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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). 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 practice 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

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* 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

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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.\textsuperscript{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


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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 *structural 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.

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The result from correlation matrices, in the former's 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 though 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**

<table>
<thead>
<tr>
<th>Variable label</th>
<th>1 Team &amp; documenting Work practices</th>
<th>2 Customer &amp; Quality focus</th>
<th>3 Flexible work contracts</th>
<th>4 Individual learning</th>
<th>5 Decentralisation &amp; Flex-time</th>
<th>6 Business intelligence</th>
<th>7 ROT &amp; Multi task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage employees in improvements groups (TIS 44 M)</td>
<td>0.71</td>
<td>-0.05</td>
<td>0.02</td>
<td>0.11</td>
<td>-0.07</td>
<td>0.03</td>
<td>-0.01</td>
</tr>
<tr>
<td>Documenting work practices (DU 57 M)</td>
<td>0.51</td>
<td>0.33</td>
<td>0.18</td>
<td>0.11</td>
<td>0.01</td>
<td>0.10</td>
<td>0.08</td>
</tr>
<tr>
<td>Percentage employees in team with jointly decisions (DVT 40 M)</td>
<td>0.50</td>
<td>-0.17</td>
<td>0.00</td>
<td>0.34</td>
<td>0.22</td>
<td>-0.02</td>
<td>-0.03</td>
</tr>
<tr>
<td>Frequency of team briefing meetings (FTM 104 M)</td>
<td>0.48</td>
<td>0.09</td>
<td>-0.16</td>
<td>0.04</td>
<td>0.22</td>
<td>-0.37</td>
<td>0.34</td>
</tr>
<tr>
<td>Percentage flex-time (FW 48 M)</td>
<td>0.47</td>
<td>0.30</td>
<td>-0.06</td>
<td>-0.14</td>
<td>0.42</td>
<td>0.14</td>
<td>-0.11</td>
</tr>
<tr>
<td>Measure customer satisfaction (CS 61 M)</td>
<td>0.00</td>
<td>0.73</td>
<td>0.15</td>
<td>0.18</td>
<td>0.00</td>
<td>0.04</td>
<td>-0.03</td>
</tr>
<tr>
<td>Percentage of the employees with part-time? (PT 12)</td>
<td>-0.21</td>
<td>0.53</td>
<td>0.08</td>
<td>-0.23</td>
<td>0.13</td>
<td>-0.39</td>
<td>-0.09</td>
</tr>
<tr>
<td>Follow up the quality in production (EPS 53 M)</td>
<td>0.02</td>
<td>0.52</td>
<td>-0.05</td>
<td>0.22</td>
<td>-0.12</td>
<td>-0.05</td>
<td>0.40</td>
</tr>
<tr>
<td>Performance evaluation interviews (ET 94 M)</td>
<td>0.32</td>
<td>0.52</td>
<td>0.06</td>
<td>0.02</td>
<td>-0.02</td>
<td>0.27</td>
<td>-0.02</td>
</tr>
<tr>
<td>Percentage of all employees from an employment agency? (RC 14)</td>
<td>0.16</td>
<td>0.04</td>
<td>0.73</td>
<td>-0.18</td>
<td>0.00</td>
<td>0.02</td>
<td>-0.06</td>
</tr>
<tr>
<td>Percentage employees with temporary contract? (TW 11)</td>
<td>-0.03</td>
<td>0.13</td>
<td>0.67</td>
<td>0.06</td>
<td>-0.15</td>
<td>-0.17</td>
<td>0.03</td>
</tr>
<tr>
<td>Percentage employees in training no salary (UPE 100 M)</td>
<td>-0.07</td>
<td>0.04</td>
<td>0.62</td>
<td>0.22</td>
<td>0.14</td>
<td>0.11</td>
<td>0.14</td>
</tr>
<tr>
<td>Percentage employees on-the-job training (FB 102 M)</td>
<td>0.15</td>
<td>0.02</td>
<td>-0.03</td>
<td>0.73</td>
<td>0.02</td>
<td>-0.18</td>
<td>0.11</td>
</tr>
<tr>
<td>Organised competence dev. in normal every-day (DL 96 M)</td>
<td>0.07</td>
<td>0.21</td>
<td>0.09</td>
<td>0.59</td>
<td>0.11</td>
<td>0.28</td>
<td>-0.06</td>
</tr>
<tr>
<td>Percentage employees with paid training (PE 99 M)</td>
<td>0.32</td>
<td>0.22</td>
<td>0.10</td>
<td>0.40</td>
<td>-0.07</td>
<td>-0.05</td>
<td>-0.30</td>
</tr>
<tr>
<td>Decentralised quality control (QDE 34 M)</td>
<td>0.32</td>
<td>0.22</td>
<td>0.10</td>
<td>0.40</td>
<td>-0.07</td>
<td>-0.05</td>
<td>-0.30</td>
</tr>
<tr>
<td>Decentralised planning (TD 32 M)</td>
<td>-0.15</td>
<td>-0.09</td>
<td>0.09</td>
<td>0.23</td>
<td>0.77</td>
<td>0.06</td>
<td>0.14</td>
</tr>
<tr>
<td>Monitoring ideas outside the firm (FEI 59 M)</td>
<td>0.03</td>
<td>0.07</td>
<td>-0.06</td>
<td>-0.04</td>
<td>0.04</td>
<td>0.77</td>
<td>0.12</td>
</tr>
<tr>
<td>Training for rotating tasks (ROT 51 M)</td>
<td>0.04</td>
<td>0.00</td>
<td>0.12</td>
<td>-0.03</td>
<td>-0.07</td>
<td>0.12</td>
<td>0.79</td>
</tr>
<tr>
<td>Variance Explained by Each Factor</td>
<td>1.86</td>
<td>1.72</td>
<td>1.52</td>
<td>1.48</td>
<td>1.38</td>
<td>1.16</td>
<td>1.16</td>
</tr>
</tbody>
</table>

