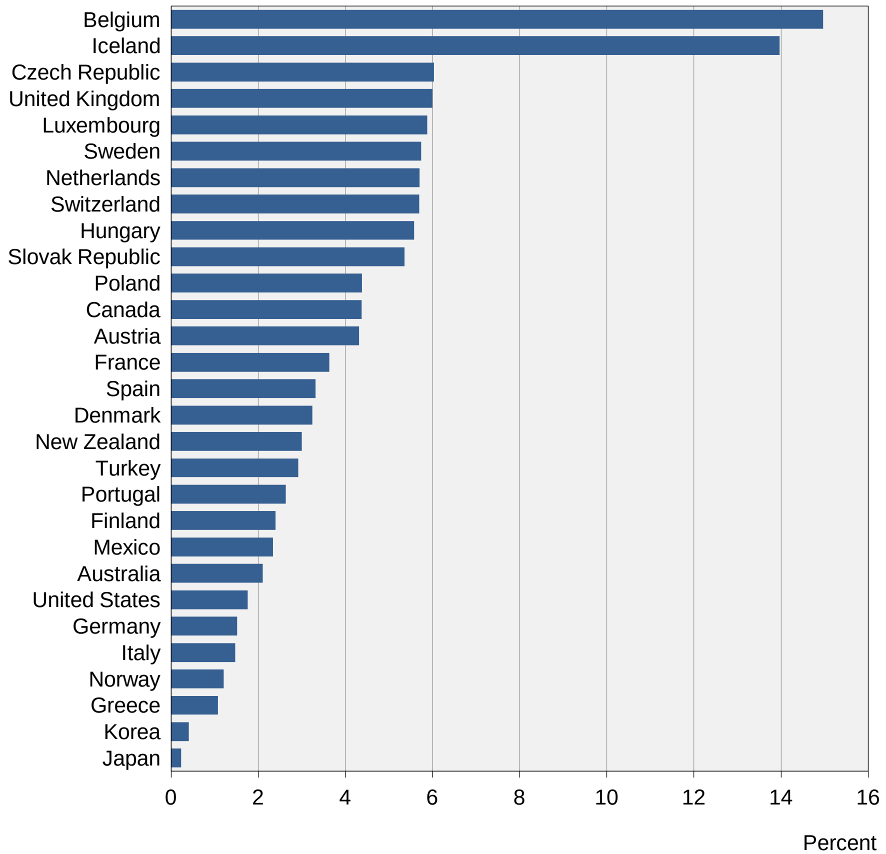
The FDI data used in this study are from the OECD Activities of Foreign Affiliates (AFA) and the FATS Databases. The first one covers the manufacturing sectors at a highly aggregated level of detail and provides information on production, employment, employee compensation, investment, trade (total and intra-firm), research and development and international diffusion of technology. The second database, created more recently, relates essentially to the services sector, starting with 1995. The FATS database covers 43 service sectors and gives a very detailed geographical breakdown (120 partner countries or zones). Until 2006, data was collected on only five variables (turnover, employment, value added, total exports and imports). Since 2007, countries have also been requested to supply data on personnel costs, intra-firm trade and R&D expenditures and personnel. As with the AFA database, coverage of the reporting countries is more extensive for inward investment than for outward investment.

3.2.1. FDI inflows to the OECD countries

As regards the overall FDI inflows figures across OECD countries, Figure 8 shows that over the 2005–2008 period, they represented almost 15% of the GDP in Belgium, followed by Iceland (13.9%). For the majority of countries, FDI inflows as a share of GDP range between 6% (Czech Republic) and 1% (Greece) whereas this same ratio was close to zero in Korea (0.4%) and Japan (0.2%).

[29] The conceptual and methodological framework for these statistics is described in OECD (2005).

Figure 8. FDI inflows to OECD countries, (2005–2008 average), as a percentage of GDP

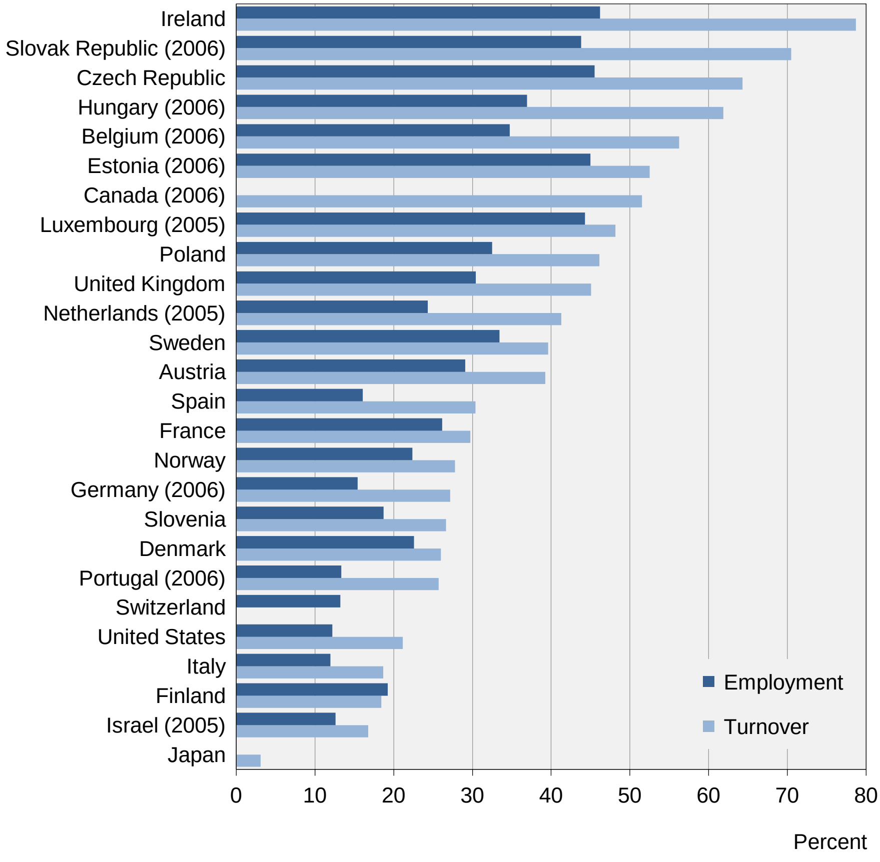


Source: OECD Economic Globalisation Indicators 2010 based on OECD, International Direct Investment and Annual National Accounts databases, June 2009.

If the inflow numbers of FDI is necessary for a first set of financial type of information, the following indicators on multinationals' activity provide more specific elements with respect to their activity and their relative importance compared to the firms of the local industries.

3.2.2. Activity of multinationals

Figure 9.
Share of foreign-controlled affiliates in manufacturing employment and turnover, 2007



Source: OECD Economic Globalisation Indicators 2010 based on OECD, AFA database, January 2010.

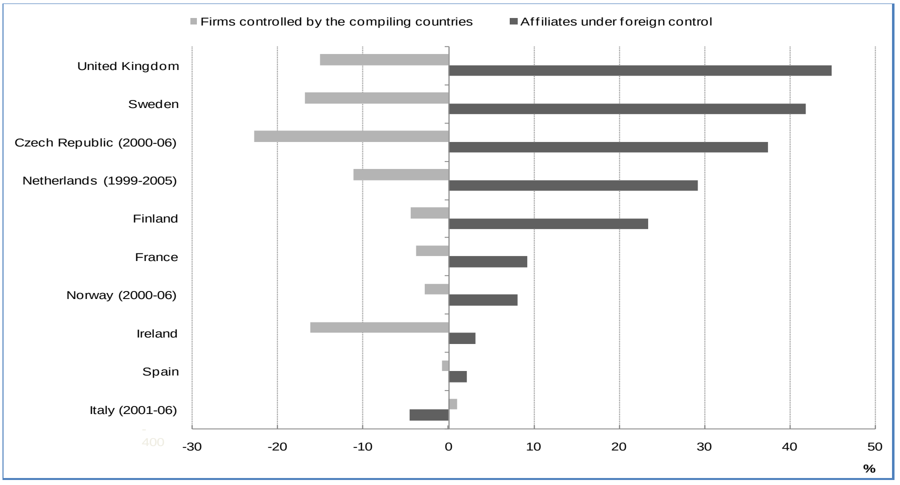
Note: The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

The relative shares of foreign-controlled affiliates as regards the employment and turnover (market sales of goods or services) figures in manufacturing sectors are presented in Figure 9. In Ireland and the Slovak Republic the turnover ratio exceeds the 70% which confirms the strong and active presence of foreign affiliates. Similar remarks are also true for the Czech Republic, Hungary and Belgium whereas the opposite picture can be observed for Japan.

The employment ratios were smaller in all countries, Ireland being again the leader where more than 46% of the manufacturing workers were employed in foreign-controlled affiliates.

Another variable of activity in the manufacturing is the value added (the value of output less the value of intermediate consumption). Figure 10 shows that between 1999 and 2006, the value added share of foreign-controlled affiliates grew more than the national ones in many countries for which the data was available. It increased more than 40% in the United Kingdom and Sweden where the national firms' share decreased by 15% and 17% respectively. This latter decreased the most in the Czech Republic (-23%), whereas Italy experienced reversed trends.

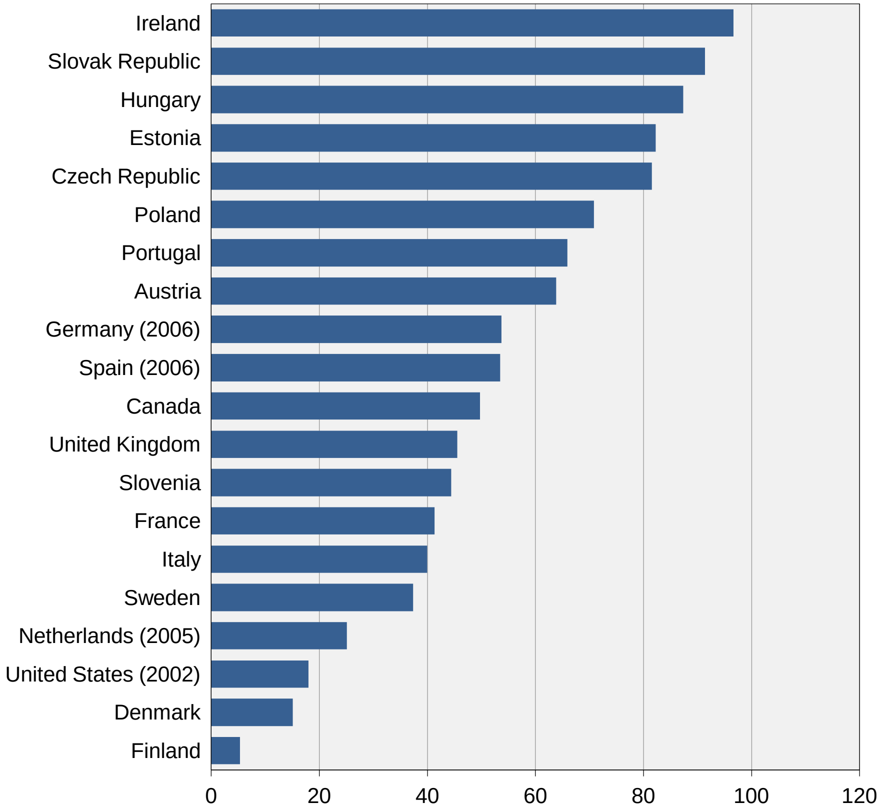
Figure 10.
Growth of foreign-controlled affiliates and national firms' share of manufacturing value added between 1999 and 2006 (%)



Source: OECD, AFA database, December 2009.

As for the skill assessment, a focus on the high technology industries shows that foreign value added is nearly 100% in Ireland and is more than 80% in the Slovak Republic, Hungary, Estonia and the Czech Republic (Figure 11). In an important number of European countries and in Canada, this ratio varied between 70.8% (Poland) and 37.3% (Sweden). The share was the lowest in Finland (5.3%), preceded by Denmark (15.1%).

Figure 11.
Share of foreign-controlled affiliates in high-technology manufacturing turnover, 2007



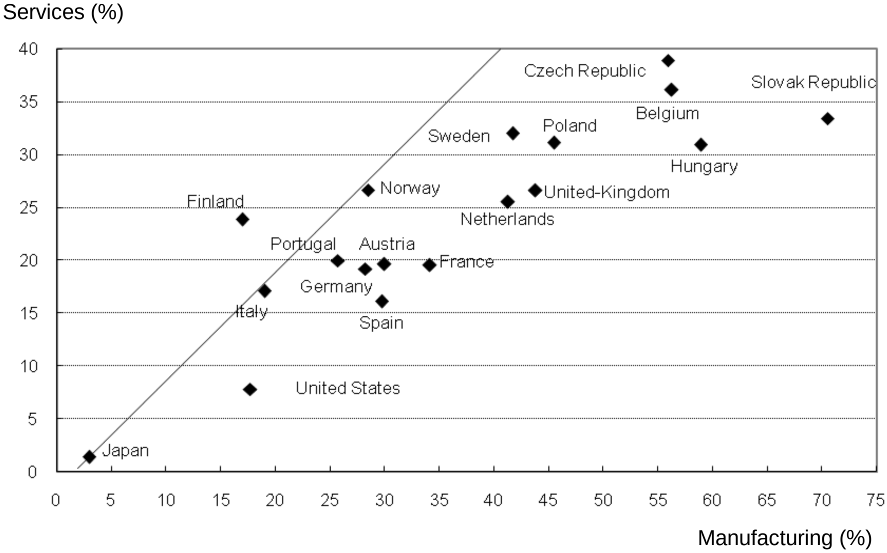
Source: OECD, AFA database, September 2011.

Finally, the last two figures aim to provide comparative information on foreign affiliates' activities in the manufacturing together with the services sectors. Figure 12 shows that there is a quite linear trend in all countries with respect to the employment shares in manufacturing and in services. Except in Finland, the employment shares in the manufacturing were either similar (such as in Japan, Italy, Norway) or higher compared to the services; the biggest gap being observed in the Slovak Republic, followed by Hungary and Belgium.

Similarly, labour productivity (value added / employment) levels can also be compared between the two sectors (Figure 13). In most of the countries, labour productivity levels were higher in the manufacturing with the exception of the Czech Republic, the Slovak

Republic, Hungary, Portugal and France where this former ratio was bigger in the services. In Japan, workers of the foreign affiliates were the most productive in the manufacturing, while this was the case for the services in France.

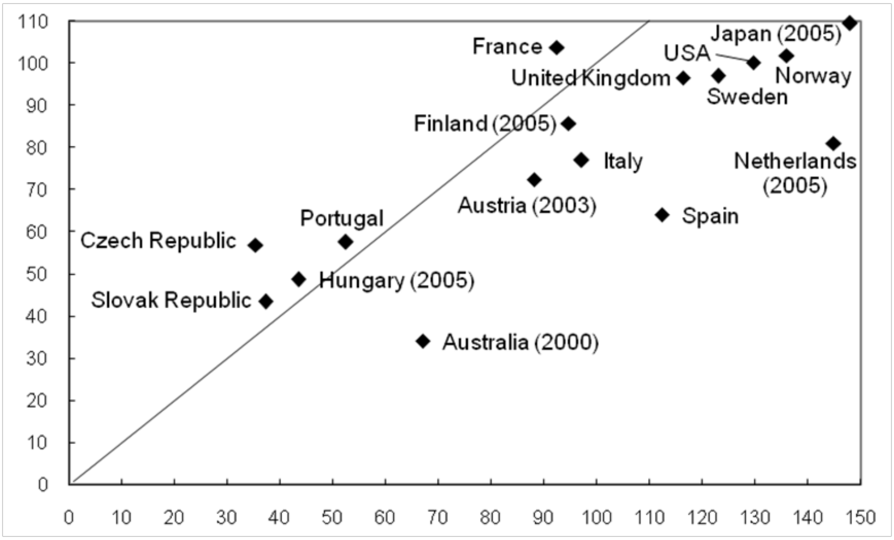
Figure 12.
Share of foreign affiliates in the employment of the services and manufacturing sectors, 2006



Source: OECD, AFA and FATS databases, December 2009.

Figure 13. Value added per employee (labour productivity) of affiliates under foreign control in manufacturing and service sectors, 2006

Services (thousand USD)



Manufacturing (%)

Source: OECD, AFA and FATS databases, December 2009.

IV. Empirical Evidence

4.1. Specification

In this section, we investigate empirically to which extent the skill composition of employment of a country influences the location decision of multinationals in this same county. While doing this, we resort to two skill proxies (as explanatory variables) that are available in the ANSKILL database: educational attainment and occupation so that to compare the relevancy of these two indicators for skill assessment. The notion of presence of foreign affiliates is also captured *via* two proxies (as dependent variables): number of foreign affiliates on the one hand, and their labour productivity levels on the other.

On the basis of the literature review presented earlier, the following equations are then tested twice; *i)* with the occupation proxy for skills (Tables 1a and 2a), *ii)* with the education proxy for skills (Tables 1b and 2b).

(1) $log\ NOE_{i,c,t} = \alpha_0 + \alpha_1.logHS_{i,c,t} + \alpha_2.logMS_{i,c,t} + \alpha_3 log(X+I) / GDP)_{c,t} + \alpha_4.log(FDI / GDP)_{c,t} + \alpha_5.log(VAf / VA)_{i,c,t} + \alpha_6.log(WAGEf / WAGE)_{i,c,t} + \alpha_7.log(Coop / POP)_{c,t} + \varepsilon_{i,c,t}$

(2) $logVAf / EMP_{i,c,t} = \alpha_0 + \alpha_1.logHS_{i,c,t} + \alpha_2.logMS_{i,c,t} + \alpha_3 log(NOE)_{i,c,t} + \alpha_4.log(FDI / GDP)_{c,t} + \alpha_5.log(WAGEf / WAGE)_{i,c,t} + \alpha_6.log(RD)_{i,c,t} + \alpha_7.log(Coop / POP)_{c,t} + \varepsilon_{i,c,t}$

Where *c* represents country at time *t* in a given industry i. $\varepsilon_{i,c,t}$ is a normally error term.

The correlation table of these variables is presented in the Annex 2 of this document.

The list of the variables used in this study is as follows:

HSo	Share of the high skilled workers (occupation definition)
MSo	Share of the medium skilled workers (occupation definition)
LSo	Share of the low skilled workers (occupation definition)
HSe	Share of the high skilled workers (education definition)
MSe	Share of the medium skilled workers (education definition)
LSe	Share of the low skilled workers (education definition)
NOE	Number of foreign affiliate firms
X	Total exports (at current $)
I	Total imports (at current $)
GDP	GDP per capita (at current $)
POP	Population
FDI	Foreign direct investment inflows (at current $)
VA*f*	Value added of the foreign affiliates (at current $)
VA	Total value added (at current $)
EMP	Number of employees of the foreign affiliates
WAGE*f*	Annual average wage per employee of the foreign affiliates
WAGE	Annual average wage per employee of all firms
Coop	Foreign ownership of domestic inventions
RD*f*	R&D expenditures of the foreign affiliates (at $ ppp)

4.2. Estimation results

In order to determine the relevancy of both of the skill proxies and to assess the impact of the high skilled workers on location decisions, a panel data analysis is conducted over the 1997–2007 period. To start, the Hausman test has been performed and allowed us to use the fixed effect model. Fixed effects control for any idiosyncratic characteristic of the countries and of industries that may explain differences in skills and productivity indicators. The estimation results of the equation (1) are shown below (Tables 1a and 1b).

Table 1a.
Log (NOE) estimation results with the occupation proxy

	model1	**model2**	**model3**	**model4**	**model5**	**model6**	**model7**	**model8**
log(HSo)	**0.306*****	**0.317*****	**0.255*****	**0.241*****	0.071	0.074	0.085+	0.040
	(4.054)	(4.004)	(3.411)	(3.429)	(1.310)	(1.198)	(1.874)	(0.884)
log(LSo)		0.029						
		(0.578)						
log(MSo)			-0.121*	-0.037	0.066	0.033	-0.049	-0.039
			(-1.999)	(-0.646)	(1.338)	(0.608)	(-0.937)	(-0.740)
log((X+I)/GDP)				**1.627*****	**0.317***	0.179	**0.488****	**0.442***
				(14.084)	(2.515)	(1.278)	(2.734)	(2.541)
log (FDI/GDP)					**0.609*****	**0.422*****	**0.207*****	0.033
					(11.653)	(10.454)	(5.090)	(0.715)
log (VAf / VA)						**0.436*****	**0.265*****	**0.257*****
						(9.144)	(5.776)	(5.647)
log (WAGEf/WAGE)							0.030	0.026
							(0.236)	(0.214)
log (Coop/POP)								**0.407*****
								(7.071)
Constant	5.022***	5.082***	4.833***	-2.222***	1.300**	3.344***	2.756	7.443***
	(54.888)	(35.571)	(40.772)	(-4.322)	(2.721)	(5.918)	(1.476)	(3.738)
r2	0.016	0.016	0.018	0.116	0.250	0.448	0.253	0.304
N	2874	2874	2874	2874	2873	2376	1532	1516

Numbers in parentheses are t - statistics. + means that the coefficients are significant at 10%,
* significant at 5%, ** significant at 1%,
*** significant at 1‰.

Table 1b.
Log (NOE) estimation results with the education proxy

	model9	model10	model11	model12	model13	model14	model15	model16
log(HSe)	**0.260*** (4.815)**	**0.192*** (3.472)**	**0.298*** (5.889)**	**0.268*** (5.634)**	**0.148*** (3.637)**	**0.148*** (4.118)**	**0.149*** (3.548)**	**0.071+ (1.693)**
log(LSe)		-0.325*** (-4.494)						
log(MSe)			0.259* (2.452)	0.217* (2.135)	0.074 (0.752)	-0.078 (-0.970)	0.040 (0.495)	-0.056 (-0.758)
log((X+I)/GDP)				**1.694*** (14.276)**	**0.407*** (3.335)**	**0.241+ (1.809)**	**0.507** (2.811)**	**0.490** (2.823)**
log (FDI/GDP)					**0.581*** (11.233)**	**0.404*** (10.811)**	**0.213*** (4.970)**	0.015 (0.271)
log (VAf / VA)						**0.439*** (9.155)**	**0.282*** (5.820)**	**0.273*** (5.829)**
log (WAGEf/WAGE)							-0.058 (-0.477)	-0.040 (-0.354)
log (Coop/POP)								**0.464*** (5.804)**
Constant	5.119*** (52.888)	4.515*** (26.675)	5.398*** (43.990)	-2.098*** (-3.874)	1.179* (2.435)	3.230*** (5.662)	1.717 (0.956)	7.025*** (3.753)
r2	0.025	0.052	0.034	0.136	0.258	0.467	0.277	0.335
N	2761	2761	2761	2761	2760	2288	1470	1453

Numbers in parentheses are t - statistics. + means that the coefficients are significant at 10%, * significant at 5%, ** significant at 1%,
*** significant at 1‰.

As for the general comments on these estimations, one can immediately notice that as soon as the explanatory variable is significant, its coefficient is positive. This means that the more the share of high skilled workers is important, the more it has an impact on the location decisions of multinationals.

Not surprisingly, another general result is the strong coefficient of the FDI/GDP ratio that can also be regarded as an indicator of foreign attractiveness. Together with the openness index (X+I / GDP), when it is introduced as the control variables, the high skill indicator (measured by the occupation proxy) lose its significance (Table 1a), whereas the coefficient of the education proxy remains positive and significant (Table 1b).

Another determinant factor for the location decisions turns out to be the VA*f* / VA which provides information on the value added level of the foreign affiliates compared to all the firms of a given industry in a given country. This variable remains always positive and significant in the model.

One might expect that in the same way, the coefficient of the variable WAGE*f* / WAGE would also act in the same direction. This variable measures the importance of annual average wage per employee compared to those of the sector. However, it remains insignificant throughout the model. This can probably be explained by the structure of the data, since most of the OECD countries are not labour intensive countries, labour cost considerations might not affect the location decisions of multinationals in these countries as opposite to the investments in the developing ones.

Finally, number of patents granted to the foreign inventors has a positive and very significant impact on the location decisions. The future work could include a focus on foreign investments in the high technology sectors that may allow a closer inspection of the coefficients of this variable.

As a result of this first set of estimations, we can conclude that the skill composition of employment can be regarded as one of the determinants of the MNEs' location decisions and the education proxy seems to have a better predictive capacity than the occupation proxy as far as the number of foreign affiliates is concerned.

These results can now be compared to the second set of estimations where the dependent variable (labour productivity) can be regarded as a better proxy of the real activity of the foreign affiliate firms.

Table 2a.
Log (VA*f* / EMP) estimation results with the occupation proxy

	model1	model2	model3	model4	model5	model6	model7	model8
log(HSo)	**0.354*** **	**0.385*** **	**0.292*** **	**0.222*** **	**0.251*** **	**0.269*** **	**0.461*** **	**0.427*** **
	(6.087)	(6.073)	(4.754)	(3.845)	(4.383)	(4.117)	(3.928)	(3.590)
log(LSo)		0.078+						
		(1.743)						
log(MSo)			-0.141*	-0.047	0.008	0.015	0.018	0.025
			(-2.085)	(-0.701)	(0.120)	(0.189)	(0.355)	(0.498)
log (FDI/GDP)				**0.259*** **	**0.157*** **	**0.097* **	**0.088+**	0.004
				(7.956)	(4.811)	(2.146)	(1.868)	(0.057)
log (NOE)					**0.144*** **	**0.113** **	0.072	0.052
					(3.664)	(2.854)	(1.001)	(0.728)
log (WAGEf/WAGE)						**0.720*** **	**0.581*** **	**0.584*** **
						(5.726)	(4.110)	(4.397)
log (RD*f*)							**0.050* **	**0.041* **
							(2.514)	(2.141)
log (Coop/POP)								**0.210* **
								(2.407)
Constant	11.586***	11.749***	11.360***	10.459***	10.257***	20.405***	18.673***	21.140***
	(163.684)	(95.022)	(94.581)	(69.345)	(48.193)	(11.713)	(9.004)	(9.281)
r2	0.026	0.029	0.030	0.082	0.121	0.146	0.243	0.257
N	2798	2798	2798	2798	2380	1532	607	607

Numbers in parentheses are t - statistics. + means that the coefficients are significant at 10%, * significant at 5%, ** significant at 1%,

*** significant at 1‰.

Table 2b.
Log (VA*f* / EMP) estimation results with the education proxy

	model9	model10	model11	model12	model13	model14	model15	model16
log(HSe)	**0.285*****	**0.230*****	**0.332*****	**0.275*****	**0.243*****	**0.283*****	**0.275*****	**0.254****
	(6.274)	(5.082)	(6.635)	(5.705)	(5.892)	(5.090)	(3.391)	(3.226)
log(LSe)		-0.263***						
		(-5.605)						
log(MSe)			**0.388*****	**0.288*****	**0.419*****	**0.491*****	**0.293***	**0.264***
			(6.435)	(4.645)	(6.391)	(4.182)	(2.233)	(2.352)
log (FDI/GDP)				**0.230*****	**0.137*****	**0.081+**	**0.104***	0.019
				(7.137)	(4.329)	(1.747)	(2.099)	(0.282)
log (NOE)					0.127***	0.095**	0.048	0.025
					(3.409)	(2.832)	(0.669)	(0.360)
log (WAGEf/WAGE)						**0.640*****	**0.497*****	**0.512*****
						(4.302)	(3.602)	(3.873)
log (RD*f*)							**0.059****	**0.050***
							(2.632)	(2.328)
log (Coop/POP)								**0.209***
								(2.379)
Constant	11.688***	11.216***	12.112***	11.111***	10.908***	20.030***	17.724***	20.315***
	(141.112)	(96.515)	(104.291)	(62.349)	(45.149)	(9.357)	(8.279)	(9.242)
r2	0.039	0.070	0.065	0.107	0.161	0.199	0.233	0.247
N	2722	2722	2722	2722	2292	1470	561	561

Numbers in parentheses are t - statistics. + means that the coefficients are significant at 10%,
* significant at 5%, ** significant at 1%,
*** significant at 1‰.

With respect to the labour productivity regressions, the high skill variable is always positive and significant, either with the occupation or the education proxy. Both of them have a strong predictive capacity while explaining the labour productivity of the foreign affiliate firms.

As opposite to the first set out models, the WAGE*f* / WAGE variable remains significant even other control variables are introduced. This shows that the wage differentials, between the average wages of the affiliates' employees and those of the sector in overall, can be a motivation factor for the employees of these former.

R&D spending of the foreign affiliates as well as the number of patents granted to the foreign inventors seem to have a positive and significant impact on the labour productivity in the foreign affiliate firms.

V. Conclusion

These preliminary explorations give important signs with respect to the role of skills in explaining location decisions of multinationals across OECD countries over the 1997–2007 period. With respect to the labour productivity regressions of this study, the high skill variable was always positive and significant, either with the occupation or the education proxy. This element can be regarded as a contribution to the existing human capital literature, pointing out that the occupation of individuals should be also taken into account for skill assessment.

Further improvements of this paper can include robustness checks through logistic panel estimations where the probability of a multinational firm to chose an industry in a given country would be assessed depending on the existence (and increase) of the high-skilled workers in that same industry of that given country.

In a policy perspective, these results confirm the important role of the investments in skills in order to promote and sustain economic growth. Indeed, many OECD countries have already entered in a phase of increasing as much as possible, the share of the high skilled individuals within the total employment. This is mainly observed by the strong increases in the educational attainment of the population. In addition, over the recent years, OECD countries oriented their immigration policies towards a more skilled-biased basis.

Nevertheless, before addressing general policy recommendations, one should take into account all the possible country and industry specifications before putting in place any specific employment policy such as the vocational training programs or *numerus clausus* types of regulations of professions. Therefore, one of the main items on our further research agenda is the emphasis on the country-specific impacts of skills on the location decisions of MNEs in order to enable member countries set up appropriate employment and investment policies.

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Annex 1. STAN Industry List

STAN industry list

Description	ISIC Rev.3	Description	ISIC Rev.3
TOTAL	**01-99**		
AGRICULTURE, HUNTING, FORESTRY AND FISHING	**01-05**	**MINING AND QUARRYING**	**10-14**
AGRICULTURE, HUNTING AND FORESTRY	**01-02**	MINING AND QUARRYING OF ENERGY PRODUCING MATERIALS	10-12
....AGRICULTURE, HUNTING AND RELATED SERVICE ACTIVITIES	01	....MINING OF COAL AND LIGNITE, EXTRACTION OF PEAT	10
....FORESTRY, LOGGING AND RELATED SERVICE ACTIVITIES	02	....EXTRACTION OF CRUDE PETROLEUM AND NATURAL GAS AND RELATED SERVICES	11
FISHING, FISH HATCHERIES, FISH FARMS AND RELATED SERVICES	**05**	....MINING OF URANIUM AND THORIUM ORES	12
		MINING AND QUARRYING EXCEPT ENERGY PRODUCING MATERIALS	13-14
		....MINING OF METAL ORES	13
INDUSTRY INCLUDING ENERGY	**10-41**	....OTHER MINING AND QUARRYING	14
MANUFACTURING	**15-37**	**ELECTRICITY, GAS AND WATER SUPPLY**	**40-41**
FOOD PRODUCTS, BEVERAGES AND TOBACCO	15-16	....ELECTRICITY, GAS, STEAM AND HOT WATER SUPPLY	40
....FOOD PRODUCTS AND BEVERAGES	15	....COLLECTION, PURIFICATION AND DISTRIBUTION OF WATER	41
....TOBACCO PRODUCTS	16		
TEXTILES, TEXTILE PRODUCTS, LEATHER AND FOOTWEAR	17-19	**CONSTRUCTION**	**45**
....TEXTILES AND TEXTILE PRODUCTS	17-18		
........TEXTILES	17	**WHOLESALE AND RETAIL TRADE - RESTAURANTS AND HOTELS**	**50-55**
........WEARING APPAREL, DRESSING AND DYEING OF FUR	18	WHOLESALE AND RETAIL TRADE - REPAIRS	50-52
....LEATHER, LEATHER PRODUCTS AND FOOTWEAR	19	....SALE, MAINTENANCE AND REPAIR OF MOTOR VEHICLES AND MOTORCYCLES - RETAIL SALE OF AUTOMOTIVE FUEL	50
WOOD AND PRODUCTS OF WOOD AND CORK	20	....WHOLESALE, TRADE AND COMMISSION EXCL. MOTOR VEHICLES	51
PULP, PAPER, PAPER PRODUCTS, PRINTING AND PUBLISHING	21-22	....RETAIL TRADE EXCL. MOTOR VEHICLES - REPAIR OF HOUSEHOLD GOODS	52
....PULP, PAPER AND PAPER PRODUCTS	21	HOTELS AND RESTAURANTS	55
....PRINTING AND PUBLISHING	22		
CHEMICAL, RUBBER, PLASTICS AND FUEL PRODUCTS	23-25	**TRANSPORT, STORAGE AND COMMUNICATIONS**	**60-64**
....COKE, REFINED PETROLEUM PRODUCTS AND NUCLEAR FUEL	23	TRANSPORT AND STORAGE	60-63
....CHEMICALS AND CHEMICAL PRODUCTS	24	....LAND TRANSPORT - TRANSPORT VIA PIPELINES	60
........CHEMICALS EXCLUDING PHARMACEUTICALS	24 *less* 2423	....WATER TRANSPORT	61
........PHARMACEUTICALS	2423	....AIR TRANSPORT	62
....RUBBER AND PLASTICS PRODUCTS	25	....SUPPORTING AND AUXILIARY TRANSPORT ACTIVITIES	63
OTHER NON-METALLIC MINERAL PRODUCTS	26	POST AND TELECOMMUNICATIONS	64
BASIC METALS, METAL PRODUCTS, MACHINERY AND EQUIPMENT	27-35		
BASIC METALS AND FABRICATED METAL PRODUCTS	27-28	**FINANCE, INSURANCE, REAL ESTATE AND BUSINESS SERVICES**	**65-74**
....BASIC METALS	27	FINANCIAL INTERMEDIATION	65-67
........IRON AND STEEL	271+2731	....FINANCIAL INTERMEDIATION except insurance and pension funding	65
........NON-FERROUS METALS	272+2732	....INSURANCE AND PENSION FUNDING, except compulsory social security	66
....FABRICATED METAL PRODUCTS, except machinery and equipment	28	....ACTIVITIES RELATED TO FINANCIAL INTERMEDIATION	67
MACHINERY AND EQUIPMENT	29-33	REAL ESTATE, RENTING AND BUSINESS ACTIVITIES	70-74
....MACHINERY AND EQUIPMENT, N.E.C.	29	....REAL ESTATE ACTIVITIES	70
....ELECTRICAL AND OPTICAL EQUIPMENT	30-33	....RENTING OF MACH. AND EQUIP. - OTHER BUSINESS ACTIVITIES	71-74
........OFFICE, ACCOUNTING AND COMPUTING MACHINERY	30	........RENTING OF MACHINERY AND EQUIPMENT	71
........ELECTRICAL MACHINERY AND APPARATUS, NEC	31	........COMPUTER AND RELATED ACTIVITIES	72
........RADIO, TELEVISION AND COMMUNICATION EQUIPMENT	32	........RESEARCH AND DEVELOPMENT	73
........MEDICAL, PRECISION AND OPTICAL INSTRUMENTS	33	........OTHER BUSINESS ACTIVITIES	74
TRANSPORT EQUIPMENT	34-35		
....MOTOR VEHICLES, TRAILERS AND SEMI-TRAILERS	34	**COMMUNITY, SOCIAL AND PERSONAL SERVICES**	**75-99**
....OTHER TRANSPORT EQUIPMENT	35	PUBLIC ADMIN. AND DEFENCE - COMPULSORY SOCIAL SECURITY	75
........BUILDING AND REPAIRING OF SHIPS AND BOATS	351	EDUCATION	80
........AIRCRAFT AND SPACECRAFT	353	HEALTH AND SOCIAL WORK	85
........RAILROAD EQUIPMENT AND TRANSPORT EQUIPMENT N.E.C.	352+359	OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES	90-93
MANUFACTURING N.E.C. AND RECYCLING	36-37	....SEWAGE AND REFUSE DISPOSAL, SANITATION AND SIMILAR ACTIVITIES	90
MANUFACTURING N.E.C.	36	....ACTIVITIES OF MEMBERSHIP ORGANIZATIONS N.E.C.	91
RECYCLING	37	....RECREATIONAL, CULTURAL AND SPORTING ACTIVITIES	92
		....OTHER SERVICE ACTIVITIES	93
		PRIVATE HOUSEHOLDS WITH EMPLOYED PERSONS	95
HIGH-TECHNOLOGY MANUFACTURES	2423,30,32,33,353	EXTRA-TERRITORIAL ORGANIZATIONS AND BODIES	99
MEDIUM-HIGH TECHNOLOGY MANUFACTURES	24 less 2423,29,31,34,352+359		
MEDIUM-LOW TECHNOLOGY MANUFACTURES	23,25-28,351	**TOTAL SERVICES**	**50-99**
LOW TECHNOLOGY MANUFACTURES	15-22,36-37	**BUSINESS SECTOR SERVICES**	**50-74**
HIGH AND MEDIUM-HIGH TECHNOLOGY MANUFACTURES (incl. 351)	24, 29-35	**NON-AGRICULTURE BUSINESS SECTOR excluding Real Estate**	**10-67,71-74**
ENERGY PRODUCING ACTIVITIES	10-12,23,40	**BUSINESS SECTOR SERVICES excluding Real Estate**	**50-67,71-74**

Annex 2. Correlation Table

	log (NOE)	log (HSo)	log (MSo)	log (LSo)	log (HSe)	log (MSe)	log (LSe)
log (NOE)	1.0000						
log (HSo)	0.0315	1.0000					
log (MSo)	0.1053	-0.5535	1.0000				
log (LSo)	-0.0769	-0.5288	-0.1115	1.0000			
log (HSe)	-0.2249	0.6708	-0.4634	-0.2704	1.0000		
log (MSe)	0.2167	0.2251	-0.0111	-0.1340	-0.2621	1.0000	
log (LSe)	-0.0776	-0.5348	0.2622	0.4827	-0.1578	-0.6188	1.0000
log (X+I/GDP)	-0.0408	0.1389	-0.0210	-0.0913	-0.1514	0.4933	-0.5222
log (FDI/GDP)	-0.0521	0.0176	-0.0339	0.0734	0.0203	0.1126	-0.2621
log (Vaf/VA)	-0.0234	0.0859	-0.1374	0.1260	0.1201	0.1256	-0.0337
log (WAGEf/WAGE)	0.1242	-0.0750	0.1107	-0.0836	0.0194	-0.2938	0.3374
log (coop)	-0.3074	0.1647	-0.0779	0.0474	0.2837	0.0961	0.2898
log (RD)	0.4284	0.2207	-0.1217	0.0138	0.2673	-0.1234	0.2120

	log (X+I/GDP)	log (FDI/GDP)	log (Vaf/VA)	log (WAGEf/WAGE)	log (coop)	Log (RD)
log (NOE)						
log (HSo)						
log (MSo)						
log (LSo)						
log (HSe)						
log (MSe)						
log (LSe)						
log (X+I/GDP)	1.0000					
log (FDI/GDP)	0.7578	1.0000				
log (Vaf/VA)	0.1622	0.3051	1.0000			
log (WAGEf/WAGE)	-0.3410	-0.2033	0.2913	1.0000		
log (coop)	-0.1310	-0.2343	0.0871	0.0756	1.0000	
log (RD)	-0.3784	-0.2153	0.3439	0.2780	0.1811	1.0000

Bank output measurement in the euro area – a modified approach[30] [31]

Antonio Colangelo[32] *and Robert Inklaar*[33]

Abstract: Banks do not charge explicit fees for many of the services they provide, bundling the service payment with the offered interest rates. This output therefore has to be imputed using estimates of the opportunity cost of funds. We argue that rather than using the single short-term, low-risk interest rate as in current official statistics, reference rates should match the risk characteristics of loans and deposits. This would lower euro area imputed bank output by, on average, 28 to 54 percent compared with the current methodology, implying that euro area GDP (at current prices) is overstated by 0.11 to 0.18 percent. This adjustment also leads to more plausible shares in value added of income from fixed capital in the banking industry.

JEL No. E01, E44, O47

Key words: Bank output, FISIM, risk, loan interest rates, deposit interest rates.

