3.6 Workpackage 6

FIRM-SPECIFIC DETERMINANTS OF THE PRODUCTIVITY GAP: A MATCHED PAIR-APPROACH INVOLVING SELECTED MANUFACTURING FIRMS IN WEST GERMANY, EAST GERMANY AND THREE CEE ECONOMIES

The objective of **workpackage 6** is to pinpoint the most important determinants of labour productivity[1] gaps between Central East European firms and West German firms as a benchmark, *i.e.* we assess firm-specific determinants. West German firms are natural benchmarks for CEE firms: showing on average higher levels of labour productivity, they sell on the same integrated European market and have access to the same technology (in as far as this technology is not firm-specific). In Central East Europe, we focussed on Polish, Hungarian and Czech firms. Additionally, we included East German firms in our panel, because the comparison of CEE firms with firms in East Germany yields a picture of what adjustments and developments would have taken place, if CEE firms would have endured a comparable shock-therapy of instant and complete integration of their markets with the West (in our summaries, we use 'country' as a connotation for East and West Germany to simplify the description of analyses and results). Because the data needed to follow our research-objectives is not available in the necessary form, we had to compile an own firm-specific dataset by way of field study.

The summaries of the contributions from each participant in this workpackage are confined to the most important results including a brief description of methods and concepts applied. The analysis of the data generated was organised in a way that each participant applied a different method using the data from each sub-panel. The comparison of results of each participant hence provides more insight than if all partners would have followed the same method.

Following an introductory chapter on conceptual framework, the design of field work and the questionnaire, as well as the database generated, the representation of these contribution-summaries starts with the analysis of the Czech team: here, methods of firm-performance measurement are tested on our dataset. This analysis yields the identification of efficient firms within each country, size, and industry group. This analysis represents the most aggregate analysis of the four teams, and can serve the workpackage by providing a test of our underlying assumption that we can use the West German firms as a benchmark. Having found sufficient support for this assumption, the second representation of results is that of Johannes Stephan. This analysis applies the method of matching pairs with West German firms as benchmark in the same model specifications across all country, size, and industry groups. Whilst testing all firm-specific determinants of observed productivity gaps and whilst it is able to provide an indication of their relative weight in explaining productivity gaps, this analysis is rather restrictive in terms of implying the same structures in all industry, and size-panels. Hence, part three steps back from the explicit use of West German firms as benchmark and focuses its matching analysis to a comparison between the 'best' performing and the 'worst' performing firms of the industry, and size-panels (*i.e.* irrespective of their country of origin). The description of results of workpackage 6 closes with the analysis of the Hungarian team. In a very

[1] This research again focuses on labour productivity; the efficiency of use of capital has not been assessed, mainly because firms were reluctant to provide that kind of data, and because of difficulties in the valuation of capital stocks.

comprehensive research, their analysis uses a large variety of different multivariate methods including principle component, factor, discriminant, and regression analysis. The team places some particular additional effort in assessing the role and determinant of process and product innovations. In comparison to the benchmark-version of the matched-pair approach, the latter two analyses provides a more general picture of firm-specific determinants of productivity levels amongst the firms we interrogated, and can hence claim more generality.

WP 6.1 The conceptual framework

In our conceptualisation, we follow the typical production-function methodology applied here to the firm level: we assess the determinants of firm-productivity levels, namely capital and labour stocks, human capital, and a variety of additional determinants which are subsumed under the ‘technology’ catch-all in production functions. Hence, firm-specific productivity gaps typically root either in a rational choice of strategies (*e.g.* the decision to produce with a higher labour intensity, because labour costs are lower: the capital/labour ratio), or root in a lower quality of human capital, or in firms using less advanced technology (or use the same technology less efficiently). We are hence interested in the particular conditions of the production, management, and marketing processes of individual firms.

Previous research into the determinants of the productivity gap between East and West Germany has shown that the so-called ‘soft factors’, *i.e.* differences in the organisation of production processes and differences in the management of firms (marketing, inadequate market position, networking, *etc.*) account for a large fraction of the productivity gap (see *e.g.* Bellmann / Brussig, 1998; Ragnitz *et al.*, 2000).

The researchers in this workpackage developed a two-group classification of criteria for the questionnaire to make the results accessible for empirical and econometric analysis. These two groups consist of inputs and outputs. The basic idea of our application of methods is first to identify (the most) efficient input-output-relations (input-output-relations include *e.g.* number of employees and value of capital stock as inputs and total value added as output). Second, input-vectors (explanans) can then be compared with productivity levels (explanandum) to derive a picture of firm-specific determinants of productivity <u>levels</u> (duly sorted in classes of homogenous firms). Third, our analysis yields the identification and ranking of firm-specific determinants of productivity <u>gaps</u> *vis-à-vis* West German firms by comparing the performance of level-determinants between East and West.

WP 6.2 The design of the field work and the questionnaire

The field work was conducted by four country-teams with the German team covering both East and West Germany. We designed a questionnaire and focussed the questions on: the effective, not necessarily formal, qualification of all groups of firm-staff and the intensity of training of staff, on the intensity of strategic planning on behalf of firm managers or owners (as an input-variable); on the intensity of networking with contractors and partners of the firm, on the use of a variety of modern communication technologies, and on one particular management-strategy, namely product specialisation *vs* diversification (as output-variables); and on the management’s perception about the intensity of competition, the intensity of use of capital *vis-à-vis* labour, and the intensity of investment (as control-variables). Finally, we cross-tested our results by asking firms to select from a given list their most preferred strategies to increase their own productivity and to cope with intensifying competition. We targeted the construction industry (NACE F) and four manufacturing industries with our questionnaire, namely machinery manufacturers (NACE 290), Furniture manufacturers (NACE 361), Electrotechnical manufacturers (NACE 310), and Cosmetics manufacturers (NACE 245).

Machinery manufacturers are producers of typically non-mass products. Whilst their final products are often not comparable between firms, their production processes are. Hence, the method of matching comparable pairs is viable. Machinery manufacturers often produce a small number of very specified, non-standardised products, tailored to the demands of the customers. This is particularly pronounced in smaller firms. In the new WIFO taxonomy, machinery manufacturers typically employ highly qualified personnel (Peneder 1999, p. 36-37). In terms of competitive management strategies, such industries would typically focus their attention on horizontal integration, and innovation by new technology (Kaniovski / Peneder 2001). Within our sample, firms mainly produce special purpose machinery for *e.g.* packaging, harnessing of material, for printing and publishing, as well as equipment for production lines.

Furniture manufacturers and cosmetics manufacturers typically produce more standardised products, in some cases probably even mass-produced, large-scale products. Firms in the electrotechnical industry are producers of rather mixed products, yet most are also specialised on mass-produced, large-scale products. In those industries, products and production processes are sufficiently comparable to warrant the use of a comparative analysis. Furniture manufacturers are typically considered rather labour intensive with a comparatively less skill-intensive personnel, and typically derive their endogenously created firm-specific advantages from intangible investments into marketing (Peneder 1999, p. 36-37). In terms of their competitive strategy, firms in this industry can be expected to favour innovation by variety, brand creation, as well as vertical integration, either within the firm or via networking (Kaniovski / Peneder 2001). Within our sample, firms mainly produce goods as *e.g.* kitchen furniture, office furniture and other furniture like mainly living room chairs and tables. Cosmetics and electrotechnical firms are more marketing-driven, employ medium-skilled labour (Peneder 1999, p. 36-37), and are characterised by high inputs for retail and advertisement (Kaniovski / Peneder 2001). In our cosmetics sample, the main products are detergents, toilet articles, washing liquid and the like. Our electrotechnical firms are mainly producers of cables and wires, of light-bulbs and lamps, of electrical generators or parts thereof, and of electrical heaters.

