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Productivity at operations, business and national levels

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Abstract

This paper focuses on labour productivity changes, examining its influencing factors, effects and their relationships at the level of operations, businesses and national economies. We start out from the standpoint that there are two sets of drivers at the operations level, which influence labour productivity growth: current working practices and action programs of improvement. The connection between these two sets of drivers and productivity changes are analyzed, then we examine characteristics of effects by country and by industry. Connections between productivity and business success are also investigated.

Data of the ISSM-IV Survey, for twelve countries and eight industries are used for the analysis.

Introduction

Productivity is a key performance indicator in all levels of the economy, from the shop floor through business enterprises to the national economy. In the most general terms, it measures

output relative to input. It is a core factor of economic growth (OECD, 2001) and an enabler of ensuring strategic advantage (Porter, 1980).

Irrespective of the importance of productivity both at macro and micro level, there are very few studies which approach them from an operational perspective (Wacker et al. 2006, Neely, 2005). Since logically macro productivity is kind of an aggregate measure of micro productivity, there is a natural need for understanding the connection of the two.

For achieving this understanding we believe that an important step can be made if we study those productivity drivers, which influence micro (firm) level productivity. According to our view the most important drivers can be found at the operational level.

If we want to explain the connections between various levels of productivity, we have to disclose very complex causes and effects. In this paper we have chosen to study the following issues:

- What is the influence of operational level productivity drivers on company level business success?
- How industry-, and country-specific factors influence the effectiveness of various productivity drivers?

Literature review

Among the types of input resources (labour, capital and intermediate, see OECD, 2001) labour productivity plays a particular role. Although the level of capital invested in businesses has increased heavily in the last decades, first in the US, and later in other industrialized countries, like Germany or Japan (van Ark and Pilat, 1993), labour productivity shows even more dynamics especially when we study operations level productivity drivers. From this point of view it is particularly important that labour productivity growth absorbs a large part

of capital productivity growth. A good example for that is the strong impact of ICT investments on labour productivity growth, as it is shown by Pilat et al. (2002). Gust and Marguez (2004), examined international macro data from a different angle to discover connections between productivity growth and other measures. As they show, the more intense use of information technology and a less regulated labour market can lead to higher increase in productivity growth. The OECD productivity book also says (OECD, 2001), that although capital productivity can be measured separately, labour productivity measures incorporate some effects of capital productivity.

As for the connection of various levels of productivity which we wish to examine we have found the following in the literature:

a.) There are very few papers which analyze the micro sources of labour productivity change, or even productivity change in general, in the operations management literature (Wacker, 2006; Hayes-Clark, 1986; Haasen, 1996). Although there are some elements investigated in more detail, their total contribution to labour productivity has not yet been researched. For example the effect of team size (Hoegl, 2005; Tohidi and Tarokh, 2006), the incentive system, including wages and other payments (Petersen and Snartland, 2004; Millea and Fuess Jr., 2005, Conti, 2005; FitzRoy and Kraft, 1995), training (Conti, 2005), employee participation (Zwick 2004).

b.) The connection of labour productivity growth and business growth is unclear. As total productivity change is important in business success change we assume that labour productivity (including blue and white colour labour productivity) might be also a good predictor of business growth and leads to success on the long run. An important question is, however, what kind of industries we investigate. In Wacker et al. (2006) the small machine tool and non-fashion textile industries were used for the analysis and researchers did not find significant differences between industries. Whybark (1997) also drew the conclusion that in

the production area country differences seems to be larger than industrial ones. He used the same industries than Wacker (small machine tool and non-fashion textile) to draw the conclusions.

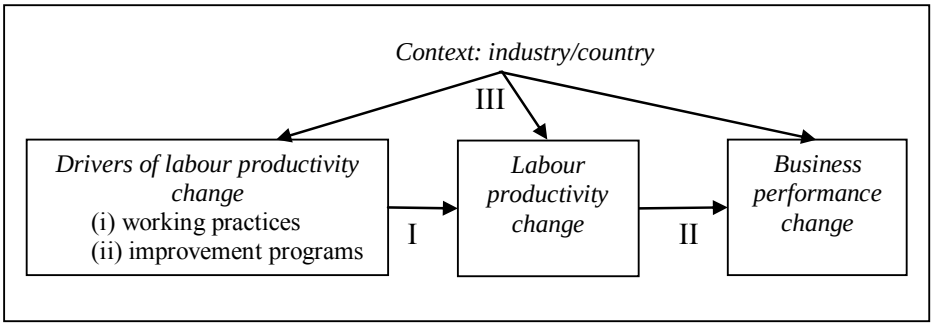
There are few papers which try to find explanation for productivity differences within firms. Hayes and Clark (1986) compared 12 factories in 3 companies. They identified the following factors that affect total factor productivity the most: i) capital investment (connected with labour learning), ii) waste reduction (due to less rejects), iii) reduction of work-in-process (due to faster product cycle times, or faster feedback about product failures) and iv) the reduction of confusion stemming from i-iii.

c.) There are several international surveys which aim at comparing operations management practices and strategies in various countries. From among them Wacker et al. (2006) studied productivity issues. They examined 16 countries. In four of these countries (Germany, Sweden, Bulgaria and Poland) production labour was the most productive resource. In seven countries (China, New Zealand, Northern Ireland, Ireland, England, Wales, Hungary) non-production labour was the winner. Finally in five countries (Spain, USA, Japan, Russia, Mexico) capital was the most productive resource.

According to Pagell et al. (2005) national culture is an important predictive factor of labour productivity. They examined how national culture (for example uncertainty avoidance or individuality, see Hofstede, 1980) affects some typical operations decisions, like supplier per parts, or ratio of export.

The research model

Our research model is the following:



According to this model we first (I) examine (i) actual working practices and (ii) implemented operations improvement programs, as labour productivity change drivers. Next, the connection between labour productivity change and business performance change is analyzed (II). Finally, the context is examined to see to what extent the industry and/or the country (cultural, social, legal environment) affects (or more precisely related to) the drivers of labour productivity change, labour productivity itself and business performance change (III).

We use international data to analyze components and effects of labour productivity change. Although we use firm data for the analysis, our objective is to see industry and country specific effects.