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1 Introduction

Banks do not charge explicit fees for many of the services they provide.[34] Instead, the payment for the services is usually bundled with the interest rates charged on loans and paid on deposits. Any complete measure of bank output should take this into account by estimating what part of bank interest rates is a payment for services and what part is the cost of funds. This is often referred to as the 'user cost' methodology and is widely adopted by statistical agencies.[35] In this paper, we argue that the methodology that is currently used in the euro area (and in many other economies) is flawed because it does not take into account the risk characteristics of loans and deposits. We present new euro area estimates based on our proposed methodology and compare them with results based on the current methodology.[36]

The key point of contention in estimating bank output is identifying the opportunity cost of funds. In current European National Accounts methodology, the inter-bank rate is used as the cost of funds for all loans and deposits.[37] However, in recent theoretical work, Wang *et al.* (2009) show that profit-maximizing banks would not use such an interest rate as a measure of the opportunity costs of funds. Instead, they would use an interest that reflects the (systematic) risk associated with each loan or deposit, so taking into account the risk of default and any term premium.[38] Recently, the Wang *et al.* (2009) methodology has been applied for US commercial banks in Basu *et al.* (2011). They find that current methodologies

[34] Where we talk about banks, we refer to the group of other Monetary Financial Institutions (MFIs), which mainly includes credit institutions and money market funds (MMFs); for more information, see Regulation ECB/2008/32. The bias from including MMFs is marginal; MMFs loans and deposits vis-à-vis non-MFI euro area residents were on average 0.03% of MFI loans and deposits for the period 2007 to 2010.

[35] The user cost approach has its origin in the theoretical work of Diewert (1974) and Barnett (1978). Applications in an academic context are, amongst others, Fixler and Zieschang (1993) and Begg, Bournay, Weale and Wright (1996); and an accessible discussion of the implementation in a statistical context is found in Fixler, Reinsdorf and Smith (2003).

[36] This paper concentrates on estimates of output at current prices. For details on the methodology for FISIM volume measures, see Eurostat (2001), Basu and Wang (2006) and Inklaar and Wang (2011).

[37] This is consistent with the recommendations of the System of National Accounts, see *1993 SNA*, paragraph 6.128.

[38] The arguments are based on financial intermediation theory, such as discussed in Bhattacharya and Thakor (1993), Allen and Santomero (2001), and Levine (2005).

overestimate US imputed bank output by 45 percent. The contribution of this paper is to apply the Wang *et al.* (2009) methodology to the euro area to establish whether or not the large overestimation is a common feature across countries.

It is important to have an accurate and appropriate measure for imputed bank output. First of all, it is part of overall banking sector output (in addition to fees and commissions) and insofar as banks serve households, government or foreign demand, imputed bank output contributes to overall GDP. Additionally, the interest margin is part of the price of bank output, so how this price is measured will affect overall producer and consumer prices. In this paper, we match bank interest rates with market interest rates with comparable risk characteristics and compare our new bank output estimates to those under the current methodology. Our findings imply that, on average, imputed bank output is overestimated by 28 to 54 percent and euro area GDP (at current prices) is overestimated by between €8.8bln and €14.7bln or 0.11 to 0.18 percent. The higher numbers are estimated using the same conceptual approach as Basu *et al.* (2011), so we conclude that euro area bank output is overestimated to the same degree as US bank output.

Our proposed methodology would be a conceptual improvement, because it strengthens the internal consistency of the System of National Accounts (SNA). By excluding the compensation for risk-bearing from bank output, the financing mix of a firm (bonds versus bank loans) would no longer affect firm value added and bank output would no longer change if the bank decides to securitize and sell loans rather than keep those loans on the balance sheet. This represents a modest adjustment to the SNA, but it is certainly not the only possible adjustment to improve consistency.[39] Households could be credited with risk-bearing output from holding bonds and equity and the output of insurance firms could be set equal to gross premiums, rather than premiums minus expected losses, to reflect risk-bearing output. This would require an expansion of the set of inputs recognized under SNA: not only labour, fixed capital and intermediate inputs (i.e. the output of other industries) would provide income, but also financial capital. In turn, the value from risky activities, such as investing in new ventures, would shift from

[39] For a more general discussion on different approaches to accounting for the output of bank services in National Accounts, see Diewert, Fixler and Zieschang (2011).

where it is created to where the income from it ends up. We do not argue that such an alternative system would be conceptually better or worse, merely that it would require a much more drastic adjustment to the current system than our proposed adaptation to the measurement of bank output.

The rest of the paper is organised as follows. Section two describes the current methodology for estimating bank output in European statistics; Section three deals with our proposed methodology, presenting both its conceptual framework and the empirical set-up. The estimates from the new methodology are presented in Section four for the euro area[40] as a whole and compared to imputed bank output derived according to the current European methodology.[41] Finally, we offer some concluding remarks.

2 Imputed bank output – current methodology

Imputed bank output is commonly referred to as Financial Intermediation Services Indirectly Measured (FISIM) in official statistics. FISIM are the financial services that other MFIs and Other Financial Intermediaries (excluding insurance corporations and pension funds, OFIs) provide to their customers but which are not directly invoiced. For depositors, these services generally include the management of the accounts, the provision of accounts statements and fund transfers between accounts. Banks may charge explicit fees for deposit accounts, but in addition, the interest rate received on these accounts is typically lower than what customers could have obtained by lending their money directly on the market. For borrowers, these financial services include the screening and monitoring of their creditworthiness, financial advice, the smoothing over time of repayments, and the recording of the repayments for accounting purposes. They are paid by an increase of the interest rates charged by banks.

In contrast, there is no intermediation service for debt securities: to the extent that a bank was involved in issuing or placing these securities, they will have received an upfront fee and to the extent

[40] All estimates in the paper refer to the moving composition of the euro area, i.e. data prior to January 2007 do not include Slovenia and similarly, data prior to January 2008 do not include Cyprus and Malta.

[41] The FISIM estimates presented in this paper are not based on national official statistics but have been derived by the ECB simulating this methodology.

that they bought these in the secondary market, they have not provided services.

FISIM is valued on the basis of the difference between the actual rates of interest payable on deposits and receivable on loans vis-à-vis other sectors (including the rest of the world) and a "reference" rate of interest. For loans, it is measured as the difference between the effective interest rate charged on loans and the amount that would be paid if a reference rate were used. For deposits it is measured by the difference between the interest they would receive if a reference rate were used and the effective interest they actually receive.

In turn, the reference rate is defined as the average interest rate at which FISIM-producer sectors lend money to each other.[42] In particular, the *1995 ESA* distinguishes between an internal reference rate, to be used for transactions among residents, and an external reference rate, to be used for the business between residents and the rest of the world, with the possibility of compiling different external reference rates according to currencies of denomination and counterpart areas.

The current approach has various shortcomings. The method does not appropriately capture the differences between the various types of loans and deposits: for instance, whereas the inter-bank business is mainly short term with low default risk premium, deposits and loans from/to other sectors may have completely different maturity structures with sometimes high default risk. Within the current methodological framework, compensation for term premium and default risk is treated as a productive service, while recent economic theories argue against this.

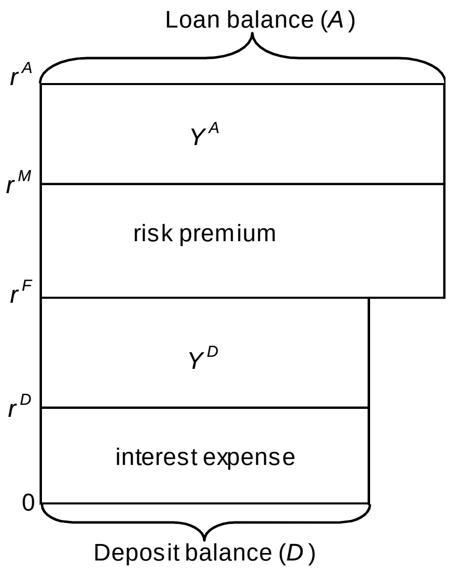
[42] The reference rate is computed as a weighted average of money market rates that reflects the currency and maturity composition of the financial intermediaries' lending market. The positions vis-à-vis the central banks are excluded from this computation. It also follows that when comparing reference rates for different reference areas, the average inter-bank rates may differ due to the currency and maturity composition of the market. As financial intermediaries include banks and OFIs, the reference rate may also diverge from the average inter-bank rate depending on the relative size of OFIs.

3 The new methodology

3.1 The conceptual framework

A measure of bank output cannot be estimated without a description of the financial services that customers buy. This is also the starting point of the model developed in Wang *et al.* (2009) and this section is based on their arguments. It goes too far in an empirical paper like this to provide a full exposition of their general equilibrium model, so this section will focus on the main arguments and empirical implications of their model. The key conclusion of Wang *et al.* (2009) and the earlier Wang (2003) studies is that the value of bank services output depends on the interest charged and the corresponding, risk-adjusted opportunity costs of funds. To impute the cost of funds on any such risky financial instrument, one should use the rate of return on (debt) securities subject to the same risk, but without any services attached. Total income net of the pure costs of funds then measures the true value of bank services implicitly charged for. This conclusion is summarized in Figure 1, which shows graphically how we impute the value of bank services related to loans (Y^A) and deposits (Y^D) using data on the interest rate paid on deposits (r^D), the interest rate charged on loans (r^A) and market interest rates on risk-free securities (r^F) and risky securities (r^M).

Figure 1
Decomposition of a bank's interest flows (simplified version)



Notes:
r^A: (Average) interest rate received on loans
r^M: Expected rate of return required on market securities with the same (systematic) risk characteristics as the loans
r^F: Risk-free rate
$r^{F'}$: Short-term risk-free rate
r^D: (Average) interest rate paid on deposits
Y^A: Nominal output of bank services to borrowers
Y^D: Nominal output of bank services to depositors
For a more detailed decomposition, see Wang (2003).

As implied by the figure, the output associated with loans is calculated as:

(1) $$Y^A = \left(r^A - r^M\right)A,$$

and the output associated with deposits as:

(2) $$Y^D = \left(r^F - r^D\right)D$$

The output related to loans, Y^A, is associated with information services, such as screening the creditworthiness of new borrowers and monitoring their behaviour over the duration of the loan. The output related to deposits, Y^D, is related to the transaction services a bank provides to depositors: ready access to funds through ATMs, easy payment through credit and debit cards and electronic fund transfers. Here we follow the financial intermediation literature, such as discussed in Bhattacharya and Thakor (1993), Allen and Santomero (2001) and summarized in Levine (2005), on the functions that banks provide.

In imputing the output related to deposits, we argue that households could choose an alternative investment, rather than putting money in a deposit account. Since most deposit accounts are insured, they are (close to) default risk free, though they are still exposed to term risk. So when a depositor accepts a lower return than the default risk-free rate, he must be receiving transaction services with the same value in return. Although a truly default risk-free investment alternative may not be available in practice, an AAA-rated government bond would come closest.[43] Likewise, a borrower would be willing to pay a higher interest rate on a loan than he would have to pay to investors in the financial markets only if the borrower receives information services of the same value from the bank. Especially smaller firms would not usually have the option to borrow directly from investors, but even for those firms, banks would take into account the systematic risk associated with lending to such a firm in determining the opportunity costs of its funds.

Figure 1 illustrates the difference between the current methodology and our proposed methodology. The current methodology imputes bank services related to loans using r^F, so bank output includes the risk premium, while we argue that it should be excluded. To give the main intuition for this argument, consider a firm that can choose to borrow from a bank or can issue a bond. This firm would need to pay r^M to its bondholders or r^A to the bank. Under the accounting approach in the SNA, any interest paid would count as a transfer of income, while a service payment would be considered a purchase of intermediate services. Value added of the borrowing firm will thus depend on how much of r^A is considered an interest payment and how much a service payment. Under the current methodology, if the firm borrows from a bank only r^F is considered an interest payment while if the firm issues a bond, the interest payment is r^M. We propose a symmetric treatment of bank and bond borrowing: in

[43] Moreover, since the government treasury is usually the ultimate guarantor of deposit insurance schemes, the default risk on deposit accounts would be related to the default risk on government bonds.

both situations the firm is credited with the same interest payment of r^M.

Our proposed methodology would also make bank output invariant to whether the bank chooses to keep a loan on its balance sheet or whether it securitizes and sells it to other investors. In both cases, the bank determines the creditworthiness of the borrower and ensures the borrower pays the interest. In other words, the banks provide the same services.[44] The investors that buy the securitized loan would require a rate of return of r^M, leaving Y^A as the fee for originating and servicing the loan. Under the current methodology, a bank that securitized all its loans would have an output of Y^A while if the same bank kept all loans on its balance sheet, it would have an output of Y^A plus the risk premium. Since there is no difference in the financial services the bank provides to its customers, the borrowers, we would argue there should be no difference in the value of its output.

Of course, this is not the only internally consistent accounting system, see more in general Diewert, Fixler and Zieschang (2011) on accounting for financial services within the framework of National Accounts. One could alternatively decide to classify risk bearing as a productive service, but this would require farther-reaching adjustments to the SNA than what we propose here. For instance, bondholders should then also be credited with output equal to the risk premium. Likewise, the output of an insurance firm should no longer be equal to gross premiums minus expected losses, but equal to gross premiums instead since it is also bearing risk. Moreover, since this risk-bearing output is not 'produced' using labour, intermediate inputs or fixed capital, a different class of inputs, perhaps 'financial capital', should be distinguished.[45] In our view, such a system of national accounts would not be better or worse, but merely very different from the system we have now. We therefore propose a comparatively modest change to the current accounting rules to improve its internal consistency.

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[44] This assumption may not hold in general, but finds support in Benmelech *et al.* (2011).

[45] To see why, consider what traditional inputs it would take to start bearing risk on corporate bonds: the purchase of the bond, i.e. the provision of financial capital, itself is enough to start bearing risk.

3.2 The empirical set-up

Figure 1 illustrates the type of data we need to implement both the current and proposed methodology, namely bank interest rates, market interest rates, and loan and deposit balances. For the bank interest rates, we make use of the MFI interest rate (MIR) statistics.[46] These statistics provide a harmonised and comprehensive coverage of the interest rates charged by euro area banks to households and non-financial corporations on euro-denominated loans and deposits on a monthly basis since 2003. These data are available at the national and euro area level, and distinguish between the interest rate on new business, i.e. newly negotiated interest rates during the period, and average rates on outstanding amounts. Detailed breakdowns are provided both by maturity and type of deposit, while for loans the data are broken down by maturity/period of rate fixation and, in the case of households, by purpose of the loan, i.e. consumer credit, loans for house purchases and other credit.

The first proposed improvement is to take into account the maturity structure of loans and deposits using the government bond yield curve[47] and, for short maturities, money market rates; in this paper we use the euro area government bond yield curve derived by Thomson Reuters Datastream based on AAA government bonds issued in the euro area. In the absence of detailed information on the average maturity/period of rate fixation for each category of loans and deposits for households and non-financial corporations, the reference rates have been selected based on the estimation of a pass-through equation in an error-correction framework. The market rate that provides the best-fitting model is used as reference rate.[48]

Bank loan rates are also higher because of default risk. Data on the yield on bonds, specifically indices of non-financial corporate bonds

[46] The requirements for MIR statistics are laid down in Regulation ECB/2009/7. In particular, it should be underlined that the reporting scheme defined in the Regulation applies only to other MFIs, thus excluding central banks and MMFs. For further information, see http://www.ecb.europa.eu/stats/money/interest/interest/html/index.en.html.

[47] The government bond yields are based on (notional) zero-coupon bonds, so the duration of these bonds is equal to its maturity. Most bank loans will have regular interest payments, so the duration of those loans will be smaller than their maturity. For most maturities, this distortion is likely to be small. Assuming annual interest payments of a 5 percent interest rate, the duration will be on average 10% of a year shorter than the maturity for the maturity bracket of one to five years.

[48] Appendix 2 discusses this approach and shows the estimation results.

and of covered bonds are used to take this into account.[49] The indices we use are compiled by Merrill Lynch, which provides information on the average yield of the bonds after adjusting for option-like features of these bonds. For those indices Merrill Lynch also provides the average residual maturity of the underlying bonds, thus allowing us to take into account the difference in maturity structure of the bond indices compared to the loan categories, see Section 3.2.2 for more details.

For the other sectors, as well as for cross-border positions, some working assumptions are applied due to missing basic data; in Section 3.2.3 below we will argue that this approach is likely to lead to more sound estimates compared to the current framework.

We estimate interest margins using bank interest rates and reference rates. We consider two sets of margins, namely one set where the reference rates account for the term risk of the corresponding bank interest rates (see Table A1) and one set where the reference rates account for both term and default risk (see Table A2). To estimate FISIM, we follow at two-step procedure. First, we calculate a weighted average margin for each instrument across different maturities/periods of rate fixation. The weight on each maturity/period of rate fixation category is given by the amount of new loans and deposits, since information about total outstanding amounts does not follow the same categories, see Section 3.2.1. The margin for each instrument is then multiplied with outstanding loans and deposits from the ECB data on MFI balance sheets to calculate bank output.[50] For a given loan instrument, this can be summarized as:

$$Y^A = A\sum_i s_i^N \left(r_i^A - r_i^M\right) \tag{3}$$

[49] Another way of indirectly performing the correction would be to use data on loan provisions which may be collected for financial stability purposes by national authorities; in practice this approach may lead to incomparable results due to the lack of harmonisation of statistics on loan provisions across countries and this would not allow for identification of systematic risk.

[50] This approach could overestimate bank output as some of the services on loans are provided only at the time of agreeing on or renegotiating the terms. This bias should be small for non-financial corporations as most these loans have initial rate fixation below one year, but could be more problematic for households. Still, this approach looks more sound than relying on new business volumes only, thus neglecting those services that are provided over the life span of deposits and loans.

where $s_i^N = A_i^N \Big/ \sum_i A_i^N$ is the share of maturity/period of rate fixation category *i* in total new loans of that instrument and *A* is the total amount of loans outstanding of that instrument.

In our analysis, we abstract from differences in tax treatment of interest earnings and in accounting rules. This is because we are primarily interested in comparing FISIM including and excluding compensation for risk bearing. Tax laws and accounting rules would affect FISIM, but we have no reason to believe they would affect the difference between the FISIM measures.

3.2.1 Bank interest rates for households and non-financial corporations

As indicated before, an important question is whether to use the 'new business' (NB) or 'outstanding amounts' (OA) bank interest rates. The estimated margin should be relevant for the entire portfolio of bank loans, arguing for OA rates. A drawback of this approach is that the correct reference rate is difficult to define as many loans have interest rates that were agreed some years before. Ideally, the reference rate should then be a weighted average of past bond yields, where the weights reflect the share of loans from each period in the past that are still on banks' balance sheets.

In addition, current definitions of NB and OA interest rates are not homogeneous for different maturities. NB rates are categorised according to the initial period of rate fixation while OA rates are categorised according to the original time to maturity of the loan.[51] Hence, for instance, if a loan has an original maturity of seven years, but rates are renegotiated annually, it would be more appropriate to compare the interest rate on this loan to the yield on a bond with a time to maturity of one year rather seven years. Given these considerations, we will rely on the NB rates to calculate the interest margins. This differs from the current methodology, which uses OA rates.[52]

[51] For a detailed discussion of the MIR statistics, see ECB (2003).

[52] In this paper we do not take into consideration interest rate statistics on bank overdrafts that are available in the context of MIR statistics. Before June 2010 this category was indistinguishable from revolving loans (including those obtained through a line of credit) and credit card debt. The difficulty of matching the resulting interest rates with reference rates reflecting maturity and risk characteristics of these instruments leads us to leave them out of the scope of the paper.

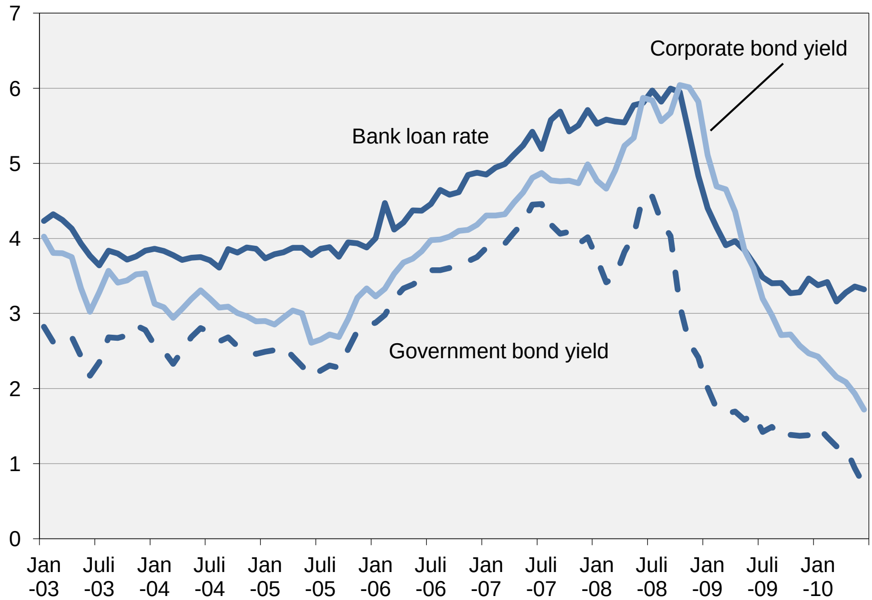
3.2.2 Reference rates for loans to non-financial corporations and households

The proposed method requires data on the current market yield of different types of debt securities with a broad coverage of the euro area market. Therefore, bond indices are preferred over individual bonds. By using bond indices, we assume that the *systematic* risk associated with this group of bonds is representative for the corresponding bank loans. Bank loans may default at a higher rate than bonds and individual loans may have considerable idiosyncratic risk, but the Wang *et al.* (2009) theory implies that the opportunity cost of funds covers only systematic risk.

Merrill Lynch publishes a range of bond indices[53] for non-financial corporations broken down by rating category or broken down by maturity band. We choose the bond index broken down by maturity band as it allows us to identify the term risk reasonably well, by comparing the yield on this index to the yield on government bonds with comparable maturity. This does imply we assume that the systematic default risk on bonds in this index, with average rating between BBB and A, is representative for bank loans to non-financial corporations.

[53] See www.mlindex.ml.com for these data as well as the bond index rules and definitions. Merrill Lynch does not produce country-specific bond indices as most national debt markets within the euro area are not deep enough for the derivation of reliable and meaningful bond indices.

Figure 2
Interest rate on business loans compared to corporate and government bonds (%), January 2003 – June 2010



Sources: ECB (MIR interest rates), Thomson Reuters Datastream (Government bonds), Merrill Lynch (Corporate bonds)

Notes: All series for the euro area. Bank loan rate refers to loans to non-financial corporations with an initial rate fixation between 1 and 5 years. Government bond yield is the 2-year constant maturity bond yield. Corporate bond yield is the spread of the Merrill-Lynch bond index for non-financial corporation bonds with a remaining maturity between 1 and 5 years over the 3-year constant maturity government bond yield, plus the (2-year constant maturity) government bond yield. See Tables A1 and A2 for further details.

Figure 2 compares the interest rate on new business loans to non-financial corporations with a period of rate fixation between one and five years with the corresponding corporate bond yield and government bond yield. As expected, the loan rate is higher than the (adjusted) corporate bond yield, which in turn is higher than the government bond yield. Corporate bond yields did exceed loan rates during the depth of the financial crisis from late-2008 through early 2009. As the more complete analysis below will demonstrate, negative spreads occur in other instances as well and we will discuss possible reasons for negative margins in theory and in practice. More broadly, the difference between the corporate bond yield and the government bond yield widened considerably over the period, from, on average, 0.55 percent before the financial crisis that started in mid-2007 to 1.55 percent since then.

This illustrates the unappealing choice for statisticians in troubled financial times: one could either rely on government bond yields and see a sharp widening of interest margins or use corporate bond yields and see a contracting interest margin. Using government bonds probably overstates margins by more in the recent period: why would loans that used to require a service margin of about 1.2 percentage points before the financial crisis suddenly require up to 2.0 percentage points? On the other hand, a negative margin is likewise problematic. One explanation for the observed pattern in the later months of the sample is that banks are compensating their negative margins from 2008–2009 with larger positive margins since mid-2009.

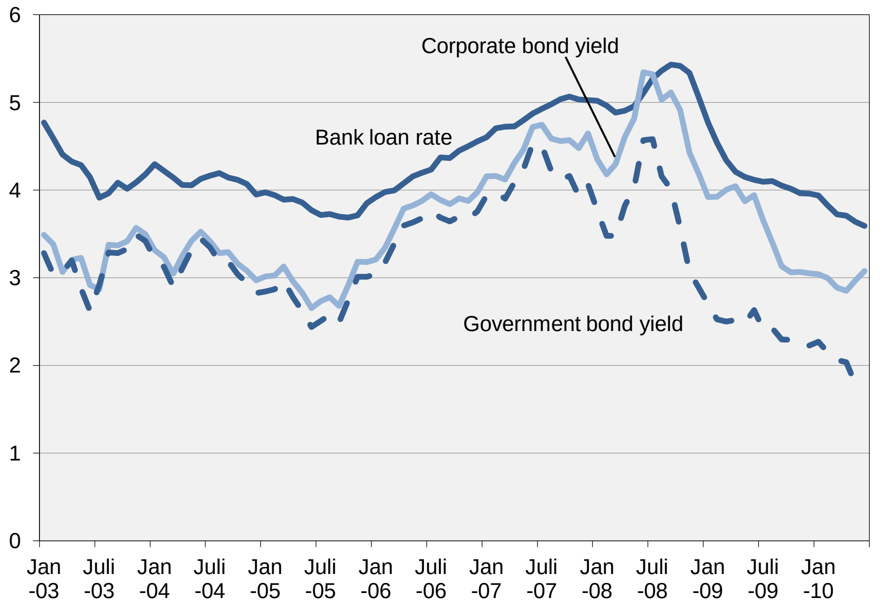
For loans to households, it is more challenging to identify reference rates since households do not generally raise funds directly from financial markets. The most comparable securities are mortgage-backed securities (MBS) and covered bonds. For both types of securities, the interest payments by households are passed on to the buyers of the securities, with a servicing fee for the originating bank. The difference is that loans that are part of MBS are taken off bank balance sheets while covered bonds remain on bank balance sheets since investors still have recourse to the bank in case of losses. In both cases though, the yield on these securities represent a market rate of return on the underlying mortgages and indeed, this yield has been broadly similar for most of the period. The yield on covered bonds was somewhat lower, presumably because investors have greater recourse to the originating bank in case of defaulting borrowers.

In choosing between the MBS index and the covered bond index, the comparative size of the market is an important factor, since a larger market is more likely to be a representative benchmark for banks in determining the opportunity costs of funds. Based on this criterion, we use the covered bond index since this is based on around 750 underlying bonds, while the MBS index covers only around 30 bonds.[54] Moreover the yield developments of the MBS index after September 2008 suggest serious liquidity problems specific to those securities, since these developments are not mirrored in the covered bonds index. As the Merrill Lynch covered bond index has an

[54] By comparison, the corporate bond index is based on about 700 bonds. Similar indices for the US cover around 3000 corporate bonds and 1500 RMBS or collateralized mortgage obligations (CMOs).

average residual maturity of around four years, the spread over the four-year government bond index for each fixation period band is applied for the matching.

Figure 3
Interest rate on housing loans compared to covered bonds and government bonds (%), January 2003 – June 2010



Sources: ECB (MIR interest rates), Thomson Reuters Datastream (Government bonds), Merrill Lynch (covered bonds)

Notes: All series for the euro area. Bank loan rate refers to loans to household for house purchases with an initial rate fixation between 1 and 5 years. Covered bond yield is the yield on the Merrill-Lynch bond index for covered bonds (average residual maturity of 4 years). Government bond yield is the 4-year constant maturity bond yield.

Figure 3 shows the interest rate on household loans for housing purposes with a period of rate fixation between one and five years compared to the covered bond index and the government bond yield with the same maturity. The interest margin for this type of loans varies more than the corporate margins as the inertia of bank interest rates seems greater. On the other hand, the interest margin stays positive throughout the period, with the exception of June and July 2008.

3.2.3 The treatment of other sectors

Loans and deposits of non-financial corporations and households represent about 80 percent of outstanding loans and deposits involving the non-financial sector. Loans and deposits of other domestic sectors, i.e. the government and insurance companies and pension funds, represent another 11 percent while loans and deposits from the rest of the world make up the remaining 9 percent.[55] Little is known about these loans and deposits except their overall size; especially data on corresponding interest rates are not available. This means the methodology we apply for non-financial corporations and households cannot be followed for these other sectors.

In the case of other domestic sectors, we assume that the interest margins are the same as for non-financial corporations. This differs from the current approach, where the margin is calculated as the differences between (assumed) sectoral interest rates on loans and deposits and the common reference rate.[56] Here we assume constant margins, thus allowing the (implicit) reference rates to be different. Our approach is justifiable on various grounds. First, loans and deposits to non-financial corporations likely involve similar financial services as those to the government[57] and insurance companies and pension funds. Second, in many countries, banks' business with these sectors (mainly insurance corporations) has a very long maturity and negative margins may result in the framework of the current FISIM methodology. Third, given the lack of data on interest rates and flows for these sectors, the current FISIM method seems to involve a higher degree of estimation than the alternative proposed.

[55] These shares are based on the average balance sheet composition over the period from January 2003 to June 2010. Loans and deposits of financial institutions are omitted, as under the current FISIM regulation, a sector can be either a FISIM producer or user, not both. As the focus of this analysis is on different margin estimates, we stay comparable in the coverage of sectors.

[56] For the purpose of simulating FISIM results under the current methodology, interest rates on loans to the general government and insurance corporations and pension funds are estimated using financial market data, while the corresponding interest rates on deposits are assumed to be the same as for NFCs.

[57] For the government sector this may not be the case as transactions are likely to be automated and involve high volumes, thus implying small service components. On the other hand, this sector makes up a small share of deposits and loans, implying a small impact on the final estimates.

When deriving euro area estimates for residents in the rest of the world, we assume that they buy, and pay for, the same services as euro area residents. This may be not fully correct as, for example, screening costs incurred by banks may be higher for non-resident borrowers. Still, this assumption seems more plausible than using, for example, foreign margins (if those were available) as, presumably, foreign customers buy financial services from euro area banks rather than their own banks only if their cost appears reasonable to them. As no breakdown by sector is available in MFI balance sheet statistics for positions vis-à-vis (private, non-bank) residents of the rest of the world, we use a weighted average of euro area margins based on the sectoral composition of cross-border balances of loans and deposits within the euro area.

Using the margins on services provided to residents for services to non-residents (i.e. exports) is an approach that also differs from current methods. Currently, an external reference rate is compared to market interest rates on cross-border positions within the euro area and for the rest of the world.[58] In view of the lack of reliable and detailed sectoral data on interest rates and margins for the positions with extra euro area residents, the proposed method has the advantage of conceptual clarity and is more appealing from our point of view since it focuses on the services provided, rather than trying to estimate the service margin as a residual based on two sets of statistics, possibly involving a high degree of estimation, that are neither complete nor consistent.

4 FISIM calculations

4.1 Interest margins

This section discusses the interest margins estimated in our framework. For loans, the interest margin is calculated as the excess interest rate a borrower has to pay compared to the market rate to compensate the bank for the information services provided (equation 1). For deposits, it is the opposite: how much less a

[58] In our simulation of the current FISIM official methodology, the external reference rate and cross-border interest rates are based on estimated interest flows which are derived from inter-bank rates (EURIBOR, LIBOR) for the inter-bank component, from MIR rates for the intra euro area positions vis-à-vis non-banks, and from balance of payment statistics for the positions vis-à-vis extra euro area non-bank residents.

depositor is willing to accept than the market rate in return for the transaction services the bank provides (equation 2).[59]

Table 1 shows the average interest margin on different loans and deposits for the euro area. Our analysis uses monthly data from January 2003 to June 2010, thus covering 90 months. We compare three sets of interest margins. The first set is calculated by simulating the current approach where implicit interest margins are obtained by comparing MIR rates on outstanding amounts to the internal reference rate, based on (short-term) inter-bank rates. The second set takes into account that for longer-term financial assets a term premium is paid, so the reference rates are based on government bond yields with comparable maturity. For loans, we also calculate a third set, where the reference rates are based on corporate and covered bonds, taking into account the systematic default risk as well. A weighted average margin is calculated across loans and deposits with different maturity periods, using the shares in new business volumes as weights. For each set of margins, we compare the average over the period, the standard deviation, and the number of negative margins.

[59] There are no MIR statistics on deposits redeemable at notice placed by non-financial corporations. We assume non-financial corporations receive the same interest rate as households on these deposits.

Table 1
Euro area interest margins on loans and deposits using different reference rates (weighted average across maturities, January 2003 – June 2010, %)

	Average			Standard deviation			Number of negatives		
	I	II	III	I	II	III	I	II	III
Loans									
Loans to non-financial corporations	1,83	1,09	0,29	0,45	0,27	0,42	0	0	12
Loans for house purchases	2,02	0,96	0,63	0,84	0,30	0,33	0	0	3
Consumer credit	3,92	4,18	3,71	0,77	0,61	0,49	0	0	0
Other household loans	3,92	1,62	1,30	0,77	0,36	0,34	0	0	0
Non-financial corporation deposits									
Overnight	1,58	1,20		0,47	0,71		0	12	
With agreed maturity	-0,20	0,05		0,34	0,18		62	18	
Redeemable at notice	0,20	0,11		0,42	0,68		27	49	
Household deposits									
Overnight	1,94	1,56		0,73	0,96		0	12	
With agreed maturity	-0,23	-0,05		0,72	0,56		57	25	
Redeemable at notice	0,56	0,48		0,65	0,94		18	21	
Non-financial corporation and household deposits									
Repurchase agreements	0,21	0,00		0,23	0,13		9	27	

Notes: Interest margins are calculated as the difference between the relevant interest rate minus a reference rate

Reference rates:

I Current methodology: euro area internal reference rate, based on inter-bank rates

II Adjusted for term premium: government bonds used as reference rates

III Adjusted for term and default risk premium: in addition to II, an adjustment is made for the higher risk of bank loans using bond index yield spreads

Interest rates:

I: interest rates on outstanding amounts

II and III: interest rates on new business

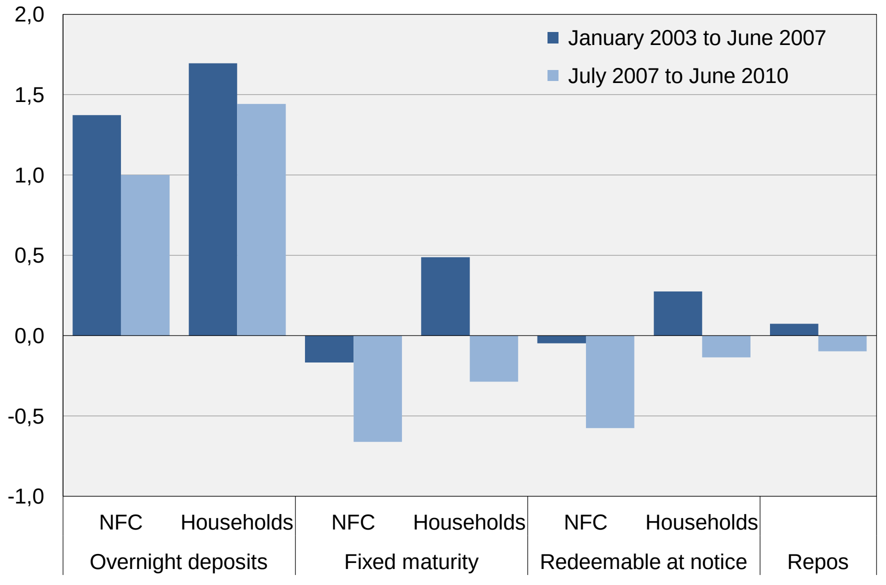
Interest margins shown are weighted averages of the margins derived for the different maturities and periods of initial interest rate fixation. The weights used reflect the outstanding amounts (case I) or the volumes of new business (cases II and III).

See Tables A1 and A2 in Appendix 1 for further details.

In the case of loans, accounting for the term premium and default risk decreases margins. Note that when comparing column I to columns II and III, the reference rates change to reflect the risk of the loans but also the interest rates change from those on outstanding amounts to interest rates on new business. In general, the changes in methodology have the largest effect on loans, where margins decrease by up to 2.4 percentage points. In addition, the variability of the margins decreases as variations in the yield curve and default risk is taken out of the interest margins. Despite the large reductions in average margins, the margins on loans remain positive in (almost) all months, with the financial crisis as the main exception.

The adjustment to the average margins is smaller for deposits as most deposits are short-term. The effect on variability is also less uniform. Interest margins are negative in many months, under both the current approach and our suggested alternative. Margins for the sizeable deposit categories (overnight and with agreed maturity) are less prone to being negative. Also, as Figure 4 below shows, the negative margins are more pronounced in the period since the financial crisis compared with the 2003–2007 period.

Figure 4
Euro area interest margins on deposits by instrument, 2003–2007 vs. 2007–2010



Notes: NFC: non-financial corporations. Repos: repurchase agreements. Interest margins shown are weighted averages of the margins derived for the different maturities and periods of initial interest rate fixation. The weights used reflect volumes of new business.

There are both conceptual and practical reasons that may explain negative interest margins. First, banks may accept small or even negative margins if a borrower or depositor brings in income from deposits or fees for other services. The analogy with a supermarket is useful here: they often price visible brand-name products at or below cost to draw in customers, who then spend on other goods. Second, long-term business relationships may also play a role: in times of rising market interest rates, banks may choose not to raise their loan interest rates in return for more favourable margins in periods of lower market rates. There may be some support for this in the data as many of the loan interest rates are less volatile than the corresponding reference rates. This is in general indicative of imperfect pass-through of market interest rates to retail bank interest rates. Our finding of more negative interest margins for deposits than for loans is also consistent with the pass-through literature, where deposit rates are generally found to be more inelastic.[60] An additional reason for the negative deposit margins is balance sheet constraints: especially since 2007, banks face more difficulties in attracting funds in equity or public debt markets. Paying higher rates on deposit accounts would then be an attractive source of funding, even if they pay more than a risk-free rate. Indeed, the negative margins are particularly prominent in longer-term deposits, which make better substitutes for market-based financing.

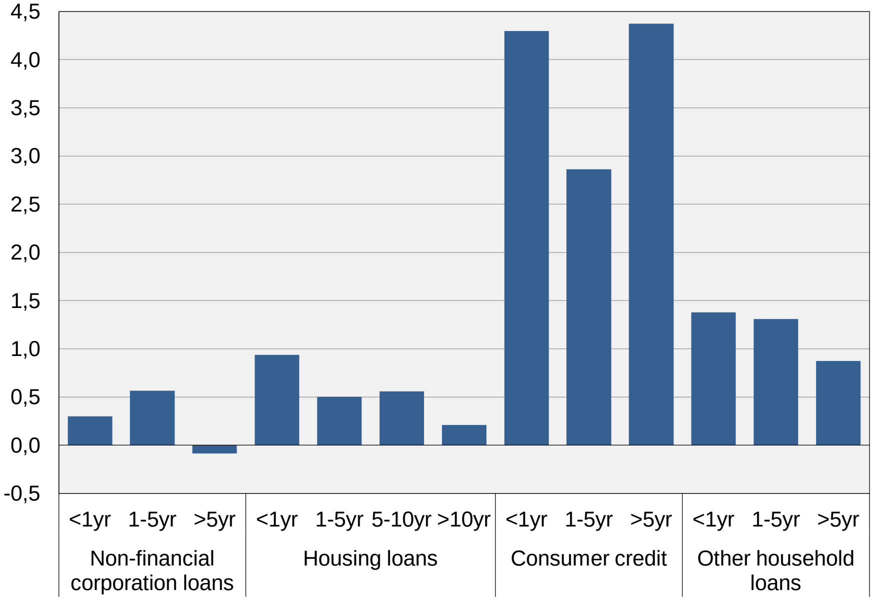
A more practical reason for some of the negative margins may be shortcomings in the available data, such as mismatches between interest rates and bond indices in terms of maturities and risk profiles. For example, the negative values shown in Figures 2 and 3 occur when the reference rates show sharp increases that are not matched in the interest rate data. Similarly, for deposits with an agreed maturity of more than two years we have selected five-year government bonds as the reference rate for households. However, in Germany deposits are on offer with much longer maturities so that a ten-year government bond might have been a more representative security. In some countries bank loans to highly creditworthy firms

[60] See, for instance, Hannan and Berger (1991), Berger and Udell (1992), Elsas and Krahnen (1998), Berlin and Mester (1999), Boot (2000), Mojon (2001), De Bondt (2005) and De Graeve *et al.* (2007). Besides relationship banking, other factors can contribute to the sluggishness of bank interest rate pass-through. For example, customer-switching costs for retail bank products can make demand inelastic to price changes (Calem *et al.* (2006)). In addition, when banks set their interest rates they take into account the fixed costs of adjusting their retail rates and they may opt for no adjustments especially when changes in policy rates are perceived as temporary or are minor (see e.g. Hannan and Berger (1991) and Hofmann and Mizen (2004)). Banks also tend to react differently depending on whether policy rates are moving up or down (i.e. the so-called asymmetric pass-though; see, for instance, Mester and Saunders (1995), Sander and Kleineier (2004) and Gropp *et al.* (2007)). Furthermore a higher degree of competition is expected to have a positive impact on the speed and degree of the pass-through (Sander and Kleimeier (2004), and Van Leuvensteijn *et al.* (2008)).

may also be more prevalent, making a corporate bond index with a high credit rating a better choice. Another reason for the observed negative margins may be sampling error in the MIR survey. The evidence for this is somewhat circumstantial, but the interest rates of relatively uncommon loans and deposits tend to be more volatile. In short, negative margins for certain instruments and years do not invalidate the basic approach. Negative margins for long periods of time, though, can imply that a different security is needed to reflect country-specific circumstances.