WP 6.3 The 'CEE firm-specific productivity determinants database'

In three main waves of collecting data with our questionnaires during 2002 and 2003, we interrogated a very large number of firms across a selection of the countries of our interest. The first year questionnaire asked firms not only to specify their performance for a large selection of inputs and outputs. It also asked firms to assess their own performance for the current year (2001), for 1999 and additionally 1997. This would have allowed us to compare the performance of firms over a longer period of time; for the analysis, this would have allowed us not only to use cross-sectional methods. We also selected a large number of branches and industries to allow our field work to represent a fair share of the economies. This would have granted a larger generality of results. However, the rates of return for all partners were clearly far too low to continue our field work on such a comprehensive scale; we had to focus on a lesser number of questions, referring only to the current year, and on a lesser number of industries. The second and third year field work generated the necessary size of data to meet our objectives and test our hypothesis.

Table WP 6.1 Distribution of sample-FIEs according to industry, country/region, and size

	Machinery (NACE 290)			Furniture manufacturers (NACE 361)		
	small firms	large firms	total	small firms	large firms	total
West Germany	22	20	42	28	25	53
East Germany	22	25	47	29	20	49
Poland	17	23	40	22	20	42
Czech Republic	21	22	43	20	19	39
Hungary	69	35	104	27	21	48
Sum	151	125	276	126	105	231

	Cosmetics manufacturers (NACE 245)			Electrotechnical manuf. (NACE 310)		
	small firms	large firms	total	small firms	large firms	total
West Germany	20	16	36	17	19	36
East Germany	20	11	31	20	15	35
Poland	25	25	50	28	22	50
Czech Republic	20	19	39	19	24	43
Hungary	13	7	20	57	21	78
Sum	98	78	176	141	101	242

Note Small firms are such with less than 50 employees, large firms employ at least 51.
In our field work, we additionally collected filled out questionnaires from some construction firms (38), computer retailers (3), meat processing firms (12), transport (logistics) firms (23), textile manufacturers (1), and hotels (15). Because of their low number and because we adjusted the questionnaire, those do not form part of the 'CEE firm-specific database'.

Most of the interrogations were done via the telephone, some firms preferred to fill out the questionnaires on paper. In any case, full confidentiality was guaranteed.[2] In total, we collected data from 925 firms which form the **'CEE firm-specific productivity determinants database'**. We set ourselves a target to collect at least 20 filled out questionnaires in each of the 40 sub-panels (which was impossible in 8 cases) to provide sufficient data for econometric analysis. In general, the rate of return was very low across all samples.

WP 6.4.1 The methods of firm-performance measurement

The Czech team, consisting of Petr Fiala and Josef Jablonský, applied several quantitative modelling frameworks for performance measurement. There are several principles that emerge from suggested performance measurement frameworks. Different perspectives must be considered in contrast to a traditional single focus on *e.g.* financial performance. Many authors have suggested including non-financial measures in production performance measurement systems, in order to control for the correct implementation of the production strategy with respect to all competitive priorities. But the use of non-financial performance measures makes it difficult to assess and compare the overall effectiveness of each decision making unit in terms of support provided to the achievement of the production strategy, since to this aim it is necessary to integrate performance measures expressed in heterogeneous measurement units. The first step into analysis by the Czech team was a descriptive analysis which yields an impression of what indicators might serve as determinants for the productivity gaps at the firm level. This analysis was focused on averages,

2 In the cases where firms had several establishments, we asked interview partners to answer from the perspective of their immediate establishment only.

standard deviations, and correlation coefficients. Next, the general production functions methodology was used to estimate the impact of different determinants on the productivity of firms.

Finally, the Czech team based most of its effort on applying performance evaluation models based on data envelopment analysis (DEA) and multi-criteria analysis. The DEA encompasses a variety of models and methods to evaluating performance. In this analysis, we consider *n* decision making units U_1, U_2, …, U_n. Each of them produces *r* outputs and for their producing spent *m* different inputs. Let us denote $X_j = \{x_{ij}, i=1,2,\ldots,m\}$ the inputs and outputs for decision making unit U_j a similarly $Y_j = \{y_{ij}, i=1,2,\ldots,r\}$ the outputs for U_j. X is the (m x n) matrix of inputs and Y the (r x n) matrix of outputs. The efficiency of the decision making unit U_0 is given by the ratio

$$\frac{\text{weighted sum of outputs}}{\text{weighted sum of inputs}} = \frac{\sum_i u_i y_{i0}}{\sum_j v_j x_{j0}}$$

The formulation of DEA models consists in the maximization of the above ratio under the conditions the efficiency of all other units being less or equal to 1. The modification of the standard CCR model is the model known as BCC model. These two models belongs to the most often used DEA models.

Multicriteria evaluation methods compare firms by their value of inputs and outputs as performance criteria. There are many multi-criteria methods and most of them use weights as subjective preference information. The methods use an exogenously specified set of weights. The aim of the multi-criteria analysis can be the selection of the set of “good” firms, the selection of the best firm, or a ranking of all the firms.

Multicriteria analysis methods are introduced to meet various judgments of firms, branches, and countries. The general formulation of multicriteria decision problem can be expressed by the criterion matrix as follows:

$$\begin{array}{c} \\ \mathrm{a}_1 \\ \mathrm{a}_2 \\ \vdots \\ \mathrm{a}_\mathrm{p} \end{array} \begin{array}{c} \begin{array}{cccc} \mathrm{f}_1 & \mathrm{f}_2 & \cdots & \mathrm{f}_\mathrm{k} \end{array} \\ \begin{bmatrix} y_{11} & y_{12} & \cdots & y_{1\mathrm{k}} \\ y_{21} & y_{22} & \cdots & y_{2\mathrm{k}} \\ \vdots & & \ddots & \vdots \\ y_{\mathrm{p}1} & y_{\mathrm{p}2} & \cdots & y_{\mathrm{pk}} \end{bmatrix} \end{array}$$

where $A = \{a_1, a_2, \ldots, a_p\}$ is the set of decision alternatives and $F = \{f_1, f_2, \ldots, f_k\}$ are the criteria. The elements of the criterion matrix y_{ij}, i=1,2,...,p, j=1,2,...,k, express the evaluation of alternatives. In our problem formulation the alternatives can be firms and the criteria are inputs and outputs.

There are many multicriteria methods based on different assumptions and approaches. The methods can be classified upon different forms of preference information on attributes and alternatives. The different preference information can vary from aspiration level, ordinal, cardinal to marginal rate of substitution. The methods ‘weighted sum approach (WSA) and PROMETHEE were used in our evaluation of firms.

In the WSA, the decision maker assigns a set of importance weights to the attributes $w = (w_1, w_2, \ldots, w_k)$. Then the most preferred alternative a^0 is selected such that

$$a^0 = \left\{ a_i \middle| \max \sum_{j=1}^{k} w_j y_{ij} \right\}$$

where y_{ij} is the outcome of the i - th alternative about the j - the attribute with numerically comparable scale.

The PROMETHEE class methods use preference functions expressing the measure of preference of one alternative for another for the criterion. This method offers six types of preference functions for the user to choose. The complete ranking of all the alternatives is obtained by their descending ordering according to so called net-flow values.