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 explanations 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 (Ansoff, 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\(^4\). 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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\(^4\) The Baldrige Program and the Malcolm Baldrige 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. Benchmarking

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 analysis 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. 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.

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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.

Statistics Sweden 53
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

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

Rotated: Variance Explained by each factor (eigenvalue)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotated: Variance Explained by each factor (eigenvalue)</td>
<td>1,73</td>
<td>1,37</td>
</tr>
<tr>
<td>Cumulative percent of all variances explained</td>
<td>0,28</td>
<td>0,44</td>
</tr>
</tbody>
</table>

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 thoroughgoing 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**

<table>
<thead>
<tr>
<th>Variables in TQM principle ii</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage employees received instructions or education while performing ordinary daily tasks (on-the-job-training FB 102 M)</td>
<td>0,73</td>
<td>-0,01</td>
</tr>
<tr>
<td>Percentage employees with paid time-off to undertake education/training (PE 99 M)</td>
<td>0,65</td>
<td>0,00</td>
</tr>
<tr>
<td>Organised competence development in normal day (DL 96 M)</td>
<td>0,64</td>
<td>0,18</td>
</tr>
<tr>
<td>Employees trained to rotate tasks (ROT 51 M)</td>
<td>-0,11</td>
<td>0,82</td>
</tr>
<tr>
<td>Percentage employees participated in education/training with no salary (UPE 100 M)</td>
<td>0,22</td>
<td>0,63</td>
</tr>
</tbody>
</table>