In Figure 5, we show how the average loan margin varies by band of initial fixation periods for the different types of loans for the euro area, calculated using reference rates that account for both the term premium and default risk, i.e. case III in Table 1 above. In general, margins are lower on loans with a longer period of initial rate fixation. The main exception is consumer credit with a fixed interest rate for more than five years. The pattern is clearer for housing loans, where the margin on loans with a fixation period of less than a year is 0.94 percent while loans with a fixation period of more than ten years have a margin of only 0.21 percent.

Figure 5
Euro area interest margins on loans by instrument and period of initial rate fixation, average January 2003 – June 2010



One possible reason for this pattern is that the screening of new borrowers is an important part of the financial services provided to borrowers. As this screening process only takes place before the loan is agreed upon, the associated costs are spread over the life of the loan. Alternatively, it could reflect higher administration costs for loans with variable interest rates. This is likely to be a factor for loans to non-financial corporations: only 12 percent of new loans have a fixed rate for more than one year, but 70 percent on the outstanding loans have an (original) maturity of more than one year. This implies that most loans to non-financial corporations have (fairly) flexible rates and a long maturity. Another explanation could be that only low-risk borrowers receive a fixed rate for longer periods of time, while our reference rates assume the same default risk across maturities. This would imply that our default risk adjustment is overdone for loans with long-term fixed rates.

When comparing margins on the different financial instruments, a few observations stand out. First, the estimated margins for consumer credit and, to some extent, other household loans are very high compared to the other instruments, regardless of the approach taken. This could reflect high information and processing costs, but could indicate that a more effective method to account for the higher risk associated with these loans should be developed. The frequent absence of collateral for such loans can be used to argue both ways: the lack of collateral makes the loan riskier but might also induce more screening and monitoring activities by banks. Without further information on the risk of bank portfolios, it is hard to make a more definitive assessment but our approach seems to (at least) improve the current methodology.

The margins on loans to non-financial corporations are noticeably lower than those on loans to households; only the margins on loans for housing purposes are close. An explanation could be that amounts lent to households are generally smaller so that banks provide more services per euro lent and need to charge a higher relative price to cover their fixed costs. Also, the risk associated with corporate loans may be easier to gauge than that of loans to households. This would be the case if non-financial corporations tended to have standardized financial reports compared to less standardized or less detailed financial information provided by households. Non-financial corporations (in particular large ones) may also be better informed and have more bargaining power than households. In addition, large corporate loans are often collateralized. Loans to non-financial corporations with a fixation period of more than 5 years even show negative average margins, mostly driven by the financial crisis period, but these loans account for only about 6 percent of total loans to non-financial corporations.

4.2 FISIM results for the euro area

With a complete set of interest margins, the implications for imputed bank output (FISIM) can be shown. The interest margins discussed in the previous section are applied to outstanding amounts of loans and deposits, following equations (1) and (2). Since we only have margins for households and non-financial corporations, we apply the margins estimated for non-financial corporations to loans and deposits of insurance corporations and pension funds and general government. For an estimate of exported financial services, we use a weighted average of the relevant domestic margins, using the share in intra-euro-area cross-border positions.

The top panel of Table 2 shows three estimates of FISIM by sector: (I) following the current FISIM methodology, (II) when the term premium is removed from the interest margins and (III) when the default risk premium for loans is also removed. This mirrors the three sets of interest margins from Table 1. The bottom panel shows the weighted average interest margin for each sector, based on the underlying margins for deposits and loans.

Table 2
Imputed banking sector output (FISIM) and interest margins in the euro area by sector, current regulation and modified approaches (average 2003Q1–2010Q2)

	I Current methodology	**II** Adjusted for term premium	**III** Adjusted for term and default risk premium
FISIM (€bln)			
Total	235,7	170,6	108,2
Non-financial corporations	81,0	51,2	19,0
Households	147,5	94,5	78,4
Insurance companies & pension funds	-2,5	1,8	1,2
Government	9,9	11,5	4,3
Exports	-0,2	11,6	5,3
Interest margin (%)			
Total	1,3	1,0	0,6
Non-financial corporations	1,6	1,0	0,4
Households	1,7	1,1	0,9
Insurance companies & pension funds	-0,4	0,3	0,2
Government	0,9	0,9	0,4
Exports	0,0	0,7	0,3

Notes: FISIM is calculated as the interest margin of each type of loan and deposit times the outstanding balance. The interest margins in the bottom panel are weighted averages of loan and deposit margins. Current regulation FISIM uses interest rates on outstanding amounts and reference rates, which mainly represent weighted averages of inter-bank interest rates. The two alternatives use interest rates on new business. When adjusting for the term premium, the government bond yield with the most closely matching maturity is used as reference rate. When also adjusting for the default risk premium, yields on corporate and covered bonds are used. See Tables A1 and A2 in Appendix 1 for details.

The differences are substantial. Both alternatives show lower FISIM than the current approach: the average annual banking sector output is €170.6bln after adjusting for the term premium and €108.2bln after adjusting for the default risk premium as well. This implies that bank output is 28 and 54 percent lower than under the current methodology. This implies an overestimation of, on average, €14.7bln or 0.18 percent of euro area GDP at current prices, if both default and term risk are removed from FISIM.[61] If only term risk is removed, euro area GDP is overestimated by €8.8bln or 0.11 percent.

[61] This assumes FISIM from consumer and other household loans, household deposits, government loans and deposits, and exported loans and deposits are deliveries to final demand. The remainder of FISIM is assumed to be intermediate consumption.

While the current methodology implies an average interest margin of 1.3 percent, this falls to 1 and 0.6 percent under the two alternatives. The impact differs across sectors, with the largest drop in the margin for non-financial corporations and a more moderate adjustment in the household sector. As Table 1 showed, for nearly all types of loans and deposits the margins paid by corporations are lower than for households, even when a short-term interest rate is used. Any downward adjustment will therefore represent a relatively larger part of the margin.

Non-financial corporations and households are the main contributors to total FISIM and are derived on the basis of reliable sets of statistics. The proposed alternatives for the other sectors are based on assuming constant margins and as a result, there is no negative average FISIM for any of the sectors under either of the two alternative approaches, unlike the current estimates of FISIM that show frequent and steady negative results.

Figure 6
Euro area imputed bank output (FISIM) and the value of default and term risk premia (annualized data, billions of euros), 2003Q1–2010Q2

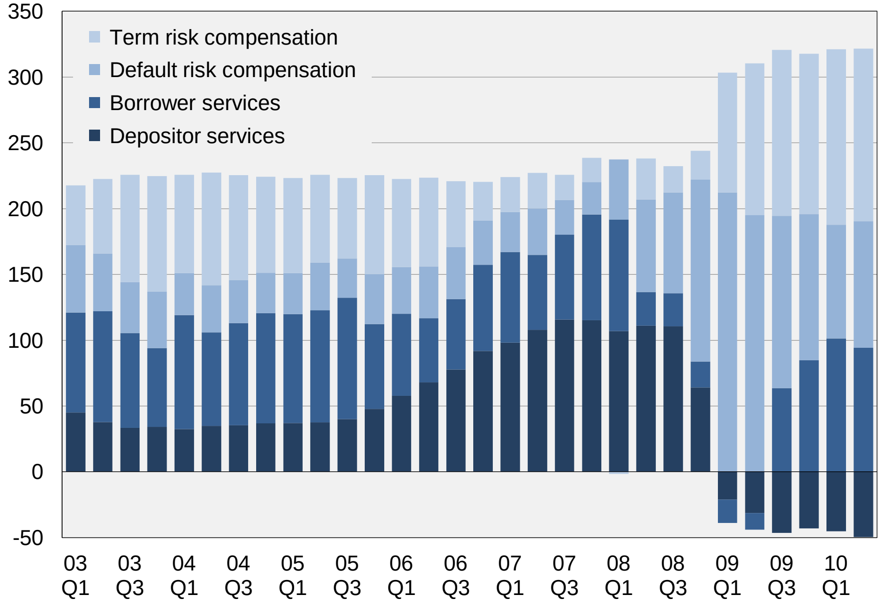


Figure 6 provides a summary overview of euro area FISIM over time. The bottom two areas show depositor and borrower services, calculated using interest margins from which both the term premium and default risk have been eliminated. The top two areas show the compensation for bearing default and term risk, both of which are included in current-practice FISIM. The term risk compensation follows the yield curve: widening between 2003 and 2006, narrowing in 2007 and 2008, before expanding sharply in 2009. Depositor services follow the reverse pattern, with negative FISIM since 2009Q1. As discussed earlier, these negative margins can be understood from the literature on relationship banking or that banks may find that subsidizing deposits is cheaper source of funds than equity or bond markets. The default risk compensation was fairly stable through 2007, before dramatically widening. In 2009Q1 and Q2, this even led to negative borrower services, which have since been partly compensated by much higher borrower services.

4.3 Plausibility of the results

One of the consequences of lowering bank output is a lower operating surplus: since labor costs and intermediate inputs are given,[62] any reduction in bank output translates to a smaller income for the owners of fixed capital. Table 3 therefore compares the share of capital income in value added in banking to that in the overall market economy and in retail trade for the euro area and the US. For banking, we present three alternatives: the capital share as based on the National Accounts and two adjusted versions, mirroring Tables 1 and 2, removing the term risk compensation and additionally the default risk compensation from bank output. The market economy, which excludes the real estate, government, health and education industries, is included as the broadest reference. A drawback is that the market economy also includes more capital-intensive industries, such as metalworking and utilities. We therefore also include retail, as it is an intermediation industry like banking.

[62] An exception is intermediate purchases of bank output by banks. In what follows, we adjust for this.

Table 3
Share of capital income in value added in the market economy, retail trade, and banking, average 2003–2008 (%)

	Euro area	United States
Market economy	32	42
Retail trade	13	40
Banking		
I Current methodology	41	59
II Adjusted for term premium	29	53
III Adjusted for term and default risk premium	13	41

Sources: Market economy, retail trade and production structure of banking: EU KLEMS, supplemented with OECD STAN, National Accounts through Eurostat and Supply-Use tables through Eurostat. Information on fee and commission income for banking: ECB Statistics on Consolidated Banking Data, supplemented by OECD Banking Statistics before 2007/2008. United States is from Basu et al. (2011) and refers to 2003–2007. Market economy for the United States refers to the private economy.

To arrive at capital income and value added for banking, we first add fee and commission income to the FISIM estimates, estimated based on the ECB Statistics on Consolidated Banking Data and OECD Banking Statistics. The overstatement of FISIM can then be translated into estimates of overstatement in total bank output. These overstatement estimates are then used to adjust national accounts data on gross output, value added and capital income from EU KLEMS. The period 2003–2008 was chosen in part because industry national accounts statistics for 2009 are not yet fully available but also because the financial crisis had its most devastating effects on bank output in 2009 (cf. Figure 6). Comparing the capital income share of the airline industry in 2001 and 2002, in the wake of the 9/11 terrorist attacks, would likewise bias the results compared to more ‘normal’ periods.

The table shows that in the euro area the fully adjusted capital income share is almost identical to that in retail trade, while the original capital income share is much higher than even the capital income share of the market economy. Indeed, only mining, utilities and the (petro)chemical industry have higher capital income shares than the original banking share. This mirrors the results for the United States, drawn from Basu et al. (2011). They also show that with the much lower capital income share, the internal rate of return on fixed capital in banking is much closer to that in the market economy, while this rate was amongst the highest of all industries before adjustment. The lack of sufficiently detailed capital data for the euro area precludes such an analysis here. Still, the more realistic capital income share already provides useful support for the argument that our alternative methodology is more consistent with the rest of the System of National Accounts by allocating the compensation for bearing risk not to the provider of funds but to the industries where this risk originates.

5 Concluding remarks

Banks do not charge explicit fees for many of the services they provide, so the value of those services needs to be imputed by comparing bank loan and deposit rates to reference rates that serve as a measure of opportunity costs of funds. This paper has shown how euro area banking output (FISIM) would change if the compensation for bearing risk were removed from output. The current statistical methodology includes compensation for bearing risk in bank output, but this leads to various inconsistencies: firm output changes depending on the source of funding and bank output changes depending on whether loans are held on the balance sheet or sold to outside investors. We have argued that removing the compensation for bearing risk from bank output may not be the only solution, but it would be the least invasive solution to such inconsistencies. What remains of bank output would compensate the bank for screening, monitoring and transaction services, i.e. the services provided using 'traditional' inputs, such as fixed capital (branches, ATMs), labour (loan officers) and intermediate inputs (software consulting).

Our empirical application of the risk-adjusted bank output model covers the euro area from the first quarter of 2003 to the second quarter of 2010. The results show that if we only remove the term premium, bank output is on average 28 percent lower than under the current methodology. If we also remove the default risk premium, bank output is on average 54 percent lower. In other words, the choice of reference rate is crucial and the empirical impact of this choice is substantial. This also has an effect on GDP, to the extent that bank services are part of final demand; our new estimates imply a GDP level (at current prices) that is up to, on average, 0.2 percent lower. Comparable work for the United States by Basu *et al.* (2011) has shown an adjustment to banking sector output of a similar magnitude, so our findings for the euro area do not depend on specific data or assumptions. Our results also imply a more plausible (fixed) capital income share in value added than based on the current methodology.

Beneath these headline results, a number of issues remain. The financial crisis of 2007–2009 in particular illustrates the challenges: overall output to depositors has turned negative since 2009 and borrower services have also been negative for two quarters. This raises practical issues, such as whether we have adequately matched loan and deposit categories to financial market yields; or whether institutional differences between euro area countries, such as in tax laws or accounting regulations, have a substantial impact. There are also conceptual questions, such as whether the current accounting scheme of the System of National Accounts is best suited to capture financial services. In particular activities to manage risk would seem to be central to the banking business but do not show up in the national accounts. These questions also arise under the current methodology, though. Since our proposed methodology is more consistent with the rest of the SNA; interest margins are more stable and our final bank output estimates imply a more plausible capital income share, we would argue that removing compensation for bearing risk improves bank output measurement.

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Appendix 1

Table A1
Bank loan and deposit instruments and reference rates: term premium adjustment

Instrument	Reference rate
Loans	
Non-financial corporations	
Up to 1 year	5-month EURIBOR
Over 1 year and up to 5 years	2Y government bond yield
Over 5 years	5Y government bond yield
Households	
For house purchases	
Up to 1 year	1Y EURIBOR
Over 1 year and up to 5 years	5Y government bond yield
Over 5 year and up to 10 years	7Y government bond yield
Over 10 years	10Y government bond yield
Consumer credit	
Up to 1 year	1-month EURIBOR
Over 1 year and up to 5 years	5Y government bond yield
Over 5 years	5Y government bond yield
Other purposes	
Up to 1 year	5-month EURIBOR
Over 1 year and up to 5 years	5Y government bond yield
Over 5 years	7Y government bond yield
Deposits	
Non-financial corporations	
Overnight deposits	EONIA
Deposits with agreed maturity	
Up to 1 year	1-month EURIBOR
Over 1 year and up to 2 years	1Y government bond yield
Over 2 years	2Y government bond yield
Deposits redeemable at notice	
Up to 3 months	3-month EURIBOR
Over 3 months	1Y government bond yield
Repurchase agreements	EONIA
Households	
Overnight deposits	EONIA
Deposits with agreed maturity	
Up to 1 year	1-month EURIBOR
Over 1 year and up to 2 years	2Y government bond yield
Over 2 years	5Y government bond yield
Deposits redeemable at notice	
Up to 3 months	3-month EURIBOR
Over 3 months	1Y government bond yield
Repurchase agreements	EONIA

Acronyms:

ML: Merrill Lynch

Euribor: Euro interbank offered rate

EONIA: Euro overnight index average

Table A2
Bank loan and deposit instruments and reference rates: default risk and term premium adjustment

Instrument	Reference rate
Loans	
Non-financial corporations	
Up to 1 year	ML NFC bond index, 1-5Y minus 3Y government bond yield plus 1Y government bond yield
Over 1 year and up to 5 years	ML NFC bond index, 1-5Y minus 3Y government bond yield plus 2Y government bond yield
Over 5 years	ML NFC bond index, 5-10Y minus 6Y government bond yield plus 5Y government bond yield
Households	
For house purchases	
Up to 1 year	ML covered bond index minus 4Y government bond yield plus 1Y government bond yield
Over 1 year and up to 5 years	ML covered bond index minus 4Y government bond yield plus 5Y government bond yield
Over 5 year and up to 10 years	ML covered bond index minus 4Y government bond yield plus 7Y government bond yield
Over 10 years	ML covered bond index minus 4Y government bond yield plus 10Y government bond yield
Consumer credit	
Up to 1 year	ML covered bond index minus 4Y government bond yield plus 1Y government bond yield
Over 1 year and up to 5 years	ML covered bond index minus 4Y government bond yield plus 5Y government bond yield
Over 5 years	ML covered bond index minus 4Y government bond yield plus 5Y government bond yield
Other purposes	
Up to 1 year	ML covered bond index minus 4Y government bond yield plus 1Y government bond yield
Over 1 year and up to 5 years	ML covered bond index minus 4Y government bond yield plus 5Y government bond yield
Over 5 years	ML covered bond index minus 4Y government bond yield plus 7Y government bond yield
Deposits	
Non-financial corporations	
Overnight deposits	EONIA
Deposits with agreed maturity	
Up to 1 year	1-month EURIBOR
Over 1 year and up to 2 years	1Y government bond yield
Over 2 years	2Y government bond yield
Deposits redeemable at notice	
Up to 3 months	3-month EURIBOR
Over 3 months	1Y government bond yield
Repurchase agreements	EONIA

Table A3 (continued)

Instrument	Reference rate
Households	
Overnight deposits	EONIA
Deposits with agreed maturity	
Up to 1 year	1-month EURIBOR
Over 1 year and up to 2 years	2Y government bond yield
Over 2 years	5Y government bond yield
Deposits redeemable at notice	
Up to 3 months	3-month EURIBOR
Over 3 months	1Y government bond yield
Repurchase agreements	EONIA

Acronyms:

ML: Merrill Lynch

Euribor: Euro interbank offered rate

EONIA: Euro overnight index average

Notes: Over the period under analysis, the average residual maturities of the bonds underlying the indices have been 4 years for the covered bond index, and 3 and 6 years for the corporate indices for the bands 1 to 5 years and 5 to 10 years respectively.

Appendix 2. Modelling interest rates into an error-correction framework.

Error correction models have occupied a prominent role in economic literature to study the transmission of monetary policy rates to bank interest rates via changes in market interest rates. Under this framework, changes in a bank interest rate *B* are regressed on simultaneous and lagged changes in a relevant market rate *M*, lagged changes in the bank interest rate itself and include an error-correction term reflecting the divergence of the bank rate from its long-run equilibrium relationship with the market rate in the previous period. The equation reads as follows:

$$\Delta B_t = \alpha_1 \Delta M_t + \alpha_2 \Delta M_{t-1} + \alpha_3 \Delta B_{t-1} + \beta_1 (B_{t-1} - \beta_2 M_{t-1} - \beta_3) + \varepsilon_t ,$$

where Δ stands for the difference operator and ε_t are zero-mean i.i.d. random variables. In particular, the coefficients α_1 and β_2 represent the immediate and final pass-through while β_1 relates to the speed of adjustment; the latter is also referred to as the cointegration parameter as testing its equality to zero is a way to testing for cointegration. For further details, see De Bondt (2005) and references therein.

In this paper we have used the error correction model to match each interest rate on deposits and loans with its relevant reference rate. In particular, each bank interest rate has been regressed against a spectrum of market rates reflecting a maturity falling into the band of maturity or period of rate fixation of the rate, and the reference rate has thus been selected performing the model selection on the basis of the Schwarz information criterion (or BIC). Estimations have been carried out supplementing MIR statistics for the period from January 2003 to June 2010 with historical ECB estimates from January 1999 to December 2002 when available. Table A3 below provides the details of the model selection and Table A4 thus reviews the main results of the estimations for the selected models.

It should be underlined that there is some evidence that after the outbreak of the financial market turbulence in August 2007 the pass-through of retail bank interest rates was somehow affected by the money-market malfunctioning, banks' scramble for safe deposits and flight to safety flows in the government bond market.

Nonetheless our results would not be too much affected when restricting the sample to periods up to June 2007.

Table A4
Retail interest pass-through process within error-correction framework: maturity selection

	Loans						
	Non-financial corporations			Households, for house purchases			
	<1 year	1-5 years	>5 years	<1 year	1-5 years	5-10 years	>10 years*
Eonia	-628,93			-692,61			
Eur. 1M	-702,89			-721,46			
Eur. 2M	-721,11			-721,98			
Eur. 3M	-760,61			-737,14			
Eur. 4M	-768,66			-746,82			
Eur. 5M	**-780,92**			-757,32			
Eur. 6M	-771,51			-765,33			
Eur. 7M	-762,74			-766,71			
Eur. 8M	-753,84			-768,97			
Eur. 9M	-744,70			-769,93			
Eur. 10M	-734,58			-769,88			
Eur. 11M	-726,09			-769,26			
Eur. 12M	-719,09			**-770,22**			
GB 1Y		-536,44			-718,27		
GB 2Y		**-537,43**			-738,34		
GB 3Y		-532,37			-748,68		
GB 4Y		-523,72			-752,55		
GB 5Y		-515,11	**-636,86**		**-753,25**	-762,02	
GB 6Y			-625,03			-765,26	
GB 7Y			-612,69			**-766,37**	
GB 8Y			-603,21			-765,31	
GB 9Y			-596,23			-761,14	
GB 10Y			-591,29			-755,99	**-514,78**
GB 12Y			-585,73				-502,43
GB 15Y			-584,71				-497,05
GB 20Y			-585,55				-496,45
GB 30Y			-578,29				-494,46

Table A5 (continued)

	Loans					
	Households, consumer credit			Households, other purposes		
	<1 year	1-5 years	>5 years	<1 year*	1-5 years*	>5 years*
Eonia	-354,54			-349,99		
Eur. 1M	-354,47			-368,59		
Eur. 2M	-356,24			-374,39		
Eur. 3M	-355,65			-382,50		
Eur. 4M	-356,08			-384,17		
Eur. 5M	-356,28			**-384,21**		
Eur. 6M	-356,88			-384,10		
Eur. 7M	-356,84			-383,80		
Eur. 8M	-356,79			-383,29		
Eur. 9M	-356,99			-382,35		
Eur. 10M	-356,96			-381,35		
Eur. 11M	-357,00			-379,89		
Eur. 12M	**-357,03**			-378,49		
GB 1Y		-558,04			-349,59	
GB 2Y		-561,44			-357,32	
GB 3Y		-563,65			-363,23	
GB 4Y		-565,13			-367,16	
GB 5Y		**-565,66**	**-494,46**		**-367,20**	-396,67
GB 6Y			-492,85			-400,43
GB 7Y			-491,28			**-402,46**
GB 8Y			-489,96			-400,54
GB 9Y			-489,07			-395,80
GB 10Y			-488,07			-391,01
GB 12Y			-486,92			-384,53
GB 15Y			-486,12			-382,27
GB 20Y			-484,56			-382,18
GB 30Y			-483,85			-380,19

Table A6 (continued)

	Deposits, Non-financial corporations					
	Overnight deposits	Deposits with agreed maturity			Deposits redeemable at notice	
		<1 year	1-2 years*	>2 years*	<3 months**	>3 months**
Eonia	-891,53	-682,13				
Eur. 1M		-731,97				
Eur. 2M		-701,21				
Eur. 3M		-716,33				
Eur. 4M		-727,83				
Eur. 5M		-723,31				
Eur. 6M		-726,74				
Eur. 7M		-720,56				
Eur. 8M		-713,00				
Eur. 9M		-706,59				
Eur. 10M		-700,95				
Eur. 11M		-696,14				
Eur. 12M		-693,68				
GB 1Y			-212,07			
GB 2Y			-211,14	-208,60		
GB 3Y				-208,27		
GB 4Y				-206,29		
GB 5Y				-202,69		
GB 6Y				-197,95		
GB 7Y				-192,92		
GB 8Y				-188,82		
GB 9Y				-186,09		
GB 10Y				-184,21		
GB 12Y				-182,62		
GB 15Y				-182,29		
GB 20Y				-182,88		
GB 30Y				-182,44		

Table A7 (continued)

	Deposits, Households						NFC/HH
	Overnight deposits	Deposits with agreed maturity			Deposits redeemable at notice		Repurchase agreements
		<1 year	1-2 years*	>2 years*	<3 months**	>3 months**	
Eonia	-887,81	-691,20			-801,69		-764,38
Eur. 1M		-770,26			-804,69		-660,37
Eur. 2M		-743,86			-807,08		-659,80
Eur. 3M		-744,77			-807,50	-874,12	-652,26
Eur. 4M		-750,02				-875,60	-651,09
Eur. 5M		-738,56				-877,06	-651,46
Eur. 6M		-736,50				-879,27	-650,15
Eur. 7M		-731,94				-880,92	-649,44
Eur. 8M		-724,75				-881,92	-647,81
Eur. 9M		-719,97				-883,00	-646,41
Eur. 10M		-715,19				-884,16	-645,19
Eur. 11M		-710,89				-885,12	-644,58
Eur. 12M		-708,26				-886,24	-643,25
GB 1Y			-570,96			-867,01	
GB 2Y			-571,55	-534,91		-872,66	
GB 3Y				-540,05		-877,03	
GB 4Y				-543,50		-878,98	
GB 5Y				-545,52		-880,04	
GB 6Y				-545,04		-879,69	
GB 7Y				-542,85		**-879,84**	
GB 8Y				-538,98		-878,54	
GB 9Y				-534,86		-877,32	
GB 10Y				-530,49		-875,88	
GB 12Y				-524,27		-873,99	
GB 15Y				-520,68		-872,76	
GB 20Y				-519,95		-872,09	
GB 30Y				-511,93		-862,10	

Notes: The table displays the value of the Schwarz Criterion (BIC) for each of the models; non-linear least squares estimates using the Trust-Region Reflective algorithm; sample period January 1999 to June 2010 (unless otherwise specified)

*: Due to the lack of historical estimates, the sample period is January 2003 to June 2010 for these series.

**: No model selection as margins are the same as for household deposits of the same type.

Acronyms:

Eonia: Euro overnight index average

Eur.: Euro interbank offered rate

GB: Euro area government bond yield curve

NFC/HH: Non-financial corporations/Households

Table A8
Retail interest pass-through process within error-correction framework: estimation results

	Immediate pass-through (α_1)	Final pass-through (β_2)	Speed of adjustment (β_1)	Correlation	Adjusted R^2	BIC	Share of new business[4]
Loans							
Non-financial corporations							
Up to 1 year	0.690	0.871	-0.131				
	(0.033) *	(0.032) *	(0.039) *	0,992	0,885	-780,92	87,9%
Over 1 year and up to	0.290	0.905	-0.157				
5 years	(0.064) *	(0.076) *	(0.036) *	0,913	0,378	-537,43	6,2%
Over 5 years	0.293	0.994	-0.200				
	(0.043) *	(0.055) *	(0.033) *	0,927	0,469	-636,86	5,9%
Households							
For house purchases							
Up to 1 year	0.298	1.285	-0.029				
	(0.031) *	(0.212) *	(0.011) *	0,905	0,829	-770,22	45,8%
Over 1 year and up to	0.218	1.200	-0.070				
5 years	(0.028) *	(0.099) *	(0.017) *	0,900	0,712	-753,25	13,3%
Over 5 year and up to	0.262	1.450	-0.067				
10 years	(0.028) *	(0.108) *	(0.017) *	0,920	0,733	-766,37	17,9%
Over 10 years[2]	0.207	1.277	-0.128				
	(0.035) *	(0.130) *	(0.027) *	0,825	0,513	-514,78	23,1%
Consumer credit							
Up to 1 year	0.026	0.897	-0.061				
	(0.142)	(0.490)	(0.036)	0,440	0,098	-357,03	28,2%
Over 1 year and up to	-0.042	0.649	-0.159				
5 years	(0.056)	(0.094) *	(0.033) *	0,698	0,184	-565,66	43,6%
Over 5 years	-0.085	0.279	-0.282				
	(0.073)	(0.065) *	(0.063) *	0,444	0,236	-494,46	28,2%
Other purposes							
Up to 1 year[2]	0.514	0.724	-0.286				
	(0.079) *	(0.032) *	(0.083) *	0,982	0,679	-384,21	75,9%
Over 1 year and up to	0.074	1.132	-0.258				
5 years[2]	(0.067)	(0.097) *	(0.044) *	0,809	0,430	-367,20	10,5%
Over 5 years[2]	0.150	1.140	-0.201				
	(0.060) **	(0.135) *	(0.044) *	0,792	0,429	-402,46	13,7%
Deposits							
Non-financial corporations							
Overnight deposits	0.173	0.490	-0.019				
	(0.021) *	(0.195) **	(0.015)	0,880	0,718	-891,53	
Deposits with agreed maturity							
Up to 1 year	0.592	0.711	-0.053				
	(0.036) *	(0.184) *	(0.049)	0,994	0,842	-731,97	98,4%
Over 1 year and up to 2	-0.036	1.020	-0.142				
years[2]	(0.153)	(0.217) *	(0.052) *	0,756	0,224	-212,07	0,6%
Over 2 years[2]	-0.031	0.638	-0.501				
	(0.165)	(0.065) *	(0.102) *	0,820	0,318	-208,60	1,1%

Table A4 (continued)

	Immediate pass-through (α_1)	Final pass-through (β_2)	Speed of adjustment (β_1)	Correlation	Adjusted R^2	BIC	Share of new business[4]
Deposits redeemable at notice							
Up to 3 months[3]							
Over 3 months[3]							
Repurchase agreements	0.655 (0.038) *	0.895 (0.027) *	-0.151 (0.050)*	0,996	0,862	-764,38	
Households							
Overnight deposits	0.101 (0.020) *	0.239 (0.023) *	-0.114 (0.034) *	0,937	0,447	-887,81	
Deposits with agreed maturity							
Up to 1 year	0.440 (0.027) *	0.896 (0.243) *	0.020 (0.014)	0,910	0,845	-770,26	89,9%
Over 1 year and up to 2 years	0.138 (0.057) **	1.147 (0.408)*	-0.037 (0.020)	0,703	0,434	-571,55	3,9%
Over 2 years	0.187 (0.060) *	1.018 (0.110) *	-0.136 (0.029) *	0,837	0,232	-545,52	6,1%
Deposits redeemable at notice							
Up to 3 months	0.028 (0.027)	0.326 (0.028) *	-0.151 (0.030) *	0,852	0,450	-807,50	93,5%
Over 3 months	0.061 (0.020) *	0.196 (0.860) *	-0.023 (0.008) *	0,706	0,758	-886,24	6,5%
Repurchase agreements[3]							

1) Non-linear least squares estimates using the Trust-Region Reflective algorithm; sample period January 1999 to June 2010 unless otherwise specified; * and ** denote significance at the 1% and 5% level respectively; standard errors are reported in parantheses; model selection is performed on the basis of the Schwarz Criterion (BIC).

2) Due to the lack of historical estimates, the sample period is January 2003 to June 2010 for these series.

3) No model selection as margins are assumed the same as for household deposits of the same type.

4) Average shares in total new business volumes derived for the period January 2003 to June 2010.

OECD Science, Technology and Industry Scoreboard 2011:Main productivity /innovation challenges

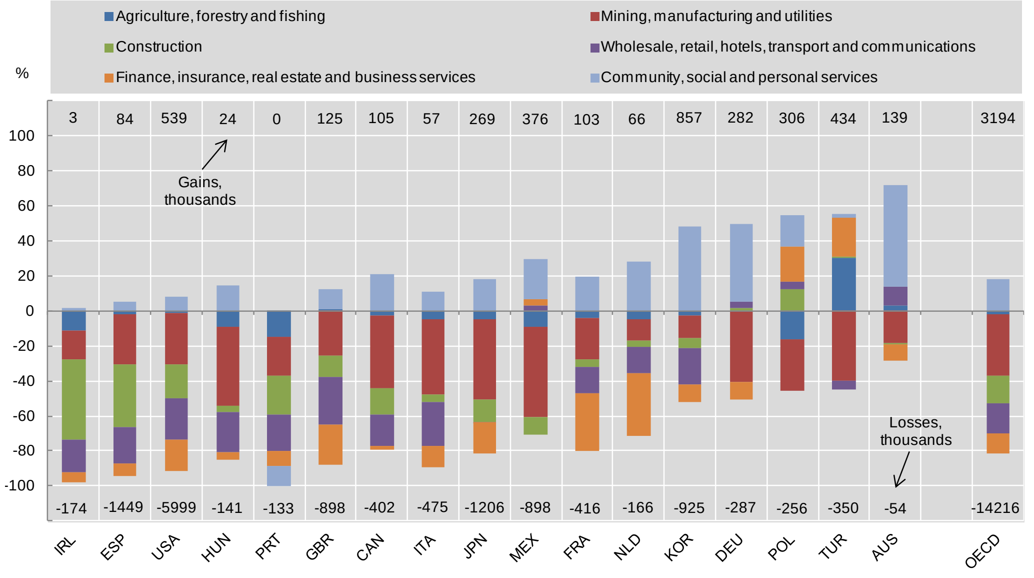
Elif Köksal-Oudot

Innovation and growth in knowledge economies

Highlights

Today, the world's economies are facing some extraordinary challenges. The effects of the recent economic downturn are still being felt, with national debt levels rising and unemployment remaining high. Accompanying this is continued globalisation of economic activities. Its distinctive features are increasing international trade, deepening economic integration – especially in emerging economies – and greater geographic fragmentation of production processes generating ever more complex global value chains. In this new geography of growth, international competition from new players is eroding the lead of more established economies. Environmental pressures challenge the sustainability of our existing growth models and longer life expectancy is putting a greater strain on the capability of health systems to meet the needs of an ageing population. Innovation is increasingly seen as being critical for effectively meeting these challenges. It will play a major role in lifting economies out of the economic crisis and finding new and sustainable sources of growth and competitiveness.

The new geography of growth
Where people lost their jobs, selected countries, 2008–09
Relative contribution to change in total employment by major sectors of economic activity



Source: OECD, Structural Analysis (STAN) Database, OECD National Accounts (SNA) Database and national statistical institutes, June 2011.

Statlink 2 http://dx.doi.org/10.1787/888932484797

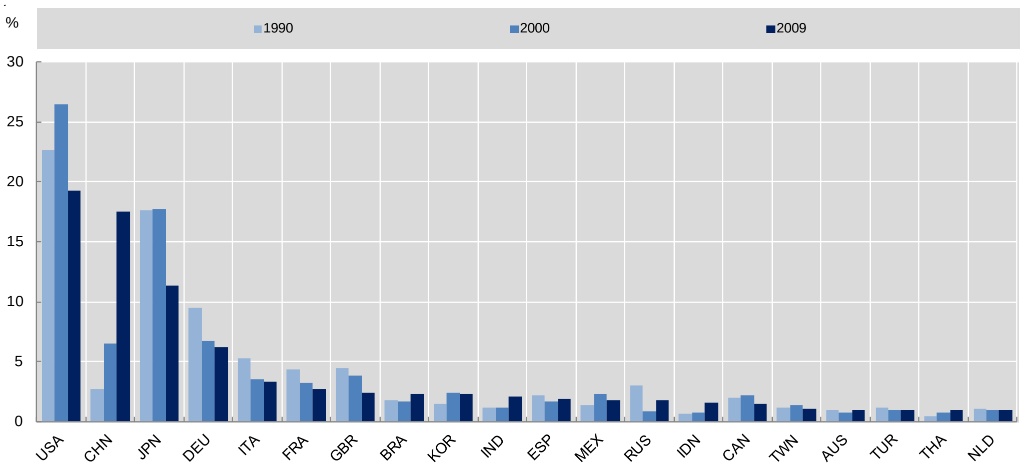
Between 2008 and 2009, in the immediate aftermath of the crisis, the OECD as a whole suffered a net loss in employed persons of about 11 million, a 2% drop. Half of these losses occurred in the United States. Manufacturing as a sector lost most jobs, although construction (Ireland, Spain) and finance and business services (France, Netherlands) were also strongly impacted. For many OECD countries, significant losses in employment continued well into 2010.

> In 1990 the G7 countries accounted for two-thirds of world manufacturing value added but they now account for less than half

The decline in manufacturing production in many OECD countries occurred against the backdrop of longer-term growth trends in emerging economies and increasing international competition. By 2009, the People's Republic of China had almost caught up with the United States in manufacturing production, and the share of Brazil and India among world manufacturers is now similar to that of Korea.

Declining manufacturing production means that, on average, services now account for about 70% of OECD gross domestic product (GDP). In addition, over 35% of employees in manufacturing in the OECD area perform services-related occupations, with percentages ranging between 17 % and 52% across economies.

Top manufacturers in the last 20 years, 1990, 2000 and 2009
Percentage share of total world manufacturing value added



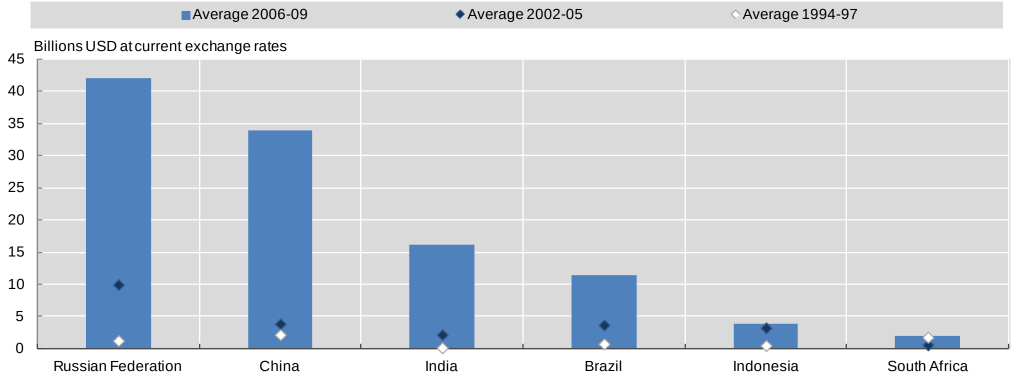
Source: United Nations Statistical Division, National Accounts Main Aggregates Database, May 2011.

Statlink 2 http://dx.doi.org/10.1787/888932485082

> Average outward investment flows from China increased ninefold between the early and late 2000s; those from India increased more than sevenfold

The BRIICS economies (Brazil, the Russian Federation, India, Indonesia, China and South Africa) have become more integrated in the global economy. China is set to become the second largest recipient of foreign direct investment. During the period 2003–09, EU countries invested four times as much in the BRIICS economies as the United States or Japan. Direct investment in China from Europe, which partly includes flows from non-EU multinationals located in Europe, averaged USD 6.5 billion a year, 75% more than that from the United States, and over USD 9 billion a year in Brazil, four times that from the United States.

Foreign direct investment outward flows from BRIICS, 1994–97, 2002–05 and 2006–09
Yearly averages



Source: IMF, Balance of Payments Statistics, June 2011.
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China's role as an exporter of high-end intermediates and capital goods has increased over the past 15 years

While OECD countries' export volume has nearly doubled over the past 15 years, their share of world exports declined from 75% to 60%. In 1995 the value of China's exports was USD 148 billion, of which 60% was destined for final consumption. By 2009, the value of China's exports had increased more than tenfold from USD 148 billion to USD 1 529 billion and the composition of its exports had changed substantially. In the BRIICS, high-technology manufacturing trade now represents about 30% of their total manufacturing trade, compared to 25% for the OECD area.