WP 6.4.2 The main results of the Czech team

The DEA provides a comparison of firms, branches or countries by efficient scores. Their summarisation based on the results of the CCR and BCC model is given in following two tables (results are based on the whole set of firms – all the firms from all the branches were evaluated simultaneously). The computed weights by the DEA approach can specify the most important determinants of productivity.

Table WP 6.2 Average efficiency scores of firms given by CCR model

Branch	CZ	GE	GW	HU	PL
Furniture/large	0.2384	0.4026	0.5915	0.1212	0.1906
Furniture/small	0.2610	0.4389	0.4689	0.0994	0.3911
Furniture/all	*0.2500*	*0.4242*	*0.5265*	*0.1086*	*0.2956*
Investment/large	0.1818	0.4545	0.6694	0.1625	0.2687
Investment small	0.1860	0.5072	0.5936	0.2456	0.3644
Investment/all	*0.1838*	*0.4792*	*0.6297*	*0.2207*	*0.3094*
Country	0.2161	0.4533	0.5741	0.1877	0.3023

Table WP 6.3 Average efficiency scores of firms given by BCC model

Branch	CZ	GE	GW	HU	PL
Furniture/large	0.2463	0.4593	0.7115	0.1296	0.3097
Furniture/small	0.2933	0.5298	0.5525	0.1752	0.7216
Furniture/all	0.2704	0.5013	0.6271	0.1561	0.5255
Investment/large	0.2046	0.5107	0.7588	0.1727	0.4355
Investment small	0.2032	0.5712	0.6789	0.2991	0.4338
Investment/all	0.2039	0.5390	0.7170	0.2612	0.4348
Country	0.2364	0.5212	0.6686	0.2303	0.4812

Tables WP 6.2 and 6.3 show that the higher efficiency score were given for GW (Germany West) firms. This domination was stronger for large firms. The further results demonstrate very good results for GE (Germany East) firms and poor efficiency for Czech and Hungarian firms. Of course, the tables show only the average results and there are several Czech or Hungarian firms with very high efficiency level but the number of such firms is very small in comparison to firms from Germany. The results of the models are not surprising – only the higher efficiency of Polish firms comparing to the Czech and Hungarian ones can be difficult explained. Probably the original data sets and their credibility can be discussed.

Table WP 6.4 Average efficiency scores of firms given by BCC model

- 4 inputs and turnover as one output -

Branch	CZ	GE	GW	HU	PL
Cosmetics/large	0.6289	0.8547	0.7305	0.7511	0.7640
Cosmetics/small	0.5913	0.7990	0.7818	0.7940	0.7558
Electrotechnical/large	0.4494	0.6503	0.6413	0.5825	0.5932
Electrotechnical/small	0.4979	0.5748	0.5390	0.4349	0.4972

Tables WP 6.4 and 6.5 show similar results for the second wave of analysis (cosmetics and electrotechnical firms). Comparing to previous result the efficiency scores are much higher, because the firms from different branches were evaluated separately.

Table WP 6.5 Average efficiency scores of firms given by CCR model

- 8 inputs and turnover as one output -

Branch	CZ	GE	GW	HU	PL
Cosmetics/large	0.3439	0.6618	0.6780	0.4687	0.5379
Cosmetics/small	0.5643	0.7539	0.7503	0.4321	0.4130
Electrotechnical/large	0.2532	0.4980	0.6340	0.1416	0.2991
Electrotechnical/small	0.4583	0.6818	0.6750	0.3227	0.4613

As in the first wave of analysis the results show the dominance of Germany firms. In this case the results are almost the same for GE and GW firms. The worse efficiency was given again for Czech and especially Hungarian firms.

Multicriteria methods were applied especially in the first year of the project because they can compare the firms only and it is not possible to identify by them the sources of inefficiencies as the DEA models can.

Results provided by multicriteria methods can compare firms, branches and countries. We used the WSA and PROMEETHE methods for comparison of countries and branches. The methods use the weights for aggregation of factors. The weights express the importance of determinants for total productivity. The summarisation of results by countries and several branches are given in tables WP 6.6 and 6.7.

Table WP 6.6 Country summarisation of the WSA and PROMETHEE results

Country	Total # of firms	Average utility (WSA)	Average util. (Promethee)
CZ	42	0.615	0.352
GE	16	0.642	0.424
GW	23	0.670	0.419
HU	17	0.619	0.352
PL	15	0.593	0.343

Table WP 6.7 Branch summarisation of the WSA and PROMETHEE results

Branch	Total # of firms	Average utility (WSA)	Average util. (Promethee)
Construction	38	0.646	0.406
Computers	3	0.572	0.337
Furniture	21	0.612	0.350
Hotels	15	0.639	0.361
Meat	12	0.674	0.419
Transport	23	0.585	0.331
Textile	1	0.712	0.510
Total	113	0.628	0.375

The results in tables for multicriteria analysis confirm the findings from DEA analysis. The average best efficiency was found out for Germany (West and East) firms. Among branches the most efficient is again meet industry and building (except textile industry but there is only one firm).

WP 6.5.1 The matched-pair approach with West German firms as benchmark

The method used by Johannes Stephan is an application of the matched-pair approach. The method of ‘matching pairs’ originates from clinical surveys in which treatment effects are controlled for by use of a non-treatment control group. It is a non-parametric approach which allows us to analyse field data without prior assumptions on functional distributions. For a description of the method, and an early application for British and German manufacturers, see *e.g.*, Daly/Hitchens/ Wagner (1985). The matched-pair method can either group several pairs of firms from the West and the East to test the set of hypothesis. This, however, would necessitate a careful selection of firms to be assessed in deep-level interviews. The results largely depend on the selection of firms. We therefore decided to rather spread our field work as wide as possible within selected industrial branches, so as to reduce the selection-bias on results. Even if, strictly speaking, results are methodologically not generalizeable, they do offer valuable insight into the firm-level conditions within the selected manufacturing branches. So long as our sample of firms, on average, achieves a productivity gap comparable with the one for the whole industrial branch, our results can claim some weight. In any case, an assessment of all firms is impossible even in selected industrial branches, as such data is simply not collected by statistical offices.

Our matched pair analysis proceeds in four steps: we first test whether the shape of the candidate determinant is positively correlated with the productivity level between all firms in one panel (East and West of one product and size group). A statistically significant positive correlation would tell us that the candidate is in fact a good firm-specific determinant of the productivity level. What remains to be assessed in the second step is the distribution of the shape of determinant between firms in the West and in the East. In case the Eastern firms are in fact weaker with respect to this determinant candidate, we positively tested this candidate as a firm-specific determinant of the productivity gap between the Western and Eastern firms within our samples. The correlation analysis hence tells us which factors are in fact determinants of productivity gaps within the different sub-samples of industry and firm size and between the individual Eastern country-samples and West Germany. The method, however, does not take into considerations the interactions between the different determinants: to determine the ranking order of determinants and to compare the respective relevance of determinants across our sub-samples, we use a linear regression analysis with productivity levels as dependent and a set of determinants as explanatory variables. We finally test whether the variable in fact takes a lower shape in our Eastern panels.