Survey data

We have used IMSS (International Manufacturing Strategy Survey) data for our analyses. IMSS-IV data bank extends to 711 observations from 23 countries from the time period between 2005 February and 2006 March. The objective of IMSS is to study international manufacturing strategies, their implementation and resulting performances in operations. For details of the survey see the IMSS website (http://web.mac.com/janfrick/iWeb/IMSS-

researchnet/Welcome.html), the summary book of IMSS-I (Lindberg et al., 1998) or some articles which used previous rounds of the survey (eg. Frohlich and Westbrook, 2001).

In our paper we use the data of 12 countries where the number of observations is equal to or higher than 30. Table 1 contains the structure of the data.

Table 1.: Distribution of companies by country and industry

	Industry ISIC code								
Country	*Metal*	*Machine*	*Office*	*Electronic*	*Communi-cation*	*Instrument*	*Automotive*	*other vehicle*	*Total*
	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)	
Argentina	24	6	1	5	1	1	5	1	44
Belgium	16	4	0	4	4	0	1	3	32
China	7	10	2	13	2	1	3	0	38
Denmark	10	8	1	7	2	5	1	1	35
Hungary	22	9	0	4	6	1	9	3	54
Italy	8	19	0	4	7	1	2	4	45
New Zealand	12	13	0	4	0	0	0	1	30
The Netherlands	20	13	4	13	0	5	3	5	63
Sweden	26	20	0	9	4	5	12	5	81
Turkey	5	13	0	2	1	0	9	5	35
USA	13	0	3	1	1	2	4	8	32
Venezuela	20	0	0	3	0	0	6	0	29
Total	183	115	11	69	28	21	55	36	518

Our survey included two *labour productivity measures*: labour productivity change in the last 3 years (1 = deteriorated more than 10%; 2 = stayed about the same; 3 = improved 10%-30%; 4 = improved 30%-50%; 5 = improved more than 50%) and labour productivity compared to competitors (Relative to our main competitor(s), our performance is 1 = much worse; 3 = equal; 5 – much better). We decided to use the first one for the following reasons:

- Managers are usually better in estimating the progress of their own company as compared to themselves than in relation to the competitors.
- The scale we used for measurement is more objective.
- Several companies, especially the small ones do not have the resources to carefully follow the changes at their competitors. The number of answers reflects this statement.

We have 511 valid answers for the labour productivity change variable, while only 394 for the comparison with the competitor.

- There is a high correlation between the two variables (Pearson correlation: 0,411, p=0,000) which suggests that the two variables can substitute each other to some extent.

Two groups of variables were used to find the *drivers of labour productivity change*. One group of variables relates to everyday working practices. The following variables were used.

1. What proportion of your direct employees' compensation is based on incentives? _ % of compensation
2. What proportion of your total work force work in teams?:
   In functional teams _____ % In cross-functional teams ____ %
3. How many hours of training per year are given to regular work-force? _____ hours per employee
4. How many of your production workers do you consider as being multi-skilled? _____ % of total number of production workers.
5. To what extent do employees give suggestions for product and process improvement (number of suggestions per employee per year, 1- no suggestion, 3-few, about five, 5-many, more than ten)?
6. How frequently do your production workers rotate between jobs or tasks? (1-never, 5-frequently)
7. To what extent is your workforce autonomous in performing tasks? (1-no autonomy, 5 - high)

The other group contains action programs implemented in the last three years in order to increase production efficiency. The following action programs are considered: (the possible answers were from 1 = not used at all to 5 = in full operation).

1. Expanding manufacturing capacity
2. Restructuring manufacturing processes and layout to obtain process focus and streamlining
3. Undertaking actions to implement pull production
4. Undertaking programs for quality improvement and control
5. Undertaking programs for the improvement of your equipment productivity
6. Undertaking programmes to improve environmental performance of processes and products
7. Increasing performance of product development and manufacturing through e.g. platform design, standardization and modularisation
8. Increasing the organizational integration between product development and manufacturing
9. Increasing the technological integration between product development and manufacturing

10. Engaging in process automation programs
11. Implementing Information and Communication Technologies and/or Enterprise Resource Planning software
12. Implementing actions to increase the level of delegation and knowledge of your workforce
13. Implementing the Lean Organisation Model by e.g. reducing the number of levels and broadening the span of control.
14. Implementing Continuous Improvement Programs through systematic initiatives
15. Increasing the level of workforce flexibility following your business unit's competitive strategy

We have used four measures for *business performance change*: change of gross output, market share, return on sale, (ROS) and return on investment (ROI). The scale in each case was the same like for labour productivity change: 1 = deteriorated more than 10%; 2 = stayed about the same; 3= improved 10%-30%; 4 = improved 30%-50%; 5 = improved more than 50%.

Drivers of labour productivity change

In order to find the drivers of labour productivity, we divided the sample to three groups on the basis of labour productivity change. Group 1 includes companies where managers reported more than 10% decrease or the same level of labour productivity in the last 3 years (1 or 2 on the scale). Group 2 contains companies where the change of labour productivity has moderately increased (3 score). Group 3 consists of companies with high level of labour productivity change (4 of 5 scores). We compared the effects of everyday working practices (Appendix 1) and action programs (Appendix 2) on labour productivity in case of Group 1 and 3 (called low and high productivity companies).

The more intense use of teamwork (both functional and cross-functional), higher level of training and higher self-dependence is characteristic at dynamically improving (high productivity change) companies. The rest of working practices are not significantly different, but usually better for high productivity growth group. The only exception is the use of

multifunctional workers, where the low productivity group has higher average but the difference is not significant. In case of action programs the use of all but one program is significantly more characteristic for the high productivity group. In other words, it means that programs which lead to changes in the working methods and practices can increase productivity. The method of work is less relevant than the changes themselves, which continuously force people to rethink their way of work.

We found that there is a significant size difference between companies with low and high productivity (average size for low productivity group is 340 employees, and for high productivity group is 639 employees, F=8,45, p=0,04). In order to control this effect, we examined a subsample: SME companies from the same productivity groups across the same variables. According to EU definition companies employing less than 250 employees can be considered as small and medium sized. In our sample 84 companies (60%) of the low productivity group and 47 companies (47%) of the high productivity group are SMEs. We compared these two groups of companies. Significance levels can be seen in the last column of Appendix 1 and 2.