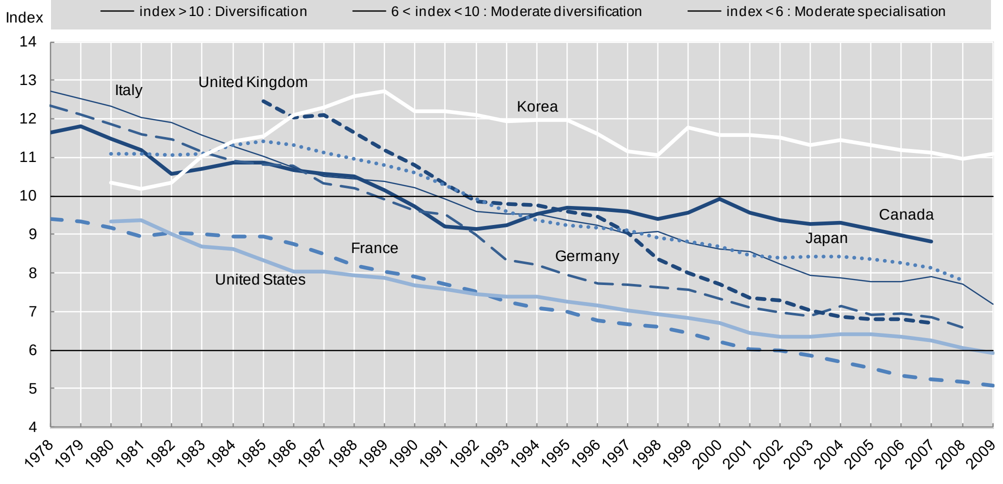
Competing in the global economy

As economic activities become more global, economies tend to become more specialised. The degree of industrial specialisation, for example a strong reliance on mining, construction or financial services, has important impacts on economies' long-run productivity, their resilience to a crisis, investment patterns, innovativeness and performance of firms and sectors. A new OECD indicator shows rising economic specialisation since the 1970s, with Canada the only G7 country to experience periodic bursts of diversification. In contrast, Korea's specialisation patterns partially reflect the development path previously travelled by G7 countries – early increasing diversification (into industry and services), peaking in the late 1980s, before gradual specialisation as comparative advantages became more pronounced.

> In the G7 countries, the four largest sectors represent on average 55% of total value added

A few broad sectors, typically "Wholesale and retail" and "Business services", are consistently among the top four in terms of their share of value added. The size of the two leading sectors differs considerably across countries: in Norway, "Mining and quarrying" is three times the size of the second largest sector but in Spain, the largest sectors are of more similar size.

Industrial diversification index for selected countries, 1978–2009
Sectoral concentration measured by shares of sectors in total value-added, current prices



Source: OECD, Structural Analysis Database (STAN), May 2011.
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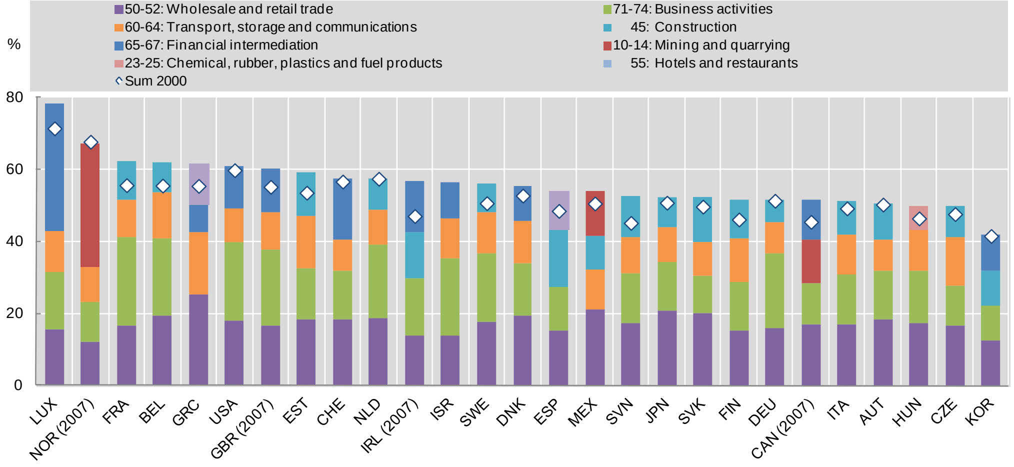
Value added of the top four industries, 2008
As a percentage of total value added (excluding real estate and the public sector)



Source: OECD, Structural Analysis Database (STAN), May 2011.
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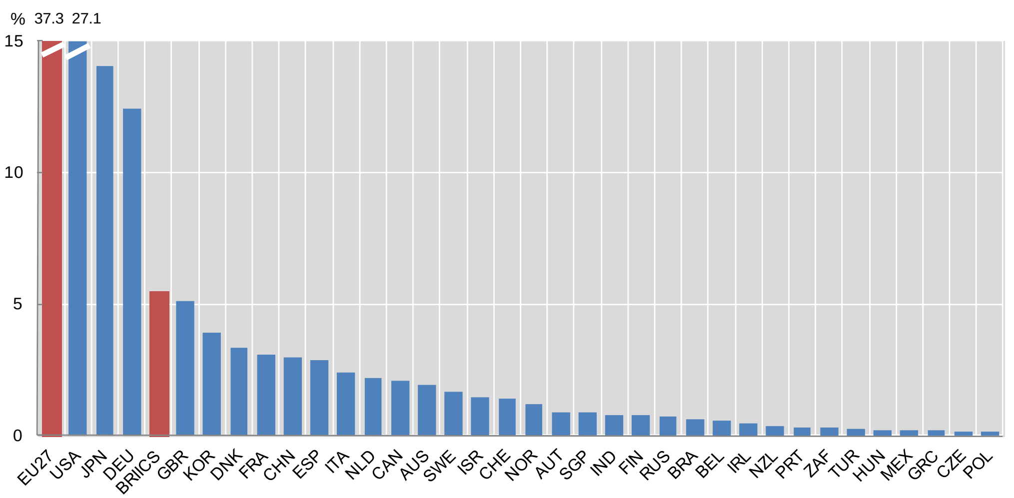
> Universities are among the three top sectors in the commercialisation of key enabling technologies such as biotechnology and nanotechnology

One way to measure technological innovation is through the commercialisation of inventions as reflected in patenting. While countries "specialise" in certain economic activities, new OECD indicators based on linking patents with companies' information reveal the benefits of a broad industrial base and a strong university sector for the development of key enabling technologies. Chemical firms, for example, contribute to the advancement of pharmaceuticals and biotechnologies, and to a lesser extent also to nanotechnologies. Institutions such as universities are also essential to these fields with 10–12% of patents originating from the education sector. Similarly important are research and development service providers. New information and communication technologies are concentrated in computer and communications industries, while environmental technologies are shaped by the patenting activity of specialised machinery manufacturers and certain technical and engineering service activities.

Europe is targeting and leading in "clean" energy technologies – the EU27 represented 37% of all PCT filings in this field in the late 2000s

Countries are building technological capabilities in new fields. Revealed technology advantage indexes show that in the past decade China went from having no area of specialisation to being one of the top 3 countries specialised in ICT innovation. Denmark, Belgium and Spain are among the top specialised countries in biotechnology; the Czech Republic, Ireland and the Netherlands are relatively specialised in nanotechnologies and Finland in ICT innovation. Europe is targeting and leading in clean energy technologies, mainly thanks to Germany's lead. The EU27 represented 37% of all PCT filings in this field in the late 2000s, followed by the United States and Japan. China's share in such patents now ranks eighth worldwide. The United States maintains the lead in health-related technologies, while Japan leads innovative efforts in environmental technologies including innovation for climate change mitigation.

Countries' share of patents for energy generation from renewable and non-fossil sources, 2007–09
Patent applications filed under the PCT



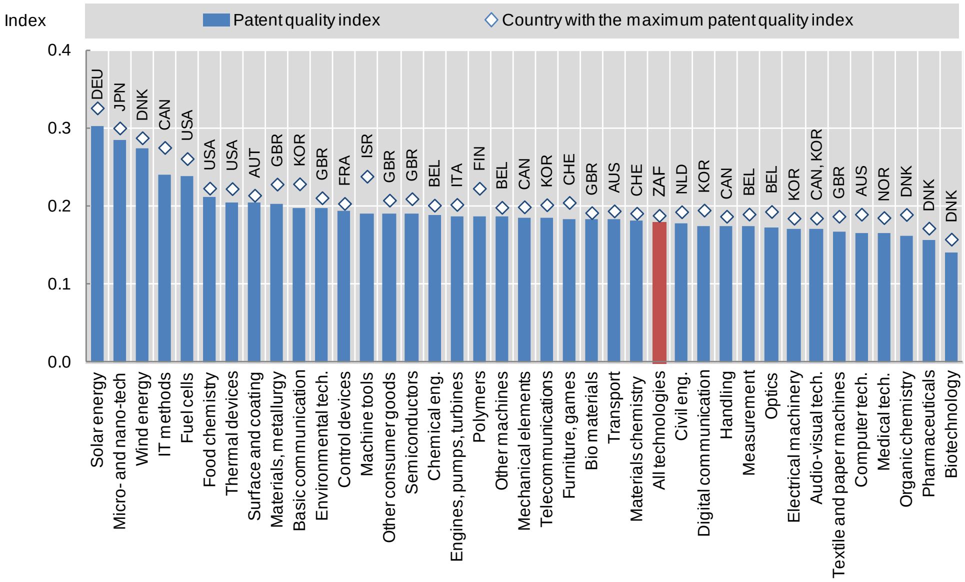
Source: OECD, Patent Database, May 2011.

Statlink 2 http://dx.doi.org/10.1787/888932486830

Between 1996 and 2000, about 70% of the top 1% of highly cited patents were from the United States, Germany and Japan. Five years later, that share had fallen to 60%

Some patents filed are more valuable than others as they may lead to major inventions. Patents from inventors in the United States, Germany and Japan are still among the most highly cited ones, however the Asian powerhouses of China, India and Korea have gained in importance. On average, only under a quarter of all patents filed make it to the market (they are granted by the patent examiner). A new composite index of "quality" of patents granted, based on six dimensions, shows the average quality of patents filed at the European Patent Office. The index suggests that rising patenting activity has been accompanied by an average 20% decline in patent quality over the past two decades. The quality of innovations protected in Europe in the past decade was highest in renewable energy technologies, nanotechnologies and software for business methods. These are less mature markets in which there is more scope for breakthrough inventions. Differences between top performers and the average quality level for a particular sector provides an indication of countries' innovative advantages. The quality of UK inventions protected on the EU market outperforms average quality on a wide range of technology fields (six fields in the chart), followed by Korea (five fields, mostly related to ICTs).

Patent quality index by technology field, 2000–10
Composite index based on patents granted by the EPO



Source: OECD, calculations based on the Worldwide Patent Statistical Database, EPO, April 2011.

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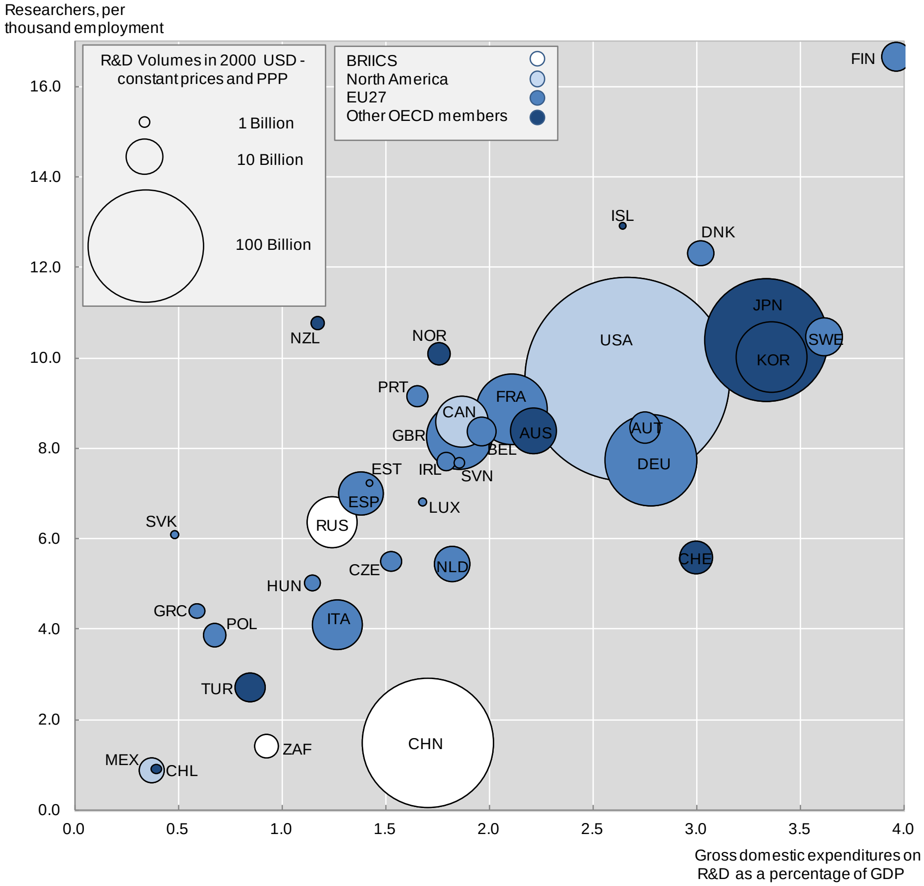
Benefiting from global knowledge at the local level

Scientific production relies on critical mass that supports the creation of networks of knowledge sharing. Many countries are building centres of excellence to create the optimum conditions for raising research quality and impact. While the United States remains the largest performer of research and development (R&D) in the world, non-OECD economies account for a growing share of the world's R&D, measured in terms of both number of researchers and R&D expenditures. In 2009, China became the second largest R&D performer in the world, investing USD 154 billion at current prices purchasing power parity (PPP).

R&D in OECD and non-OECD economies, 2009 or latest available year



Source: OECD, Main Science and Technology Indicators Database, June 2011.
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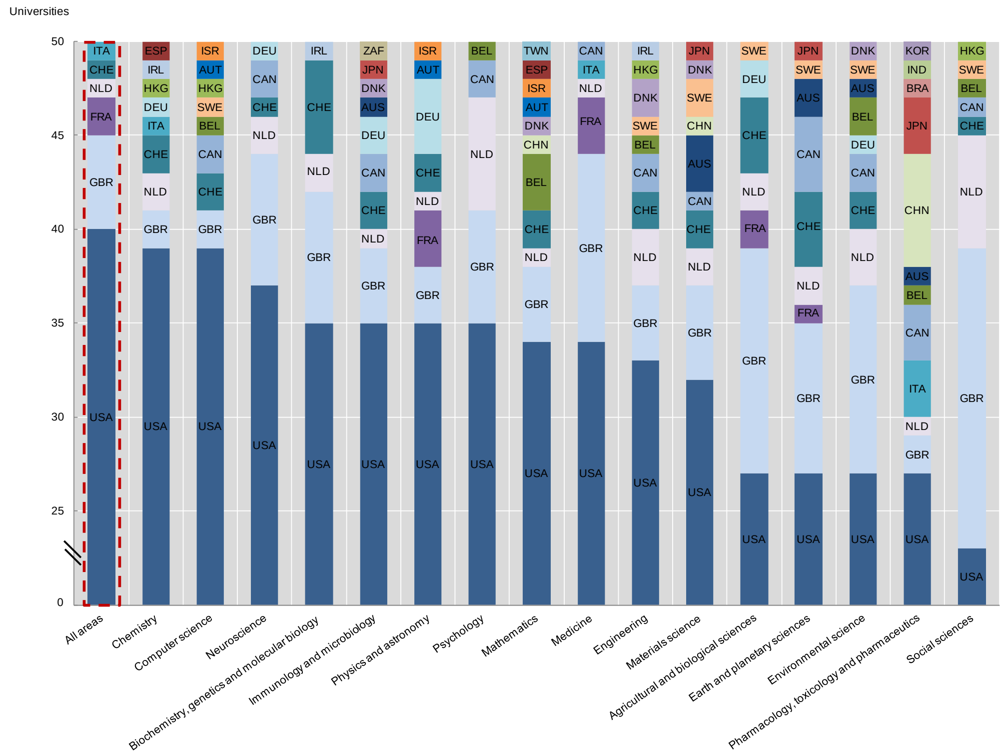
Forty of the world top 50 universities with the highest research impact – are located in the United States, with the rest in Europe

While research efforts are increasing across the globe, top research remains highly concentrated. A new indicator of research impact – measured by normalised citations to academic publications across all disciplines – shows that 40 of the world top 50 universities are located in the United States, with some US universities excelling in a wide range of disciplines. Stanford University features among the top 50 for all 16 subject areas, and 17 other US universities feature in the top 50 in at least 10 scientific fields.

A more diverse picture emerges on a subject-by-subject basis. The United States accounts for less than 25 of the top 50 universities in social sciences, a field in which the United Kingdom plays a key role. The universities producing the top-rated publications in the areas of earth sciences, environmental science and pharmaceutics are more evenly spread across economies. Universities in Asia are starting to emerge as leading research institutions: China has six in the top 50 in pharmacology, toxicology and pharmaceutics. The Hong Kong University of Science and Technology is among the top universities in computer science, engineering and chemistry.

University hotspots – geographical distribution of highest impact institutions, 2009
Location of top-50 universities by main subject areas

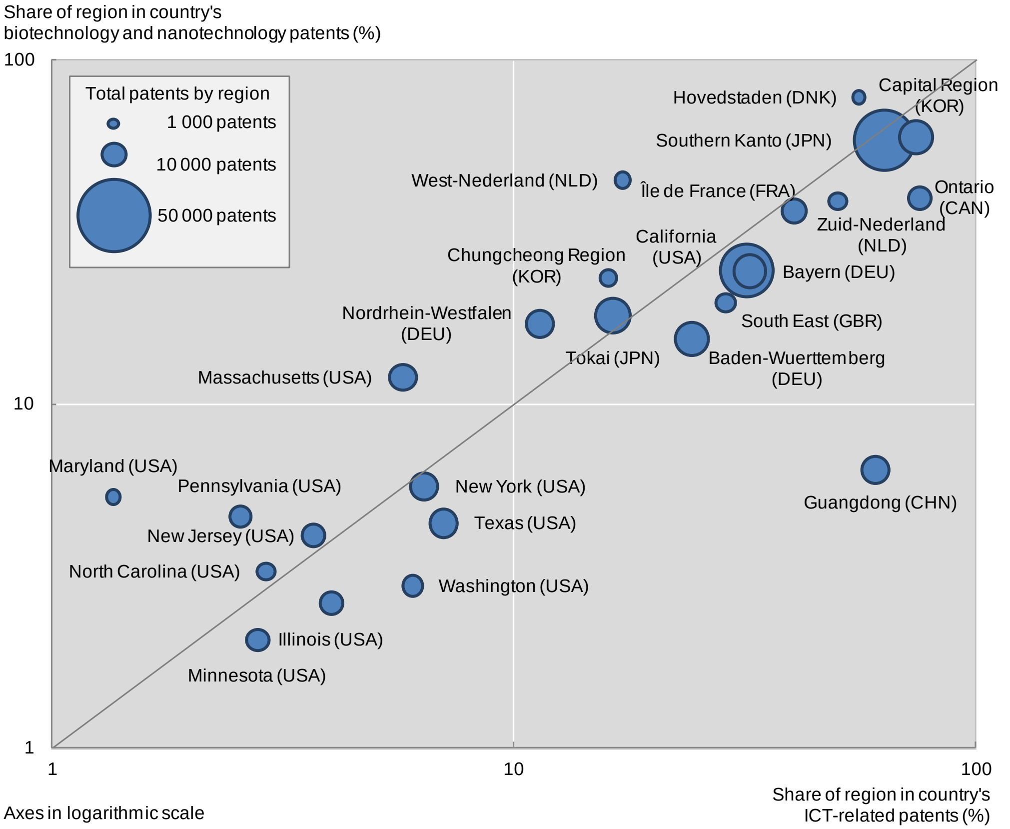


Source: OECD and SCImago Research Group (CSIC) (forthcoming), *Report on Scientific Production*, based on Scopus Custom Data, Elsevier, June 2011.

Statlink 2 http://dx.doi.org/10.1787/888932485310

Like universities, many of the leading firms in knowledge-intensive industries – such as ICT and the life sciences – are also concentrated in a limited number of regions in the world. Innovation in biotechnologies and nanotechnologies appear to be co-located with ICT-related innovation activity. The United States is unique in having a larger number of smaller hot spots from coast-to-coast as opposed to the concentrated activity that characterises many countries.

Innovation hotspots in ICT, biotechnologies and nanotechnologies, 2006–08
Top patenting regions by technology field as a percentage of the country's patents in the field



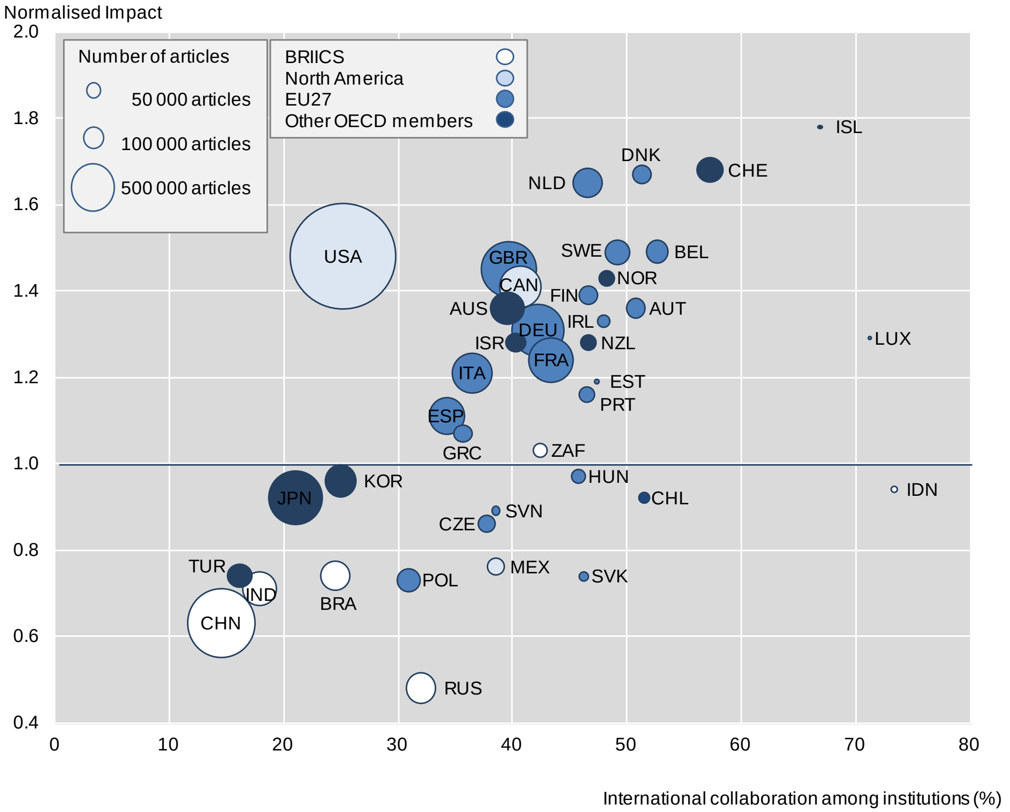
Source: OECD, REGPAT Database, June 2011.
Statlink 2 http://dx.doi.org/10.1787/888932485329

> China has the second largest number of scientific publications, after the United States, but the degree of scientific collaboration and impact of its research are among the lowest

The production of scientific knowledge is shifting from individuals to groups, from single to multiple institutions, and from a national to an international level. Researchers are increasingly networked across national and organisational borders and so are research institutes.

Greater scientific specialisation and cross-border collaboration can result in increased innovation. New *STI Scoreboard* indicators show that international scientific collaboration among institutions results in research with high impact (as measured by normalised citations) – and the broader the collaboration, the higher the impact of the research.

The impact of scientific production and the extent of international scientific collaboration among institutions, 2003–09



Source: OECD and SCImago Research Group (CSIC), *Report on Scientific Production*, based on Scopus Custom Data, Elsevier, June 2011.

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The development of "clean" energy technologies draws on a broad set of scientific disciplines

New technologies often draw on a broad base of scientific knowledge. Focusing on "clean" energy technologies, a new OECD indicator based on citations to scientific publications reveals that material science makes the single largest contribution to clean energy, followed by chemistry and physics; energy and environmental science only account for 10% and 1.7% respectively. The diversity of scientific sources highlights the difficulty of identifying a single major scientific contributor to innovation in this area.

Collaboration is key to innovation processes. In all countries R&D-active firms tend to collaborate more frequently on innovation (usually twice as much) than non-R&D-active firms. In the United Kingdom, collaboration is embedded in the innovation processes of over 50% of non-R&D-active firms.

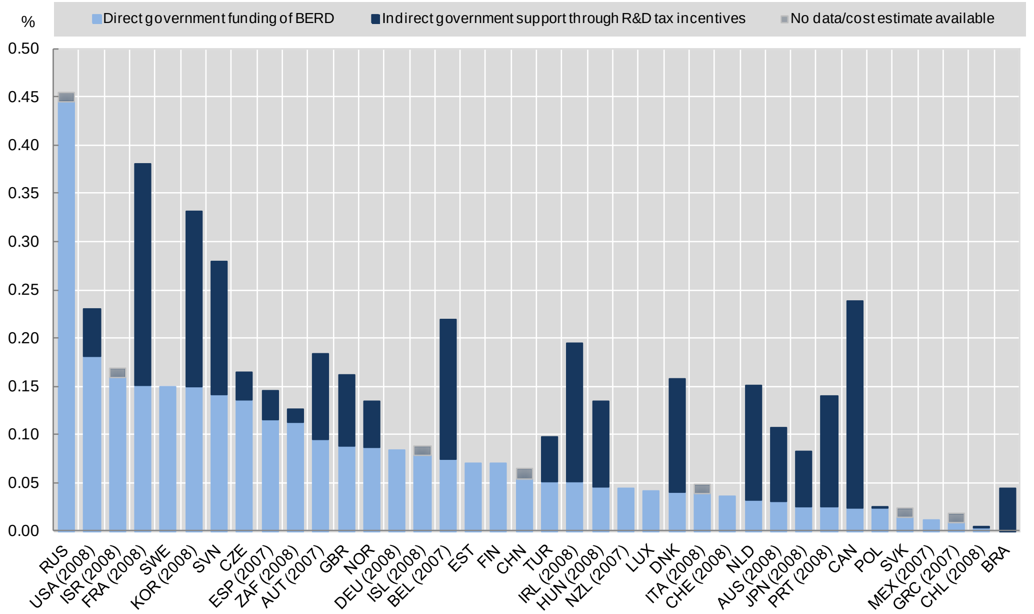
Unleashing innovation

Governments foster business R&D with direct support via grants or procurement and fiscal incentives, such as R&D tax incentives. Today, 26 OECD governments use fiscal incentives to promote business expenditure on R&D. Among those that do not (Germany, Finland, Sweden), some are discussing their introduction. Brazil, China, India, the Russian Federation, Singapore and South Africa also offer incentives for investment in R&D.

The Russian Federation, France and Korea provide the largest combined government support to business R&D relative to GDP

New estimates of the cost of R&D tax incentives and data on the value of direct public funding to support business R&D show that the United States and Spain rely more on direct support, while Canada, the Netherlands, Portugal and Japan mostly use indirect tax support to foster business R&D.

Direct government funding of business R&D and tax incentives for R&D, 2009
As a percentage of GDP

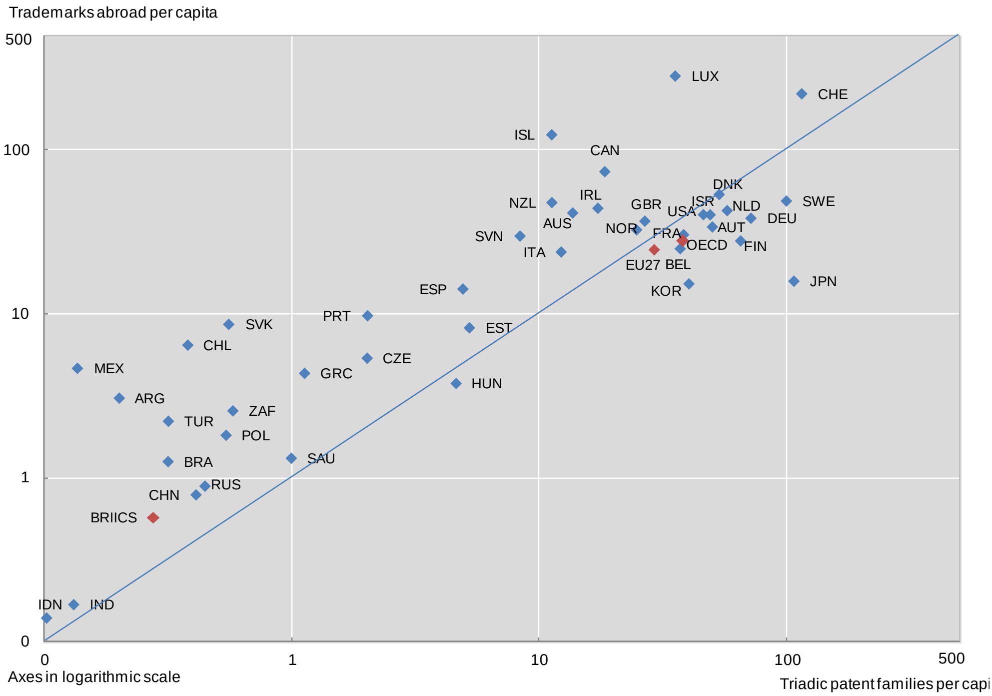


Source: OECD, based on OECD R&D tax incentives questionnaires, January 2010 and June 2011; and OECD, Main Science and Technology Indicators Database, June 2011.
Statlink 2 http://dx.doi.org/10.1787/888932487400

> Countries in the process of catching-up have a lower propensity to seek protection for their innovations (via patents or trademarks) than OECD countries

Indicators based on trademarks – a new measure that also reflects innovations in the service sector – point to the important role of incremental and marketing innovations and confirm that firms perform both technological and non-R&D-based innovation. Countries with a large manufacturing sector or a high degree of ICT specialisation have a greater propensity to patent than to "trademark". Countries with a large services sector tend to engage more in trademark protection.

Patents and trademarks per capita, 2007–09
Average number per million population, OECD and G20 countries



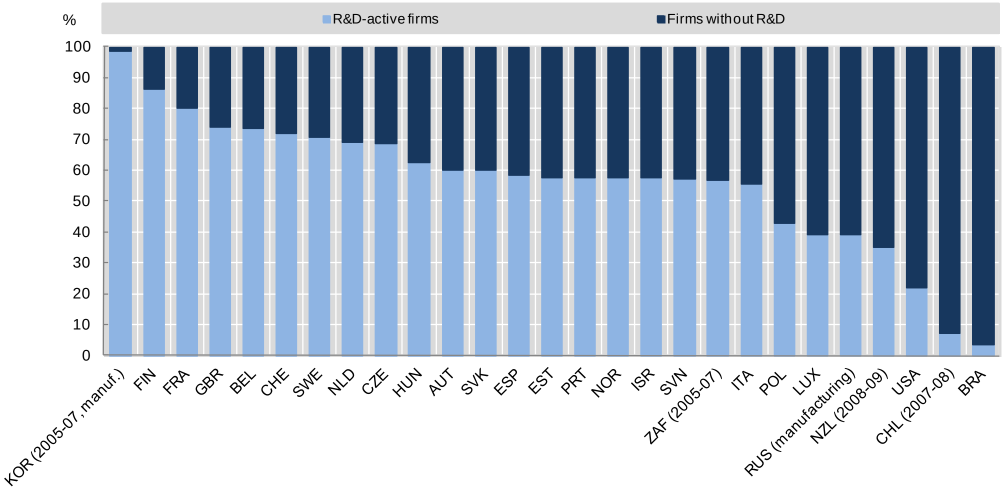
Source: OECD, Patent Database, May 2011; US Patent and Trademark Office (2011), "The USPTO Trademark Casefile Dataset (1884–2010)"; OHIM Community Trademark Database; CTM Download, April 2011; *JPO Annual Reports 2008–2010*.

Statlink 2 http://dx.doi.org/10.1787/888932485386

More than 65% of product innovators in the United States and New Zealand and more than 90% in Chile and Brazil do not perform R&D

Analysis of firm-level data on innovation shows that firms follow various innovation strategies and that these are not always based on formal R&D. However, product innovation is often associated with R&D. Indeed, in most countries, more than half of all product-innovating firms also engage in R&D. Remarkably, more than two-thirds of product innovators in New Zealand and the United States are not engaged in R&D as well as more than 90% in Chile and Brazil.

Product innovators by R&D status, 2006–08
As a percentage of product innovators



Source: OECD, based on Eurostat (CIS-2008) and national data sources, June 2011.
Statlink 2 http://dx.doi.org/10.1787/888932487134

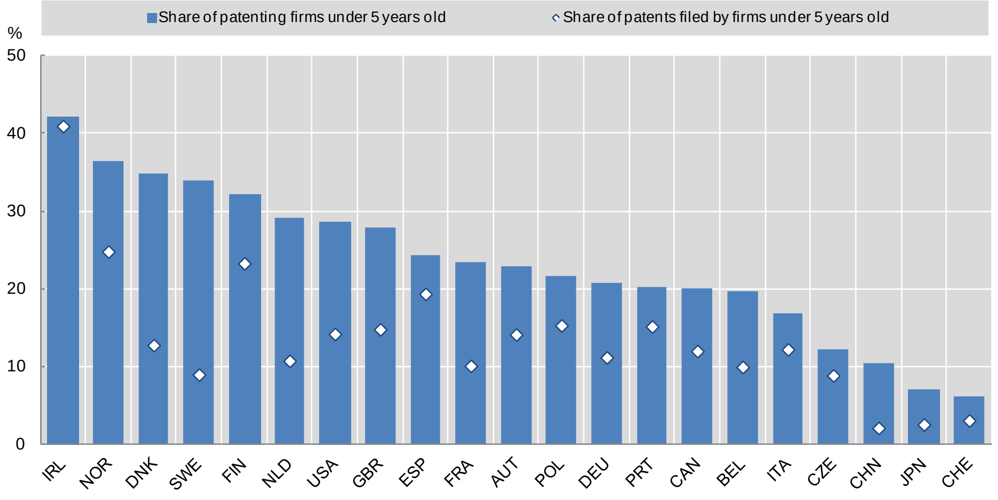
Broader innovation is essential for economic growth and social advancement. Innovation entails investment in a range of complementary assets beyond R&D such as software, human capital and new organisational structures. Investment in these intangible assets is rising and even exceeds investment in physical capital (machinery and transport equipment) in Finland, the Netherlands, Sweden, the United Kingdom and the United States. Encouragingly, in some countries, recent estimates of intangible assets explain a significant portion of multi-factor productivity growth.

Over 30% of patenting firms in Ireland and in the Nordic countries are less than five years old

A dynamic business sector is a key source of technological and non-technological innovation. The *STI Scoreboard 2011* includes indicators reflecting the business environment for innovation, for example on the availability of venture capital and business angel networks, as well as regulatory and taxation indicators. Among OECD and BRIICS countries, the United Kingdom has the lowest barriers to entrepreneurship, while China has the highest.

New OECD indicators based on linking patents with companies' information reveal that, during 2007–09, firms less than five years old filing at least one patent application represented on average 25% of all patenting firms, and generated 10% of patent applications. The share of young patenting firms varies considerably across countries, led by Ireland (42%) and followed by the Nordic countries.

Patenting activity of young firms, 2007–09
Share of young patenting firms and share of patents filed by young patenting firms, EPO and USPTO



Source: OECD, calculations based on the Worldwide Patent Statistical Database, EPO, April 2011; and ORBIS© Database, Bureau van Dijk Electronic Publishing, December 2010; matched using algorithms in the Imalinker system developed for the OECD by IDENER, Seville, 2011.

Statlink 2 http://dx.doi.org/10.1787/888932488122

Reader's guide

Abbreviations

For most of the charts, this publication uses ISO codes for countries and economies.

ARG	Argentina	GBR	United Kingdom	NLD	The Netherlands
AUS	Australia	GRC	Greece	NOR	Norway
AUT	Austria	HKG	Hong Kong, China	NZL	New Zealand
BEL	Belgium	HRV	Croatia	POL	Poland
BGR	Bulgaria	HUN	Hungary	PRT	Portugal
BMU	Bermuda	IDN	Indonesia	ROU	Romania
BRA	Brazil	IND	India	RUS	Russian Federation
BRB	Barbados	IRL	Ireland	SAU	Saudi Arabia
CAN	Canada	ISL	Iceland	SGP	Singapore
CHE	Switzerland	ISR	Israel	SVK	Slovak Republic
CHL	Chile	ITA	Italy	SVN	Slovenia
CHN	People's Republic of China	JPN	Japan	SWE	Sweden
CYM	Cayman Islands	KOR	Korea	THA	Thailand
CZE	Czech Republic	LIE	Liechtenstein	TUR	Turkey
DEU	Germany	LTU	Lithuania	TWN	Chinese Taipei
DNK	Denmark	LUX	Luxembourg	UKR	Ukraine
ESP	Spain	LVA	Latvia	USA	United States
EST	Estonia	MEX	Mexico	VGB	Virgin Islands (British)
FIN	Finland	MLT	Malta	ZAF	South Africa
FRA	France	MYS	Malaysia		

Country groupings

BRIICS	Brazil, the Russian Federation, India, Indonesia, China and South Africa
EA15	Euro area
EU27	European Union
G7	Canada, France, Germany, Italy, Japan, the United Kingdom and the United States
OECD	Total OECD
ROW	Rest of the world
WLD	World

Long time series –Industrial Production Index & Capacity Utilisation

Sofie Lord

Summary

In accordance with its terms of references, the project has developed long time series for the Industrial Production Index and Capacity Utilisation back to 1980. A method inquiry has established the backcasting method and the level of detail for the series.

Industrial Production Index (IPI)

The project has backcasted a sample of series that are retrospectively compatible in Swedish NACE 2007. This means that there is a reasonable one-to-one relationship between NACE 2007, NACE 2002 and NACE 69.

The quality of the spliced sub-series 1990–2010 is considered to be adequate. The reliability of spliced series 1980–1999 can be questioned as a result of differences in statistics production methods, earlier backcasting in NACE 2002 as well as the absence of actual information in NACE 69. The extent to which this affects the reliability of the statistics has not been possible to examine within the remit of the project.

The main backcasting approach is based on splicing the sub-series from the various NACE nomenclatures. The advantage of splicing original sub-series into one long time series is that it retains important properties in the sub-series.

The long time series developed in the project will be published with reservations for the reliability flaws pointed out in the method inquiry. The time series will be published in a historical table on the product page for IPI together with documentation on the method of procedure.

Capacity Utilisation

The project has backcasted the series in NACE 2007 that are currently published in SSD (Sweden's statistical database). Backcasting has been done for the period Quarter 1 1990 to Quarter 4 2007. These data are deemed to be of adequate quality.

For the time period Quarter 1 1980 to Quarter 4 1989, a smaller number of series have been backcasted. The majority of these series are deemed to be of adequate quality, while some series (NACE 20-21 and NACE 29) are based on approximate calculations.

The main backcasting approach is based on ratio adjustments of the series in NACE 2002 and NACE 69 respectively.

The series between 1980 and 1990 developed in the project will be published in a historical table on the product page for Industrial Capacity Utilisation, while the remaining series will be published as official tables in SSD.

1 The project

1.1 Background and task of the project

In connection with the conversion to NACE 2007, time series breaks have occurred leading to a lack of long, continuous series for the Industrial Production Index (IPI) and Capacity Utilisation.

For IPI there are regular estimates in accordance with NACE 2007 from January 2008 onwards. In addition, there are backcasted data in accordance with NACE 2007 from January 2000 to December 2007 inclusive. As regards Capacity Utilisation data, there are only regular estimates in accordance with NACE 2007 from the first quarter of 2008 onwards.

On the Swedish Riksbank's initiative, an inquiry will be conducted to see if it is possible to extend IPI and Capacity Utilisation time series back to 1980.

The objective is for Statistics Sweden to develop IPI and Capacity Utilisation time series from 1980 and onwards in accordance with NACE 2007.

1.1.1 Method and level of detail

A method inquiry is to examine which method should be applied and at what level of detail time series can be reported without risking a substantial deterioration in quality.