WP 6.5.2 Results of the matched-pair approach

We tested a set of nine hypothesis: (1) Intensity of use of capital *vis-à-vis* labour as a control variable. Do managers in firms where labour is relatively cheaper than in the benchmark region substitute capital by labour, hence deliberately and in conformity with market conditions choose a more labour-intensive production technology resulting in a lower level of labour productivity? If we were to establish this, then the labour productivity gap between East and West Germany should not be perceived as a deficiency but rather as a management strategy. (2) Product specialisation: the decision on the scope of products is firm-specific and we expect firms with a narrow line of products (*i.e.* strong concentration) to enjoy specialisation benefits. This does not necessarily equal with higher profits or sustainability on the market, however, as diversification can be a method of risk-reduction in case of demand-shocks. (3) Extent of qualification of personnel (higher formal qualification or extraordinary work experience). Staff was categorised in two groups (management, administration and workers). Whilst it goes without saying that the level of efficiency of the firm will tend to increase with the relevant qualification of its staff, we are interested in the respective relevance of the two categories. (4) Intensity of training of personnel. We assume that not only the improvement of qualification profiles will affect productivity levels positively. We also expect that such a personnel policy will develop a heightened consideration of individual qualification profiles and hence result in more efficient allocation of labour to the heterogeneous tasks in the firm and improved quality of selection in the procurement of new staff. (5) Intensity of investment into fixed assets. We assume that with investment outlays assuming a large share of total costs, firms strive to reap efficiency benefits stemming from complementarities between the use of capital and labour. Of course, investment activities of firms not only reflect the firms' attempts to increase production efficiency, but also the necessity to replace or renovate outdated machinery or buildings. The typically discontinuous character of investment at the firm level demands particular care when assessing this determinant. (6) Intensity of product innovations. Innovative products grant the firm a monopolistic 'head-start' on the market. With prices being higher, nominal productivity can likewise be higher. (7) Intensity of strategic planning by the management, *i.e.* the share of time invested by firms' managers to strategic planning. We assume that the ability of firm managers to think strategically, *e.g.* if firms have a sufficient degree of division of labour to allow managers to reflect on future opportunities in a strategic manner, will typically improve the firms' performance. (8) Intensity of networking with suppliers, customers and other stake-holders. Networking was further specified as contractual relationships with a history of at least two years. Firms balance inner-firm coordination costs with transaction costs in their relations with other firms (*e.g.* contracts). A high intensity of networking allows firms not only to reduce transaction costs, but also to sharpen division of labour within the firm and with networking partners. Specialisation advantages can be assumed to translate into productivity increases. (9) Intensity of use of modern communication technologies, in particular Email, internet, and e-business. In order to efficiently network, partners can make use of modern communications technologies. We assume firms that use such technologies more intensively to also benefit more from the advantages of networking - hence also to achieve higher levels of productivity.

From the characterisation of main features of these industries presented in the introduction to this workpackage, we expect firms in all industries to particularly benefit in terms of productivity levels from a highly specialised product-strategy (hypothesis 1). Highly qualified personnel could be expected to make a difference in particular for the machinery manufacturers and less so for the other industries (hypothesis 2). In the machinery and electrotechnical groups, we expect firms to benefit from upgrading of obsolete fixed assets (hypothesis 3). In the machinery group additionally from intense product innovation (hypothesis 4). In all firms, we expect the "soft" management variables of strategic planning (hypothesis 5), intense networking (hypothesis 6), and the use of modern technologies for communication (hypothesis 7) to play a relevant role in explaining productivity levels and gaps.

We test those hypothesis by our four-step application of the matched-pair approach. The results of the first two steps are depicted graphically in the table "Results of Spearman rank-correlation analysis and comparison of averages: performing firms-specific determinants". Two kinds of positive results are represented: empty dots where the candidate determinant proved to be a significant determinant of productivity levels; full dots where the determinant of productivity levels also performs as a firm-specific determinant of productivity gaps. Here, the average size of the determinant in East is in fact lower than in West Germany.

Table WP 6.8 Results of Spearman rank-correlation analysis and comparison of averages: performing firms-specific determinants

	Machinery								Furniture								Cosmetics								Electrotechnical							
	large				small				large				small				large				small				large				small			
	EG	P	C	H	EG	P	C	H	EG	P	C	H	EG	P	C	H	EG	P	C	H	EG	P	C	H	EG	P	C	H	EG	P	C	H
1 Control variable								●		●												●		●		●		●		●	●	●
2 Specialisation				●	●							●		●					●				●						○			
3 Qualification																																
3a Qual. management	○				○				○				●														●					
3b Qual. workers	○				●				●		●		●				●		●								●		●	●	●	
4 Training																																
4a Trai. management	●	●	●	●		●	●	●	●	●	●	●		●	●	●						●		●		●				●	●	●
4b Trai. workers																	●	○			○	●		●	●	●			●	●	●	●
5 Investment		○		●		●	●			●		●			●	●							●	●						●	●	
6 Innovations		●	●	●													○								○				●	○		●
7 Strategic planning	●	●	●	●	●	●	●	●		●	●			●	●	●	●	●	●	●	○	●	●	●	●	●	●	●	●	●	●	●
8 Networking intensity																																
8a Netw. suppliers	●	●			●	●		●	●	●			●	●	○	●	○	●		●	●	●	●		●	●	●	●	●	●	●	●
8b Netw. customers	●	●			●	●			●	●			●	●	●	●	○		●	●	○	●	●	●	●	●	●	●	●	●	●	●
8c Netw. stake-holders	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
9 Communication tech.																																
9a Email	●	●		●	●	●		●	●	●		●	●	●	●	●	●	●		●	○	●		●	●	●	●		●	●	●	●
9b Internet	●	●		●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	○	●	●	●	○	●	●		●	●	●	●
9c E-business	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●

Notes: Small firms are such with less than 50 employees, large firms employ at least 51.

E...East Germany; P...Poland; C...Czech Republic; H...Hungary.

Training of personnel did not distinguish between “management and administration” in the panels of machinery and furniture.

○ denotes a significant Spearman-rank correlation with the correct sign between the determinant and productivity levels within the group (hence interpretable as determinant of productivity levels).

● denotes additionally a gap for the average Eastern firms *vis-à-vis* the average over West German firms (hence interpretable as firm-specific determinant of productivity gaps).

Table WP 6.9 Results of regression analysis and comparison of averages: the ranking order of firms-specific determinants (composite indicators)

	Machinery								Furniture								Cosmetics								Electrotechnical							
	large				small				large				small				large				small				large				small			
	EG	P	C	H	EG	P	C	H	EG	P	C	H	EG	P	C	H	EG	P	C	H	EG	P	C	H	EG	P	C	H	EG	P	C	H
1 Control variable																	27.3	28.5	31.8	32.7					14.5	26.2	26.2	26.2	0.8	29.0	28.7	29.4
2 Specialisation									*-3.0*	2.1	*-2.9*	14.6									6.6	3.4	8.2	3.1	*-4.8*	2.4	2.8	*-3.2*				
3 Qualification																																
3a Qual. management																					*-0.1*	*-0.1*	0.7	*-3.5*								
3b Qual. workers									1.7	*-1.1*	2.0	0.4																	4.5	9.7	7.9	*-3.4*
4 Training																																
4a Trai. management	0.7	2.4	1.6	3.8	0.1	1.9	2.4	0.2	2.3	4.2	2.2	5.3																				
4b Trai. workers																													0.9	1.4	1.2	1.6
5 Investment	*-8.9*	9.5	*-12.3*	7.2	0.4	11.5	10.6	1.6	*-14.4*	23.3	*-9.2*	2.9	3.0	*-10.6*	22.5	15.6	0.7	17.2	17.4	*-10.4*	*-1.3*	8.1	5.6	9.5	6.4	8.7	12.3	12.8	*-6.1*	11.4	12.5	8.2
6 Innovations	0.9	2.7	3.1	3.3																												
7 Strategic planning	0.3	10.4	12.2	13.6	8.0	33.0	23.0	23.8	0.4	3.4	3.0	2.0					0.9	2.1	2.1	3.0	10.9	37.0	30.0	29.1	2.2	16.9	11.5	13.2	1.6	17.1	15.2	13.3
8 Networking intensity	0.3	2.3	0.1	1.2	0.7	3.9	0.3	1.9					1.8	6.1	1.0	2.9					0.2	4.5	2.4	1.6					0.5	3.7	2.1	1.7
9 Communication tech.	2.1	8.6	3.2	6.3					0.9	4.2	0.5	2.7	2.7	10.9	3.9	8.0	1.2	6.4	1.8	3.4					0.9	18.5	4.5	2.6				
Regression: R^2 adj.		0.55				0.33				0.46				0.50				0.39				0.79				0.67				0.71		
DW		1.85				0.86				1.29				1.63				1.07				1.66				1.41				0.99		
n		89				104				70				68				35				48				44				55		