The majority of differences remained significant as compared to the original sample results. There are some differences, however. One variable, direct incentives, is significant in the SME sample and non-significant in the original one. It means that among SMEs an important source of higher productivity is to make workers interested in the performance of the company. In larger companies that is not so important (or at least no so easy). Some variables are far from significance in the SME sample: action programs of **automation and ICT,** for example. ICT is a coordination tool, and larger firms require more coordination, smaller companies might not gain so much. Also, larger firms produce in larger amounts which can help in faster return of investing in automation. It might not be a relevant action program for small companies (their values is 2,29 and 2,55 for low and high productivity SMEs,

respectively). **Functional teamwork** provides more improvement opportunities in larger firms where communication among groups is more complex – it might not be so important in smaller companies with several informal links. **Worker flexibility** does not depend on company size, the values we got for the two groups are similar to the values of the original sample (2,87 and 3,17, respectively).

Connection between labour productivity change and business performance changes

Productivity is an important factor of business success. If the amount of inputs decreases for the same level of output that can mean a reduction in cost levels (if wages remains stable or increase slower than productivity). This automatically leads to profit increase.

Really, looking at the data (Table 3) we can see highly significant correlations between labour productivity change and business performance changes. Companies with higher labour productivity could increase their business success as measured by sales, market share, ROS or ROI, or, alternatively, successful companies could invest in increasing labour productivity. This result can be seen in Table 2.

Table 2: Business change statistics (1-5 scale)[1]

	Low productivity		*High productivity*			
	N	*Mean*	*N*	*Mean*	*F*	*Sign.*
Labour productivity change in 3 years	140	1,94	102	4,12	3546,77	**0,000**
Sales change in 3 years	131	2,78	91	3,26	9,85	**0,002**
Market share change in 3 years	124	2,33	86	2,97	28,28	**0,000**
ROS change in 3 years	122	2,15	85	2,69	15,70	**0,000**
ROI change in 3 years	114	2,17	81	2,72	14,97	**0,000**
Total business change in 3 years[2]	111	2,34	76	2,86	22,38	**0,000**

[1] Meaning of scale: 1= deteriorated more than 10%; 2 = stayed about the same; 3= improved 10%-30%; 4 = improved 30%-50%; 5 = improved more than 50%

[2] The „Total business change in 3 years" variable was created by taking average of the sales, market share, ROS, ROI changes for each company.

Table 3: Correlation between labour productivity change and business changes

	N	*Mean*	*Standard deviation*	*Correlation with labour prod. change*	*Significance (2-tailed)*
Sales change in 3 years	479	2,94	1,088	0,153(**)	0,001
Market ratio change in 3 years	417	2,46	1,004	0,233(**)	0,000
ROS change in 3 years	458	2,56	0,863	0,188(**)	0,000
ROI change in 3 years	437	2,46	1,034	0,182(**)	0,000
Total business change in 3 years	398	2,59	0,777	0,230(**)	0,000

** Correlation is significant at the 0.01 level (2-tailed).

Quite interestingly, the most significant correlation is with market share change, which suggests, that labour productivity can provide an important source of market competitiveness.

The measures of business success change have a high correlation, but they reflect different angles of company performances. We made a composite index of these four measures by calculating the average. (Cronbach alpha is 0,79 for the four variables.) The correlation of this index with labour productivity is significant.

Figure 1 shows how labour productivity change and business change moves country by country (with casewise deletion of missing values). Labour productivity change is larger in the majority of countries. Two exceptions are Argentina and Belgium. In China and Turkey labour productivity growth is much larger than in other countries but their business growth is less dynamic. These countries started from lower levels of labour productivity, they work now on reducing the gap. Their productivity level might be not so high yet to be of competitors to more developed countries. Anyhow, the co-movement of labour productivity growth and business performance growth seems to be supported both by Table 3 and Figure 1.

We have examined the industry wise relationship of the same composite index with labour productivity (Figure 2). The industry wise business performance change and labour productivity change are in less close correlation than in the country wise analysis. Comparing

the data in Figure 1 and Figure 2 we can see that the fluctuation of labour productivity change by country is much bigger than by industry.

Figure 1: Labour productivity growth and business performance growth in various countries

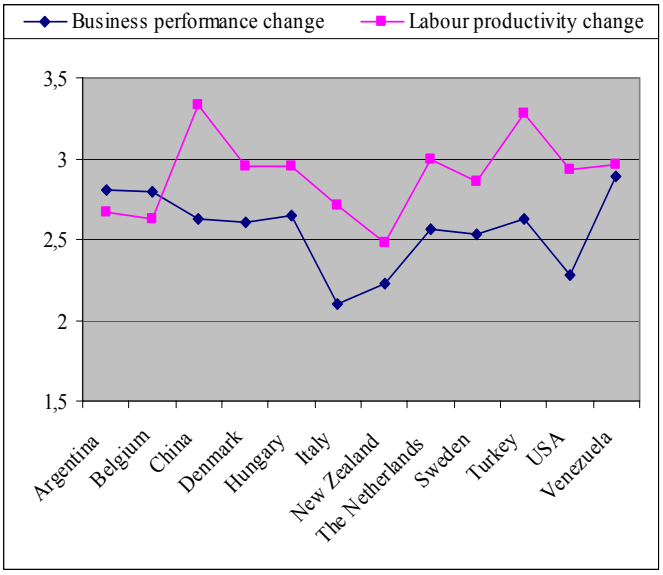
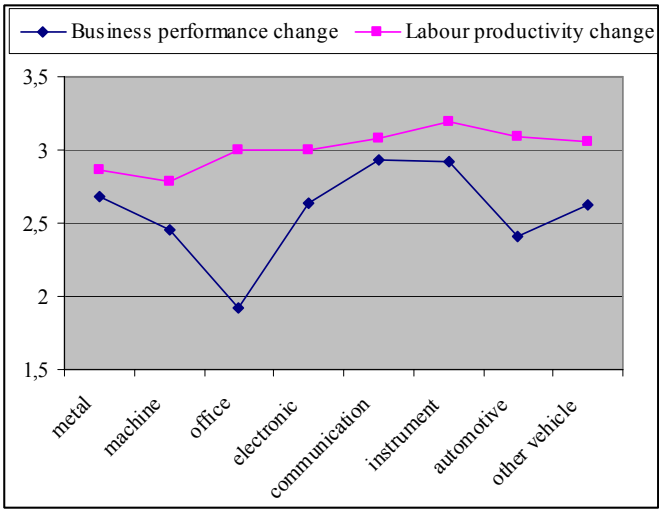


Figure 2: Labour productivity growth and business performance growth in various industries



Country and industry wise differences

We have examined the effects of productivity drivers on labour productivity both by countries (12 countries) and by industries (8 industries). The results can be found in Appendices 5, 6, 9, 10. The following conclusions can be drawn from these calculations.