The series must be quality-assured. Interpretation problems for each level of aggregation respectively and any individual industries must be documented.

1.1.2 Publication

The idea is that the series will be loaded into Sweden's statistical database (SSD) and documentation will be published on the product page.

1.2 Participants

Lennart Nordberg PCA/MFFM (up until September 2010)
Pär Lindholm PCA/MFFM (as from September 2010)
Suad Elezovic PCA/MFFM
Lars Öhman ES/UI
Sofie Lord ES/UI

2 Customers and customer requirements

The project is part of the Riksbank agreement which the National Accounts Department (NR) at Statistics Sweden has with the Riksbank. The project is monitored by SAMEK via Kaisa Ben Daher at NR.

The project has been commissioned by the unit manager of ES/UI (Economic Statistics Department, Unit for Foreign Trade and Industry Indicators).

3 Meeting with the Riksbank and the National Institute of Economic Research

The project group initiated a meeting with the project’s commissioner, the Swedish Riksbank, at an early stage. The project group wanted to discuss some issues of principle before beginning its backcasting work. The level of detail in the time series and the commissioner’s aim with long time series were questions that the project group intended to discuss. A representative of the National Institute of Economic Research was also present at the meeting.

The project group’s proposal was to backcast IPI to 1990, and not to 1980 as stated in the project order. In return, the group offered to do calculate all 50 series back to 1990 for the Riksbank. The offer also applied to Capacity Utilisation.

Consultations with users indicated, however, that there was no need for time series back to 1990 for all industrial sectors. The Riksbank, and other users of IPI and Capacity Utilisation, have a much greater need for time series back to 1980 for a small number of key sectors. The commissioners then approved the proposal that Statistics Sweden would develop time series from 1980 for a limited number of sectors.

The Riksbank wants the IPI and Capacity Utilisation data to be published in SSD, Sweden’s statistical database. The Riksbank also wants Statistics Sweden to seasonally adjust the developed series.

4 Results

4.1 Industrial Production Index

To determine which IPI series should be backcasted, the wishes of the Riksbank and the existing methodological possibilities for backcasting series of (reasonably) good quality have been weighed against each other. The series in NACE 2007 will be backcasted to 1980.

When the reporting system converted to NACE 2007 (January 2009), an inquiry was held into backcasting IPI series to the year 2000. As regards the choice of backcasting method, the inquiry came to the conclusion that a micro approach, i.e. starting the calculations from the enterprise level, was not appropriate. A macro approach was chosen instead. The macro approach also worked well for series on the detailed and aggregated level. On the total level between IPI in NACE 2007 and IPI in NACE 2002, the differences in the index numbers were very small.

A natural alternative is therefore to discuss a macro approach for backcasting to 1980 as well. Briefly, the macro approach involves using keys (or a key matrix) between series in NACE 2002 and NACE 2007. A key matrix is developed for *one* year in which the enterprises in the Statistics Sweden Business Register are dual-coded. The key matrix describes the flows between NACE 2002 and NACE 2007 on the detailed level expressed in terms of, for example, value added or turnover. These keys can then be used to backcast series.

Within the remit of the project, such a matrix can be developed between NACE 2007 and NACE 2002 and then used to backcast the series in NACE 2007 to 1990. This can be achieved either by directly backcasting an index series using the key matrix, or by firstly constructing links between the months on the detailed level and then aggregating these links to higher levels using backcasted weights in NACE 2007, calculated with the help of the key matrix, and then linking them together to an index series.

None of these approaches were considered to provide sufficiently good quality when backcasting to 1980, however. By using the key matrix, you can interpret the method as maintaining the weight structure between the industries included from a specific year (2008) all the way back to 1980. Assuming a constant weight structure must however be said to be a weak description of reality, making the method a dubious one. In addition, there is no key matrix available between NACE 2002 and NACE 69.

With this in mind, the project has chosen a more limited IPI backcasting method. The project has only backcasted a sample of IPI series. The sample of series includes series in NACE 2007 that are (reasonably) compatible back in time. In other words, there is a one-to-one relationship (or close to a one-to-one relationship) for these industries in NACE 2007, NACE 2002 and NACE 69 and the industries are particularly interesting subject-wise.

The levels in NACE 2007 that are backcasted are:

B+C (Mining and quarrying, manufacturing)

C (Manufacturing industry)

10-12 (Food product, beverage and tobacco industry)

16_1 (Saw-mills and planing-mills)

17 (Industry for pulp, paper and paper products)

24 (Industry for fabricated metal products)

29 (Industry for motor vehicles)

4.1.1 Methodological approach to backcasting and requirements on the long time series

As the project has elected to only backcast series that are (reasonably) compatible in NACE 2007, NACE 2002 and NACE 69, the problem is reduced to one of linking or splicing the sub-series from the various NACE nomenclatures.

When we talk of sub-series in NACE2007, NACE 2002 and NACE 69, we are referring to the following periods:

NACE 2007 (2000–2010)

NACE 2002 (1990–2000)

NACE 69 (1980–1990)

The advantage of splicing original sub-series into one long time series (1980–2010) is that it maintains important properties from the sub-series, e.g. the positive effects of chaining. Other types of properties can and should also be maintained from the sub-series in the spliced series.

One such property is that the annual rate in the long, spliced time series should be the same as the annual rate in the sub-series for all the years. Another property that should be maintained is that the annual growth figures (month in the current year compared to the corresponding month the year before) in the spliced series is the same as in the sub-series except for the "splice" year.

The long spliced time series shall be expressed as reference year 2005.

4.1.1.2 Adjustment of sub-series

Before the nomenclatures were spliced, some sub-series were adjusted to make them as compatible as possible over time.

In NACE 2002, Publishing (NACE 22.1) is included in IPI. In NACE 2007, however, Publishing is classified as a service industry (NACE 58.1, 59.2). To make IPI in NACE 2002 more compatible with series B+C and C in NACE 2007, the corresponding sub-series in NACE 2002 have been adjusted. The series have been adjusted by de-weighting Publishing from NACE 2002. In the ten-year period 1980–1990, publishing houses were responsible for around 3 percent of the total value added in industry. No adjustment is made for Publishing in the corresponding series in NACE 69 as there are no data on publishing houses in NACE 69.

In addition to Publishing, there are other out- and inflows from IPI in SNI2002 to IPI in SNI2007 and vice versa. The recycling industry is one such example. The flows between the nomenclatures are on the other hand so small that no adjustment is necessary.

4.1.1.2 The methodology for splicing sub-series (concerns all levels of IPI)

The three sub-series are spliced in accordance with the following diagram (for an arbitrary level of IPI).

Assume we have three sub-series volumes,

$S(nace2007)_{2000}^{2010}$, $S(nace2002)_{1990}^{2000}$, $S(nace69)_{1980}^{1990}$.

For simplicity's sake, we can call each volume

$$S(nace2007)_{2000}^{2010} = S^A$$

$$S(nace2002)_{1990}^{2000} = S^B$$

$$S(nace69)_{1980}^{1990} = S^C$$

where

$$S^A = \{I_{2000,1}^A, I_{2000,2}^A, \dots\dots, I_{y,m}^A, \dots\dots I_{2010,7}^A\}$$

$$S^B = \{I_{1990,1}^B, I_{1990,2}^B, \dots\dots, I_{y,m}^B, \dots\dots I_{2000,12}^B\}$$

$$S^C = \{I_{1980,1}^C, I_{1980,2}^C, \dots\dots, I_{y,m}^C, \dots\dots I_{1990,12}^C\}$$

and where $I^{A}_{2000,1}$ is the index for year 2000 and month 1 in sub-series NACE 2007.

Start by splicing the sub-series in NACE 69 and NACE 2002.

Calculate the factor as

$$f_C^B = \frac{\left(\sum_{y=1990,m=1}^{y=1990,m=12} I^B_{1990,m}\right)/12}{\left(\sum_{y=1990,m=1}^{y=1990,m=12} I^C_{1990,m}\right)/12}.$$

To splice sub-series S^C with S^B, we multiply all the numbers in sub-series S^C by f_C^B.

We also create the new spliced series

$$S^{CB} = \{I^{C*}_{1980,1}, I^{C*}_{1980,2}, \dots\dots, I^{C*}_{y,m}, \dots\dots I^{C*}_{1989,12}, I^{B}_{1990,1}, I^{B}_{1990,2}, \dots\dots, I^{B}_{2000,12}\}$$

where $I^{C*}_{1980,1}$ is the spliced index number for year 1980 and month 1 in the sub-seriesS^{CB}.

In the next step we splice the sub-series S^{CB} and S^A.

We calculate the factor as

$$f_B^A = \frac{\left(\sum_{y=2000,m=1}^{y=2000,m=12} I^A_{2000,m}\right)/12}{\left(\sum_{y=2000,m=1}^{y=2000,m=12} I^B_{2000,m}\right)/12}.$$

To then splice sub-series S^{CB} with S^A we multiply all the numbers in the sub-series S^{CB} by f_B^A.

This gives us the final spliced series

$$S^{CBA} = \left\{ \begin{matrix} I^{C**}_{1980,1}, I^{C**}_{1980,2}, \dots\dots, I^{C**}_{y,m}, \dots\dots I^{C**}_{1989,12}, I^{B*}_{1990,1}, I^{B*}_{1990,2}, \dots\dots, I^{B*}_{1999,12}, \\ I^{A}_{2000,1}, I^{A}_{2000,2}, \dots\dots, I^{A}_{2000,7} \end{matrix} \right\}$$

where $I^{C*}_{1980,1}$ is the dual-spliced index number for year 1980 and month 1 in the sub-seriesS^{CB}.

We then recalculate the index numbers in the spliced series S^{CBA} so that the reference year is 2005.

4.1.2 Reliability and comparability in the backcasted series

Since the sub-series are only spliced into one long time series, the splicing method itself does not lead to any errors in the time series apart from the annual growth figures for the splice year.

The errors in the long time series occur because the sub-series are not fully compatible with each other. The sub-series are not fully compatible because of, among other things, the differences in the various NACE nomenclatures and because different methods of producing the series have been used.

There is a certain overlap of available data for the various sub-series. Data in NACE 69 are available for the period 1980–1994, data in NACE 2002 are available for the period 1990–2008 and data in NACE 2007 are available for 2000 and onwards. There is therefore an overlap between the series during the periods 1990–1994 and 2000–2008. For these periods, the growth figures in the various sub-series (which are to describe growth for the same population) can be studied in order to make a simple comparison of how compatible the series are.

Within the whole industrial sector (B+C in NACE 2007), there are differences in growth during the periods when the sub-series in NACE 69 and NACE 2002 overlap each other. The differences in the annual rate amount to 4.6 percentage points for a few years and the difference in annual growth is over 10 percentage points for several months. Similar differences can also be found for manufacturing, level C. On more detailed levels, the differences vary considerably, from 2 to 10 percentage points as the smallest and greatest difference in annual rate.

Within the scope of this project, it has not been possible to examine whether these differences are caused by the backcasting of NACE2002 (or e.g. NACE 92) for the period 1990–1993 or by the use of different statistics production methods.

We can say for certain, however, that different methods were used to produce statistics in NACE 69 and NACE 2002. Hours worked and production volumes are used to a greater extent in NACE 69 as the sources of input data for the calculations. In addition, the sub-series in NACE 69 are based on a fixed-base index, while the series in NACE 2002 are a chain index. Furthermore, the actual sub-series in NACE 69 has been developed from a calendar-adjusted series (see Section 4.1.3.1 for more information). It has not been possible to study the effects of these method differences within the scope of this project.

For the industry for motor vehicles (NACE 29 in NACE 2007), there are additional problems between the nomenclatures NACE 69 and NACE 2002. In NACE 69, only data on the aggregate "Motor vehicles + Other transport equipment" are available. Since NACE 69 has no sub-series for Other transport equipment, the project has not been able to adjust the sub-series industry for motor vehicles by de-weighting the contribution from Other transport equipment. During the ten-year period, the sub-series Other transport equipment is responsible for between 6 and 10 percent of the aggregate "Motor vehicles and Other transport equipment" in terms of value added. The project has therefore made the assumption that the sub-series industry for motor vehicles has (almost) the same growth as the aggregate "Motor vehicles + Other transport equipment" in NACE 69. The maximum error in this assumption is, after simple tests, approximately 4 percentage points (but 0-2 percentage points for most years) in the annual rate. The project has taken the decision to accept the problem and backcast the series since the error is so small in combination with the fact that industry for motor vehicles is a key manufacturing sub-industry.

Between the sub-series in NACE 2002 and NACE 2007, the differences in overlapping data are significantly smaller compared to NACE 69/NACE 2002. The quality of the spliced sub-series (1990–2010) is considered in general to be adequate.

4.1.3 Seasonal adjustment

The main aim of seasonal adjustment is to remove seasonal variation in the spliced series. The methods currently used by most statistics offices in the EU and the rest of the world have certain limitations when it comes to series that contain different types of seasonal variation during different periods. One pre-condition for successful seasonal adjustment of a long series is that the series is sufficiently homogeneous as regards seasonal patterns, i.e. that the series does not contain varying seasonal effects. In our case, it is likely that the spliced series do not fulfil this basic pre-condition (see discussion in Section 4.1.2). For this reason, the seasonal adjustment must be reviewed and a suitable alternative to the standard method must be developed, based on processing a long series using one single time series model.

4.1.3.1 Method for anti-calendar-adjustment

The actual sub-series in NACE 69 were not available to the project. The only data available were in the form of calendar-adjusted information. This means that the project was forced to recreate the actual sub-series in NACE 69 in an appropriate fashion.

Calculation of the spliced series described in Section 4.1.1 requires the actual sub-series in NACE 2007, NACE 2002 and NACE 69 to be available. There were no actual data in NACE 69 for the selected industries in the period 1980–1990, apart from the period 1987–1989.

The calendar-adjusted series were however available for the entire period. On condition that the method for calendar adjustment used at Statistics Sweden between 1980 and 1990 is known, it is possible to recreate the actual series. Another requirement for recreation is knowledge of the calendar factors used to produce calendar-adjusted series.

For the period 1987–1989 data for both calendar-adjusted and actual series were available but there was no description of the calendar adjustment method. A reasonable approach was then to study the relationship between two related series for each relevant industry (and aggregate) to discover which method was used for calendar adjustment.

After comparisons and calculations, it transpired that the calendar factors developed corresponded to a typical calendar adjustment based on a five-day working week. This approach is currently used for the publication of official series in NACE 2007. This made it relatively easy to approximately recreate actual series with the help of developed calendar factors in accordance with the following principle:

$$Y_t^F = Y_t^{KK} \times \left(\frac{N_t}{21}\right)$$

where Y_t^F is an actual series, Y_t^{KK} a calendar-adjusted series in month t. N_t represents the number of working days in month t and 21 is the average number of working days a month. The number of working days a month and the calendar-adjusted series are known. On condition that the calendar adjustment principle in the expression above is a good approximation of the method, the actual series have been recreated with a satisfactory degree of accuracy.

4.1.3.2 Principle for seasonal adjustment of long time series

The seasonal adjustment method used for IPI is called Tramo-Seats, developed by the Bank of Spain, and recommended by Eurostat as one of two preferred methods. The calculation method is called TSW (Tramo Seats for Windows, Version 1.57), which, together with SAS 9.2, is used for calculations and data processing.

In the first part of the procedure, effects of different types of disturbances such as outliers, calendar effects and any effects of explanatory variables, are estimated. Once the series is free from disturbances, the main procedure starts. This identifies components that are assumed to form the basis of the underlying process of the series; seasonal components, trend-cycle components and irregular components. A seasonally adjusted series could hence be described as a series consisting of a trend-cycle component and irregular component. Calendar-adjusted series are calculated with the help of estimated calendar factors that are used to adjust the original actual series. The trend-cycle component is basically a seasonally adjusted series without irregular effects (random variation, temporary disturbances in the form of certain types of outliers and inexplicable effects).

Currently published IPI series start in 2000. In accordance with an agreement with the Riksbank, the new long-time series (from 2000 onwards) will be seasonal adjusted in the same way as they are today, which will enable post-2000 revisions. The part of the series created before 2000 will be seasonally adjusted separately and this seasonal adjustment will not be updated in new productions. The risk of any time series breaks between the locked series and the series updated in each new production is minimised by using similar time series models for related data. To the greatest degree possible, the models have been adapted to the models employed for the publication period 2000–2010. In addition, a special technique is used to splice together series from the selected sub-periods (see the discussion below). Together, this enables a smooth transition in the seasonal adjustment between the two sub-periods.

One reason for using the seasonal adjustment approach in different periods is that the older series are considerably unreliable, especially those produced before 1990. Another even more important reason is based on empirical conclusions, which show that the series cannot be seasonally adjusted in their entirety. This is because the seasonal adjustment program cannot handle the different types of seasonal patterns that obviously occur in the extended series.

Periods identified as relevant for seasonal adjustment are Period 1: 1980–1993, Period 2: 1994–1999 and Period 3: 2000–2010. Two seasonal adjustment strategies have been compared with each other. One that splits data in accordance with the above periods and seasonally adjusts each of the parts separately and one than uses the splicing technique. The latter approach seasonally adjusts the period 1980–1993 and the period 1990–2010 separately and then splices together the estimated series in accordance with the following principle:

1) From seasonally adjusted data for the period 1980–1993 use only estimates that refer to the period 1980–1989.
2) Extend the data in a) using the seasonally adjusted series referring to the period 1990–2010 by including estimates from 1990 and 1999 inclusive.
3) The published figures are used from 2000 onwards.

The second method results in smoother transitions at critical breakpoints, i.e. 1990, 1994 and 2000. The variation of the series from one month to another reveals small changes over the whole period 1980–2000. This is a pre-condition to be able to correctly interpret seasonally adjusted data.

4.2 Capacity Utilisation

An evaluation of the quality of the data compiled for industrial capacity utilisation statistics was performed at the end of the 1990s. Because of major non-response, the estimates on the detailed industry level in accordance with NACE 2002 were deemed too unreliable for publication. It was therefore decided that the data would only be presented for the following aggregates and industries for the period Quarter 1 1990 to Quarter 4 2008 in SSD.

C+D	(Mining and quarrying, manufacturing)
INS	(Intermediate goods industry)
INV	(Capital goods industry)
IVKON	(Non-durable consumer goods industry)
VKON	(Durable consumer goods industry)
C	(Mining and quarrying industry)
D	(Manufacturing industry)
24	(Manufacture of chemicals and chemical products)
27	(Industry for basic metals)
29	(Industry for machinery and equipment n.e.c.)
32	(Industry for manufacture of computer, electronic and optical products)
34	(Industry for motor vehicles)

With the transition to NACE 2007, the industries that most closely correspond to the coding in NACE 2002 have been published from Quarter 1 2008 and onwards. As an approximation for the total industrial sector (NACE B+C) data has been entered in accordance with NACE 2002 (C+D). The following industries and aggregates according to NACE 2007 are currently published in SSD.

B+C	(Mining and quarrying, manufacturing)
INS	(Intermediate goods industry)
INV	(Capital goods industry)
IVKON	(Non-durable consumer goods industry)
VKON	(Durable consumer goods industry)
B	(Mining and quarrying industry)
C	(Manufacturing industry)
20-21	(Manufacture of chemicals and chemical products, basic pharmaceutical products and pharmaceutical preparations)
24	(Industry for basic metals)
26	(Industry for manufacture of computer, electronic and optical products)
28	(Industry for machinery and equipment n.e.c.)
29	(Industry for motor vehicles)

4.2.1 Methodological approach to backcasting and requirements on the long time series

The pre-conditions for the backcasting of Capacity Utilisation figures differ from those for the backcasting of IPI. Capacity Utilisation shows estimates expressed as percentages and it is not necessary to consider reference years and similar complications. The main approach is based on ratio adjustments of the series in NACE 2002 and NACE 69 respectively.

4.2.1.1 Backcasting for the period Quarter 1 1990 – Quarter 4 2007

All industries and aggregates that are currently reported in SSD have been backcasted to the Quarter 1 1990. These data will be published in SSD.

The backcasting method used is a simple ratio adjustment of estimates in accordance with NACE 2002. Data are available for the period Quarter 1–3 2008 in accordance with both NACE 2002 and NACE 2007. The ratio between the estimates in accordance with NACE 2007 and NACE 2002 for the above period has been used for backcasting.

There is a one-to-one relationship (or close to one-to-one relationship) for the backcasted industries in NACE 2002 and NACE 2007.

SNI2007	Ratio
B+C	0.998
INS	1.009
INV	0.992
IVKON	0.975
VKON	0.995
B	1.000
C	0.999
20-21	1.002
24	1.000
26	1.002
28	1.010
29	1.000

The industries Publishing and Recycling belonged to the industry sector in NACE 2002 but are outside the industry in NACE 2007. This affects the adjustment of industries B+C, C, INS and IVKON.

4.2.1.2 Backcasting for the period Quarter 1 1980 – Quarter 4 1989

The aim has been to backcast as many as possible of the industries currently published in SSD according to NACE 2007. As a result of the major differences between the industry nomenclatures, the backcasting has been limited to a certain number of industries. The sample of industries includes those that are (reasonably) compatible in NACE 2007, NACE 2002 and NACE 69.

B+C	(Mining and quarrying, manufacturing)
B	(Mining and quarrying industry)
C	(Manufacturing industry)
20-21	(Manufacture of chemicals and chemical products, basic pharmaceutical products and pharmaceutical preparations)
24	(Industry for basic metals)
29	(Industry for motor vehicles)

Regarding the aggregates B+C and C, the same ratio adjustment method has been used as for the period Quarter 1 1990 and onwards. As regards the aggregate B and SNI24, there is a one-to-one relationship, which means that the estimates according to NACE 69 have been used without adjustment. Chemical manufacturing etc., (NACE 20-21) has been calculated approximately by weighing the estimates for NACE 69 industries 351 and 352 by number of employees.

For industry for motor vehicles (NACE 29 in NACE 2007), there are only data on the aggregate "Motor vehicles + other transport equipment" available in NACE 69. As an approximation for NACE 29 according to NACE 2007, the aggregate NACE 3842-9 according to NACE 69 has been used for backcasting. The aggregate comprises motor vehicles and other transport equipment. The sub-series motor vehicles accounts for about 85 percent of the total number of employees for the aggregate.

4.2.2 Seasonal adjustment

Seasonal adjustment of the extended Capacity utilisation series is performed using the same method as for IPI. The seasonal adjustment strategy will however be different since the seasonal variation in the actual (both backcasted and published) series is weak. Seasonal adjustment using Tramo-Seats results in non-significant seasonal effects for each of the selected series. This basically means that the actual and the seasonally adjusted series are virtually identical. The trend-extrapolated series, on the other hand, indicate a certain difference.

Despite the conclusion about non-significant seasonal effects, the series will still be seasonally adjusted as the seasonal adjustment tool estimates calendar factors that can be significant. Furthermore, the trend-cycle component is an indicator of the long-term trend in the series, which can be of interest for users.

The series have been seasonally adjusted with classification into two periods, 1980–1989 and 1990–2010 and beyond. The first period will be seasonally adjusted once and the seasonally adjustment will not be updated in new productions. Data from 1990 onwards will be seasonally adjusted and updated for each new production. The time series breaks in seasonally adjusted data in 1990 have been minimised by using fixed time series models for respective series during the whole period 1980–2010. The actual figures for some observations at the end of the time series are updated in each new production. The seasonal adjustment will hence revise the related observations at the end and any further observations back in time. It is rather unlikely that the revision will affect the values at the beginning of the second sub-period (around the breakpoint in 1990) as it is seldom the case that Tramo-Seats revises estimates further than 2–3 years back in time.

As regards Capacity Utilisation, it is even more unlikely that seasonally adjusted data will give rise to noticeable time series breaks since the seasonal variation has not proven significant. A time series break can only occur if there already is one in the actual figures, which is not the case with the selected series.

Comparisons have also been made with other seasonal adjustment methods, X11 and X12-Arima, which don’t result in any significant seasonal effects either.

5 Dissemination of results

In accordance with its terms of references, the project has developed long time series for the Industrial Production Index and Capacity Utilisation back to 1980. A method inquiry has established the backcasting method and the level of details for the series.

The Riksbank wants the IPI and Capacity Utilisation figures to be published in SSD, Sweden’s statistical database. The Riksbank also wants Statistics Sweden to seasonally adjust the developed series.

5.1 Publication of the Industrial Production Index

The quality of the spliced sub-series (1990–2010) for IPI is considered in general to be satisfactory. The reliability of the spliced series 1980–1999 can be questioned as a result of differences in statistics production methods, earlier backcasting in NACE 2002 as well as the absence of unadjusted data in NACE 69.

The long time series developed in the project will be published with reservations for the poor reliability pointed out in the method inquiry. The time series will be published in a historical table on the product page for IPI together with documentation on the procedure.

An unadjusted, calendar-adjusted, seasonally adjusted and trend series will be published in the historical table for 1980–1999.

5.2 Publication of Capacity Utilisation statistics

The project has backcasted the time series in NACE 2007 that are currently published in SSD. A reasonable one-to-one relationship between NACE 2007 and NACE 2002 exists for these series. Data have been backcasted from Quarter 1 1990 and onwards. These series will be published as official tables in SSD.

Furthermore, a smaller number of series have been backcasted for the period Quarter 1 1980 to Quarter 4 1989. The majority of these series have an acceptable one-to-one relationship between NACE 2002 and NACE69. Approximate calculations have been made for some series. These series will be published in a historical table on the product page for Capacity Utilisation.

An unadjusted, calendar-adjusted, seasonally adjusted and trend series will be published.

Quarterly Structural Business Statistics – the version for Saltsjöbaden Conference 2011

Barbro von Hofsten

Summary

During the financial crisis, it became known that there was a need for better ways to follow the financial situation in Swedish enterprises than is possible with the existing structural business statistics. Demands have been made for quicker statistics on income statements and balance sheets, as well as statistics on size categories of enterprises. Therefore the aim of this project has been to produce proposals on how a new quarterly survey could be designed.

One of the tasks of the project has been to study Statistics Sweden's profit statistics[63], which were discontinued in 1996, to see if it was possible to use experience from those statistics. The project has gone through a number of quarterly reports of large enterprises, focusing on economic key ratios and cash flow analysis. The project has proposed six key ratios which could be useful to calculate on a quarterly basis. Viewpoints from prospective users of a new survey were assessed to be particularly important in the project. An enquiry about viewpoints has therefore been sent to a number of potential users. Among others, Statistics Sweden's national accounts have contributed with viewpoints and requests about the contents of variables.

The project has produced three possible alternatives for the arrangement of a survey. The first alternative is the one recommended by the project and is called the NA (national accounts) track. This alternative meets the national accounts' needs of variables that are required to calculate intermediate consumption, thus improving the quarterly calculations of GDP. In addition, this arrangement can produce statistical results according to the

[63] Preliminary statistics on profit for enterprises

previous survey and enable calculation of the proposed key ratios in the project. The variable content according to alternative one is relatively simple with nine variables from the income statement and six variables from the balance sheet. The method involves a cut-off of 20 employees, stratification based on industry (NACE classification) and size category and the presentation of 12 NACE groups without presenting size classification. This proposal involves a sample size of about 4 600 companies and an annual cost of roughly SEK 6.3 million.

The second alternative that was studied in the project is a variable content for cash flow analysis, which requires four variables from the income statement, seven variables from the balance sheet as well as changes in equity. The arrangement for methodology is the same as the NA track. The third alternative is the size class track, which involves the same variable content as the NA track but the sample sizes need to be increased considerably. If a cut-off on one employee is selected, the sample needs to include all of 22 250 enterprises, which would mean an annual cost of SEK 24.4 million.

The project has also discussed issues on data provision with Statistics Sweden's group for large enterprises. In addition, a measurement test has been conducted with the variable content in both alternative one and two. The test included 11 enterprises.

2 Description of the project

2.1 Background and task of the project

The economic development during the financial crisis gave rise to questions that point out the needs for new statistics. One such question is: to what degree has the financial crisis revealed underlying structural problems in the economy? Has the financial crisis revealed the beginning of future industrial crises or is it only a question of access to capital in the enterprises? This question is difficult to answer with the current statistics. Better short-term statistics on the non-financial enterprises' income statements and balance sheets would be needed to improve the statistics.

The Committee on Finance has stated that there is a lack of information about how small and medium-size enterprises handled the need for capital during the financial crisis. This is the reason they gave the Swedish Riksbank the assignment to investigate this together with Statistics Sweden, among others. The Riksbank has also assigned Statistics Sweden to investigate the possibility to present statistics on profits on a quarterly basis. The project will submit a proposal on how a study could be organised together with the costs involved. The project has been financed by the Riksbank.

2.2 Participants

Project leader: Barbro von Hofsten ES/NS

Project participants:

Lisa Allemo ES/NS

Stefan Berg PCA/MFFM

Staffan Berge Holmbom PCA/MFFM (methodology)

Jonny Hall ES/NS

Daniel Lennartsson ES/NS

3 Results

3.1 A study of Statistics Sweden's profit statistics

One of the sub goals of the project was to study Statistics Sweden's preliminary statistics on results for enterprises. Starting in 1978 and up until the end of 1996 Statistics Sweden produced quick statistics on profitability of industrial enterprises. The survey included the 500 largest industrial enterprises in Sweden. The information referred to interim values for the first 6 or 8 months of the calendar year and was published in October of the same year. In the press release information was presented about the enterprises' turnover, operating margin, net margin and net financial income.

The survey was discontinued in 1997 for economic reasons. This was an unfortunate decision because the product was very much in demand and often attracted considerable attention in the media. To be able to present the same results as with Statistics Sweden's preliminary statistics on results, four variables need to be collected from the income statement: net turnover, operating profit, net financial income and net profit.

3.2 User contacts

3.2.1 Enquiry to potential users

The project has regularly tried to obtain viewpoints about the contents, use etc. from potential users of a new survey. Among other things, Statistics Sweden's User Council for economic statistics and

Statistics Sweden's National Accounts Department have been contacted. Viewpoints have been obtained from the National Accounts Department, the Riksbank, Almega (employer and trade organisation for the Swedish service sector), the National Institute of Economic Research, the Swedish Agency for Growth Policy Analysis and the Research Institute of Industrial Economics.

3.2.2 Statistics Sweden's National Accounts

Because the main user of a new survey would probably be Statistics Sweden's National Accounts Department, the project has prioritised those requests that have come from contacts with the National Accounts Department. The National Accounts prioritise information that make it possible to calculate the value added per quarter, i.e. information on intermediate consumption. The National Accounts also pointed out that income statements and the balance sheets that are related would be valuable for everyone. The national accounts need this information 45 days after the end of the quarter to be able to use them in the quarterly calculations.

3.3 Economic key ratios

A sub goal in the project was to study which key ratios that could be compiled on a quarterly basis. A review of the quarterly reports of 15 of the larger enterprises indicated the key ratios that seem to be most common to publish on a quarterly basis. The project also tested calculating five different key ratios with data from the annual survey Structural Business Statistics for the years 2004 – 2008. However, the test is not included in this report.

Economic key ratios are often used as a tool to assess the economic health and future prospects of an enterprise. By calculating a number of normal key ratios on a quarterly basis, the project members think this would give an indication on the current health of enterprises and how the economy can be developed in the future. It would be possible to see patterns that could for instance give indications on an upcoming downturn in the economy. This could be interesting for both analysts and the media.

The project proposes a number of key ratios that would be interesting to calculate quarterly:

- **operating margin** (operating income/net turnover)
- **net margin** (net income/net turnover)
- **equity ratio** (adjusted equity/balance sheet total)

- **quick ratio** (current assets excluding inventory/short term liabilities)
- **return on total assets** (operating results+financial assets/balance sheet total)
- **return on equity** (net result/adjusted equity)

3.4 Cash flow analysis

One of the project's sub goals was to study if the procedure to use cash flow analysis is an accessible way to reach the goal with the survey. The project did a test of calculating cash flow analysis with data from the survey Structural Business Statistics for the years 1998–2008. However, the test is not included in this report.

The Swedish Financial Accounting Standards Council describes cash flow analysis as a useful basis to assess the future cash flow of an enterprise. Cash flow analysis can thus form a basis for assessing the ability of an enterprise to generate liquid assets required to conduct operations, make investments, repay loans, make payments of other obligations and distribute dividends to shareholders. This applies to all enterprises, regardless of the type of operations. Cash flow analyses from enterprises within different industrial groups probably would have been an interesting tool to study the access to capital in the enterprises during the financial crisis. A cash flow analysis allows one to see where shortages of capital are greatest in enterprises: in operations, investment activities or financing activities.

To make a cash flow analysis, 4 variables from the income statement and 7 variables from the balance sheet are required. In addition, a number of variables are needed that show the change in equity during the quarter (dividends, new share issues, shareholder contributions and group contributions).

3.5 Proposal for content of variables

The project has shown that there are many potential users of a new quarterly survey and that the needs of different users vary quite significantly. That is why it has been necessary to produce several different proposals of variable content based on these varied needs. We have chosen three possible tracks for the survey: The national accounts track (NA track), the cash flow analysis track and the size class track.

The NA track satisfies the needs of the national accounts for variables to calculate intermediate consumption, which can improve GDP calculations per quarter. In addition, this arrangement can produce statistics on results and make it possible to calculate the proposed key ratios of the project. The method in the NA track involves a cut off of 20 employees, stratification based on industry and size class and presentation of 12 NACE groups without presenting size classification. The cash flow analysis track requires a few more variables but the method arrangement is the same as the NA track. The size class track involves the same variable continent as the NA track but the sample sizes need to be increased considerably to allow reporting for micro-, small-, medium-sized and large enterprises.

3.5.1 NA track

In summary, the following variables are needed to cover the real needs of the National Accounts:

Income statement
Net turnover
+Other operating income
-Operating costs excluding employee benefit expenses and depreciation
- Employee benefit expenses
-Depreciation and impairment
=Operating profit

With the above set of variables, a simple calculation of value added could be done on a quarterly basis. If statistics on profits are desired (the key ratios operating margin and net margin) similar to Statistics Sweden's preliminary statistics on results, two more variables are needed:

+Financial income
-Financial costs
=Net profit

If we also want to calculate the key ratios equity ratio, quick ratio, return on total assets and return on equity another six variables are needed:

Balance Sheet
Inventory
Current assets
Equity

Untaxed reserves
Current liabilities
Balance sheet total

A list of variables that both meets the needs of the national accounts for information on intermediate consumption and allows us to calculate the key ratios that the project has proposed includes nine variables (including two steps for results) from the income statement and six variables from the balance sheet. Then the items in the income statement are automatically covered, as in the old profit statistics. The above set of variables is recommended by the project and we assess it to be a reasonable level for a new quarterly survey.

The project has produced a proposal for industrial groups that we assess to be suitable for presenting the results.

Table 1
Industrial groups according to the Swedish Standard Industrial Classification 2007 (NACE 2007)

NACE (character)	NACE (number)	Industry description
B	05-09	Mining and quarrying
C1	10-12	Food products, beverages and tobacco
C2	13-18	Textiles, leather, wood, paper and graphic industry
C3	19-24	Petroleum, chemical, pharmaceutical, rubber and plastics, mineral, steel and metal industry
C4	25-33	Metal goods, electronics, electrical equipment, other machines, vehicle and transport industry, furniture industry, other manufacturing and repairs of machinery and apparatus
DE	35-39	Electric- and waterworks, sewage-treatment, waste management, recycling and remediation
F	41-43	Construction
G	45-47	Wholesale and retail trade, repair of motor vehicles and motorcycles
H+I	49-56	Transport, storage, postage, hotel and restaurant operations
J-L	58-68	Information and communications, financial and insurance operations and real estate services
M-N	69-82	Consultancy, research and development, veterinarian operations, rentals, staffing services, security, travel agencies, real estate services and business services
P-S	85-96	Education, healthcare, culture, leisure activities, gambling and other service operations

3.5.2 Cash flow analysis

To get a better look at financing and capital management, a cash flow analysis is a good tool. However, cash flow analysis requires a few more variables:

Income statement
Depreciation
Operating profit
Profit/loss from financial items
Tax

Balance Sheet
Tangible assets
Financial assets
Inventory
Current receivables
Equity
Non-current liabilities
Current liabilities

Changes in equity
Share dividends
New issues of shares/shareholders' contributions/group contributions

3.5.3 Size class

After the financial crisis, a desire for statistics based on size classification has arisen. To illustrate the economic trends for the smallest enterprises however, large sample sizes are needed because the number of small enterprises is so large. Nevertheless we have made some proposals for a survey based on size classification. The classification is based on the standard that is used within the EU for small and medium-sized enterprises. Enterprises with up to 9 employees are classified as micro enterprises, enterprises with 10 – 49 employees are classified as small enterprises and enterprises with 50 – 249 employees as medium-sized enterprises. Enterprises with 250 or more employees are regarded as large enterprises. The contents of the survey to small enterprises should be relatively simple, because some of these enterprises are not required to do regular bookkeeping or produce an annual report. We have therefore proposed that the contents of this approach should be the same as the variable contents in the N A track (see 3.5.1 above). An alternative to data collection from income statements and balance sheets for small enterprises could be a questionnaire with "easy questions". Even today there are already a number of surveys within the financial area that are directed to small enterprises. We have not investigated the need for a new short-term survey of this type.

3.6 Proposal for design of the sample

Here we present a number of proposals for sample sizes together with explanations and advantages/disadvantages of the proposals. Each proposal presents the study domains, the stratum as well as the number of enterprises that must be included to reach a certain precision. Precision refers to the relative standard error of the estimation, as described in the section on methods 5.10.2. In general when we speak of industrial groups or group classification, we referred to the 12 groups that are also described in 3.5.1 above and the four size classes that are called micro-, small-, medium-size- and large enterprises according to 3.5.3 above. For a more detailed description about the procedure, the exacted delimitation of the population and a description of methods, see section 3.8 below.

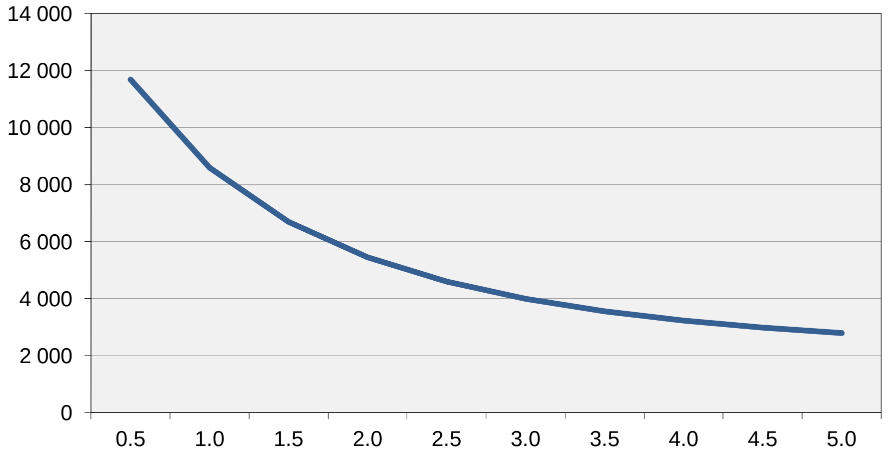
3.6.1 Design according to the NA track

Proposal 1

Presentation	12 NACE groups
Stratum	Industrial classification on the level of characters.
Allocation variable	Net turnover
Cut-off	Only enterprises with 20 or more employees
Totally surveyed	Enterprises with >249 employees

The proposal means that we want to present the results of the 12 NACE groups but without size classification. A cut-off is placed so that only enterprises with 20 or more employees will be in the frame, resulting in a frame that has the size of 16 692 enterprises. A test to get optimal allocation results in the following sample sizes:

Graph 1
Sample sizes given the presentation of 12 NACE groups



The Y axis is the total number of enterprises in the sample and the x axis is the precision with which we want to present the results in each study domain. Precision thus refers to the relative standard error (see 3.8.2 for details). Finer precision (left of the x axis) gives increased sample sizes. Precision at 2.5 percent is usually most interesting for the important study domains.

If we carefully study 2.5% precision in particular, table 2 below shows that we need to draw 4 593 enterprises to reach the desired precision in all the study domains.