Notes: Small firms are such with less than 50 employees, large firms employ at least 51.

E...East Germany; P...Poland; C...Czech Republic; H...Hungary.

The composite indicators are calculated as regression coefficients times the gaps in performing determinants: the higher the coefficient (elasticity) and/or the gap, the higher is the composite indicator, interpreted as the more important the firm-specific determinant. Negative values result from the Eastern panel exhibiting a lower value of the determinant even if the regression sign was positive. Counter-intuitive regression signs are not reported here, and occurred only in the human capital proxies of qualification of personnel.

Regression models were estimated for all large or small industry groups individually (a total of 8 different regression models).

The regression model for small machinery firms is not as robust as the other regressions: the Durbin-Watson and Q-statistics tests suggest some heteroscedasticity problems. Test of normality of residuals, however, confirmed the regression model.

The most obvious result is that across all country-pairs and all industries, the use of modern communication technologies proved to perform most often as firm-specific determinant. This in the decreasing order of use of e-business, internet and e-mail. The second most frequent group pertains to the intensity of networking, with regularly contracting over at least two years, with stake-holders of the firm being more often a performing determinant than networking with customers or suppliers. Next, strategic planning turned out to be a relevant determinant of gaps, followed by training of personnel and in particular of workers, and then the intensity of investment. Notably, the level of qualification of management and administrative staff turned out to often negatively correlated with productivity levels, a result that was also obtained in other studies on a comparison between East and West Germany. It roots mainly in East German entrepreneurs having a high level of formal qualification in technical fields which, however, prove to be of less relevance as compared to marketing and management expertise.

Intensity of innovations only turned out to be significant as firm-specific determinant of productivity gaps in a few cases. The diversification *vs* specialisation issue also produced significant results only in few cases and, noteworthy, in all but one case with a negative sign, suggesting that concentration on a fewer number of products is positively associated with productivity levels in all but the electrotechnical industry.

Finally, the control variable, here defined as the correlation between “labour costs per employment” and either the “rate of automatisation” in the machinery and furniture panels, or “value of fixed assets per employment” in the cosmetics and electrotechnical panels suggests only in very few cases and mostly amongst electrotechnical firms, that lower labour costs triggered substitution of relatively more expensive capital with labour. Only in these cases is some of the productivity gap accountable to a rational strategic decision of the managers.

To discriminate between the performing firm-specific determinants and in order to infer the ranking order within industry and country-groups, we test regression models and compare country-averages in the two final steps in our analysis. In total, eight regression models were estimated: one for each of the two size groups and for each of the four industries. This adheres to the concept of matching pairs: we sought a common model for *e.g.* all small machinery firms, regardless of their country or region of origin (this obviously implies that in the regression analysis, we must not control for country-differences). A composite indicator is developed by multiplying the regression-coefficients and the gaps in determinants for each of the 40 sub-samples: the higher the regression coefficient (duly interpreted as elasticity, because the data was used in logarithmic form) and/or the higher the gap, the more important is the firm-specific determinant. Only in this framework of analysis are we able to test our hypothesis. The results are represented in the table “Results of regression analysis and comparison of averages: the ranking order of firms-specific determinants (composite indicators)”.

The first set of results pertains to the kind of determinants that turned out to be significant in the size-and industry-specific regression models: the control variable, here defined as an interaction terms between labour costs per employment and either one of the two capital intensity measures, positively tested for substitution of labour in only three cases, namely amongst both size-groups of electrotechnical manufacturers and large cosmetic manufacturers. In all other samples, productivity gaps have nothing to do with a strategic decision of firms to exploit the comparative advantage of lower levels of wages. Investment intensity could be included as significant regressor in all eight models and typically ranks very high in terms of regression coefficient. Second, strategic planning turned out to significantly explain productivity levels in all but one model with elasticities reaching 0.45. Intensities of networking and the intensity of use of modern technologies (both averaged to reduce the number of regressors) were significant both in five of eight cases, however, with lower coefficients. All human capital proxies and the specialisation vs diversification issue are significant explanatory variables in a lesser number of industrial and size-panels and with lower coefficients. Surprisingly, the intensity of product innovations turned out to be significant only in the regression model for large machinery firms. This, however, might be due to the difficult definition of innovations and hence their comparison between firms. These results compare well with the results from the correlation analysis, the remaining differences are due to interaction between the determinants and due to the fact that in the regression analysis, not all firms could be included due to missing values in at least one of the regressors.

Not all of the hypotheses tested positively in terms of constituting a significant determinant for productivity gaps. We expected all four panels to particularly benefit in terms of productivity levels from following a highly specialised product strategy (hypothesis 1). This, however, was only true for large Polish and Hungarian furniture manufacturers, for all small cosmetics manufacturers, and for large Polish and Czech electrotechnical manufacturers. We expected in hypothesis 2 that human capital would play a particularly important role in the group of machinery manufacturers: in fact, qualification of personnel did neither perform in the correlation analysis, not could we establish a significant coefficient in the regression. Even though, training of personnel did turn out to be important, and also more so than for the cosmetics and electrotechnical manufacturers, however, not any more than for the furniture industry. Hypothesis 3 assumed that investment was particularly important for the machinery and electrotechnical industry. Whilst this might be true for more mature market economies, the performance of furniture and cosmetics manufacturers in transition economies depends not less on investment. Hypothesis 4 on product innovations in particular in the machinery industry tested positively: only amongst large machinery manufacturers could we establish a significant regression coefficient, innovations are most important for the large Hungarian and Czech machinery manufacturers, a bit less for the Polish ones, and even much less for the East German ones. Hypothesis 5, 6 and 7 were targeted at the “soft” management variables: strategic planning turned out to be of very high importance both to explain productivity levels within groups and productivity gaps *vis-à-vis* West German firms. This is particularly pronounced in small machinery firms and small cosmetic firms, and to a lesser degree in small and large electrotechnical firms and large machinery firms. Noteworthy, in all groups, this determinant played a lesser role for East German firms. In terms of the hypothesis 6, the intensity of networking is important in a large number of groups, yet to a lesser extent: composite indicators range between 0.1 and 6.1. For the use of modern communication technologies, composite indicators are much higher and range up to 18.5.