Appendix 5 and 6 show that far higher number of significant correlations can be found between action programs and productivity growth, than between the latter and working practices. This can be explained by considering that while working practices are established characteristics of companies, action programs cause more dynamic effects. Therefore the former can have great influence on the *level* of productivity, while its *change*, what we examine, can be caused more by the latter. Also, there are important differences between countries; when examining the effects of action programs: some work more in a few countries, some others in several. The country-wise differences in the correlation of action programs and productivity change are also important: in some countries several programs have great impact (in China eight, in the Netherlands seven, in Italy six), while in other countries (Hungary, Sweden) none. To explain these phenomena country-specific studies should be conducted.

Industry-wise differences (Appendix 9 and 10) show similar pattern: action programs have more effect than working practices. The explanation can be the same like in case of countries. It is striking, that there are extremely few industries where working practices matter to a significant extent. There are two industries where the correlation between action programs and labour productivity growth is frequently significant: they are the electronic industry and the machine industry.

Appendix 5 and 8 gives an opportunity to compare the strength of effects of action programs by country and by industry. In order to see more clearly if there are specific countries or industries causing the differences we made a factor analysis for action programs. Before

doing that the consistency of action variables was tested. Only capacity expansion had to be deleted and the Cronbach alpha of the remaining 14 action programs is 0,869. Figure 3 contains the factor scores by countries, while Figure 4 shows the factor scores by industries.

Figure 3: Action programs factor scores by country

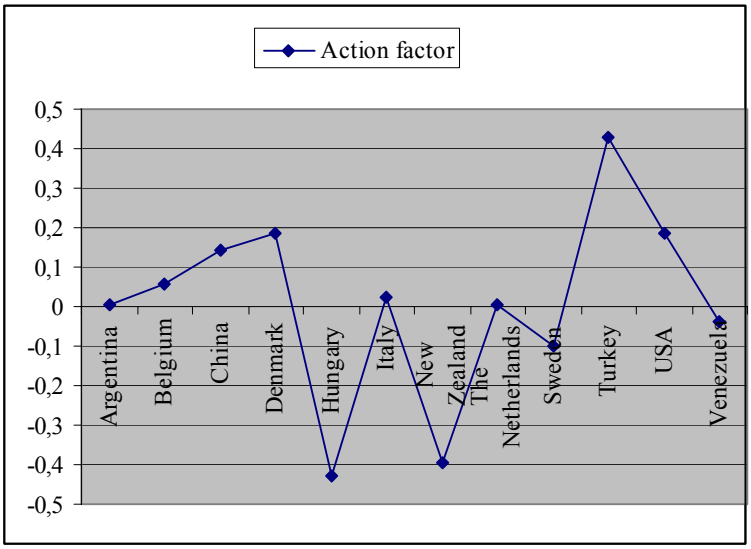
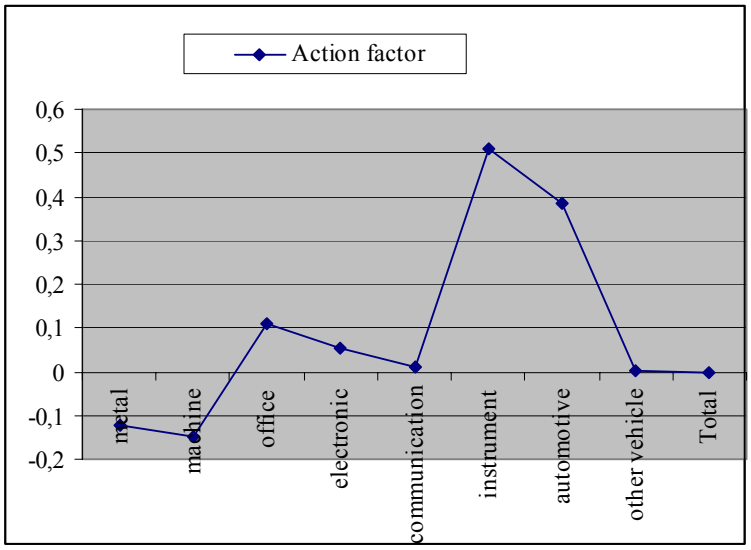


Figure 4: Action programs factor scores by industries



The least active countries in implementing the action programs is Hungary and New Zealand, the most active is Turkey, Denmark, USA and China. The spread of values is somewhere

between -0,45 and +0,45. In industry comparison the spread is smaller (from -0,15 to 0,5) and there are only two industries, instruments and automotive which causes differences.

Results of the factor analysis (Figure 3 and 4) support the findings of Whybark (1997) that in production management country differences are generally larger than industry differences. There are only two industries (instruments and automotive) where there is a bit larger deviance from the otherwise quite smooth set of data. Country wise data are much more volatile. It is important to note, however that both country-wise and industry-wise analysis show significant differences.

Conclusions

Our research was based on the hypothesis that operations level characteristics have significant effect on labour productivity changes which influence business success. Also, we assumed that these effects can be different by country and by industry. We found there is rather scarce literature both on the subject of connection between productivity at various levels of the economy and on the differences which the environment of operations (industry-specific and country-specific ones) causes on productivity growth. We used the International Manufacturing Strategy Survey questionnaire data for the analysis.

The following main conclusions result from our analysis:

- There is a significant size difference between low and high productivity companies, the larger companies showing higher rate of productivity growth.
- There is a high degree of correlation between labour productivity change and business performance change, measured by sales, market share, ROS, ROI or by a composite index of the four. The industry-wise business performance change and labour productivity change are in less close correlation then in the country-wise analysis.