Table 2
Sample sizes given the presentation of 12 NACE groups and 2.5% precision

Study domain	NACE code	Sample 2.5% precision
B	05-09	22
C1	10-12	135
C2	13-18	166
C3	19-24	345
C4	25-33	402
DE	35-39	136
F	41-43	388
G	45-47	757
HI	49-56	684
JL	58-68	523
MN	69-82	819
PS	85-96	216
Total		**4 593**

In certain industrial groups, above all MN and G, a relatively large number of enterprises are needed to achieve the desired precision. Part of the explanation is that the number of enterprises in the frame in these industrial groups is relatively large. For example, there are 3 219 enterprises involved in wholesale and retail trade (industrial group G) in the frame, while there are only 356 enterprises in group C1. Another important factor that explains the sample sizes is how large the dissemination is for the variable net turnover, which is our allocation variable. If the dissemination is large, we must include more enterprises to be sure that the results achieve the desired precision. For example, group MN is very heterogeneous, and therefore we need to study an entire 819 enterprises out of a total of 2 387 enterprises in the frame to reach the desired precision.

The allocation thus allows the precision in each industry group to be sufficient, but is not influenced by the size of turnover (in the entire population) in an industrial group. Industries in wholesale and retail trade (group G) account for nearly one third of all turnover, while all industries from H to S together have a lower turnover than wholesale and retail trade. This does not influence the sample sizes but it is good to keep in mind for further discussions.

In section 3.7 Quality, the coverage rate within the industrial groups is discussed. We see here that a cut-off of 20 employees removes a considerably larger proportion of the total net turnover in the service sector enterprises than within the industrial sector enterprises. Altogether we have quite a heterogeneous service sector that requires large samples to obtain good precision in the NACE-groups. However, coverage is relatively bad and the total net turnover is relatively small (except for wholesale and retail trade). If we want to increase coverage in the service sector, we need to lower the cut-off and thus receive a larger sample there. This is clearly a question of prioritisation, especially if the budget does not allow a larger sample. The methodologist for a possible future survey should review the questions and highlight the ones that concern coverage and sampling. Perhaps it is possible to use another approach than a cut-off at 20 employees in all NACE-groups. Section 3.7 Quality describes an approach for a goal of 70% coverage for all NACE-groups. This approach has its advantages as well as disadvantages.

3.6.2 Design for size class presentation

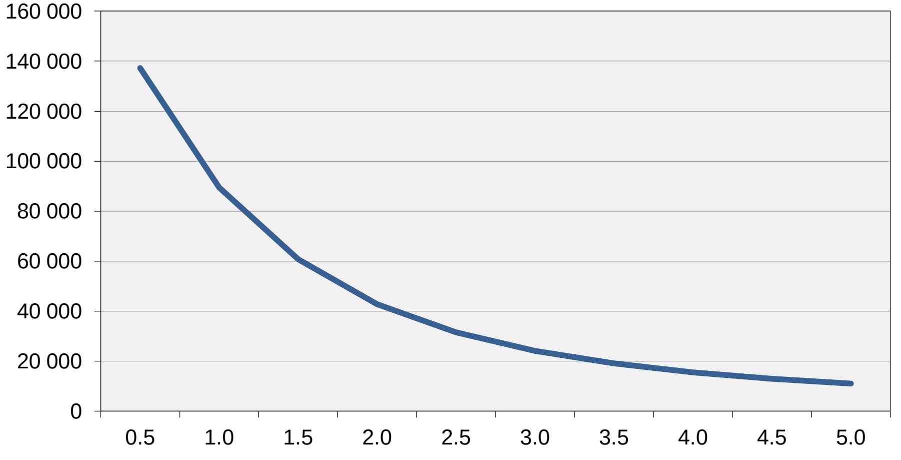
The project group received a request to be able to present income statements and balance sheets broken down by small and medium size enterprises. It is a demanding task to present statistics on enterprises by size class with regard to sample sizes, especially if there is no cut-off used for the smallest enterprises.

Proposal 2

Presentation	Industrial sector enterprises and service sector enterprises with 4 size classes, total 2*4=8 study domains.
Stratum	The breakdown by NACE on the level of characters and 8 size classes which follows SAMU's (Statistics Sweden's standardised tool for drawing a sample) size classification up to 500 employees.
Allocation variable	Net turnover
Cut-off	Only enterprises with 1 employee or more
Totally surveyed	Enterprises with >249 employees

The objective of Proposal 2 is to be able to present industrial and service industries separately as well as to present size, which implies four classes (described in 3.5.3). A cut-off is used to avoid the enterprises without employees. The frame then includes close to 240 000 enterprises. The programme then shows the following sizes of samples:

Graph 2
Sample sizes given in the presentation of 8 study domains



All of 31 479 enterprises must be drawn to reach a precision of 2.5% in each study domain. If we can consider another level of precision, Graph 2 above gives us an indication of which sizes would then apply. In Table 3 below we see that nearly 60% of the enterprises in the case with 2.5% precision are service enterprises with fewer than 10 employees. Industrial and service sector enterprises with more than 249 employees are surveyed in total.

Table 3
Sample sizes given in the presentation of size classification breakdown of the industrial sector and the service sector with 2.5% precision, cut-off 1 employee

Study domain	Industrial group	NACE code	Size class	Sample 2.5% precision
I0	Industrial sector enterprises	05-43	1–9 employees	3 780
I1	Industrial sector enterprises	05-43	10–49 employees	1 774
I2	Industrial sector enterprises	05-43	50–249 employees	751
I3	Industrial sector enterprises	05-43	250–	633
T0	Service sector enterprises	45-96	1–9 employees	18 361
T1	Service sector enterprises	45-96	10–49 employees	4 161
T2	Service sector enterprises	45-96	50–249 employees	1 114
T3	Service sector enterprises	45-96	250–	905
Total				**31 479**

Proposal 2 is a very costly proposal, but it provides good statistics even for the micro enterprises, regardless of the enterprises without employees that fall below the cut-off. Certain reallocations in the service sector can be considered to try to limit the sample. Certain industries on a finer level could be deleted completely or estimated in another way.

Proposal 3

Presentation	Only 4 size classes (3 size classes if a cut-off of 20 is used)
Stratum	Industrial classification at the level of characters as well as 8 size classes that follow the SAMU size classification of up to 500 employees.
Allocation variable	Total net turnover
Cut-off	Different perspectives were tested
Totally surveyed	Enterprises with >249 employees

In proposal 3 we are not interested to present anything else except the four size classes. A cut-off to remove enterprises without employees (3a) and a cut-off for enterprises with fewer than 20 employees (3b) are tested.

The first sub-proposal (3a) uses a cut-off for enterprises without employees. It is necessary to draw 22 252 enterprises to reach a precision of 2.5%. Again there is a considerable overweight for enterprises with between 1 and 9 employees. The proposal can be compared to the 31 500 enterprises from Proposal 2 where the same cut-off was used, but where we wanted to present industrial sector enterprises and service sector enterprises separately.

Sub-proposal 3a

Table 4
Sample sizes given in the presentation of size classification with 2.5% precision, cut-off 1 employee

Study domain	Size class	Sample for 2.5%
0	1–9 employees	15 403
1	10–49 employees	3 901
2	50–249 employees	1 410
3	250–	1 538
Total		**22 252**

Here it is thus possible to see the total changes for micro enterprises or small enterprises. It is worthwhile to know that the margin of error (2*precision) is 5% so changes that are less than 5% will be inside the margin of error.

Sub-proposal 3b

Table 5 Sample sizes given the presentation of size classification with 2.5% precision, cut-off 20 employees

Study domain	Size class	Sample for 2.5%
1	20–49 employees	2 272
2	50–249 employees	1 410
3	250–	1 538
Total		**5 220**

In this sub-proposal, we are not so interested in the smallest enterprises, but instead raise the cut-off to 20 employees. A precision of 2.5% gives 5 220 enterprises in the sample. Micro enterprises are not included because the cut-off is too high.

3.7 Quality

One way to assess the quality of a survey in advance is to study the quality of the coverage when a cut-off is used. It is possible to measure coverage in the number of enterprises, in the turnover or some other variable that is accessible. We are not really interested in the number of enterprises, since we know that most of the enterprises are those that do not have any employees at all. In our population, only 34% of the enterprises have at least one employee and 2% of the enterprises in the population have 20 or more employees.

What are then the risks that coverage is too small? The population that we wish to discuss is actually the entire population of enterprises within the boundaries we have set. For instance, if we use a cut-off of 20 employees, our calculated results will only apply to the enterprises above the cut-off. Then we usually assume that enterprises above and below the cut-off behave about the same, so that the results apply to all enterprises in the population. The fewer enterprises that are covered above the cut-off (of a given variable), the higher the risk is to discuss the entire population. Of course it is not so important what happens below the cut-off if it only accounts for 5–10% of the total.

How much of the net turnover and balance sheet total lies above the cut-off that is used? There are considerable differences among different industries, so statistics broken down by industry would be wise. In addition, we know that a relatively small number of the large holding enterprises have significant assets, but have neither staff nor turnover. These enterprises (with more than SEK 500 million in the balance sheet total) are moved up to the largest group of enterprises. Table 6 shows how large a part of the total balance sheet total (column '**Balance above the cut-off**') and net turnover (column '**Turnover above the cut-off**') that is included when we have a cut-off that excludes enterprises without employees.

Table 6
Coverage above a cut-off of 1 employee broken down by NACE group

Cut-off 1 NACE-group	Number of enterprises	Balance above cut-off	Turnover above cut-off
B	331	92.5%	93.5%
C1	1 995	94.7%	99.2%
C2	5 069	96.8%	98.1%
C3	2 478	92.0%	99.5%
C4	14 355	93.9%	99.2%
DE	1 080	80.2%	91.9%
F	32 339	85.7%	92.6%
G	52 958	90.6%	96.4%
HI	31 578	90.7%	95.9%
JL	22 603	69.3%	82.6%
MN	51 520	81.7%	91.1%
PS	23 347	85.4%	88.2%
Total	239 653	84.0%	94.7%

Two notable effects are that coverage in the industrial sector enterprises is better than in the service sector enterprises, and that coverage of turnover is better than coverage of the balance sheet total. The latter is probably because the cut-off is on the variable for employees and that the number of employees at an enterprise correlates (there is a stronger connection) better with the company's turnover than the company's balance sheet total.

Table 7
Coverage above a cut-off of 20 employees broken down by industry group

Cut-off 20 NACE-group	Number of enterprises	Balance above cut-off	Turnover above cut-off
B	37	79.5%	84.4%
C1	356	72.9%	91.0%
C2	707	65.7%	86.4%
C3	670	84.3%	94.9%
C4	2 446	84.6%	91.5%
DE	288	61.3%	81.1%
F	1 805	55.1%	57.3%
G	3 219	64.0%	68.6%
HI	1 909	66.5%	67.3%
JL	1 520	49.1%	63.4%
MN	2 387	52.4%	61.6%
PS	1 348	48.9%	60.1%
Total	16 692	63.9%	73.5%

If we use a cut-off of 20 employees (see table 7), the levels are still good for the industrial sector enterprises, especially regarding turnover. 16 692 enterprises thus account for 73.5% of all turnover in the entire population of enterprises. However, certain industries have a coverage of around 60%, which gives us more uncertain results for these groups. The balance sheet total has even worse coverage above the cut-off, even though we inserted enterprises in the frame that lack employees and turnover, but have large values in the balance sheet total. The variables that are most important to concentrate on depend of course on how the survey is designed and which variables that we finally want to study.

The approach for level of coverage

An alternative to using a cut-off of 20 employees could be to see that the coverage is sufficiently good in all NACE groups. This is effective if we want to be sure that all NACE groups with different structures do not receive different levels of coverage. If we want to make adjustments in the frame population, e.g. to increase or decrease the coverage in some industry, it is then possible to quickly see how this influences the number of enterprises in that industry.

Table 8
The approach for level of coverage. The number of enterprises per NACE group required to cover 70% of the total turnover

Industrial group	Level of coverage	Cumulative turnover	Number of enterprises
B	0.7	0.726844	3
C1	0.7	0.701721	58
C2	0.7	0.700657	156
C3	0.7	0.701452	78
C4	0.7	0.700136	196
DE	0.7	0.700422	48
F	0.7	0.700005	3 449
G	0.7	0.70001	1 789
HI	0.7	0.700039	1 106
JL	0.7	0.70007	1 333
MN	0.7	0.700011	2 432
PS	0.7	0.700016	2 651
Total			13 299

If, for example, we would like to have coverage of net turnover at 0.7 (the variable *Level of coverage* stands for the cut-off value) in each industrial group, we can get the results as in the table above. The idea is that we add those enterprises with the largest net turnover in an NACE group until their joint net turnover (the variable

Cumulative turnover) exceeds 70% of the total net turnover in the NACE group (turnover of all enterprises in the industrial group). The variable *number of enterprises* shows how many enterprises that have been added to reach the cut-off value.

One problem could be that we do not get relatively large enterprises in the frame. If an industry includes only a few very large enterprises, maybe they cover 70% of the turnover of the industry themselves, so that medium-sized enterprises do not have a possibility to enter the frame. In addition, there is a risk that enterprises with many employees or a high balance sheet total but a low turnover will not be included.

Before deciding the design for a possible survey, it is recommended to look at the possibilities of combining cut-off and the level of coverage approach. It is also an idea to try to reach sufficiently good quality of several variables at the same time to find the best possible design.

3.8 Methodology

The methodology work mainly consisted of producing possible sample sizes and deciding the precision that these samples give.

3.8.1 Population

Because the survey is intended to be used as a "quarterly Structural Business Statistics survey", it was natural to use the same gross list of enterprises that is used by the Structural Business Statistics survey. This includes all non-financial enterprises (business units, VE) from all industries. No cut-off is used.

Because the most recent completed production round of the Structural Business Statistics Survey is 2008, the gross list from that year is used to conduct different types of tests. In total there are about 916 000 enterprises in the gross list of enterprises. It was decided at an early stage to exclude agriculture, forestry and fishery, of which there were about 200 000 enterprises. The size of the population was then approximately 709 000 enterprises.

The variables that were considered relevant for stratification and allocation were the Swedish industrial classification 2007 (corresponding to NACE 2007), the number of employees, net turnover and balance sheet total. Because the balance sheet total is information that enterprises submit per company unit (FE), these figures were counted down to the business unit level. If a business unit accounts for 70% of its company unit net turnover, it is assumed that the same business unit accounts for 70% of its balance sheet total. This recalculation is of course not perfect, but is probably the best we can do.

3.8.2 Sample frame and stratification

The size of the sample frame and its scope was discussed in the project group, above all regarding the boundaries. Different approaches regarding the cut-off were used to create the frame. The variable used for the cut-off was the number of employees. Without the cut-off the frame is similar to a gross list of enterprises (the population). Approaches with at least one employee, at least 5 employees or at least 20 employees were tested. We then chose to use the first and last alternatives.

In order to keep the large holding enterprises (those enterprises that administrate the assets for a group of subsidiaries) in the frame we also selected enterprises with a high balance sheet total but without employees and net turnover. A turnover of SEK 500 million was considered high here. This was done mainly to increase coverage of the variable for balance sheet total above a cut-off (see 3.7 Quality).

The number of employees according to SAMU's breakdown of up to 500 employees (see below).

0 employees
1–4 employees
5–9 employees
10–19 employees
20–49 employees
50–99 employees
100–199 employees
200–499 employees
500– employees

Stratification was also done on the industrial classification (Swedish Industrial Classification 2007) and then at the corresponding character level (See MIS 2007.2 for details).

We found that it was best to allocate with regard to net turnover, given a stratification of employees and industries. It is logical that the correlation between the number of employees and net turnover is high, but the information about the industry also correlated considerably with the net turnover and was thus a good variable for stratification. The use of the balance sheet total for allocation gave worse results than the use of the net turnover.

Precision can be described as the relative standard of error in an estimation. A 95% confidence interval with an estimated value is received by

estimation ±(estimation x2 x relative standard error).

The report often uses 2.5% precision, which means we can expect a confidence interval that corresponds to 5% of the estimation.

3.9 Estimation of costs

The following gives a cost estimate for two examples of survey design for a quarterly Structural Business Survey. We want to achieve a precision of 2.5% in both examples.

The first example is based on the so-called NA track (see section 3.5.1 and 3.6.1) with a cut-off of 20 employees and presentation of twelve industrial groups with no size class breakdown at all. The NA track has a sample size of about 4 600 enterprises to achieve the desired precision. This design is the one we recommend.

Table 9
Estimated costs for a survey according to the NA track, SEK

Competence	Start-up cost	Regular annual cost
Data collection		2 392 000
Methodology	300 000	828 000
IT	400 000	828 000
Knowledge of subject matter	100 000	2 300 000
Total	800 000	6 348 000

If instead we were to choose the track with cash flow analysis, this would probably require a similar sample size as the NA concept, but it would be more difficult from a respondent perspective.

In the second example, estimated costs are shown for a survey with size class breakdown with a cut-off of 1 employee (see sub proposal 3a in section 3.6.2). It would then be necessary to increase the number of enterprises to

22 250 to reach acceptable quality. Costs for IT and methodology are assumed to be constant despite the increased number of enterprises in the survey.

Table 10
Estimated costs for a survey with size classification presentation (cut-off 1 employee), SEK

Competence	Start-up cost	Regular annual cost
Data collection		11 570 000
Methodology	300 000	828 000
IT	400 000	828 000
Knowledge of subject matter	100 000	11 125 000
Total	800 000	24 351 000

3.10 Response burden

Because the aim of the project is to produce a proposal for a completely new survey, it is important to consider the perspective of the respondent. We have contacted our colleagues who work with large enterprises to obtain viewpoints from the perspective of the respondent. A study of similar surveys has also been done. In addition, a measurement test in the form of qualitative interviews with enterprises has been conducted after the project was formally concluded in October 2010. The test included 11 enterprises and was conducted during December 2010.

Final report – Total Production Index

Daniel Lennartsson
Statistics Sweden

Summary

The Riksbank of Sweden and the User Council for Economic Statistics have expressed a desire for Statistics Sweden to produce a monthly production index for the business sector. One of the arguments for this is that it would lead to better Gross Domestic Product (GDP) forecasts. Assuming the necessary resources are made available and the index is deemed to maintain a sufficiently high level of quality, the aim of the project is for Statistics Sweden to start producing a Total Production Index for the business sector in 2012.

The project has evaluated the quality of the Index of Construction Production (ICP) and the Index of Service production (ISP). The quality of these indices has been evaluated in relation to both the production data for the corresponding activities in the National Accounts (NA) and the input data sources on which the indices are based. The reason for the comparison with NA is because the project's assessment is that a Total Production Index will be evaluated against the outcome in NA.

The ICP differs from the NA quarterly trend in construction production and the correlation coefficient for the results from the two surveys is 0.45. Strangely, the NA data are more volatile than the ICP data. The major reason for the differences is because the ICP uses hours worked as a proxy for production whereas the NA production calculations are mostly based on data from the user side. A comparison between an ICP calculated using only monthly wages and salary statistics (KLP) shows a poorer correlation to NA than the current ICP. The project recommends therefore that for the time being the ICP be calculated in the same way as it is today and to await the best methods from the taskforce created by Eurostat for ICP.

ISP has been produced monthly since January 2008 and during that period, there have only been minor differences compared to the NA service production. There has been major concordance between NA and the ISP especially since the rapid downturn in the economy from the fourth quarter of 2008 and thereafter. The project makes the assessment that the ISP maintains a satisfactorily high level of quality to be included in a Total Production Index.

The project has described the Index of Industrial Production (IIP) in brief and evaluated the effect of the stock adjustment made in the NA delivery.

The project has reviewed the scope for compiling monthly production data for agriculture, forestry and fishing and for the financial sector. Regarding agriculture, there are good monthly statistics on livestock production whereas there is a total lack of monthly statistics on crop production. Data for the latter would be based entirely on expert assessments from the Swedish Board of Agriculture. Regarding fish production, the Swedish Board of Fisheries has monthly data on marine fishing and some for freshwater fishing. There is little scope for estimating the monthly production for forestry. Currently, there are only monthly data for some of the components necessary to calculate forest production on a monthly basis. As regards the financial sector, the project believes that it is possible to make monthly production estimates if new data on directly measured financial services can be collected from credit market companies. The annual cost of collecting this data amounts to about SEK 125 000 (EUR 13 500). For the remaining components (FISIM, non-life insurance and life insurance) of the financial sector, there is plenty of scope for making monthly production estimates.

The project has also produced two reports on how to do index calculations, working-day adjustments and seasonal adjustments for a Total Production Index. The proposed index method is a chain index with annual overlap and in which year-month links are retrieved on an aggregated level from the individual surveys IIP, SPI, etc. Chaining with year-month links is also proposed for the working-day-adjusted series. When it comes to seasonal adjustment, a method is proposed whereby the Total Production Index is subordinate to the included components. Direct seasonal adjustment will not be used for final production of the index since it would probably lead to certain inconsistencies between the included indices and the Total Production Index. The seasonally adjusted series will be estimated using a regression model, in which the weights for the respective sub-activities are estimated as a first step and then an estimate of the seasonally adjusted series is made in step two using the estimated weights and the seasonally adjusted sub-indices series.

The project has developed a production system for calculating a Total Production Index in fixed prices and calendar-adjusted volume. What remains is to set a production environment for seasonal adjustment and trend calculation.

The project has also carried out test calculations of a Total Production Index that show good concordance in relation to corresponding production estimates in NA. The correlation between the quarterly development ratios amounts to 0.97.

The project concludes that there are four different options to choose from for a Total Production Index; a narrow production index, a production index without further data collection, a production index with new data collection and a Total Production Index (please see Section 3.9 for a review of the different options).

The results of the project have been presented to the Riksbank and the National Institute of Economic Research, who were very positive to the work done in the project and would be pleased to see Statistics Sweden produce a Total Production Index.

1 The project

1.1 Project background and task

In the spring of 2008, the ES/NS unit began producing a Index of Service Production (ISP) for the business sector. The ES/UI unit has been producing industrial production and construction production indices for quite some time. Prior to the start-up of the ISP at Statistics Sweden, visits were made to users at the Riksbank, National Institute of Economic Research and the User Council for Economic Statistics. During these visits, it emerged that users wanted Statistics Sweden to develop a monthly Total Production Index for the business sector. One of the arguments for this is that it would lead to better Gross Domestic Product (GDP) forecasts for the business sector.

Assuming the necessary resources are made available and the index is deemed to maintain a sufficiently high level of quality, the aim is for Statistics Sweden to start producing a Total Production Index in 2011. The project is to evaluate the quality in the various sub-components in this production index.

Stage 1

The following activities are to be performed in Stage 1:

- Evaluate of the quality of the included indices
- Review the scope for producing monthly production data for non-covered activities
- Method (index calculations and seasonal adjustment)
- Calculate the cost of start-up and the running costs for a Total Production Index
- Gain support for the project ideas from department heads and users

Stage 2

The following activities are to be performed in Stage 2:

- Calculate the production index and test it during the second half of 2010. Compare with NA quarterly calculations for corresponding activities. Do test calculations for IIP, ISP and ICP.
- Develop statistical methods for working-day adjustment of the ICP and seasonal adjustment of a Total Production Index.
- Look at the size of sample required in financial activities in order to estimate commission earnings

2 Results

2.1 What is a Total Production Index?

The Total Production Index is to be based on the production indices that have already been established at Statistics Sweden and that are currently part of the official statistics – the IIP and the ISP. Within the framework of the project, investigations are being carried out to see whether it is possible to cover the whole private business sector, i.e. including agriculture, forestry and fishing, the construction sector and the financial sector.

A Total Production Index is a volume index intended to measure the change in the economic activity of the entire private business sector, in terms of *value-added volumes*, between two periods.

Value-added volumes can be seen as the difference in volumes between goods/services finally produced and what is needed in terms of intermediate consumption to produce these goods/services. It is however difficult to measure both production and intermediate consumption volumes on a short-term basis. In practice it involves the use of another volume change as a proxy. Normally, the aim is to measure only the change in production volume. The assumption that is implicitly made when measuring the change in production volumes instead of value-added volumes is that the consumption share is constant over time (or at least between two consecutive years) in relation to final production.

The Total Production Index is to be produced once a month. This means that an *index series* in the form of a time series can be produced. Based on the index series, the change between two arbitrary months, or between two arbitrary periods (e.g. quarter/quarter) can then be calculated. A time series of monthly (or quarterly) data should also be both working-day and seasonally adjusted so that the user can make an accurate assessment of the change between, for example, two months.

2.2 Evaluation of the scope for calculating monthly production in the agriculture, forestry and fishing sector – NACE 01-03

An evaluation of the scope for calculating monthly production in the agriculture, forestry and fishing sector has been performed. This evaluation is described below.

2.2.1 Agriculture

As a first step, contact was made with the person responsible for calculating agricultural production in the NA quarterly calculations. NA calculates agricultural production based on both crop and livestock production.

The Swedish Board of Agriculture is the agency responsible for compiling official statistics on agriculture. The Board compiles statistics on livestock production every month and on crop production less frequently.

It is possible to produce monthly data on livestock production by combining transfer prices for different types of product with delivered (weighed-in) quantities. A total production figure for livestock production could be supplied from the Swedish Board of Agriculture to Statistics Sweden every month around T +45/50.

There are no monthly or quarterly data on crop production. Instead, the production value must be estimated based on the economic accounts for agriculture (EAA) forecasts and then divided into months based on the Board's expert knowledge of how production is spread out during the year.

The Board imagines a method which combines:

- Last year's values retrieved from the EAA.
- A price index with monthly weights reflecting the spread of production over the year.
- A quantity index that is "continuously" updated with quantities and forecasted values for e.g. the crop harvest.

Using a forecast to compute monthly data on crop production is a problem since Statistics Sweden wants to use actual quantities as much as possible. The forecast is based on a model that takes e.g. temperature and precipitation into account. According to the Swedish Board of Agriculture, the quality of the first forecast produced is not particularly good – in fact only slightly better than mere chance.

2.2.2 Fishing

As a first step, contact was made with the person responsible for calculating fish production at NA. When calculating fish production, NA uses data from marine fishing (NACE 03.11) and takes it as an indicator of total production. Production in the fishing industry also consists of farmed fish and freshwater fish. The Swedish Board of

Fisheries is responsible for producing official fishing statistics. The Board compiles statistics on marine fish production on a monthly basis. Statistics on other fish production are reported less frequently and on an annual basis.

Production estimates for marine fishing can be retrieved on a monthly basis no later than 30 days after the end of the month. Total production figures are available and are deemed to be of good quality. No major continuous revisions are made and any minor ones are only made once a year. It is more difficult to compile current data on other types of fish production. It might be possible to adapt the data collected monthly on freshwater fishing. A simplification is, as NA does, to take marine fishing as an indicator for all fish production. In 2008, the landed catch from marine fishing constituted about 76 percent of the value of total fish production, including fish farms.

2.2.3 Forestry

As a first step, the person responsible for calculating forestry production at NA was contacted. The production calculations at NA are based on two quarterly models, which provide felling and net forest growth estimates.

Data on gross felling and net growth are needed to be able to calculate forestry production on a monthly basis. These data are currently only available on an annual basis. It is hence necessary to base calculations on a model-based estimate of consumption, stock and net growth. Consumption and stock have to be limited to the largest consumers of forest raw materials, i.e. sawmills and the pulp industry. Consumption by sawmills and the pulp industry can be estimated monthly based on the production of sawn timber and pulp by assuming fixed raw volume equivalents. This provides only a rough estimate of some of the consumption in these industries since there are no monthly data on stocks of input goods. Monthly data on stocks of saw timber and pulp wood, both in wood-consuming industries and in forest stocks, are needed to make an acceptable estimate of production. These data are only available quarterly and only annually when it comes to saw timber stocks in the forest. A possible solution is to make a model-based estimate of monthly stocks, which would require extensive investigative work. The figures would probably also be very unreliable.

Data on net forest growth are only available on an annual basis. In the NA quarterly calculations, the assumption is made that the growth is spread equally over the four quarters. This assumption is not well supported since we can safely assume that growth varies over the year. Correspondingly, if we were to assume that annual growth is the same every month of the year, the figures would be even more unreliable.

The conclusion to be drawn from this review is that estimating monthly forestry production is flawed. If forestry is to be included in a Total Production Index, new monthly collections of production value data are needed. Starting such a survey would require investigative work that is beyond the scope of this project.

2.2.4 Conclusion

Production in agriculture, forestry and fishing is not a crucial factor in the publication of a Total Production Index. If it turns out to be possible to compile production data for these three industrial activities (agriculture, forestry and fishing), being able to report each of them separately as a part of the production in the business sector does have a value. This would require a new survey of forestry production. Starting such a survey would require investigative work that is beyond the scope of this project. This being the case, the project group could accept the model estimate proposed by the Swedish Board of Agriculture to compile crop production data.

2.3 Industrial Production Index (NACE 05-33+35)

The aim of the Index of Industrial Production (IIP) is to provide monthly information on Swedish industrial production, both in total and broken down by activity. The IPI is based on different types of data. Most of it is based on data on **deliveries** (93 %) compiled to produce business cycle statistics for industry. Delivery data are retrieved from a sample survey, with a cut-off at 10 employees, consisting of about 2 300 businesses. In the delivery survey, the businesses are only asked about the turnover that can be attributed to the production of goods. This means that trading and service revenues are not captured in the delivery statistics. The turnover attributable to goods is responsible for 80 percent of total industrial turnover. A smaller part of the IIP is based on data on **hours worked** (3 %) collected in Statistics Sweden’s survey on private sector salaries. Data on **production volumes** (4 %), collected from a sample of businesses, are used for some activities.

IIP is used as a basis for GDP calculations. Since the data from the IIP are used in GDP calculations, it is adjusted for the stock changes in the current quarter. The monthly IIP is not stock-adjusted. This means that the monthly IIP is not comparable with the quarterly IIP used in NA. The IIP mainly estimates indices in the form of delivery volumes and not in terms of production volumes (or actually in terms of value-added volumes). Somewhat carelessly, the IIP is usually said to measure "non-stock-adjusted volumes".

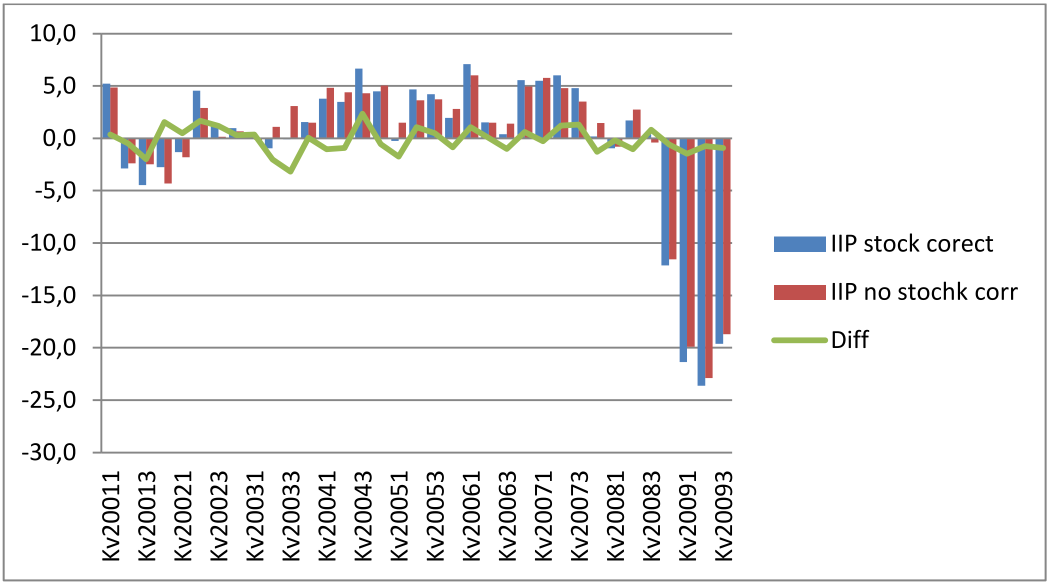
The relationship between production and delivery volumes for an arbitrary quarter, *q* can be described in terms of

$$\text{Productionvolume}_{\text{q}} = Deliveredvolume_{q} + \Delta Stockvolume_{q,q-1}.$$

In other words, that which is produced, either delivered or put in stock.

In reality, the change in stock volume has been shown to be relatively small in relation to the total production volume. Since the business cycle is subject to dramatic fluctuations, as during the financial crisis, the stock effect has shown itself to be of greater significance. Figure 1 shows the annual growth rate for stock-adjusted and unadjusted IIP and the difference between the two.

Figure 1
Comparison of growth rates for stock-adjusted IIP and unadjusted IIP
Annual rate



As we can see from Figure 1, there are only minor differences between the unadjusted and the stock-adjusted growth in the IIP. The absolute difference between the two amounts to 1 percentage point during the compared period. We can see from the diagram above that there is no systematic difference between the two series.

2.4 Evaluation of the quality of the Index of Construction in Production (NACE 41-43)

An evaluation of the quality of the Index of Construction in Production (ICP) has been performed. This evaluation is described is given below.

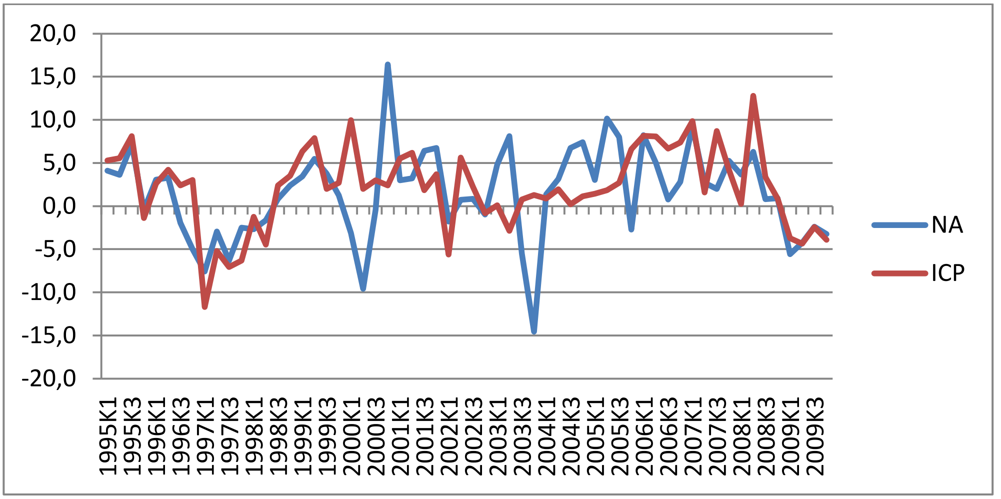
The ICP is a monthly chain index with reference base year 2005=100 and start-year 1994. The ICP covers privately undertaken production in NACE 41-43 and separate series are reported for total industry, plant and house building respectively. The index is based on a combined appraisal of number of hours worked from the Labour Force Survey (LFS), the Business Cycle Statistics, Private Sector Salaries (KLP) and the Payroll Expenses, Employer Contributions, and PAYE tax statistics (the latter is “deflated” with the Labour Cost Index (LCI) so that it can be compared to other input data sources). An unadjusted series and a working-day-adjusted series are reported. To obtain a more accurate measure of production, the ICP is adjusted with the productivity trend in the activity. Productivity trend data is obtained from NA.

The index is not considered to be an official statistical product (and is not funded through appropriation) and is therefore not published. Construction production is mainly used by Eurostat and is included in the STS Regulation (Commission Regulation (EC) No 472/2008).

Since it is difficult to estimate construction production from the output side (due to the fact that production and deliveries often take place intermittently in connection with projects being finalised or progress-billed), a measure of input (here the number of hours worked) is considered to give a better picture of production trends. A larger investigation by Karl-Johan Dahlöf, Background Facts 2005:7, was performed before the ICP could be constructed and implemented. An evaluation of quality should therefore be based on the input data used by the ICP.

The National Accounts (NA) produce production statistics for the construction industry on a quarterly basis. NA's calculation is based on a weighted volume trend in construction investment, repairs and other construction production in order to compute FP t-1. The volume trend in construction investment is obtained from the user side while assumptions are made every quarter for repairs and other construction production. The trend in current prices for the construction industry is obtained by reflating with a weighted index of a combined construction repair index and combined construction investment index. Bearing in mind that the calculation method for quarterly construction production uses other input data sources and is computed from the user side, it is difficult to compare with the NA's construction production calculations. The ICP has been converted from monthly data to quarterly and annual data so that it is possible to make some form of comparison with the NA quarterly and annual volume trend figures. Since NA, in contrast to the ICP, seasonally adjusts its working-day-adjusted figures, we have chosen to study the unadjusted, non-working-day-adjusted series. The NA's quarterly volume trend is calculated by dividing the FP t-1 for the quarter by FP t for the same quarter the year before. FP t-1 is the value added expressed at the previous year's price level. FP t is obtained by dividing the annual value for value added in current prices by 4 (for each quarter) using the quarterly division from FP t-1 for a given year.

Figure 2
Annual percentage volume trend in total production for the construction sector based on the ICP and NA, quarterly data



As we see, the NA construction production trend differs on a quarterly basis and the correlation coefficient amounts to 0.45. Strangely enough, the NA's figures also seem to be more volatile. The diagram above also shows that the covariance was considerable in 1995–1999 and during the last two years. There has been substantial concordance between NA and the ICP especially during the rapid downturn in the economy from the fourth quarter of 2008 and onwards.

Respective input data series in the ICP have also been converted into a chain index in volume so that annual changes for each quarter between input data sources and between input data sources and output data can be compared. The correlation matrix below is based on different corresponding periods depending on the fact that the index series are of different lengths. Unweighted mean value indices have been computed for the combinations LFS and LAPS, LFS and KLP and KLP and LAPS, aimed at comparing whether there is any difference in the results depending on the combination chosen. The table below shows that the correlation with the NA quarterly index is greatest for LFS and KLP combined.

Table 1.
Correlation matrix

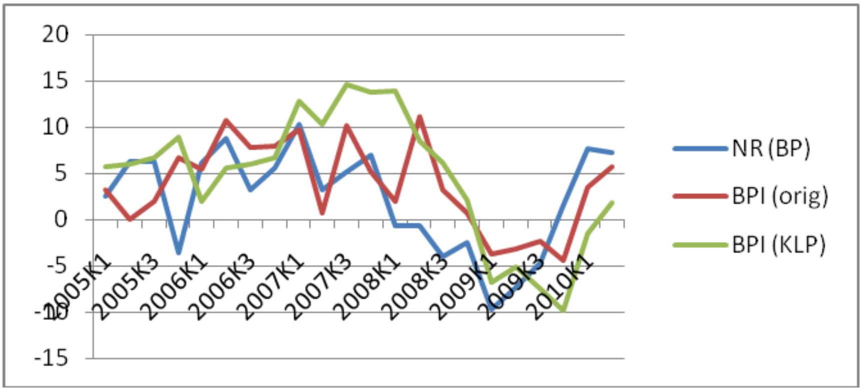
	NA	KLP
CPI	0.45	
LFS	0.47	0.69
KLP	0.50	
LFS+LAPS	0.52	
KLP+LAPS	0.53	
LFS+KLP	0.55	

From a purely logical point of view, the project thinks that KLP is the source that should best reflect production in the private sector. The KLP measures hours worked in the private construction industry while LFS measures hours worked for all business sectors. Logically, the project thinks that using LAPS as a proxy for construction production is dubious. Standard error for the number of hours worked is 2 percent in the definitive estimate from KLP. The corresponding figure for LFS is 7 percent. Furthermore, the measurements in KLP come from businesses while the measurements in LFS come from individuals. The major drawback of the KLP as an input data source is, however, that it isn't fast enough. About T+40 days after the reference month, the response rate for the construction industry is 60–80 percent. If the KLP is to be used as the only input data source for computing the ICP, it must be speeded up so that a high response rate can be achieved after T+40 days. With the support of the Data Collection Enterprises and Organisations Department at Statistics Sweden (DFO), KLP has calculated the costs of speeding up the KLP for the construction industry (409 enterprises). In addition to the work already being done, a further 60 hours/month are needed to obtain an unweighted response rate of 80 percent. The costs of this are estimated to be SEK 465 000 (EUR 51 500) per year. Start-up costs of SEK 6 000 (EUR 665) need to be added to this figure since some adjustments need to be made to the existing production system.

In stage 1 of this project, it has been assumed that only productivity-adjusted hours worked from the KLP would be a better measure of construction production than the combined measure of LAPS, KLP and LFS that is currently used. In Figure 3 we can see the outcome of construction production based on the KLP and CPI according to the current method compared to the outcome in NA. The correlation for the method currently used in CPI compared to NA amounts to 0.56

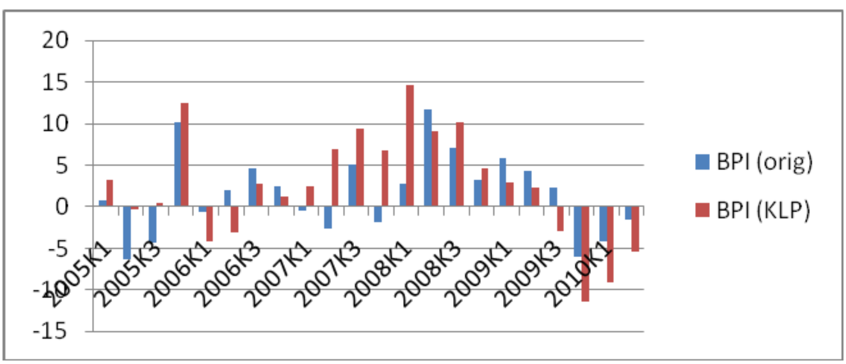
while the correlation for a CPI based solely on the KLP amounts to 0.45.