In general, the intensity of investment, of strategic planning, of long-term contractual networking, and of the use of modern communication technologies turned out to be good determinants of both productivity levels and productivity gaps for most of the industries and size-groups assessed here.

WP 6.5.3 Firm-specific strategies

Finally, we asked firms in the cosmetics and electrotechnical manufacturing industries to specify which of the proposed strategies they prefer to:

i to improve productivity levels in their own firm, and

ii to cope with intensifying competition.

The analysis has been conducted by comparing percentages of all firms stating that the named strategy is important. The analysis was conducted within, and is comparable across country, size, and industry-specific panels. The presentation of results follows in the form of figures (Figures WP 6.1 to 6.6).

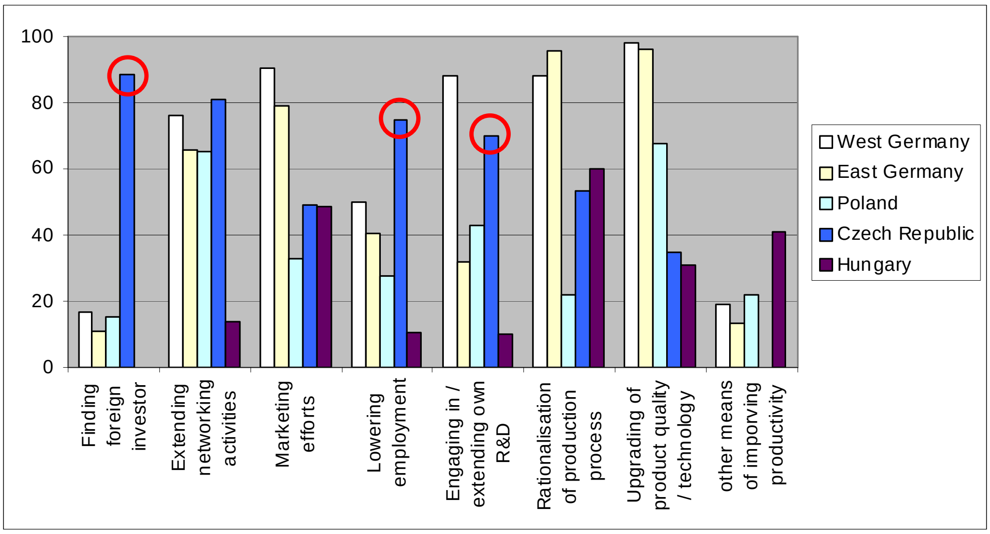

Figure WP 6.1 Machinery manufacturers

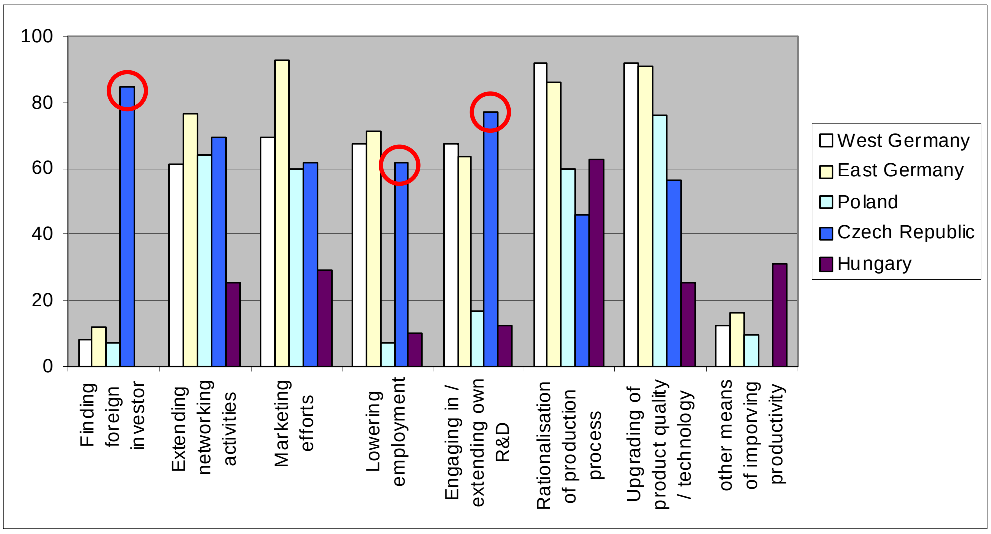

Figure WP 6.2 Furniture manufacturers

The first, most important results is that our questions appear to have covered most of the strategies relevant to firms: the control-group of “other means” is sufficiently low. Second, another obvious result is that the answers can neither be grouped homogenously across manufacturing industries or across size-groups. Rather, common structures emerge at the country-level: East and West German firms seem to prefer quite similar strategies, only with respect to “engaging in/extending own

R&D" appear to exist significantly different views, even if only amongst machinery manufacturers. We would have expected that the well-established financing-gap might well have produced a clearer distinction here. Additionally, East and West German answers appear to be closer to each other than to any CEEC.