- There is a far higher correlation between action programs and productivity growth than between the latter and everyday working practices. This can be explained by the more dynamic influence of action programs.
- It is a very general and we believe important conclusion (which supports the results of Whybark, 1997) that country differences in production practices (in our case in causes and effects of productivity changes) are larger than industry differences. This calls attention to the limits of globalization of production and the importance of differences in culture, habits and social circumstances.

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Appendix 1: Use of working practices in low and high productivity groups

Working practices	*Low productivity*		*High productivity*		*F*	*Significance*	*Significance SME***
	N	*Mean*	*N*	*Mean*			
Direct incentives (% of workers)	129	12,20	93	18,34	2,97	0,086	**0,003**
Functional teamwork (% of workers)	125	44,13	92	57,68	8,03	**0,005**	0,290
Cross-func. Teamwork (% of workers)	117	13,56	87	26,89	15,96	**0,000**	**0,007**
Hours of training/year	125	24,28	91	35,07	4,60	**0,033**	**0,042**
Multi-skilled (% of prod. Workers)	132	54,67	98	49,37	1,86	0,174	0,139
Worker suggestion (1-5)*	137	2,66	99	2,89	3,20	0,075	0,110
Rotation of prod. Workers (1-5)*	138	3,07	100	3,23	1,55	0,215	0,884
Self dependence (1-5)*	134	2,90	101	3,22	6,55	**0,011**	**0,048**

* Meaning of scale: 1= not characteristic, 5 = highly characteristic

** Significance level for SMEs within the low versus high productivity group

Appendix 2: Use of action programs in low and high productivity groups (1-5 scale)*

Action programs	*Low productivity*		*High productivity*		*F*	*Sign.*	*Significance SME***
	N	*Mean*	*N*	*Mean*			
Capacity expansion	138	2,99	99	3,57	15,08	**0,000**	**0,003**
Process focus	137	3,01	99	3,66	18,81	**0,000**	0,069
Pull production	136	2,54	98	3,33	28,68	**0,000**	**0,020**
Quality programs	136	2,82	101	3,43	20,32	**0,000**	**0,008**
Machine productivity	136	2,46	101	3,38	54,56	**0,000**	**0,000**
Environment	134	2,39	97	3,15	22,77	**0,000**	**0,000**
Product development improvement	135	2,81	99	3,17	7,59	**0,006**	**0,022**
Organiz. Integration	135	2,68	99	3,09	9,51	**0,002**	0,058
Technological integration	134	2,96	99	3,23	3,59	0,059	0,825
Automation	135	2,46	98	2,93	10,47	**0,001**	0,192
ICT and/or ERP	133	2,94	99	3,28	4,90	**0,028**	0,225
Delegation and training	136	2,70	101	3,00	5,77	**0,017**	0,059
Lean model	137	2,53	99	3,09	16,87	**0,000**	**0,019**
Continuous improvement	136	2,65	100	3,20	13,88	**0,000**	0,064
Worker flexibility	136	2,85	100	3,25	8,60	**0,004**	0,118

* Meaning of scale: 1= deteriorated more than 10%; 2 = stayed about the same; 3= improved 10%-30%; 4 = improved 30%-50%; 5 = improved more than 50%

** Significance level for SMEs within the low versus high productivity group

Appendix 3: Drivers of labour productivity change - country differences for working practices

Working practices	*Arg*	*Bel*	*Chi*	*Den*	*Hun*	*Ita*	*N Z*	*Net*	*Swe*	*Tur*	*USA*	*Ven*	*Total*	*F**
Direct incentives (% of workers)	10,49	5,11	23,58	12,74	59,27	8,26	0,52	5,89	5,20	10,56	7,17	14,84	14,18	**25,794**
Functional teamwork (% of workers)	37,20	35,20	61,78	67,12	62,08	37,10	45,50	57,80	69,61	43,50	32,03	43,22	52,15	**6,524**
Cross-func. Teamwork (% of workers)	20,59	15,60	23,32	13,55	26,02	13,45	15,00	20,71	15,16	20,62	26,21	31,07	20,02	***1,854***
Hours of training/year	25,20	30,38	83,44	42,69	12,76	33,79	28,48	22,52	24,20	22,44	21,91	39,13	29,86	**10,631**
Multi-skilled (% of prod. workers)	48,68	54,03	22,62	62,29	40,43	52,58	65,41	60,56	73,17	51,44	43,91	41,72	53,28	**11,663**
Worker suggestion (1-5)	2,75	2,56	3,19	2,63	2,81	2,67	2,77	2,76	2,28	2,83	2,46	2,93	2,68	**3,062**
Rotation of prod. workers (1-5)	3,11	3,41	2,57	3,50	2,81	3,02	3,47	3,16	3,71	2,86	3,12	3,40	3,20	**5,780**
Self dependence (1-5)	3,20	2,93	3,00	3,36	2,85	3,23	3,00	3,02	3,39	2,79	2,49	2,93	3,05	**3,194**

*bald numbers reflect significant differences between countries at p<0,01 level, bald italic at p<0,05

Appendix 4: Drivers of labour productivity change - country differences for action programs

Action programs	*Arg*	*Bel*	*Chi*	*Den*	*Hun*	*Ita*	*NZ*	*Net*	*Swe*	*Tur*	*USA*	*Ven*	*F**
Capacity expansion	3,30	3,07	3,69	2,81	3,40	3,34	3,33	2,89	3,35	3,63	3,00	3,00	**2,327**
Process focus	3,40	3,23	3,37	3,44	2,81	3,15	3,10	3,48	3,33	3,49	3,54	3,24	1,505
Pull production	2,93	2,87	3,03	2,97	2,62	2,77	2,39	3,10	2,67	3,11	3,15	2,80	1,507
Quality programs	3,35	3,06	3,22	3,00	2,96	3,07	2,73	3,19	2,80	3,54	3,49	3,18	**2,301**
Machine productivity	2,84	3,00	3,11	2,86	2,75	2,78	2,59	2,89	2,58	3,31	3,03	3,07	1,655
Environment	2,84	2,77	3,00	2,63	2,43	2,73	1,73	2,42	3,12	3,46	2,69	2,79	**5,067**
Product development impr.	2,91	3,13	2,97	3,23	2,72	2,98	2,38	2,98	2,76	3,06	2,97	3,00	1,654
Organizational integration	2,82	2,81	2,78	3,12	2,62	2,76	2,71	2,57	2,65	3,29	2,94	3,23	***2,090***
Technological integration	3,18	3,35	3,43	3,26	2,67	3,12	2,96	2,70	2,93	3,26	3,29	2,77	**2,386**
Automation	2,76	3,00	2,89	2,97	2,09	2,86	2,26	2,68	2,79	2,76	3,34	2,33	**3,910**
ICT and/or ERP	2,98	3,29	3,16	2,89	2,56	3,33	2,26	3,28	2,84	3,47	3,29	2,97	**3,589**
Delegation and training	2,81	2,68	3,08	3,25	2,53	2,73	2,86	2,81	3,18	2,94	2,83	2,55	**2,559**
Lean model	2,81	2,87	2,97	2,72	2,53	2,75	2,72	2,77	2,67	3,00	2,94	2,68	0,645
Continuous improvement	2,93	2,81	3,16	2,72	2,31	2,73	2,64	2,90	3,17	3,21	3,14	2,97	**2,571**
Worker flexibility	2,95	3,50	3,00	3,31	3,00	2,82	3,03	3,02	3,04	2,82	2,74	2,61	1,721