Figure 3
Growth rate for construction production in working-day-adjusted volume, in percent



In Figure 4 we can see the differences in the growth rate of the working-day-adjusted production volume. The differences vary between zero and fifteen percentage points. The average absolute difference amounts to 4 percentage points for the original ICP while the corresponding figure for an ICP based solely on the KLP amounts to 6 percentage points.

Figure 4
Differences in growth rate (percentage points) compared with the NA for working-day-adjusted construction production volume using two different methods



In this comparison, it is difficult to conclude whether the current ICP or a ICP based only on data from the KLP provides the best illustration of the trend in construction production. It is clear however that the current ICP has a higher correlation with NA than a ICP based on KLP data has. The project recommends therefore that for the time being the ICP be calculated in the same way as it is today and await the best methods from the taskforce created by Eurostat for ICP. Furthermore, the project believes that the review of working-day adjustment performed as part of the project should be implemented in ICP.

2.5 Evaluation of the scope for calculating monthly production in financial activities (NACE 64-66)

2.5.1 Financial activities in NA

Production calculations for financial activities are broken down into five activity groups within the framework of the NA. These activity groups are (in order of share of value added):

- FISIM (Financial intermediation services indirectly measured) – (NACE 65A) – (33.6 %)
- Directly measured financial services – (NACE 65B) – (27.9 %)
- Life insurance – (NACE 6601) – (12.3 %)
- Non-life insurance – (NACE 6603A) – (18.5 %)
- Services auxiliary to financial intermediation (NACE 67) – (7.6 %)

NA's calculations of financial services are based on quarterly and monthly surveys for banks and insurance companies produced by Statistics Sweden and other organisations.

FISIM figures are produced by financial enterprises involved in the financial intermediation of depositing and loaning activities where the financial enterprises control interest rates. Banks produce about 80 percent of the Swedish FISIM statistics. The main source of FISIM calculations is the Riksbank's monthly statistics on monetary and financial institutions (MFI). The import and export of FISIM are calculated using the quarterly balance of payment statistics.

For directly measured financial services (NACE 65B), value added in current prices is estimated using the trend in *commissions* in banks, credit market companies, share funds, fund management enterprises and investment companies. Value added in current prices is calculated by deflation using two service price indices for bank services and securities services.

Value added in current prices for life insurance is calculated using the trend in administrative costs for life insurance companies. Deflation is performed using salary indices for NACE 65-67.

Regarding non-life insurance, value added in current prices is calculated using the volume trend in the change in the number of insurance policies. Value added in current prices is calculated by extrapolating changes in production, which are measured as disbursed premiums minus disbursements.

Value added for services auxiliary to financial intermediation is model-based and based on the combined trend in direct banking services, life insurance and non-life insurance.

2.5.2 Scope for making monthly estimates of financial production

2.5.2.1 FISIM

FISIM are responsible for about 30–35 percent of value added in financial activities. The quarterly calculation done within the framework of NA is based on many sources and is relatively detailed and complicated. There are monthly statistics on the domestic production of FISIM, which are responsible for about 80 percent of total FISIM production. These statistics are produced after T+25 to T+30 days after the end of the month. A monthly calculation model has been developed that is easier than the one developed in NA. It covers about 95 percent of domestic FISIM production. The model is based on the deposit and loan stock from banks, business institutions and housing institutions and interest rates from banks, housing institutions and the central bank. Regarding foreign production of FISIM, estimates must be made on a monthly basis based on the previous quarter and the trend in domestic FISIM production.

2.5.2.2 Directly measured financial services

Directly measured financial services are responsible for about 30 percent of the value added in financial activities. Data on the production of directly measured financial services (commission earnings) are currently collected on a quarterly basis by the Swedish Financial Supervisory Authority who then deliver the statistics to Statistics Sweden and the financial market statistics. The Supervisory Authority collects data from about 250 banks, credit market companies and securities companies. Some form of estimate of these must therefore be made on a monthly basis. Alternatively, data must be collected directly from the respondents.

Commission earnings are divided up into six different commission categories with relevant percentages; payment service commission (29%), securities commission (39%), loan commission (10%), deposit commission (1%), guarantee commission (3%) and other commission (17%).

The fund managers' association has monthly statistics on fund stocks made up of mixed funds, share funds and short- and long-term interest funds. Securities commission consists mainly of fees based on the fund stock for a given day. An investigation done by the project has looked at the average change in the fund stock and the change in securities and other commission. The fund stock covaries to a great extent with securities commission and other commission. The correlation between the two series amounts to 0.85. Using a model based on the change in the fund stock covers about 56 percent of the commission earnings.

As regards payment service commission there are no monthly data nor has the project established that there are any monthly data that could be used for a model estimate.

As regards commission earnings, the project advocates that data be collected directly from the banks, credit market companies and securities companies. Commission earnings do not need to be divided up into the six different earning types as they are in the quarterly survey. How large would this survey be? This is examined below.

2.5.2.2.1 Sample size – directly measured financial services

Statistics Sweden produces the annual survey *Financial enterprises, annual accounts* on behalf of the Swedish Financial Supervisory Authority. This is a total population survey of Swedish financial enterprises. The results of the survey are published about nine months after the end of the reference year. The survey contains information on commission earnings. The number of financial enterprises amounted to 526 in 2009, distributed among 16 types of institution, see Table 2. Three of these types of institution or 103 enterprises operate abroad and should not be included in a monthly survey of financial enterprises.

Table 2
Number of financial enterprises by institution type

Institution	Number
Housing institutions	7
Fund management companies	116
Financial enterprises	43
Branches of financial enterprises abroad	39
Business institutions	8
Member banks	2
Smaller savings banks	38
Larger savings banks	15
Swedish-owned banking corporations	35
Swedish-owned bank branches abroad	57
Foreign-owned banking corporations	1
Foreign-owned bank branches in Sweden	22
Foreign-owned financial company branches in Sweden	2
Securities companies, SNI65	20
Securities companies, SNI67	114
Securities companies, sv - branches abroad	7
Total	526

Table 3 shows the number of enterprises that have reported data on commission earnings in the *Financial enterprises, annual accounts* survey, that are *fund management companies* and that have reported commission earnings/administration fees/management charges in their annual accounts. The latter enterprises have been captured via the Statistics Sweden Economic Statistics Balance of Payments and Financial Market (ES/BFM) unit's list of fund management companies and the data on earnings have been compiled via manual review of the annual report. The table has been purged of enterprises with operations abroad. The number of enterprises in the table has been broken down into small and large enterprises. The enterprises contributing to 90 percent of the total *commission earnings* are classified as large enterprises and the rest as small enterprises. The number of enterprises amounts to 423. The number of enterprises that contribute to 90 percent of total commission earnings amounts to 67.

Table 3
Number of financial market enterprises by institution and broken down into small and large financial market enterprises

Institution	Small	Large	Total
Housing institutions	7		7
Financial enterprises	34	9	43
Fund management companies	101	15	116
Business institutions	8		8
Member banks	2		2
Smaller savings banks	38		38
Larger savings banks	11	4	15
Swedish-owned banking corporations	15	21	35
Foreign-owned banking corporations		1	1
Foreign-owned bank branches in Sweden	17	5	22
Foreign-owned financial company branches in Sweden	2		2
Securities companies, SNI65	15	5	20
Securities companies, SNI67	107	7	114
Total	356	67	423

Total commission earnings amounted to about SEK 66 billion (EUR 6.85 billion) in 2009. The 67 largest enterprises had commission earnings of approximately SEK 57 billion (EUR 6.2 billion).

If we imagine a cut-off point of 80 percent of commission earnings, 32 financial enterprises need to be surveyed.

A sampling frame that covers about 90 percent of commission earnings consists of only 67 financial enterprises. It would therefore be possible to conduct a total population survey of financial enterprises that would provide accurate estimates of commission earnings at a relatively reasonable cost. In the original proposal, about 250 financial enterprises would be surveyed at an annual cost of about SEK 500 000 (EUR 56 000). Surveying a quarter of these enterprises would therefore cost about SEK 125 000 (EUR 14 000). One proposal is to collect data from these enterprises within the framework of turnover statistics and the turnover statistics system. The turnover statistics system already has an efficient "infrastructure" in place.

2.5.2.3 Life insurance

Life insurance is responsible for about 12 percent of value added in financial activities. In NA, value added in current prices for life insurance is calculated using the trend in administrative costs for life insurance companies. The statistics used in this calculation are quarterly. Administrative costs mainly consist of salary costs. A calculation model has been developed based on the monthly trend in payroll expenses from the KLP for insurance activities SNI 66. The deflation can be done using the monthly salary trend for SNI 66 that is also based on the KLP.

2.5.2.4 Non-life insurance

In the National Accounts, the production value in fixed prices is calculated using the volume trend in the change in the number of insurance policies. These statistics are available on a *quarterly basis* on the insurance association's website. Value added for non-life insurance is split into about 50 percent vehicle insurance and 50 percent home and house insurance. The volume trend has been very stable over time and over the last five years has increased by between 0.5 and 1 percent.

Model estimates of the change in vehicle insurance need to be made. Regarding vehicle insurance, there is monthly information on the number of vehicles on the road. Logically, the number of vehicles on the road should covary with the number of vehicle insurance policies. According to an investigation done by the project, the number of vehicles on the road covaries relatively well with the number of vehicle insurance policies. The correlation coefficient amounts to about 0.89. The number of vehicle on the road could therefore be used to estimate the number of vehicle insurance policies on a monthly basis. Test calculations have also been done showing that the absolute standard error in the estimates of the number of vehicle insurance policies is 0.1 percentage points.

Regarding home and house insurance, the project has not been able to make a good model estimate of the volume change. Data on the change in the housing stock have been tested but have not been possible to use to estimate the change in home and house insurance policies.

2.5.3 Conclusion

As regards financial activities, the project believes that it is possible to make monthly production estimates if new data on directly measured financial services can be collected from credit market companies. The cost of collecting this new data amounts to SEK 125 000 (EUR 13 500) a year. Given monthly data on the directly measured financial services, there is good scope for making monthly production estimates for the financial sector even though some data on FISIM and non-life insurance are missing.

2.6 Evaluation of the quality of the Index of Service Production (NACE 45-96 excl. 64-66)

The Index of Service Production (ISP) has been produced since January 2008. Prior to that, turnover data were collected on a quarterly basis and no estimates of the total service production were made.

Turnover data were collected using two different samples. In the first preliminary version, data were collected from 7 000 businesses each month. This size of sample makes it possible to make estimates for seven different activity groups:

- Total service production (SNI 45-96 excl. 64-66)
- Trade (SNI 45-47)
- Transport and communications (SNI 49-53)
- Hotels and restaurants (SNI 55-56)
- Real estate, computer consultancy and other business services (SNI 58-82)
- Education, health and social care (SNI 85-88)
- Other service activities (SNI 90-96)

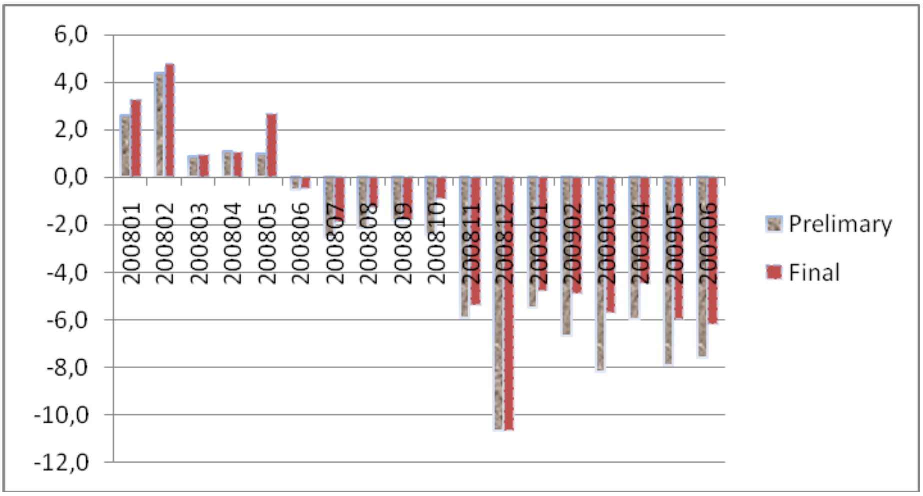
In the final version of the ISP, data are collected from a further 5 000 businesses every quarter. Data are collected every quarter but in the questionnaire, the businesses are asked to break down their turnover for each month included in the quarter. The reason the survey is designed this way is not only to keep costs down but also to reduce the costs for respondents. The final sample size is therefore about 12 000 (7 000 + 5 000) businesses. The final results are broken down into 127 activity groups, which is a requirement from the National Accounts.

The approach of using both preliminary and final estimates means the index is revised. The preliminary version of total service production for the output indicator has a relative standard error of about 1 percent and the final result has a relative standard error of 0.6 percent.

Another factor that leads to service production being revised is the absence of service price index (SPPI) data when the preliminary estimates for the ISP are made. The SPPI is used as a deflator for about 50 percent of the production. The SPPI is written with the help of a method called “exponential smoothing” for the preliminary estimate of the ISP. The produced data are replaced by final data from the SPPI when the final estimate of the ISP is made.

The figure below shows a comparison between the growth rate for the preliminary versus the final estimate of the ISP. The comparison is made for working-day-adjusted volume data.

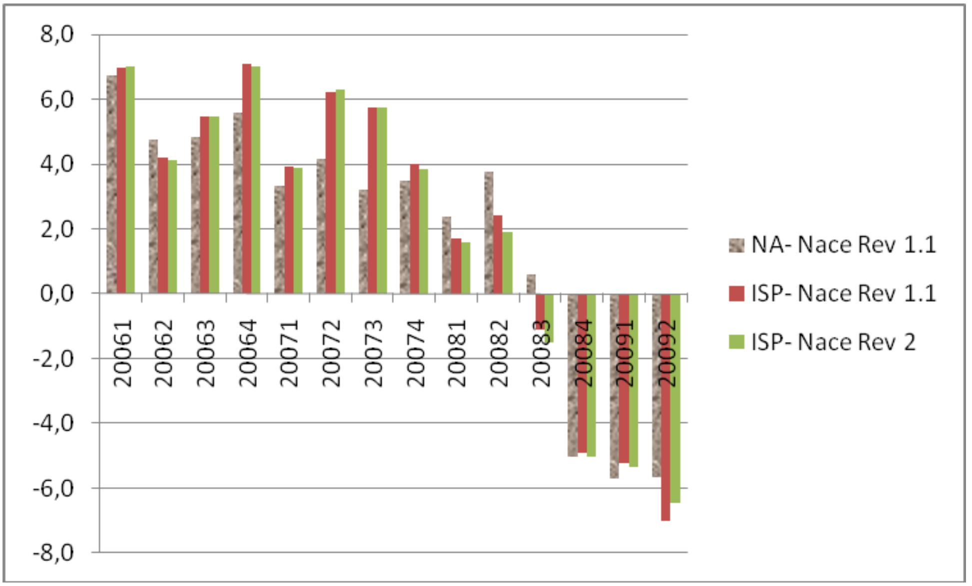
Figure 5
Comparison of the growth rate for preliminary versus definitive estimates of the ISP



As we can see from Figure 5, there are relatively minor differences between the preliminary and definitive estimates of the ISP.

The National Accounts (NA) produce production statistics for the service sector on a quarterly basis. These estimates are mainly based on results from the monthly ISP. NA must however balance the economy on both the production and user side, which can lead to revisions in the service production. How good has the ISP been as an indicator of the outcome in NA? Figure 6 shows a comparison between NA and the ISP. The ISP is based on final results.

Figure 6
Total production for the service sector based on the ISP and NA, volume data



As we can see from Diagram 6, there are only minor differences between the Service Production Index in the new and old SNI classification. The differences between these results depend on e.g. publishing being moved from industry to the service sector. We can also see that there are minor differences between the ISP and NA. The biggest difference can be seen during the third quarter of 2007. The ISP has only been produced on a monthly basis since January 2008 and from that period onwards, there have only been minor differences between NA and the ISP. There has been major concordance between NA and the ISP especially since the rapid downturn in the economy from the fourth quarter of 2008 and thereafter.

The project makes the assessment that the ISP maintains a satisfactorily high level of quality to be included in a Total Production Index.

2.7 Methods of index calculation, working-day adjustment and seasonal adjustment

2.7.1 Index construction and working-day adjustment

The Total Production Index is to be a Laspeyres index in accordance with the chain index method. The chaining/linkage to an index series is done using the "Annual Overlap" technique. Aggregation to a Total Production Index is based on activity indices (actually year-month links). Activity year-month links then make up the input to the total, *though only on condition that the activity index series are chain indices linked using the "Annual Overlap" technique.* The Total Production Index can therefore be seen as independent of the activity indices.

Aggregation to the Total Production Index starts from the following activities:

- Agriculture, Forestry and Fishing (Heading A in NACE rev.2)
- Industry (Headings B-D in NACE rev.2)
- Construction (Heading F in NACE rev.2)
- Service activities, excl. the financial sector, (Headings E, G-S, excl. K in NACE rev.2)
- Financial sector (Heading K in NACE rev.2)

Normally year-month links are aggregated starting from the lowest level (detailed activity level). In the Total Production Index, however, the aggregation of year-month links starts from already aggregated levels (activities). It is not possible however to show that stepwise aggregation via activities gives the same results as are obtained by starting from the detailed level and aggregating directly to a total.

Once year-month links for the total have been calculated for all the months included, the index series is produced.

Working-day-adjusted volumes are calculated in the same way as volume calculations.

2.7.2 Seasonal adjustment

An important issue as regards the choice of methods for seasonal adjustment and trend calculation for a Total Production Index is whether consistency between the activities and the total is fulfilled. Since no value levels will be published, total consistency is not a problem, although one may wish to avoid a situation where the seasonal adjusted and trend-purged sub-series show for example a positive trend while the series for the total shows a negative one.

If there is to be consistency, the next question is whether the total index is to be superior or subordinate to the sub-indices. If the total index is superior, adjustments have to be made in seasonally adjusted and/or trend-calculated sub-indices. This approach doesn't feel plausible as it requires the total index to be published earlier or at the same time as the other sub-indices in order to avoid revisions. Coordination and major changes must also be done in the existing sub-indices, something which is beyond the scope of this project. At this stage, the total index should therefore be subordinate to the sub-indices.

The standard software/method for seasonal adjustment at Statistics Sweden is Tramo-Seats, developed by the Bank of Spain. In addition to Tramo-Seats, the X12-Arima method is used for certain series such as the Total Production Index, LFS data. This method has been developed by the U.S. Census Bureau. Tramo-Seats and X12-Arima are considered to be similar in terms of quality according to Eurostat and are therefore the recommended methods. The reasons for using one or the other can vary. X12-Arima probably fulfils the production requirements laid down by Statistics Sweden better than Tramo-Seats since it has been implemented in SAS, Statistics Sweden's standard programming tool for its method work. *Since Tramo-Seats will continue to be a standard tool for a while longer, it is probably best to use the method here for to seasonally adjust both the Index of Construction in Production and the Total Production Index.*

Once all seasonally adjusted sub-series are in place, a seasonally adjusted series for the total production index needs to be created. The method proposed here is based on the principle that the Total Production Index is subordinate to the components included. Direct seasonal adjustment will not be used for final production of the index since it would probably lead to certain inconsistencies between the included indices and the Total Production Index. Neither will the value added weights used to calculate the actual series be used since the seasonal adjustment of the sub-series implies the implementation of a number of non-linear operations. Seasonally adjusted series are estimates based on the sample which means that some form of optimal estimation would be needed in order to produce the final seasonally adjusted Total Production Index. The principle is illustrated below:

1) Perform seasonal adjustment and working-day adjustment on the sub-indices included, $X_{i,t}$, where $i = 1,2,3,$ and $t = 1,2,\dots,T$, where T is the number of observations. Let us denote the model-based seasonally adjusted estimate for component i at time t as $\hat{X}_{i,t}^{SA}$
2) Perform direct[64] seasonal adjustment and working-day adjustment on the Total Production Index, Y_t and denote the seasonally adjusted index as Y_t^{SA}. A model-based estimate of the seasonally adjusted index will be denoted as $\hat{Y}_t^{SA}$. [65]
3) Use seasonally adjusted estimates to estimate a regression model with auto-correlated random terms (errors)[66]

$$\hat{Y}_t^{SA} = \alpha_0 + \sum_{i=1}^{3} \beta_i \hat{X}_{i,t}^{SA} + \varepsilon_t,$$

$$\varepsilon_t = \sum_{i=1}^{m} \varphi_j \varepsilon_{t-j} + v_t,$$

$$v_t \sim N(0, \sigma_v^2). \qquad (1)$$

4) Use estimates of parameters $\alpha_0, \beta_i,$ for the regression model above as weights to recreate a new estimate of the seasonally adjusted index, denoted as $\tilde{Y}_t^{SA}$. In practice this means that the predicted values from the regression model above are used as the final seasonally adjusted index.
5) Repeat the procedure according to step 1 – step 4, in each production round, for seasonally adjusted data.

The approach according to step 3 – step 4 above means that a certain model stability is assumed since the weights do not change over time during a production round. In the next production sequence,

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[64] Direct seasonal adjustment means that seasonal adjustment is applied on the total without taking into account the seasonal adjustment of the components.

[65] Y_t^{SA} depicts a "true" seasonally adjusted TotPI that is unknown. We have neither access to "the true" actual TotPI nor to "the true" seasonally adjusted TotPI. The notation $\hat{Y}_t^{SA}$ will then be used to a model-based estimate of the seasonally adjusted series.

new data come into the picture and the procedure is repeated, which also means that parameter estimates are updated. This can lead to minor revisions, which is natural for seasonally adjusted data.

Results of statistical tests are not presented here but all of them show that the model captures most of the variation in the seasonally adjusted index. All parameter estimates are strongly significant, even with the 0.01 significance level. At the same time, the residuals fulfil the basic assumptions on independent (non-autocorrelation), equal distribution and constant variance around the mean value of zero.

The results show that there is better concordance between parameter estimates for seasonally adjusted and working-day-adjusted data for Tramo-Seats-based approximation than for X12-Arima-based approximation. At the same time, the model for Tramo-Seats is simpler than the model for X12-Arima (fewer parameters to estimate), which should mean stabler estimates when the data are revised. The reasoning above does not imply that X12-Arima produces inferior results, rather that Tramo-Seats seems to be more suited to analysis where the input data have been seasonally adjusted using different methods. This conclusion is not general but relates only to data in this application.

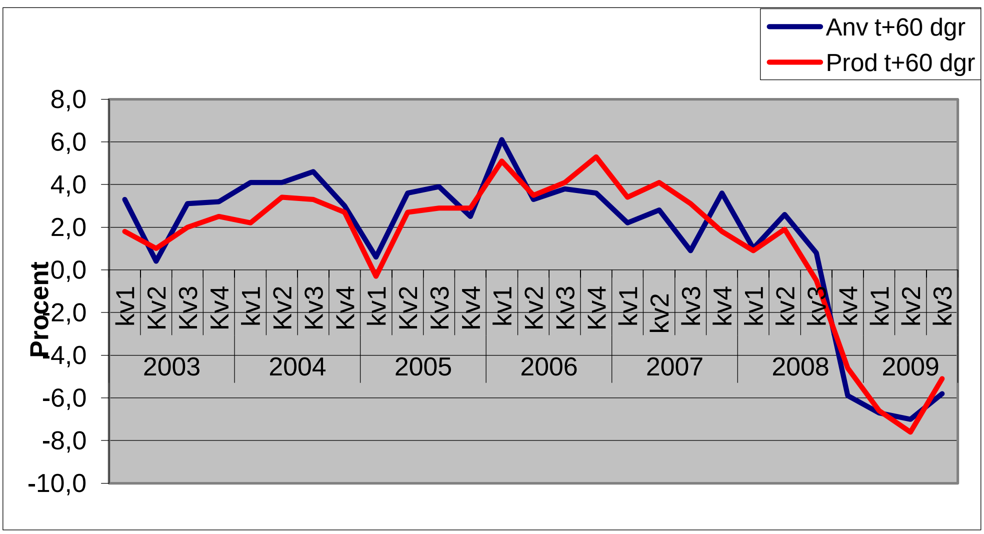
As the model adjustment is good with a high degree of clarification, the discrepancies between the final index series ($\hat{Y}_t^{SA}$) and each seasonally adjusted index are relatively small. Consequently, the estimates will be relatively close to the original, directly adjusted series. This, in turn, means that the estimated Total Production Index series are not completely subordinate to the included sub-series but also depend on the trend in the directly seasonally adjusted total index. The results from the estimates show that the discrepancy between the estimated and the directly adjusted index is relatively small..

2.8 Test calculations

2.8.1 The National Accounts (NA)

The National Accounts (NA) do quarterly calculations of GDP. NA does quarterly calculations of the economy from both the production and user side. When calculations are done from the producer side, estimates are made of the trend in value added. From the user side, the calculations are done in what is known as the balance of resources. In the balance of resources, private consumption, public consumption, investments and exports are added together and imports are then subtracted from the total. Since GDP is calculated from two different sides of the economy, there is always a difference between the producer and user side in the calculations. Historically, NA has relied more on calculations from the user side since they are based on better-quality statistics. From the producer side of the economy, NA only really has data on the trend in production value and no data on consumption. When reconciling the figures, this often leads to an adjustment in the calculations from the producer side. Figure 7 shows the trend in GDP from the producer and the user side prior to reconciliation.

Figure 7
Volume trend in GDP from the producer and the user side prior to reconciliation



NA also does yearly calculations in which new data from the annual statistics are added. Results from the very important Structural Business Statistics survey are among these new data. The yearly calculations lead to the revision of the published quarterly data.

On a quarterly basis, NA uses the industrial and service production indices to do calculations of the economy from the producer side. The ICP is not used by NA. Instead, they have a model based on data from the user side.

2.8.2 Weights

Data on the activity's/sector's weight (share of value added) in the economy is needed in order to calculate a Total Production Index. Table 4 shows each activity's/sector's share of the total value added in the economy. In 2009, the manufacturing industry for example had a 19.1 percent share of total value added. The share of private business amounted to 77.4 percent. If Statistics Sweden can do a monthly production index for the business sector, it would provide important and rapid information on economic trends.

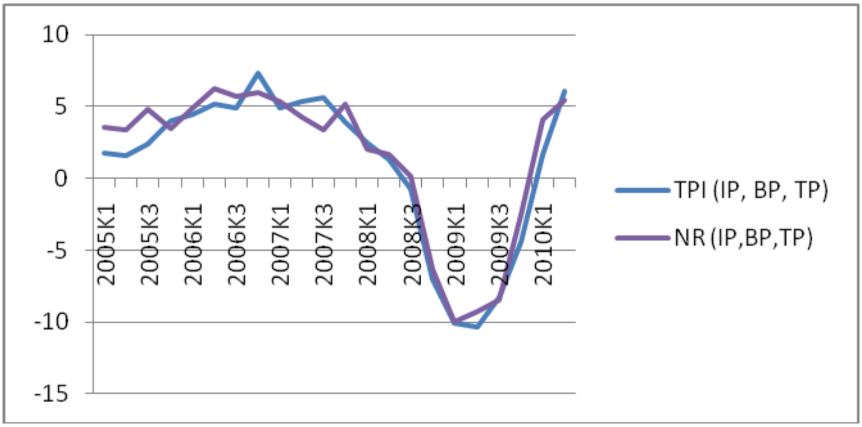
Table 4
Share of value added according to NA by activity and year, in percent

Weights	House-holds, non-profit orgs	Pub auth	Agricul-ture, forestry and fishing (01-03)	Manu Ind (05-35)	Construc-tion (41-43)	Service (36-39, 45-96)	Finance (64-66)
1999	1.1	20.7	2.3	23.8	4.3	42.9	5.0
2000	1.4	19.9	2.0	23.8	4.3	44.1	4.5
2001	1.5	20.2	2.0	22.9	4.6	44.5	4.3
2002	1.5	20.4	2.0	22.6	4.7	44.8	4.0
2003	1.5	20.8	1.9	22.3	4.6	44.7	4.1
2004	1.5	20.6	1.9	22.5	4.8	44.2	4.5
2005	1.5	20.4	1.2	22.7	4.8	44.7	4.7
2006	1.5	20.0	1.4	22.5	5.0	45.5	4.1
2007	1.4	19.7	1.7	22.2	5.3	45.7	3.9
2008	1.4	20.0	1.7	21.5	5.4	46.1	3.8
2009	1.6	21.0	1.7	19.1	5.4	46.7	4.5

2.8.3 A Total Production Index based on the industrial, service and construction production indices

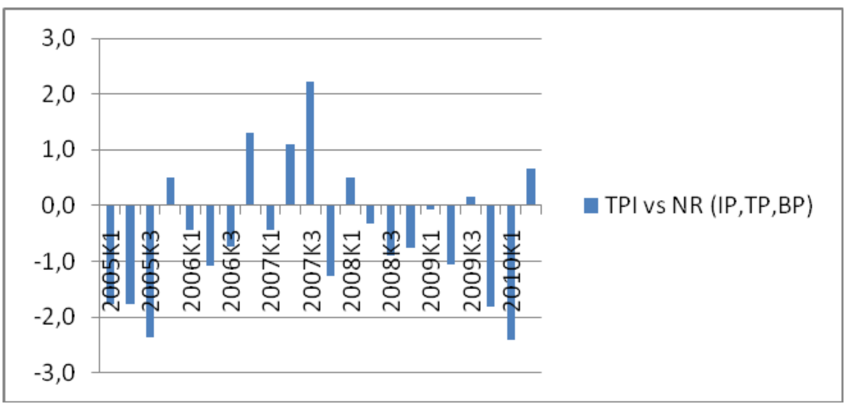
In this section, the test calculations performed in the project for a Total Production Index based on the industrial, service and construction production indices are presented. The industrial, service and construction production indices cover 71.2 percent of the total value added in the economy.

Diagram 8
Growth rate for working-day-adjusted production volume, in percent



In Diagram 8, we can see the quarterly trend for the working-day-adjusted production volume for the Total Production Index (based on IIP, ISP and ICP) and the National Accounts for corresponding activities. We can see from the diagram that the production trend in the monthly index is similar to that reported in NA. The correlation between the growth rates amounts to 0.97.

Figure 9
Differences in growth rate (percentage points) between the working-day-adjusted production volume for the total production index and NA

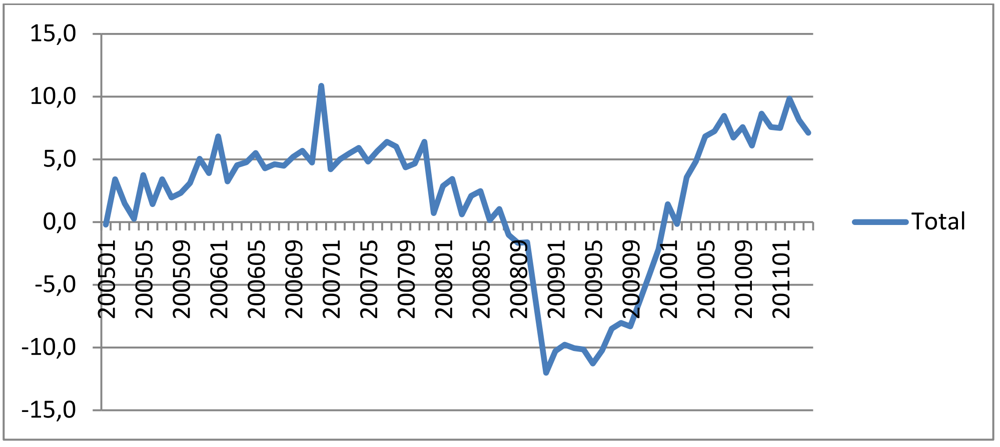


In Figure 9 we can see the differences in the growth rate of the working-day-adjusted production volume. The differences vary between zero and about two percentage points. The average absolute difference amounts to 1.1 percentage points. What do the differences depend on? The project has not investigated this but the following aspects are important to bear in mind:

- In their calculations, NA make adjustments to the economy from the producer and user side and as previously mentioned, NA rely more on the user side.
- When NA do their yearly calculations, they change source from short-term statistics to annual and often more comprehensive statistics.
- The IIP only covers the production of goods and not of services, which NA make amendment for.
- NA make stock adjustments to the IIP, which are not made in the monthly IIP.
- The ICP is not used by NA. Instead, their calculations of construction production are made from the user side.

Figure 10 shows the monthly growth rates for the working-day-adjusted total production volume.

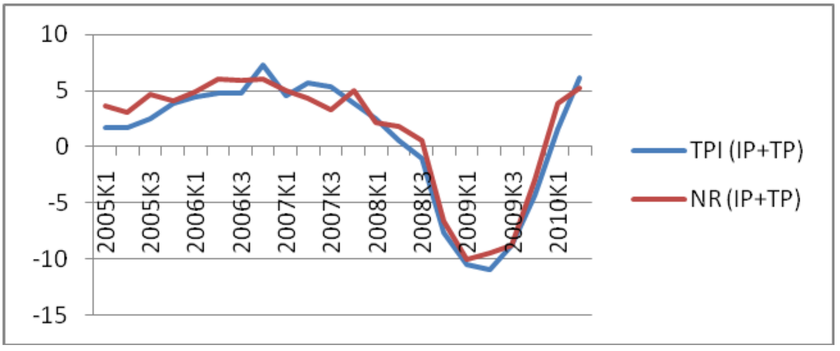
Figure 10
Monthly growth rate for working-day-adjusted total production volume, in percent



2.8.4 A Total Production Index based only on the industrial and service production indices

In this section, the test calculations performed in the project for a Total Production Index based only on the industrial and service production indices are presented, i.e. a narrow production index based only on the public monthly statistics that are currently available. The ICP that is only published via Eurostat is not included in the calculation. The ICP is also the index showing the greatest difference compared to NA's calculations. The industrial and service production indices covered 65.8 percent of the total value added in the economy in 2009.

Figure 11
Growth rate for working-day-adjusted production volume, in percent



In Figure 11, we can see the quarterly trend for the working-day-adjusted production volume for the Total Production Index (based on IIP and ISP) and the National Accounts for corresponding activities. We can see from the diagram that the production trend in the monthly index is similar to that reported in NA. The correlation between the growth rates amounts to 0.98.The differences vary between zero and two percentage points. The average absolute difference amounts to 1 percentage point.

2.9 Overview – Options

Table 5 provides an overview of the options available to produce a monthly production index for different activities. From the table, we can see the activity's share of total value added in the business sector, the actuality of the input sources and whether there is monthly information.

Table 5
Overview of the scope for publishing a monthly production index

Activity (SNI2007)	Month	Comment	Actuality	VA share
01 Agriculture				0.60
of which livestock production	Swedish Board of Agriculture monthly data	The Swedish Board of Agriculture can make an estimate of the production value based on transfer prices and quantities Deflation PPI	T+50	About 0.30
of which crop production	No data	The Swedish Board of Agriculture can make a forecast, based on EAA calculations	T+45	About 0.30
02 Forestry	Lack of monthly data or no data	There is partly a lack of data. In addition, NA's quarterly calculations are complicated and based on many assumptions. These assumptions become even more vague in monthly calculations		1.37
03 Fishing				0.03
of which marine fishing	Swedish Board of Fisheries	Monthly data on the production value. Deflation PPI	T+30	0.02
of which Other fishing	Swedish Board of Fisheries	The Swedish Board of Fisheries collects monthly data from Sweden's major lakes. Published annually, however	Annual	0.01
05-09 Mining and quarrying	IIP	Not stock-adjusted	T+40	0.6
10-33 Manufacturing	IIP	Not stock-adjusted	T+40	21.6
35 Electricity, gas, steam and air conditioning supply	IIP	Not stock-adjusted	T+40	4.2
36-39 Water supply, sewerage, waste management and remediation activities	ISP		T+35	0.1
41-43Construction	ICP	Is hours worked in KLP or LFS a better proxy for production?	T+40 (T+60-KLP)	6.7
45-96 (excl. 64-66) Service sector	ISP	Preliminary ISP and forecast of SPPI	T+35	59.5
64-66 Financial activities				5.3
of which FISIM	Financial market statistics	Volume data on deposit and loan stock deflated using the GDP deflator. FISIM exports are missing	T+30	1.8
of which direct banking services	No data	A model calculation can be done for about half the production value with the help of monthly statistics on the fund stock. The proposal from the project is to introduce new monthly data collection	T+30 (model)	1.5
of which life insurance	Trend in payroll expenses according to KLP	Production is projected on a monthly basis using the trend in payroll expenses	T+60	0.6
of which non-life insurance	Model	A model calculation can be done of vehicle insurance with the help of the number of vehicles on the road. The data for home and house insurance must be extrapolated	T+10 (vehicle-model)	1.0
of which Other financial services	Model	Trend in direct banking services, life insurance and non-life insurance		0.4
Total				100

2.9.1 Option 1 – A narrow production index

Actuality is a central quality component for the Riksbank as regards monthly short-term indicators. On several occasions, the Riksbank has expressed a desire to have all short-term statistics produced within T+30 days.

Statistics Sweden could produce a narrow total production index based solely on the IIP and the ISP. This index would cover the activities SNI 05-96 excluding the construction industry (SNI 41-43) and financial activities (SNI 64-66). It would cover about 86 percent of the value added in the business sector and could be produced within T+40 days.

A narrow production index would not contain production data for the construction industry or financial activities. The construction industry is excluded from the Total Production Index in this option assuming that the necessary measures to speed up the KLP cannot be implemented. The project also thinks it will be tricky to make model calculations of directly measured financial services. Compiling monthly statistics for financial activities requires new data on directly measured financial services to be collected from about 250 enterprises.

The recurring annual cost for producing a Total Production Index using this approach is estimated at just under SEK 220 000 (EUR 24 000). Start-up costs for programming the index calculation of about SEK 150 000 (EUR 16 300) must be added to this figure.

2.9.2 Option 2 – A production index without new data collection

Statistics Sweden could produce a Total Production Index without new data collection based on the IIP, the ISP and the ICP. This index would cover the activities SNI 05-96 excluding financial activities (SNI 64-66). It would cover about 93 percent of the value added in the business sector and could be produced within about T+45 days.

From a quality point of view, the project has, during the review of the three different surveys, been able to see that the greatest uncertainty is associated with the ICP where there is a major difference for certain quarters compared to the trend in construction production presented in NA.

The recurring annual cost for producing a Total Production Index using this method is estimated at just under SEK 220 000 (EUR 24 000). Start-up costs for programming the index calculation of about SEK 150 000 (EUR 16 300) must be added to this figure.

2.9.3 Option 3 – A production index with new data collection

This index is the same as the one described in 3.9.2 but also includes financial activities. Compiling monthly statistics on financial activities requires new data on directly measured financial services to be collected from about 67 enterprises. The cost of collecting this data amounts to SEK 125 000 (EUR 13 500) a year. This index would cover activities SNI 05-96. It would cover about 98 percent of the value added in the business sector and could be produced within about T+45 days.

The recurring annual cost for producing a Total Production Index using this method is estimated at about SEK 345 000 (EUR 37 500). What distinguishes it from Option 2 is that a new collection of data on directly measured financial services is added.

2.9.4 Option 4 – A Total Production Index covering all activities

If Statistics Sweden were to produce a Total Production Index covering the entire business sector, the actuality would be worse. A Total Production Index covering all activities would only have an actuality of T+60 days. This is because certain indicators are dependent on KLP, which is only ready after T+60 days. In addition to the activities covered in the index described in 3.9.3, this option includes agriculture, forestry and fishing (SNI 01-03).

From a quality point of view, agriculture, forestry and fishing (SNI 01-03) and financial activities (SNI 64-66) are the most difficult to estimate on a monthly basis. Regarding agriculture, there is no monthly data for crop production at all and there is none for forestry either. A new survey is required to estimate forestry production.

The project has elected not to calculate the costs of this option since the project has not done a cost calculation of a new forestry survey.