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,

Statistics Sweden
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

<table>
<thead>
<tr>
<th>Variables in TQM principle iv</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expenditure for: acquisition of machinery,</td>
<td>0.90</td>
<td>0.03</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>equipment and software (E11c_CIS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expenditure: external R&amp;D in general (E11b_CIS)</td>
<td>0.76</td>
<td>0.12</td>
<td>0.00</td>
<td>0.06</td>
</tr>
<tr>
<td>Expenditure: and acquisition of external</td>
<td>0.76</td>
<td>-0.04</td>
<td>0.06</td>
<td>-0.01</td>
</tr>
<tr>
<td>knowledge (E11d_CIS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regularly shares information electronically</td>
<td>0.06</td>
<td>0.91</td>
<td>0.00</td>
<td>0.04</td>
</tr>
<tr>
<td>with suppliers about; inventory, production</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>plans, demand forecast (D_siSuipde 18a_ICT)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and about: progress of deliveries (D_siSuipf</td>
<td>0.04</td>
<td>0.91</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>18b_ICT)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooperation with others; in production of</td>
<td>0.03</td>
<td>-0.03</td>
<td>0.76</td>
<td>0.09</td>
</tr>
<tr>
<td>goods or services (PROD_COOP 73 M)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and in procurement of parts, components,</td>
<td>-0.04</td>
<td>0.10</td>
<td>0.73</td>
<td>0.00</td>
</tr>
<tr>
<td>services (BUYMATERIAL_COOP 75 M)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and in design or development of new products</td>
<td>0.08</td>
<td>-0.04</td>
<td>0.66</td>
<td>0.16</td>
</tr>
<tr>
<td>or services (DESIGNDEV_COOP 71 M)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outsourcing; in design, development of new</td>
<td>-0.08</td>
<td>-0.08</td>
<td>0.07</td>
<td>0.76</td>
</tr>
<tr>
<td>products or services (DESIGNDEV_OUTSOURC 81 M)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and production of goods or services (PROD_OUTSOURC</td>
<td>0.05</td>
<td>0.05</td>
<td>0.09</td>
<td>0.73</td>
</tr>
<tr>
<td>83 M)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and in procurement of parts, components,</td>
<td>0.08</td>
<td>0.08</td>
<td>0.08</td>
<td>0.58</td>
</tr>
<tr>
<td>services (BUYMATERIAL_OUTSOURC 85 M)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotated: Variance Explained by each factor</td>
<td>1.99</td>
<td>1.70</td>
<td>1.56</td>
<td>1.49</td>
</tr>
<tr>
<td>(eigenvalue)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cumulative percent of all variances explained</td>
<td>0.20</td>
<td>0.36</td>
<td>0.50</td>
<td>0.61</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Variables in TQM principle v</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regularly shares information electronically with customers about; inventory, production plans, demand forecast (D_siCupde 19a ICT) and progress of deliveries (D_siCuipf 19bICT)</td>
<td>0,91</td>
<td>0,02</td>
<td>0,02</td>
</tr>
<tr>
<td>Reduce time to respond to customer or supplier (H17a CIS)</td>
<td>-0,03</td>
<td>0,80</td>
<td>-0,12</td>
</tr>
<tr>
<td>New business practice; supply chain/knowledge/quality management, re-engineering, lean, etc (H16a CIS)</td>
<td>0,09</td>
<td>0,74</td>
<td>0,16</td>
</tr>
<tr>
<td>Follow up/evaluation of quality of production (EPS 53 M) processes or service delivery</td>
<td>0,01</td>
<td>0,03</td>
<td>0,77</td>
</tr>
<tr>
<td>Customer satisfaction; questionnaires, focus groups, analysis of complaints, other methods (CS 61 M)</td>
<td>0,09</td>
<td>0,01</td>
<td>0,71</td>
</tr>
</tbody>
</table>

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? (FEL_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 on 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\(^6\). 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