*bald numbers reflect significant differences between countries at p<0,01 level, bald italic at p<0,05

Appendix 5: Correlations between labour productivity and working practices by country

Working practices		*Arg*	*Bel*	*Chi*	*Den*	*Hun*	*Ita*	*N Z*	*Net*	*Swe*	*Tur*	*USA*	*Ven*
Direct incentives (% of workers)	Pearson Correlation	0,215	-0,171	-0,263	0,075	0,257	-0,137	0,337	0,123	-0,004	-0,119	-0,382	-0,043
	Sig. (2-tailed)	0,171	0,394	0,139	0,676	0,081	0,411	0,146	0,366	0,972	0,503	**0,034**	0,841
	N	42	27	33	33	47	38	20	56	75	34	31	24
Functional teamwork (% of workers)	Pearson Correlation	0,010	0,330	-0,048	-0,112	-0,086	0,049	0,184	0,297	0,218	0,200	0,040	0,165
	Sig. (2-tailed)	0,951	0,115	0,793	0,542	0,558	0,792	0,348	**0,023**	0,074	0,257	0,831	0,442
	N	41	24	32	32	49	31	28	58	68	34	31	24
Cross-func. Teamwork (% of workers)	Pearson Correlation	0,374	0,271	-0,174	0,104	0,128	0,440	0,434	0,030	0,232	0,195	0,160	0,074
	Sig. (2-tailed)	**0,016**	0,200	0,348	0,585	0,401	**0,017**	**0,021**	0,829	0,088	0,269	0,382	0,738
	N	41	24	31	30	45	29	28	55	55	34	32	23
Hours of training/year	Pearson Correlation	0,165	0,461	0,066	0,009	0,000	-0,005	0,266	0,012	0,062	-0,211	0,229	-0,166
	Sig. (2-tailed)	0,302	**0,020**	0,719	0,961	1,000	0,975	0,199	0,929	0,614	0,231	0,193	0,459
	N	41	25	32	34	52	38	25	61	69	34	34	22
Multi-skilled (% of prod. workers)	Pearson Correlation	-0,171	0,003	-0,166	-0,109	0,197	0,055	-0,043	0,170	0,117	-0,024	-0,123	0,041
	Sig. (2-tailed)	0,266	0,987	0,347	0,540	0,165	0,737	0,827	0,188	0,318	0,891	0,487	0,834
	N	44	30	34	34	51	40	28	62	75	34	34	28
Worker suggestion (1-5)	Pearson Correlation	0,091	0,074	-0,092	-0,220	-0,047	-0,099	0,063	0,188	0,118	-0,261	0,211	0,482
	Sig. (2-tailed)	0,559	0,692	0,597	0,211	0,748	0,531	0,750	0,143	0,305	0,129	0,230	**0,008**
	N	44	31	35	34	50	42	28	62	77	35	34	29
Rotation of prod. workers (1-5)	Pearson Correlation	0,129	0,106	-0,022	0,001	0,178	0,106	0,147	0,137	0,230	0,266	0,101	0,000
	Sig. (2-tailed)	0,404	0,571	0,895	0,994	0,206	0,499	0,455	0,287	**0,044**	0,122	0,577	1,000
	N	44	31	37	35	52	43	28	62	77	35	33	29
Self dependence (1-5)	Pearson Correlation	0,321	0,126	0,124	0,190	0,075	0,221	-0,076	0,228	0,124	-0,047	0,268	0,215
	Sig. (2-tailed)	**0,034**	0,515	0,466	0,275	0,599	0,149	0,708	0,075	0,285	0,793	0,126	0,262
	N	44	29	37	35	52	44	27	62	76	33	34	29

Appendix 6: Correlations between labour productivity and action programs by country