Sweden and Spain: Two contrasting growth experiences

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Spain and Sweden are two European countries that do not have a great deal in common from a cultural, historical and economic perspective. Although they both belong to the European Union, they do not share the same currency. Spain joined the European Union (EU) in 1986 and has belonged to the Euro zone since its creation in 1999, while Sweden became a member of the EU in 1995 and does not belong to the Monetary Union. This paper revises the contrasting experiences of the two countries from the economic side. The first and most noticeable difference is in the level of development. Sweden has traditionally enjoyed one of the highest per capita incomes within the group of the most industrialized countries in the world[67]. On the contrary, Spain started the 70s in a rather backward position, with a per capita income markedly lower than the EU average[68]. This paper is structured as follows. Section 1 presents an overview from the aggregate perspective. Section 2 provides industry detail by applying a growth accounting decomposition of the sources of growth. Section 3 offers additional information on the industry specialization of the two countries by means of a shift-share analysis. Finally, Section 4 summarizes the main conclusions.

[67] See Hagén (2011) for a detailed analysis of the performance of the three Nordic countries belonging to the EU

[68] Mas, Milana and Serrano (2011) describe the patterns of growth of two Southern countries, Spain and Italy, from a long term perspective.

1. Overview

Before going into a more detailed analysis on the productivity performances of both countries, we will take a brief look at how per capita income has evolved given that the gap in this variable is probably the most remarkable difference between the two countries. In order to do this, we will take as reference a rather useful decomposition:

$$\frac{GVA}{P} \equiv \frac{GVA}{H}\frac{H}{L}\frac{L}{LF}\frac{LF}{P} \qquad [1]$$

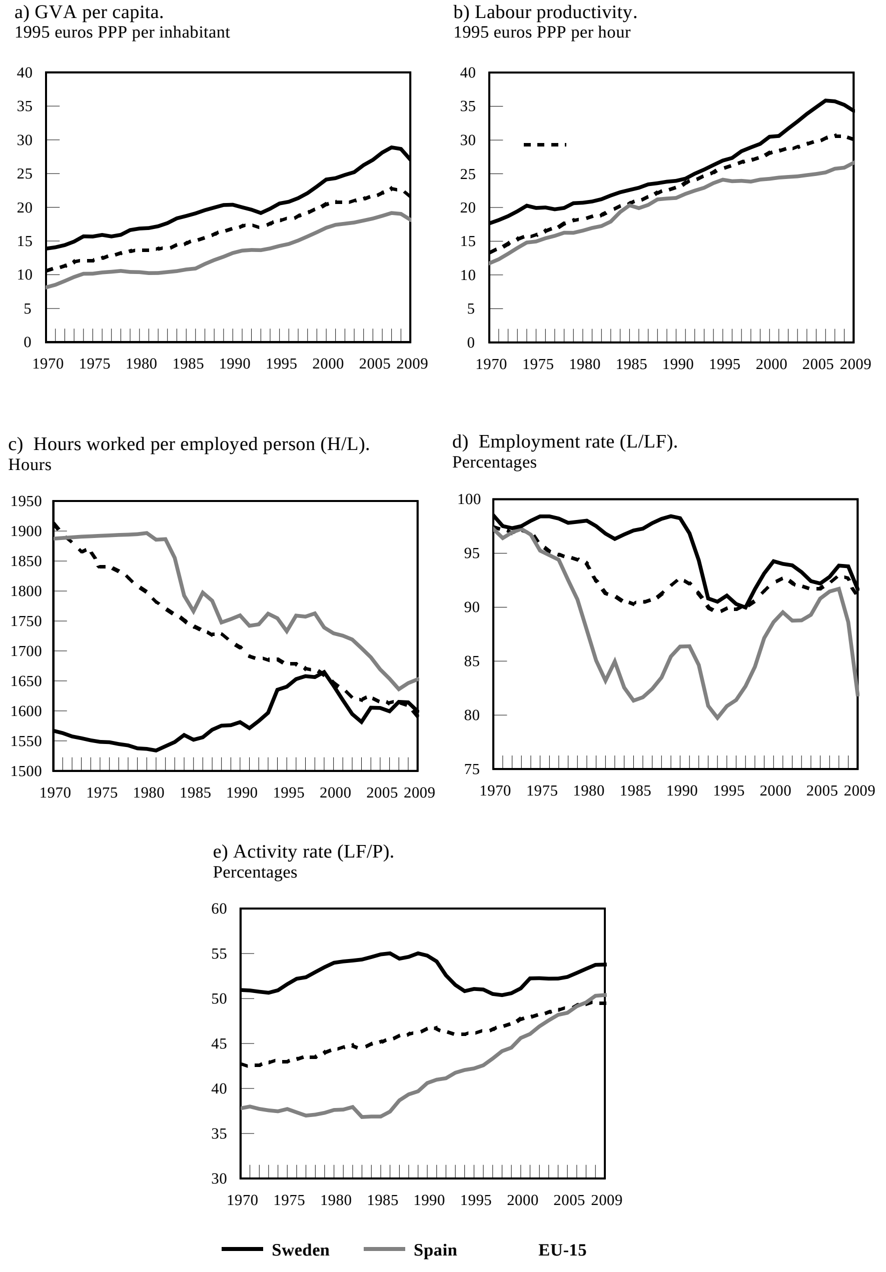
where *GVA* stands for Gross Value Added; *P* for total population; *H* are total hours worked; *L* is total employment (in persons); and *LF* represents the labour force. Therefore, the first term in the right hand side of expression [1] (*GVA/H*) measures labour productivity with respect to hours worked; the second (*H/L*) the number of hours worked per employed person; the third (*L/LF*) the employment rate; and the last component (*LF/P*) the activity rate defined in terms of the total population.

Figure 1 shows the time profile of the five variables involved in [1] for the period 1970–2009. The aspect that stands out is that Sweden´s per capita income has always been higher than the EU average, with this difference increasing in the last years of expansion. On the contrary, per capita income was lower in Spain and this difference has been maintained along the period. The gap between Sweden and Spain originated in Sweden’s higher labour productivity, as well as its higher rates of employment and activity. Spain only overtakes Sweden in the number of hours worked. Thus, Spanish workers work more hours, are less productive and support a higher percentage of dependent population.

Revising the components of per capita income behaviour, expression [1] allows us to quantify the relative importance of each one of them. By taking logs, we can obtain both the time evolution of each variable, as well as its contribution to per capita income in each point of time. Furthermore, if we deduct the Spanish figures from the Swedish ones, the relative importance of each component in per capita income differences can be tracked. Table [1] shows the percentage contribution of each component.

Labour productivity has been one of the main determinants of per capita income differences between the two countries. The other key factor is the activity rate, traditionally very low in Spain and well above EU average in Sweden. The backward position of Spain in terms of development halted the incorporation of women into the labour force, a fact that has changed dramatically since the mid-80s. This accounts for the importance of this variable in per capita income differential. However, it has not being constant over the period analyzed. In general, the higher number of hours worked per employed person in Spain acts in favour of its per capita income, while its lower activity rate has exerted the opposite force but with decreasing intensity. The Spanish unemployment rate had a negative effect on its relative per capita income during the whole period. Thus, Spain has a serious problem in almost all relevant variables that affect per capita GDP.

Figure 1 GVA per capita and its components



Source: AMECO (2011), TCB (2011), EU KLEMS (2009) and own calculations

Table 1. Nominal GVA per capita decomposition. Sweden minus Spain
(GVA per capita differences =100)

	1980	1995	2000	2005	2007
Labour productivity	48.06	30.38	61.76	79.54	70.71
Hours worked by employed person	-42.02	-15.01	-16.03	-14.56	-4.58
Employment rate	21.78	32.64	19.06	5.63	8.18
Activity rate	72.18	52.00	35.22	29.39	25.69
GVA per capita	100.00	100.00	100.00	100.00	100.00

Source: AMECO (2011), TCB (2011), EU KLEMS (2009) and own calculations

Table 2 presents the growth rate of Gross Value Added (GVA), employment (in hours worked) and labour productivity expressed in real terms and in hours worked. The table distinguishes between the whole period 1970–2009, and different relevant subperiods. The main messages are the following:

Table 2. Real GVA, employment (hours worked) and labour productivity. Total economy
(Annual rates of growth in %)

	1970-2009		1970-1995		1995-2009		1995-2007		2007-2009	
	Sweden	Spain	Sweden	Spain	Sweden	Spain	Sweden	Spain	Sweden	Spain
Real GVA	2.02	2.86	1.97	2.89	2.11	2.81	2.97	3.52	-3.05	-1.47
Employment (hours worked)	0.31	0.76	0.27	0.00	0.38	2.11	0.62	2.98	-1.06	-3.14
Labour productivity	1.71	2.10	1.70	2.89	1.73	0.70	2.35	0.54	-1.98	1.67

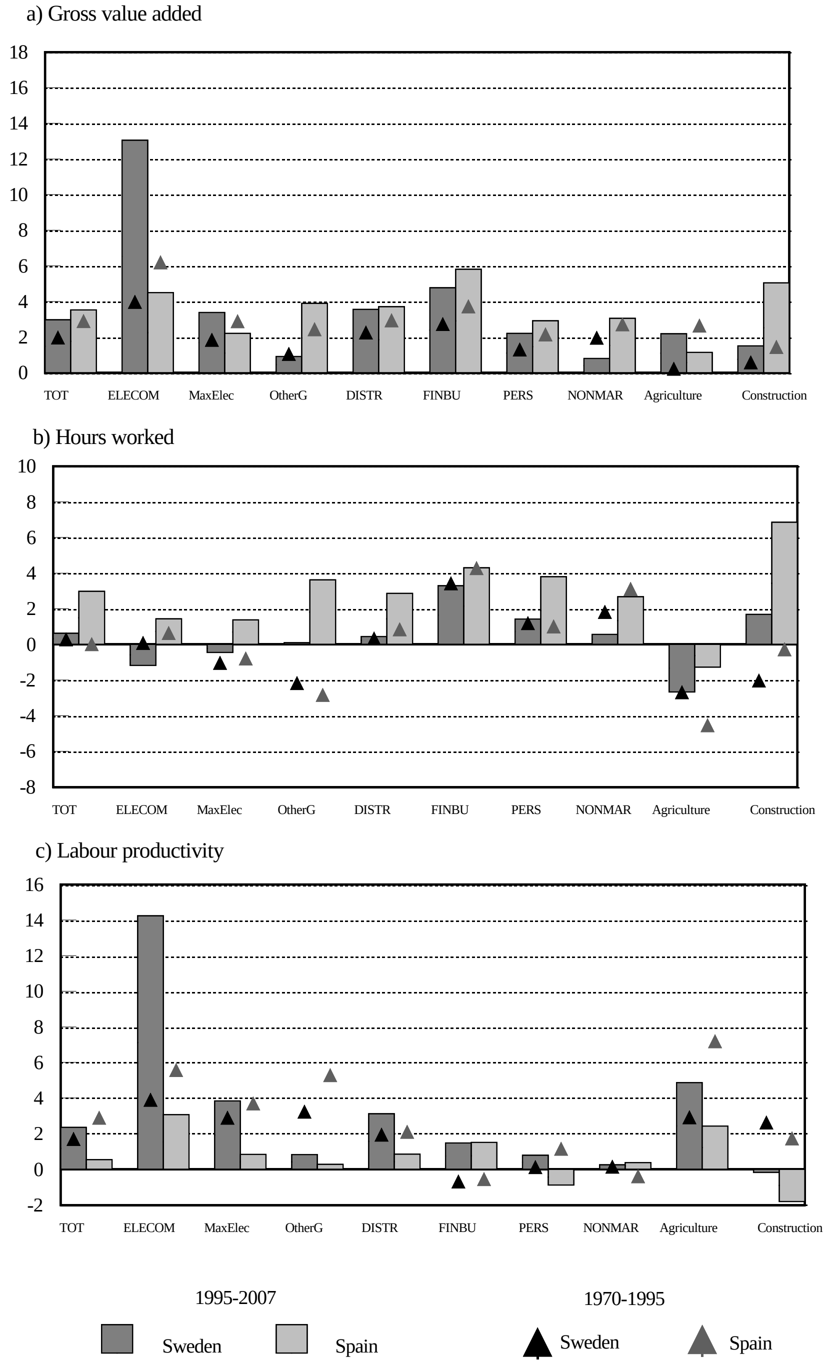
Source: TCB (2011), EU KLEMS (2009) and own calculations

In the first place it shows that over the whole period of 1970–2009 Spain demonstrated a more dynamic behaviour than Sweden in the three variables. In the second place, it shows the difficulties faced by the two countries, especially for Spain, in creating jobs between 1970 and 1995. Things changed drastically in the following years. In the period 1995–2007, Spain experienced a productivity slowdown due to its strong labour creation which helped to reduce its very high unemployment rate. Sweden increased its employment but at a more modest rate allowing productivity growth to accelerate. Thus, while Spanish productivity stagnated, in Sweden it speeded up. In the third place, the last two columns show the dramatic impact of the most recent crisis. In the 2007–2009 period both countries showed negative rates of GVA and employment growth. However, since employment destruction was much more severe in Spain than in Sweden, labour productivity grew in Spain while in Sweden it had a negative sign. Taking all this into account, what Table 2 shows is that Spain enjoyed its highest rate of labour productivity growth in 1970–1995 and in 2007–2009, precisely the years when it faced the most severe obstacles to create employment. For Sweden, the golden years of productivity growth were 1995–2007. The negative sign of the first years after the global crisis was the consequence of a reduction in GVA that was two percentage points higher than in labour. Thus, while Sweden opted for labour hoarding Spain took the alternative path of strong labour destruction, mainly –though not exclusively– in the over dimensioned construction industry.

2. Two contrasting growth experiences

Figure 2 offers an overview of the growth experiences seen in the two countries over the 37 years covered by the EU KLEMS database from an industry perspective.

Figure 2. Value added, hours worked and labour productivity growth. 1970-1995 and 1995-2007
(Percentages)



The general picture that emerges from panel a) is that Spain outperformed Sweden in terms of GVA growth at the aggregate level but with important differences between the seven aggregates of the industries considered. Sweden showed a much more dynamic behaviour in the ICT production sectors (ELECOM), 13% as compared with the modest 4% in Spain, and also in other manufacturing industries excluding *Electrical machinery* (labelled *MaxElec*)

In terms of hours worked, and as panel b) indicates, the ability of the Spanish economy to create new jobs was astonishing after 25 years of almost nil labour creation[69]. Sweden also increased its level of employment, albeit less intensively. It is interesting to notice how the two countries show opposite behaviour in the two sectors in which Sweden is stronger: ICT production sectors and *MaxElec.* While Sweden destroyed employment, Spain experienced positive growth rates. However, the most noticeable difference is the significant growth in employment in Spain's construction industry, tripling that of Sweden.

As a consequence of the different paths taken by the two countries in terms of GVA and employment, the labour productivity behaviour —shown by panel c) — looks very different. Whereas in Spain labour productivity growth decelerated in the expansion years with respect to the previous period, in Sweden it accelerated. In all industry aggregations labour productivity growth was higher in Sweden than in Spain, and the most significant difference was found in the ICT producing sector. Other sectors in which Sweden clearly outperforms Spain were *Agriculture*, *MaxElec* and *Distribution.*

Table 3 provides further insights into the two countries contrasting GVA behaviour by means of a growth accounting decomposition. This information refers exclusively to the private sector of the economy. First, in the most recent period 1995–2007, Spanish GVA growth in the market economy was dominated by strong labour creation, particularly in *Construction* and the three service aggregations, *Distribution* (DISTR) ¸ *Finance and business, except real estate* (FINBU) and *Personal services* (PERS). However, *Agriculture* experienced job destruction in both countries. Second, the ICT producing sector *Electrical machinery, post and communication services*

[69] The severity of job destruction in the Spanish economy since the beginning of the current global crisis is also astonishing.

(ELECOM) showed a very strong increase in both countries, but with very different drivers. That is, in Spain the main driver was capital accumulation, whereas Sweden was more in line with other EU countries and the US, having TFP as its main source of growth. Third, ICT capital contribution to GDP growth was slightly higher in Sweden than in Spain, while non ICT capital contribution was higher in Spain. However, the most radical difference between the two countries concerns TFP contributions, which were negative in all Spanish sectors but *Agriculture* and *Financial Intermediation* (FINBU) and positive in almost all Swedish sectors and very high in the ICT producing sector (ELECOM). *Construction, Other G* and FINBU were the Swedish sectors whose TFP contribution was negative.

Table 3. Contributions to value added growth. 1995-2007
(Percentages)

a) Sweden

	MARKT	ELECOM	MaxElec	OtherG	DISTR	FINBU	PERS	Agricul-ture	Construc-tion
1. Real GVA growth (=2+5+8)	3.96	13.05	3.38	0.91	3.55	4.77	2.17	2.19	1.50
2. Labour services contribution (=3+4)	0.78	-0.42	0.03	0.45	0.53	2.37	1.24	-1.87	1.69
3. Hours worked	0.52	-0.95	-0.26	0.30	0.30	2.07	1.19	-2.12	1.53
4. Labour composition change	0.26	0.53	0.29	0.15	0.23	0.31	0.05	0.24	0.16
5. Capital contribution (=6+7)	1.78	1.98	1.78	0.99	1.78	2.57	0.72	0.55	0.48
6. ICT	0.63	0.70	0.49	0.09	0.63	1.25	0.33	0.05	0.06
7. Non-ICT	1.14	1.28	1.28	0.90	1.15	1.31	0.38	0.51	0.42
8. MFP	1.40	11.49	1.58	-0.53	1.25	-0.17	0.21	3.51	-0.66

b) Spain

	MARKT	ELECOM	MaxElec	OtherG	DISTR	FINBU	PERS	Agricul-ture	Construc-tion
1. Real GVA growth (=2+5+8)	3.64	4.50	2.21	3.90	3.71	5.81	2.70	1.14	5.04
2. Labour services contribution (=3+4)	2.41	1.31	1.44	2.92	2.34	3.12	2.77	-0.32	5.38
3. Hours worked	2.04	0.75	0.99	2.65	1.92	2.69	2.49	-0.60	5.07
4. Labour composition change	0.38	0.55	0.45	0.27	0.41	0.43	0.28	0.28	0.31
5. Capital contribution (=6+7)	1.94	3.79	1.21	1.59	2.43	1.80	2.23	0.44	1.86
6. ICT	0.52	1.65	0.31	0.14	0.65	0.98	0.37	0.01	0.17
7. Non-ICT	1.41	2.14	0.90	1.45	1.77	0.81	1.86	0.43	1.70
8. MFP	-0.70	-0.60	-0.44	-0.61	-1.06	0.89	-2.29	1.02	-2.20

Note: MARKT=Market economy; ELECOM=Electrical machinery, post and communication services; MaxElec=Total manufacturing, excluding electrical; OtherG=Other production; DIST=Distribution; FINBU=Finance and business, except real estate and PERS=Personal services.
Source: EU KLEMS (2009) and own calculations

Table 4 provides further information from the labour productivity perspective. In the 1995–2007 period labour productivity growth was very high in Sweden (3.3%) and very low in Spain (0.63%). By far, the most dynamic behaviour was presented by the aggregation of *Electrical machinery, post and communication services* (ELECOM) with more than noticeable differences. In Sweden labour productivity growth in this sector was 14.2%, while in Spain it was a modest 3.1%. Other industries with important productivity gains in Sweden were *Agriculture* (4.9%), *MaxElec* (3.8%) and *Distribution* (3.1%). In Spain, *Agriculture* (2.4%) and FINBU (1.5%) were the two industries with the highest rates but well below the Swedish figures.

As already mentioned, TFP contributions were the most divergent drivers of growth between the two countries. In fact, the main force driving the very modest labour productivity growth in Spain was Non-ICT capital deepening. The only exceptions were *Finance and business, except real estate* (FINBU) and *Construction* where its contribution was negative. ICT capital deepening also made a positive contribution in both countries, but with less intensity in Spain than in Sweden, followed closely by the contribution of labour composition changes, especially in the Spanish case. As expected, ICT capital accumulation was very strong in the *Electrical machinery, post and communication services* sector and also in two aggregations of sectors, characterized by their intensive use of ICT, *Finance and business, except real estate* and *Distribution*.

Table 4. Contributions to labour productivity growth. 1995-2007
(Percentages)

a) Sweden

	MARKT	ELECOM	MaxElec	OtherG	DISTR	FINBU	PERS	Agricul-ture	Construc-tion
1. Labour productivity growth (=2+3+6)	3.31	14.24	3.84	0.82	3.12	1.48	0.79	4.87	-0.18
2. Labour composition change	0.26	0.53	0.29	0.15	0.23	0.31	0.05	0.24	0.16
3. Capital contribution (=4+5)	1.53	1.99	1.90	0.93	1.63	1.40	0.45	0.84	0.30
4. ICT capital per hour	0.57	0.67	0.48	0.08	0.60	0.80	0.22	0.04	0.04
5. Non-ICT capital per hour	0.96	1.32	1.42	0.85	1.03	0.60	0.23	0.80	0.26
6. MFP[1]	1.52	11.72	1.65	-0.26	1.26	-0.24	0.29	3.78	-0.64

b) Spain

	MARKT	ELECOM	MaxElec	OtherG	DISTR	FINBU	PERS	Agricul-ture	Construc-tion
1. Labour productivity growth (=2+3+6)	0.63	3.07	0.83	0.28	0.85	1.51	-0.88	2.42	-1.81
2. Labour composition change	0.38	0.55	0.45	0.27	0.41	0.43	0.28	0.28	0.31
3. Capital contribution (=4+5)	0.86	3.08	0.71	0.11	1.42	0.52	1.16	1.12	0.06
4. ICT capital per hour	0.38	1.42	0.27	0.10	0.50	0.57	0.25	0.01	0.12
5. Non-ICT capital per hour	0.48	1.66	0.44	0.01	0.92	-0.05	0.92	1.11	-0.06
6. MFP[1]	-0.61	-0.56	-0.33	-0.10	-0.98	0.55	-2.33	1.02	-2.18

Note: MARKT=Market economy; ELECOM=Electrical machinery, post and communication services; MaxElec=Total manufacturing, excluding electrical; OtherG=Other production; DIST=Distribution; FINBU=Finance and business, except real estate and PERS=Personal services.

[1] MFP growth rates might differ from Table 3, due to negative asset rental price and reallocation effects

Source: EU KLEMS (2009) and own calculations

3. Industry specialization

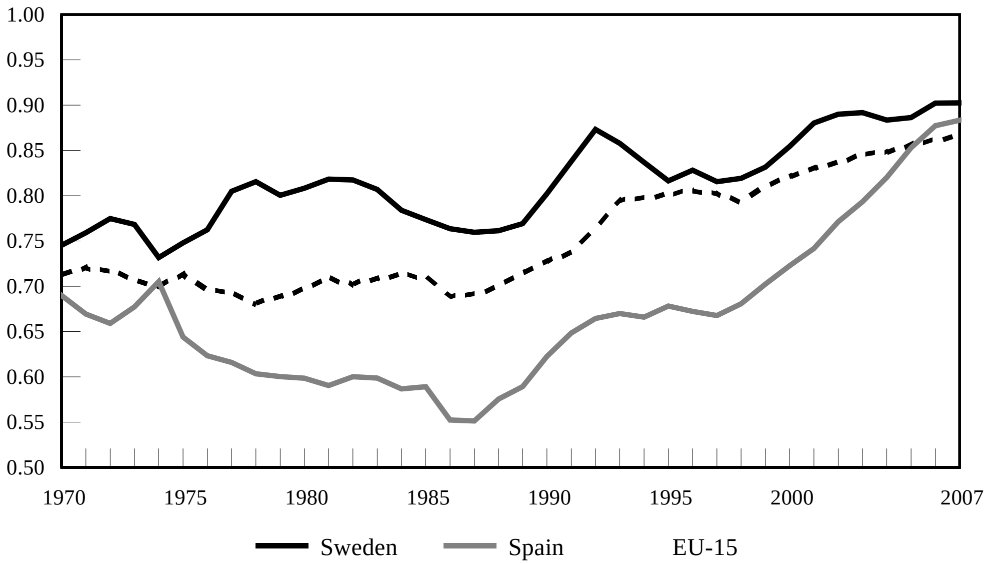
Section 2 has already provided an overview of Sweden and Spain's industry specialization. In this Section we propose an alternative approach. Subsection 3.1 provides the level and time profile of two productive structure indicators, and Subsections 3.2 and 3.3 offer the results of two shift-share analyses on labour productivity growth for both countries.

3.1. The changing composition of production

In this Subsection we address two related topics: *i*) the dispersion/concentration of production in a number of industries *inside each country*; and *ii*) the differences *between pairs of countries/areas* in terms of industry composition of output.

We start by addressing the homogeneity of the productive structure within one country. The question is: in which country is production more diversified among different sectors/activities? In answering this question, we make use of one of the most popular indexes of dispersion, the coefficient of variation. We apply this index to the share of each industry's GVA in total GVA. Figure 3 provides this information. It is clearly noticeable that the dispersion of output among the different industries used to be less pronounced in Spain than in Sweden and the EU-15 aggregate. However, in the final years of the period analyzed, inter-industry dispersion was slightly higher in Spain than in the EU-15, and was approaching that of Sweden due to the continuous increase in the construction industry's share in the Spanish aggregate. It can also be observed that the GVA dispersion in Spain decreased until the mid-80s, mainly as a result of Agriculture losing shares. Since then, we can observe a continuous increase in the coefficient of variation – or industry composition divergence – not only in Spain but also in the EU-15 aggregate, although it is less pronounced. For its part, Sweden has shown an almost continuous increase in the dispersion. By the end of the period the two countries had converged to the EU-15 average.

Figure 3. GVA sectoral dispersion
(Coefficient of variation of GVA sectoral share in total)



Source: EU KLEMS (2009) and own calculations

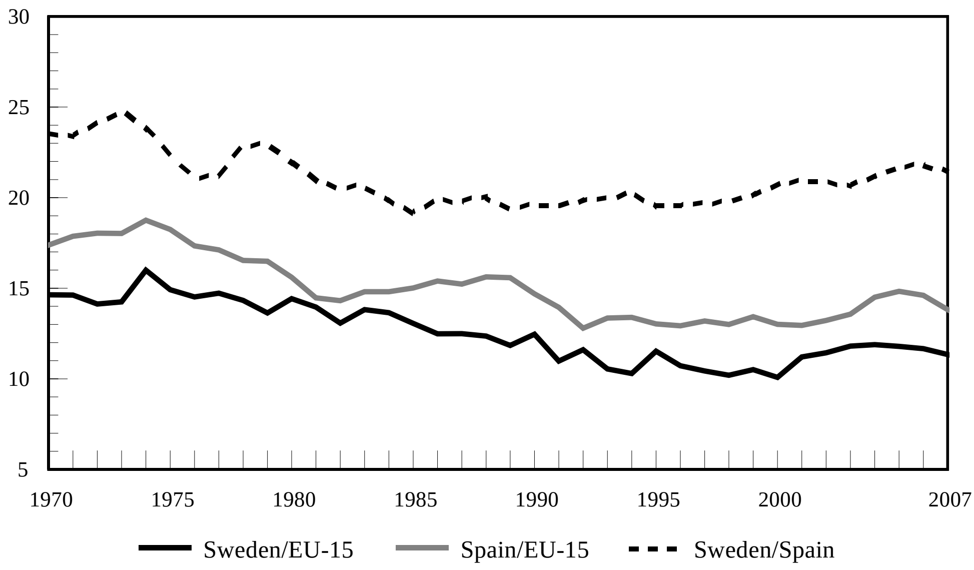
A complementary perspective is provided by an *index of differences in industry composition* computed according to [2]:

$$L_{AB} = \frac{1}{2}\sum_{j=1}^{N}\left|X_{jA} - X_{jB}\right| * 100 \qquad [2]$$

In [2], X_{jA} is the weight of sector *j* in total economy *A* in a given moment of time, and X_{jB} the corresponding value for country *B*. The index L_{AB} -bounded also between 0 and 100-measures the magnitude of differences in an industry's specialization between pairs of economies, showing higher values when the differences are greater. The results of this computation are reported in Figure 4.

From Figure 4 we can conclude the following results. First, the differences between the Swedish and Spanish GVA structure are more marked than with the EU-15 average. Second, the differences between Spain and the EU-15 are higher than between Sweden and the EU-15. Thus, the Spanish productive structure is more divergent from the EU-15 average than the Swedish one. Third, the Swedish and Spanish composition of GVA has been almost continuously approaching the EU's average, with the exception of the first and second oil crisis at the beginning of the 70s and 80s, and the most recent period 2000–2007, when the approximation to the EU-15´s average halted, or even reverted.

Figure 4. Index of differences in sectoral composition
(GVA percentages)



Source: EU KLEMS (2009) and own calculations

3.2. Labour productivity growth and specialization

As seen above, data show a deterioration in labour productivity in Spain and an improvement in Sweden in recent years compared to the EU-15. As we have also seen from different perspectives, the industrial dimension seems to play an important role in this evolution for both countries. In this Subsection we try to analyse whether the differences in productivity growth are due to a redistribution of factors towards industries with higher productivity levels or/and higher productivity growth (structural change effect), or if it is a consequence of an overall pattern of productivity growth at industrial level (within-industry effect). In order to examine this closer, we will apply a shift-share analysis to labour productivity growth:

$$\frac{Y_T}{L_T}-\frac{Y_0}{L_0}=\underbrace{\sum_{j=1}^{J}\theta_{j0}\left(\frac{Y_{jT}}{L_{jT}}-\frac{Y_{j0}}{L_{j0}}\right)}_{\text{Within-industry effect}}+\underbrace{\underbrace{\sum_{j=1}^{J}\left(\theta_{jT}-\theta_{j0}\right)\frac{Y_{j0}}{L_{j0}}}_{\text{Static effect}}+\underbrace{\sum_{j=1}^{J}\left(\theta_{jT}-\theta_{j0}\right)\left(\frac{Y_{jT}}{L_{jT}}-\frac{Y_{j0}}{L_{j0}}\right)}_{\text{Dynamic effect}}}_{\text{Structural change effect}}$$

[3]

where $Y_T/L_T - Y_0/L_0$ is the labour productivity growth between years 0 and *T*, *j* is the industry, and θ_{jT} is the share of hours worked in industry *j* in year *T*.

The *within-industry effect* shows the growth of labour productivity that would have occurred even without any structural change. That is, it is due to the aggregate productivity gains obtained because of the internal productivity improvements in each industry. The *structural change effect* captures the effect of the reallocation of factors among sectors towards industries with a higher initial level of labour productivity (*static effect*), or a higher rate of labour productivity growth (*dynamic effect*). Table 5 shows the results of this shift-share decomposition for two periods: 1970–1995 and 1995–2007.

Table 5. Decomposition of productivity growth. Shift-share analysis
(Annual average growth rates, in %)

a) Sweden

	1970-1995	1995-2007
Total effect	**1.70**	**2.35**
Within-industry effect	1.44	2.76
Structural change effect	0.26	-0.41

b) Spain

	1970-1995	1995-2007
Total effect	**2.89**	**0.54**
Within-industry effect	2.35	0.62
Structural change effect	0.54	-0.07

c) EU-15

	1970-1995	1995-2007
Total effect	**2.63**	**1.42**
Within-industry effect	2.20	1.51
Structural change effect	0.43	-0.09

Source: EU KLEMS (2009) and own calculations

Taking the EU-15 as a whole, the results show that the within-effect is always more significant than structural change among sectors. This is evident not only for the period 1970–1995 (2.20pp in comparison to 0.4pp), but also for the period 1995–2007 (1.5pp and -0.09pp respectively). Europe increased (and continues increasing) its labour productivity, mainly through internal improvements to sectors. Structural change used to have a smaller positive effect, but nowadays its contribution is almost negligible and slightly negative. The slowdown in labour productivity is noteworthy, with an average growth of 2.63% until the mid-90s to roughly half of it (1.42%) for the period 1995–2007. This decrease is the consequence of simultaneous drops in the within-effect and the structural change effect.

The majority of labour productivity growth in Sweden is the within-effect in both periods. The internal improvements account for 1.44pp from 1970 to 1995 and 2.76pp for the last period. Structural change accounts only for 0.26pp and -0.41pp respectively and has therefore played only a minor role in the Swedish performance. In fact, its contribution was negative during the most recent period. Contrary to what had happened both in the EU-15 and in Spain, labour productivity growth accelerated in the second Subperiod thanks to the within-industry effect as the structural change effect showed a negative contribution.

In the case of Spain the pattern is of decreasing labour productivity growth and the reduction is even more noticeable than in the EU-15. The rate drops from an annual growth of 2.89% over the period 1970–1995 to just 0.54% for the period 1995–2007, a decrease of 2.3 percentage points (pp) over time. Again the main source of growth is always the internal improvements within each sector. The within effect is 2.35pp in the first period and 0.62pp in the last one. The reallocation of inputs among sectors always seems to be less important. The very significant drop in the within-industry effect (-1.73pp) accounts for as much as 73.6% of the total slowdown in productivity, whereas a worse structural change effect (-0.61pp) represents the remaining 26.4%.

3.3. Labour productivity levels and specialization

Industries can vary extremely in terms of labour productivity due to differences in technology, capital deepening, rates of technical change, the use of human capital and so on. This being so, the particular sort of industrial specialization of each economy can lead to significant differences in the level of labour productivity between countries. However, a country might simply be best at doing the same thing, and therefore achieve more productivity by having a higher level of productivity across industries. Of course a country can exploit either one or another or both channels in order to be more productive. We can use a shift-share analysis in order to decompose the difference in the level of average labour productivity between any two economies A and B:

$$\frac{Y_A}{L_A}-\frac{Y_B}{L_B}=\underbrace{\sum_{j=1}^{J}\theta_{jB}\left(\frac{Y_{jA}}{L_{jA}}-\frac{Y_{jB}}{L_{jB}}\right)}_{\text{Country effect}}+\underbrace{\underbrace{\sum_{j=1}^{J}\left(\theta_{jA}-\theta_{jB}\right)\frac{Y_{jB}}{L_{jB}}}_{\text{Specialization effect}}+\underbrace{\sum_{j=1}^{J}\left(\theta_{jA}-\theta_{jB}\right)\left(\frac{Y_{jA}}{L_{jA}}-\frac{Y_{jB}}{L_{jB}}\right)}_{\text{Allocation effect}}}_{\text{Total Specialization effect}}$$

[4]

where $Y_A/L_A - Y_B/L_B$ is the difference in labour productivity between economies A and B, j is the industry, and θ_{jC} is the share of hours worked in industry j in country C. In order to make appropiate comparisons, we use labour productivity in terms of GVA per hour worked in PPP at 1995 prices.

The *country effect* shows the differences in labour productivity that would have occurred even without any difference in the industrial specialization. Therefore it is due only to the aggregate effect of the internal differences of productivity in each industry. The other effects add to the *Total specialization effect* which captures the impact of the different specialization towards high-productivity or low-productivity industries. It captures differences which would exist even if each industry had the same productivity in both countries.

Table 6 shows the results for a few key years over time as a percentage of the labour productivity in the economy of reference in the comparison (EU-15 in sections a and b, Sweden in section c).

Table 6. Decomposition of productivity growth. Shift-share analysis
(Percentages)

a) Sweden vs. EU-15

	1970	1995	2007
Total effect	**31.37**	**4.01**	**16.27**
Country effect	19.20	-2.49	11.91
Total specialization effect	12.17	6.50	4.36

b) Spain vs. EU-15

	1970	1995	2007
Total effect	**-12.69**	**-6.93**	**-16.23**
Country effect	14.86	3.42	-11.12
Total specialization effect	-27.55	-10.36	-5.11

c) Spain vs. Sweden

	1970	1995	2007
Total effect	**-33.54**	**-10.52**	**-27.96**
Country effect	11.93	18.59	-19.12
Total specialization effect	-45.47	-29.11	-8.84

Source: EU KLEMS (2009) and own calculations

We begin by looking at the differences of Sweden and Spain compared with the EU-15. Despite the fact that Spain showed a certain ability to converge to the EU-15 over the period 1970–1995, all those relative gains vanished during the last twelve years. As we can see Spain is always below the EU-15, although the difference has changed significantly over time: -12.69% in 1970, -6.93% in 1995 and -16.23% in 2007. The Swedish experience is quite different because it started above the EU-15 (+31.37% in 1970). However, its position worsened over time but it had the ability to reverse the trend in the last period. In 1995 the positive differential was only of 4.01% but the considerable improvements in the following years translated into a positive differential of 16.27% in 2007.

We can also make direct comparisons between Spain and Sweden and for this we have considered Sweden as the benchmark. Spain always had a lower level of productivity, but the initial gap (-33.54% in 1970) was already considerably reduced by 1995 (-10.52%). Between 1995 and 2007 the gap increased sharply again to -27.96% in the last year. The initial gap was mainly due to the specialization effect (-45.47pp), while the country effect was positive. Over time Spain's decomposition of labour productivity underwent a reversion with the main determinant of the gap being the *country effect* (-19.12pp), while the *specialization effect* fell to -8.84pp.

4. Final remarks[70]

The overall image of both countries is of a contrasting experience with Spain lagging behind Sweden in almost all variables. Spain's per capita income is lower than Sweden´s as a consequence of its lower labour productivity, in addition to its lower employment and activity rates. Spain only outperforms Sweden in the number of hours worked by employed person. The lower activity rate is probably caused by the different levels of development in the two countries. It is only in recent years that women have joined the labour market in Spain, whereas women have participated almost equally in Sweden for a long time now. The fact that the unemployment rate is very high in the Spanish economy indicates a poor performance on the part of the labour market that needs to be corrected.

Concerning productivity, the problem of the Spanish economy is not, or is not only, the result of its specialization in sectors with low productivity gains but is a more general problem that affects all industries. This, together with the negative TFP contributions, indicates again a problem in the functioning of the Spanish economy. In fact, the main factor causing low productivity gains in Spain is negative TFP contribution, which is also a general problem in (almost) all economic sectors. The negative TFP sign means that output is growing at a slower rate than inputs. That is, factors of production are not being utilized efficiently.

[70] This section has undergone an in-depth revision to take into consideration the comments and suggestions made by the participants at the Saltsjöbaden Conference.

The main reasons for this result are the following[71]. In terms of capital, negative real interest rates from the expansive phase, along with the continuous rise in asset prices and expectations of capital gains that accompanied it, encouraged significant rates of capital accumulation, which led to an excess of installed capacity that was not used in the production process. This phenomenon was particularly intense in assets linked to construction, causing investment bias towards these types of assets rather than those linked to new information and communication technologies (ICT).

In relation to the workforce, improvements in their skills have not been used to the full. Spain started off with a level of skills below that of most European countries, accounting for why, despite the significant efforts made to improve this area, it is still far from the EU average. However, the main problem is not the low level of skills, but the malfunctioning of Spain's labour market. That is to say, it is a dual labour market in which there are workers with indefinite contracts and a high cost of firing, while others (generally young people and better educated women) are working in precarious conditions with virtually no firing costs. The high level of temporality hinders the full utilization of the skills of the workforce, as well as facilitating the intense job destruction that has occurred with the change of the economic cycle. In our view, this is the Spanish economy's most pending issue.

On the other hand, the organization of production is not the most suitable. Full use of ICT requires changes in the organization of production, and these changes do not appear to have taken place in the Spanish economy (or at least not with the same intensity as in other economies). The possible reasons for this are the following. In the first place, the size of Spanish firms is small, predominantly micro-enterprises (businesses with fewer than 10 employees). In the second place, family ownership is widespread, slowing down improvements in the skills of business leaders and putting forward those who are not necessarily the most suitable managers. Thirdly, spending on R & D is reduced, one of the lowest in Europe. In fourth place, regulations which hinder competition in services are high, in addition to the existing duplicity among different levels of government, central, regional, and on occasion municipal.

[71] See Fernández and Mas (2011) for a detailed analysis.

The last point we wish to comment on is the potential reasons why ICT has not had the same positive effect as it has elsewhere. Firstly, investment in ICT still has a low weight in total investment as a whole. This may operate as a *threshold effect* when not yet having reached the critical mass which is crucial for its full use. Secondly, the endowments in infrastructure related to ICT are below the EU-15 average and, more importantly, are more expensive. Thirdly, technological culture is still limited, both in firms and in society as a whole. Finally, although the public sector has made a significant effort in the promotion and dissemination of ICT, it has still been insufficient to bring Spain closer to other developed countries

The comparison made in this paper with Sweden’s economy highlights the distance between the two countries, and the importance of the problems faced. But it also indicates that a better functioning of the Spanish economy is feasible.

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