\(^6\) 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

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Value added per all employee at the firm year 2008</th>
<th>R-Square ($R^2$) = 0.14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent variables:</td>
<td>Significance level Pr &gt;</td>
<td>t</td>
</tr>
<tr>
<td>Gross fixed capital formation; SEK</td>
<td>&lt; 0.0001 ***</td>
<td></td>
</tr>
<tr>
<td>University educated (≥3years); versus all other educations, percentage</td>
<td>0.0002 ***</td>
<td></td>
</tr>
<tr>
<td>Women employed, percentage (neg coeff)</td>
<td>0.5610 #</td>
<td></td>
</tr>
<tr>
<td>Age 50+ employed; versus all other employees under 50 percentage</td>
<td>0.0351 **</td>
<td></td>
</tr>
<tr>
<td>Large firms; versus medium and small sized firms, dummy (neg coeff)</td>
<td>0.2287 #</td>
<td></td>
</tr>
<tr>
<td>Foreign owned (if more than 50 percent of the voting value of the shares is held by shareholders abroad); versus Swedish owned, dummy</td>
<td>0.0341 **</td>
<td></td>
</tr>
<tr>
<td>Part of a group of firms; versus if not (not at all significant at 0.15 level), dummy</td>
<td>0.4035 #</td>
<td></td>
</tr>
<tr>
<td>Specialised vs. standardised products (not at all significant at 0.15 level), dummy</td>
<td>0.5867 #</td>
<td></td>
</tr>
<tr>
<td>Financial service NACE 66 compared with Financial service NACE 64 and 65, dummy (neg coeff)</td>
<td>0.6746 #</td>
<td></td>
</tr>
<tr>
<td>All other industries compared with Financial service NACE 64 and 65, dummy (neg coeff)</td>
<td>0.0346** to &lt; 0.0001***</td>
<td></td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>No index incl.</th>
<th>Bundles</th>
<th>TQM</th>
<th>TQM &amp; WorkContr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value added per all employee at the firm year 2008</td>
<td>R-Square (R²) = 0.14</td>
<td>R-Square (R²) = 0.30</td>
<td>R-Square (R²) = 0.12</td>
<td>R-Square (R²) = 0.14</td>
</tr>
<tr>
<td>Independent variables:</td>
<td>Sign. level</td>
<td>Sign. level</td>
<td>Sign. level</td>
<td>Sign. level</td>
</tr>
<tr>
<td>Management concept high compared to low values 2009/2010; percentage</td>
<td>—</td>
<td>**</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>Temporary workers 2008; percentage</td>
<td>—</td>
<td>In index</td>
<td>—</td>
<td>*</td>
</tr>
<tr>
<td>Gross fixed capital formation 2008; SEK</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>#</td>
</tr>
<tr>
<td>University educated &gt;8 years 2008; versus all other educations, percentage</td>
<td>***</td>
<td>**</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Percentage women, 2008 (neg coeff)</td>
<td>#</td>
<td>***</td>
<td>#</td>
<td>**</td>
</tr>
<tr>
<td>Age 50+ employed 2008; versus age of all other employees, percentage</td>
<td>**</td>
<td>#</td>
<td>*</td>
<td>#</td>
</tr>
<tr>
<td>Large firms 2008; versus medium and small sized firms (neg coeff)</td>
<td>#</td>
<td>***</td>
<td>#</td>
<td>#</td>
</tr>
<tr>
<td>Foreign owned (&gt;50 percent voting value abroad) 2008; versus Swedish</td>
<td>**</td>
<td>***</td>
<td>#</td>
<td>***</td>
</tr>
<tr>
<td>Part of a group of firms 2008; versus not</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>#</td>
</tr>
<tr>
<td>Specialised vs. standardised products (M)</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>#</td>
</tr>
<tr>
<td>Industries compared with</td>
<td>16 ind ***</td>
<td>2 ind ***</td>
<td>6 ind ***</td>
<td></td>
</tr>
<tr>
<td>Financial service NACE 64 and 65 FDB (neg coeff)</td>
<td>1 ind **</td>
<td>9 **</td>
<td>1 ind *</td>
<td></td>
</tr>
<tr>
<td>Industry NACE 66 (also incl. in above ind.)</td>
<td>*** neg</td>
<td>** pos</td>
<td># neg</td>
<td># neg</td>
</tr>
</tbody>
</table>

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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Yearbook on Productivity 2011  Bundles of practices versus TQM principles

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Bundles of practices versus TQM principles

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