Action programs	*Arg*	*Bel*	*Chi*	*Den*	*Hun*	*Ita*	*N Z*	*Net*	*Swe*	*Tur*	*USA*	*Ven*
Capacity expansion	0,186	0,172	0,123	0,335	0,200	0,068	0,083	0,375	-0,071	-0,076	0,379	0,192
	0,232	0,372	0,483	0,050	0,159	0,674	0,675	0,003	0,537	0,666	0,025	0,358
Process focus	0,303	-0,075	0,173	0,378	0,131	0,223	0,139	0,354	0,075	0,056	0,127	0,404
	0,048	0,694	0,321	0,025	0,359	0,161	0,488	0,005	0,519	0,751	0,467	0,045
Pull production	-0,063	0,200	0,194	0,233	0,160	0,538	0,302	0,350	0,132	0,116	0,340	0,113
	0,689	0,289	0,263	0,178	0,268	0,000	0,134	0,005	0,258	0,507	0,049	0,590
Quality programs	0,170	0,471	0,538	0,198	-0,026	0,018	0,120	0,219	0,088	0,268	-0,023	-0,114
	0,276	0,009	0,001	0,262	0,854	0,912	0,542	0,090	0,447	0,119	0,895	0,572
Machine productivity	0,009	0,114	0,492	0,343	0,159	0,217	0,124	0,360	0,220	0,286	0,317	0,181
	0,952	0,548	0,002	0,047	0,266	0,174	0,537	0,004	0,054	0,095	0,064	0,367
Environment	0,304	0,010	0,437	0,195	-0,127	0,308	0,423	0,402	0,014	0,197	0,321	-0,053
	0,047	0,957	0,008	0,270	0,429	0,050	0,025	0,001	0,902	0,256	0,060	0,793
Product dev. Impr.	0,049	0,368	0,368	-0,193	0,106	0,358	0,131	0,157	-0,051	-0,093	0,036	0,000
	0,751	0,042	0,027	0,274	0,458	0,020	0,515	0,222	0,671	0,597	0,838	1,000
Organiz. Integration	0,222	0,091	0,459	-0,103	0,032	0,397	-0,163	0,160	0,042	0,052	0,287	0,165
	0,147	0,625	0,005	0,568	0,826	0,009	0,427	0,213	0,727	0,769	0,095	0,420
Technological integr.	-0,004	0,184	0,066	0,067	-0,078	0,246	-0,224	0,312	0,073	0,214	0,102	-0,016
	0,977	0,331	0,701	0,710	0,596	0,116	0,271	0,013	0,546	0,218	0,561	0,938
Automation	-0,125	0,463	0,330	0,337	-0,183	0,503	0,042	0,230	0,202	0,113	-0,044	0,000
	0,431	0,010	0,046	0,051	0,193	0,001	0,842	0,079	0,081	0,524	0,806	1,000
ICT and/or ERP	0,200	-0,045	0,274	-0,185	0,070	0,045	-0,087	0,060	0,017	0,158	0,068	0,034
	0,205	0,813	0,101	0,294	0,622	0,773	0,678	0,647	0,886	0,371	0,706	0,862
Delegation and training	0,198	0,259	0,426	0,022	0,198	0,166	-0,082	0,267	-0,031	-0,058	0,124	-0,242
	0,203	0,166	0,009	0,899	0,164	0,280	0,684	0,036	0,789	0,748	0,477	0,216
Lean model	0,161	0,232	0,184	0,276	0,092	0,292	0,206	0,164	0,196	0,400	0,092	-0,116
	0,303	0,217	0,283	0,109	0,522	0,054	0,303	0,206	0,091	0,021	0,597	0,563
Continuous impr.	0,249	-0,079	0,350	0,340	0,044	0,290	0,147	0,123	0,184	0,124	0,285	-0,071
	0,107	0,671	0,034	0,045	0,762	0,056	0,473	0,345	0,115	0,491	0,097	0,721
Worker flexibility	0,037	0,267	0,183	0,245	0,156	0,335	0,019	0,245	0,195	0,238	0,287	-0,217
	0,815	0,146	0,278	0,155	0,274	0,026	0,926	0,060	0,094	0,183	0,100	0,277

Appendix 7: Drivers of labour productivity – industry differences by working practices

Working practices	*metal*	*machine*	*office*	*electronic*	*Communi-cation*	*instrument*	*automotive*	*other vehicle*	*Total*	*F*
Direct incentives (% of workers)	15,04	15,36	5,00	12,13	19,06	8,97	20,59	14,65	14,95	0,745
Functional teamwork (% of workers)	53,61	48,67	50,83	51,23	43,33	54,38	55,49	51,23	51,65	0,923
Cross-func. Teamwork (% of workers)	17,04	18,37	33,33	24,13	24,17	27,38	16,89	20,94	19,74	0,256
Hours of training/year	27,72	27,06	32,50	39,94	30,94	33,91	27,18	28,00	29,84	0,678
Multi-skilled (% of prod. Workers)	52,01	56,19	53,33	49,34	56,94	46,56	52,54	57,19	53,04	0,813
Worker suggestion (1-5)	2,68	2,78	2,00	2,85	2,94	2,75	2,46	2,52	2,70	0,210
Rotation of prod. Workers (1-5)	3,16	3,19	3,17	3,15	3,67	3,44	3,06	3,26	3,20	0,510
Self dependence (1-5)	3,06	3,19	3,00	3,11	2,56	3,50	2,69	3,03	3,05	***0,031***

Appendix 8: Drivers of labour productivity – industry differences by action programs

Action programs	*metal*	*machine*	*office*	*electronic*	*communication*	*instrument*	*automotive*	*other vehicle*	*Total*	*F*	*Sig.*
Capacity expansion	3,03	3,49	2,50	3,02	3,24	3,53	3,63	3,56	3,26	**3,444**	0,001
Process focus	3,12	3,37	4,13	3,37	3,33	3,68	3,52	3,47	3,33	1,825	0,081
Pull production	2,70	2,92	3,50	3,10	3,14	3,16	3,07	2,74	2,90	1,652	0,119
Quality programs	3,02	2,84	3,25	3,18	3,19	3,16	3,54	3,15	3,08	***2,235***	0,031
Machine productivity	2,76	2,73	2,63	2,80	3,00	2,68	3,30	2,82	2,83	1,585	0,138
Environment	2,72	2,48	2,00	2,68	2,81	3,42	3,28	2,68	2,74	**3,522**	0,001
Product development impr.	2,69	2,99	2,88	3,02	3,05	3,37	3,28	2,79	2,92	**2,791**	0,008
Organizational integration	2,70	2,72	2,63	2,78	2,95	3,58	3,04	2,94	2,82	***2,366***	0,022
Technological integration	3,04	2,95	2,75	2,92	3,05	3,42	3,54	2,85	3,05	2,011	0,052
Automation	2,84	2,49	2,75	2,68	2,71	2,89	2,80	2,65	2,71	0,970	0,452
ICT and/or ERP	2,95	2,82	3,50	3,05	3,33	3,26	3,22	3,12	3,02	1,229	0,285
Delegation and training	2,81	2,79	2,75	2,90	2,62	3,53	2,96	3,00	2,87	1,874	0,072
Lean model	2,71	2,66	3,00	3,02	2,71	3,11	2,96	2,88	2,80	1,085	0,372
Continuous improvement	2,86	2,79	3,25	2,97	2,48	3,16	3,22	3,00	2,91	1,436	0,189
Worker flexibility	2,93	3,09	3,38	3,10	2,86	3,37	2,85	2,91	3,00	0,968	0,454

Appendix 9: Correlations between labour productivity and working practices by industry(grey cells are significant)