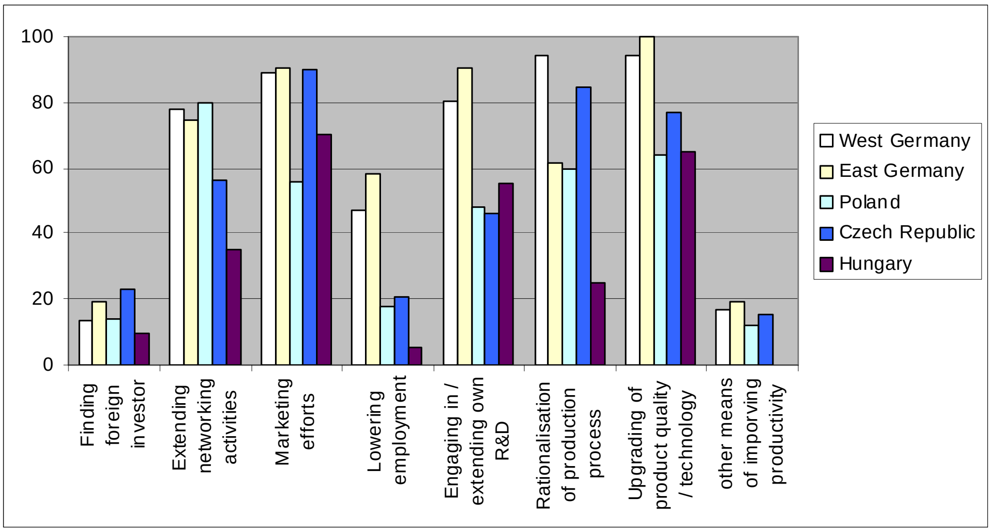

Figure WP 6.3 Cosmetic products manufacturers

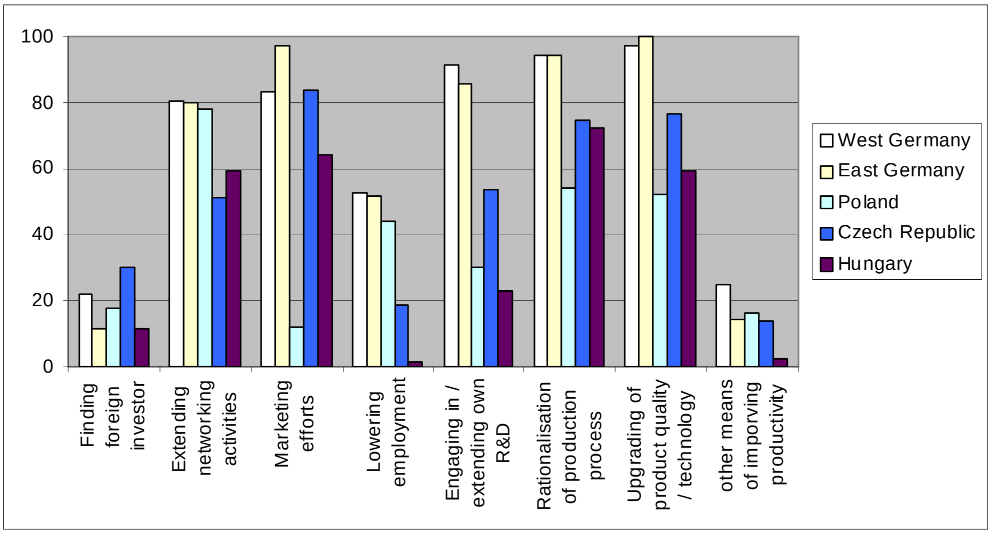

Figure WP 6.4 Electrotechnical products manufacturers

Across all samples, the recognition that a given strategy is important is highest for networking; here, in particular the Hungarian firms, show a larger gap (mainly in machinery and furniture manufacturing). Additionally, we identified recognition-gaps in Hungary for 'own R&D'. The largest gaps, however, can be observed for Poland, and mainly amongst marketing in the cosmetics industry. In comparison to East and West Germany, the largest gaps are identified for the Czech firms in general (this view is further strengthened by the question-mark we have to put to the rather difficult to motivate results marked with red circles in the figures).

Across all industry, size, and country-groups, the most preferred strategy to improve productivity levels are positive and active strategies (not including "finding a foreign investor" or "lowering employment"), but rather feature networking and marketing activities, production-process-rationalisation, product quality issues. Interestingly, “finding a foreign investor” did not turn out to be a widely preferred strategy despite the potential technology transfer (which may be due to a large number of firms already having a foreign investor).

With respect to firms’ strategies to sustain intensifying competition, East and West German firms are clearly under the pressure of high labour costs (or *vice-versa* in competition with lower labour (unit) costs in Central East Europe). In the distinction between unit labour costs and wage levels, a strategy favouring innovations would equally better competitive positions by increasing productivity. This, however, was not the preferred strategy in either parts of Germany.

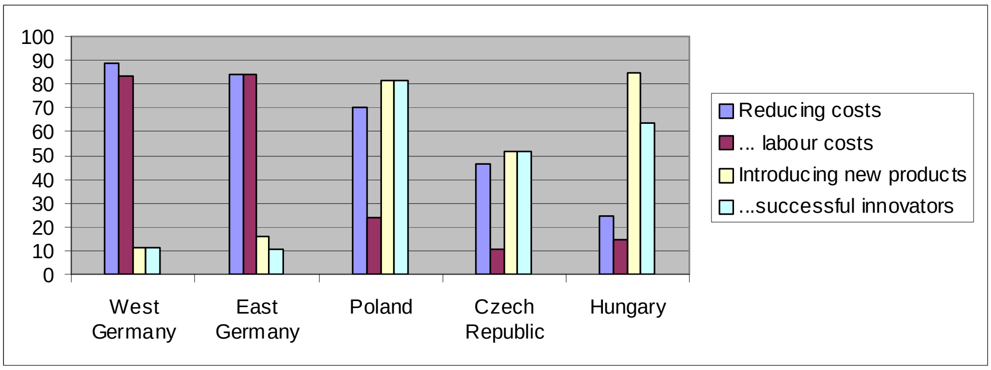

Figure WP 6.5 Cosmetic products manufacturers

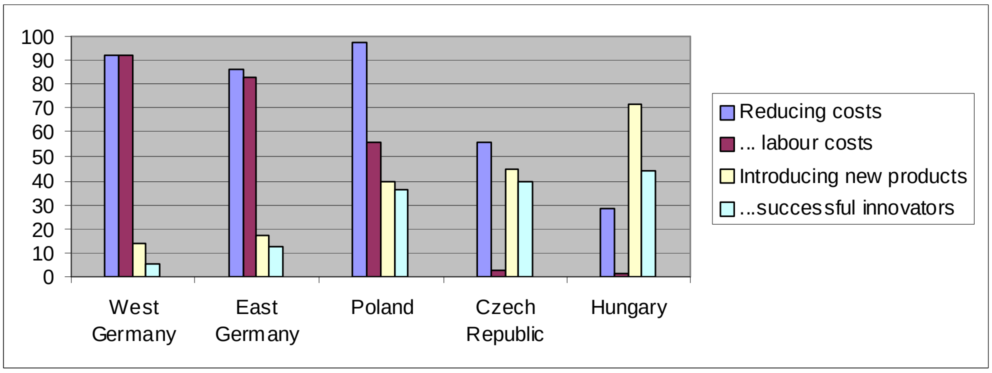

Figure WP 6.6 Electrotechnical products manufacturers

Here, the Czech Republic and Hungary appear to be more inventive in their strategies; Poland is somehow stuck in the middle without a clear preference between costs and innovation, even if labour costs do not seem to play an important role here either. In fact, the Polish and the Czech firms (and large Hungarian firms) were largely successful in producing innovations. In a comparison between size-groups, again no significant differences emerged.

WP 6.6.1 The method of the matched-pair analysis between industry, and size-specific ‘better’ and ‘worse’ firms

The analysis of the Polish team, consisting of Malgorzata Jakubiak and Anna Wziątek-Kubiak, centres around the matched-pair method. It divides the size, and industry panels into the ‘better’ performing and the ‘worse’ performing firms (with the criterion being firms’ apparent productivity levels), irrespective of their country of origin. This method is more general than the prior specification of the matched-pair analysis with an explicit and pre-determined benchmark. Additionally, the Polish team applied a cluster analysis endogenously classifying all firms of the cosmetics industry.

The surveyed branches include the construction industry (interrogated during the first year), the furniture and machinery industries (second year), and the electronics and cosmetics industries (third year). Some more effort in research was invested into the analysis of the cosmetics industry, because this sample proved to be much more homogenous than all other samples, and the most robust results are expected here.

WP 6.6.2 The main results of the Polish team

The results of the analysis of comparison between the better and the less well performing firms can be summarised in mainly six points listed below.

i In a first step in the analysis, we compared firms from the new member states to such in Germany (East plus West). The objective of this exercise is to identify the main reasons for lower levels of firm-level productivity.

- We find an extremely high differentiation in productivity levels among firms in the large and small samples, much larger differences indeed than between the two samples. This can be explained by the process of shaping the market structure in the new member states, which is a major part of their transition. The productivity gap between firms in the 'worse' sub-samples of the new member states including Germany was far greater than in the case of the 'better' firms' sub-samples. The major problem of the new member states is hence not the lack of highly productive firms but the continued operation of many very low productive firms (the so-called 'long tail'). This means that the market selection process among the firms in the surveyed countries will still have to eliminate the least efficient firms in the three new member states in the future.
- Further, we found very a low productivity level of the small firms' samples for the new member states *vis-à-vis* comparable firms in Germany. In particular, productivity levels of the 'better' sub-samples of small firms of the new member states was still lower than those of Germany's 'worse' sub-sample. Since the investment rate of the former was much lower than that of the latter, we expect a continuation of the process of deep and wide selection and the squeezing out of small firms in the new member states.
- Large firms in the new member states produce comparable products, serve mass markets and are highly productive. The most productive were Polish firms and the least were their Czech and Hungarian counterparts. In-depth analysis of 'worse' firms' sub-samples shows that Polish and German firms will likely move up the productivity ladder. This indicates increasing competition between the Polish and German surveyed firms from today's 'better' and 'worse' sub-samples, and increasing competitive pressure on Czech and Hungarian firms.
- Firms in the new member states produce more labour intensive and share a higher intensity of work per employee than the German firms. The lesser role played by R&D in the competitive strategies of these firms indicates that they will focus on a low technology type of production.