Correlations of labour productivity and …		*metal*	*machine*	*office*	*electronic*	*Communi-cation*	*instrument*	*automotive*	*other vehicle*
Direct incentives (% of workers)	Pearson Correlation	0,108	-0,013	0,595	0,057	0,154	0,050	0,097	0,177
	Sig. (2-tailed)	0,166	0,899	0,070	0,659	0,471	0,845	0,537	0,325
	N	165	100	10	63	24	18	43	33
Functional teamwork (% of workers)	Pearson Correlation	0,144	0,105	-0,071	0,171	-0,105	0,130	0,100	0,274
	Sig. (2-tailed)	0,070	0,294	0,867	0,195	0,643	0,595	0,498	0,143
	N	159	102	8	59	22	19	48	30
Cross-func. teamwork (% of workers)	Pearson Correlation	0,087	0,179	-0,205	0,288	0,209	0,066	0,318	0,589
	Sig. (2-tailed)	0,287	0,081	0,596	0,030	0,364	0,802	0,038	0,001
	N	150	96	9	57	21	17	43	29
Hours of training/year	Pearson Correlation	0,017	0,101	0,531	0,239	0,383	0,144	-0,104	-0,080
	Sig. (2-tailed)	0,832	0,319	0,114	0,069	0,049	0,533	0,474	0,665
	N	163	100	10	59	27	21	50	32
Multi-skilled (% of prod. workers)	Pearson Correlation	-0,069	-0,146	-0,042	0,133	-0,130	-0,212	0,003	0,004
	Sig. (2-tailed)	0,364	0,140	0,902	0,297	0,517	0,355	0,984	0,980
	N	176	104	11	63	27	21	53	33
Worker suggestion (1-5)	Pearson Correlation	0,134	-0,041	0,276	0,083	0,248	0,390	0,123	-0,055
	Sig. (2-tailed)	0,074	0,667	0,411	0,513	0,223	0,089	0,385	0,761
	N	179	111	11	64	26	20	52	33
Rotation of prod. workers (1-5)	Pearson Correlation	-0,006	0,022	0,000	0,151	0,050	-0,114	0,088	0,067
	Sig. (2-tailed)	0,938	0,821	1,000	0,229	0,805	0,621	0,526	0,710
	N	178	111	11	65	27	21	54	33
Self dependence (1-5)	Pearson Correlation	0,061	0,110	0,535	0,183	0,177	0,264	0,087	0,119
	Sig. (2-tailed)	0,420	0,251	0,090	0,144	0,378	0,261	0,530	0,509
	N	175	111	11	65	27	20	54	33

Appendix 10: Correlations between labour productivity and action programs by industry (grey cells are significant)

Correlations of labour productivity and …		*metal*	*machine*	*office*	*electronic*	*Communi-cation*	*instrument*	*automotive*	*other vehicle*
Capacity expansion	Pearson Correlation	0,116	0,179	0,546	0,185	0,383	0,454	0,225	-0,115
	Sig. (2-tailed)	0,125	0,061	0,103	0,140	0,059	0,039	0,110	0,525
Process focus	Pearson Correlation	0,101	0,092	-0,415	0,417	0,091	0,523	0,284	0,216
	Sig. (2-tailed)	0,183	0,345	0,233	0,001	0,664	0,015	0,042	0,228
Pull production	Pearson Correlation	-0,023	0,329	0,222	0,356	0,230	0,439	0,271	0,359
	Sig. (2-tailed)	0,760	0,001	0,537	0,004	0,279	0,046	0,052	0,040
Quality programs	Pearson Correlation	0,037	0,152	0,415	0,219	0,613	0,173	0,136	0,289
	Sig. (2-tailed)	0,628	0,111	0,205	0,085	0,001	0,467	0,336	0,103
Machine productivity	Pearson Correlation	0,109	0,339	0,541	0,312	0,325	0,124	0,368	0,164
	Sig. (2-tailed)	0,149	0,000	0,107	0,013	0,106	0,593	0,007	0,362
Environment	Pearson Correlation	0,046	0,330	0,443	0,340	0,108	0,232	0,153	0,321
	Sig. (2-tailed)	0,552	0,000	0,172	0,007	0,598	0,324	0,294	0,069
Product dev. Impr.	Pearson Correlation	-0,024	0,063	0,128	0,231	0,159	0,364	0,128	0,243
	Sig. (2-tailed)	0,753	0,517	0,708	0,066	0,468	0,105	0,360	0,181
Organiz. Integration	Pearson Correlation	-0,030	0,153	-0,203	0,345	0,387	0,097	0,055	0,569
	Sig. (2-tailed)	0,690	0,110	0,550	0,005	0,068	0,677	0,697	0,001
Technological integr.	Pearson Correlation	-0,081	0,151	-0,284	0,186	0,309	0,210	0,054	0,184
	Sig. (2-tailed)	0,292	0,116	0,397	0,140	0,151	0,361	0,702	0,314
Automation	Pearson Correlation	0,016	0,251	0,718	0,251	0,054	0,023	0,055	0,096
	Sig. (2-tailed)	0,832	0,009	0,013	0,045	0,788	0,922	0,693	0,595
ICT and/or ERP	Pearson Correlation	-0,083	0,102	0,000	0,319	-0,048	0,023	0,213	0,368
	Sig. (2-tailed)	0,273	0,297	1,000	0,010	0,811	0,922	0,130	0,035
Delegation and training	Pearson Correlation	0,040	0,058	0,394	0,264	0,108	0,300	0,123	0,190
	Sig. (2-tailed)	0,595	0,549	0,231	0,037	0,599	0,186	0,386	0,289
Lean model	Pearson Correlation	0,132	0,164	0,358	0,192	0,199	0,207	0,090	0,288
	Sig. (2-tailed)	0,081	0,086	0,280	0,131	0,341	0,382	0,526	0,104
Continuous impr.	Pearson Correlation	-0,022	0,172	0,415	0,311	0,110	0,217	0,168	0,566
	Sig. (2-tailed)	0,776	0,072	0,205	0,013	0,599	0,358	0,234	0,001
Worker flexibility	Pearson Correlation	0,105	-0,004	0,169	0,184	0,069	0,443	0,115	0,597
	Sig. (2-tailed)	0,165	0,965	0,642	0,149	0,737	0,050	0,419	0,000