- o Especially in Polish firms, we found a very low capital intensity and a low investment rate. This implies low substitution of labour by capital, in contrast to German firms' strategy.
- o Again especially in Poland, we identified exhausting possibilities to lower employment in the firms' attempts to increase productivity.
- o Amongst the firms from the new member states, we found a lower share of managers' daily time spent on strategic planning, which indicates to us a less stable business environment (rather than *e.g.* management deficiencies as suggested by the interpretation by Johannes Stephan).
- o Finally, we identify an extremely low intensity of use of modern communications technologies amongst Polish firms.

ii The following more specific conclusions for firms are based on a comparison between the 'better' and 'worse' firms' sub-samples, irrespective of their country or origin. Lower productive firms are characterized by lower fixed capital intensity and a lower investment rate, higher unit labour costs, a lower share of employees improving qualifications, and a lesser intensity of the use of modern communication technologies.

iii Our research furthermore indicates that the higher the productivity, the lower the role of fixed capital intensity and unit labour costs. It was shown in the clustering analysis that in spite of the "hard" determinants of productivity (like labour costs and investment), achieving higher productivity is also a question of sets of other, more 'soft', factors related to good management. These include: the ability to compete by being innovative and at the same time securing long-term contracts with clients, and being up-to-date with modern communications technologies. Moreover, the correct assessment of a firm's strength and weaknesses helps very much in the efficient use of factors of production.

iv The clustering analysis also confirmed that small and large firms from the cosmetics industry operating in the three new member states and in Germany have indeed different productivity determinants and face different constraints. While it is possible that the productivity of the small firms was influenced by factors not accounted for in the survey, the results obtained for large firms are straightforward. Clustering analysis performed on the group of large cosmetics firms shows that low labour costs are still a competitive advantage in the new member states, especially in the Czech Republic and Poland. If coupled with adequate investment and wise management, they can lead to higher labour productivity than in the West German firms.

v The firm-level analysis also shows that small firms are more aware of their business environment and more adequately assess their own competitive strategies than large enterprises. Views about ways to improve productivity among the group of large enterprises are more blurred and only the most productive large firms evaluate correctly what they should do in order to be more productive.

vi There exist differences in productivity performance of rural and urban firms, irrespective of whether they are large or small or whether they are from CEE or Germany. Firms located in urban areas – which enjoy better infrastructure, better access to a qualified labour force and modern technologies – are much more productive. In addition, smaller firms located in urban areas have productivity levels no different from the levels of large enterprises.

WP 6.7.1 The methods of the Hungarian team's multivariate analyses

The Hungarian team, consisting of Ilona Cserháti and Tibor Takács, examined the collected data on the selected industries by a variety of different multivariate statistical methods. The objective of this analysis is to identify the areas in which firms in the new member countries still have some way to go in terms of catching up. The firms of the machinery, electrotechnical, cosmetics, and furniture industries formed part of the analysis, because here, the number of observation units for analysis (*i.e.* firms) was large enough to warrant the use of more sophisticated econometric methods.

Before applying their multivariate methods, the team examined the dataset by descriptive statistics in order to get a general picture of the information and to filter the outliers and unreliable information[3]. As a first multivariate analysis, the team ranked all interrogated firms by creating a complex indicator that is able to reflect all or most of the information gathered about the firms. This complex indicator was constructed in two steps, first using a more subjective method of ranking weighted means, second by applying the principal component analysis and factor analysis. Because the resulting ranks can be considered to be of an interval scale and not only of the ordinary scale, the analysis to is able to use a larger selection of econometric methods.

The second multivariate method applied to the dataset is the cluster analysis. The firms can be clustered either by their original values of variables or by the factor scores resulting from the factor analysis; also different types of distances can be considered in the cluster analysis. In the case of the 'CEE firm-specific database', we can identify 'natural groups' of firms, *i.e.* firms belonging to different countries, size-groups, and to different industries. Third, the discriminant analysis identifies the variables that are most characteristic for these groups. Forth, some (linear and non-linear) regression models have been tested by use of stepwise, forward, backward, *etc.* specifications. As regressors, either the original variables and/or the principal components (or factors) were used.

We were particularly interested in the role and performance of innovation in our dataset. The team hence finally examined firms in selected industries with respect to the determinants of product and process innovation. Since the innovation activity has been measured by the number of new products/processes, this was an integer variable. The stochastic effects on such a type of variables can be examined by probit or logit regression models.

WP 6.7.2 The main results of the multivariate analyses

In the case of four industries field work generated enough information to warrant a meaningful and robust mathematical statistical analysis. This analysis covered therefore furniture manufacturing, machinery manufacturing, the cosmetics, and the electrotechnical industry. There are several companies in these industries in all the

[3] In this particular analysis, not only firms were filtered but also indicators, because some of the questions were not formulated in sufficiently unambiguous manner, or they contained too many subjective elements which could have distorted the analysis.

examined countries, and the productivity gap in these industries seemed to be relevant.

WP 6.7.2.1 Furniture manufacturers

In the case of large companies the productivity advantage of the West German ones is very characteristic. The results of the factor analysis showed that there have been three main groups of indicators that explain the difference. The main indicators of productivity appeared in the first factor together with innovation and the unit labour cost (UCL). This underlined the role of the innovation and highlighted the typically positive correlation between wages and productivity levels. Companies employing highly qualified workers with relatively higher wages also tend to be more productive. The importance of qualification was highlighted by the fact that the qualification indices had the highest scores in the second factor, which we could call therefore the factor of qualification. It was somehow surprising to observe that the qualification of physical workers is more important than that of the management.[4] The third factor could be interpreted as the one of networking. The firms have been ranked according to the factor scores for each factor. Normally, the scores in the first factor are accepted a complex indicator of the examined phenomenon, *i.e.* of the productivity in our case. The rank according to the first factor showed the dominance of the West and East German firms. This means that the gap between (East and West) German firms almost disappeared in this group of companies. The Polish companies had the lowest values in this list. The ranking has been made also for the second factor. In this rank list, the Polish firm assumed better positions.

The clustering of companies reaffirmed the above results. The firms have been clustered according to the factor scores and according to the original (but standardised) variables. The two methods yielded similar results. Filtering the outliers, the separation of the East and West German companies was apparent.

In the case of small companies of this industry, the results are similar. The factors could be interpreted similarly. The only difference was that also the indices of e-business appeared in the first factor with high scores. This underlines the importance of use of IT in the smaller companies. The second factor in this group was again determined by the indices of qualification, and the qualification of workers was again more important that that of the management. The ranking according to the first factor was a bit different from that observed in the group of large firms. Several West German companies could be found in the top ten again, but instead of East German ones, some Czech companies appeared here. This might suggest that the productivity gap among smaller companies of this industry is not that large. A sharp polarisation could be observed among Polish firms, while the Hungarian ones appeared typically in the second half of the rank list. In the ranking according to the second factor, the Polish firms have not reached such good positions than in the group of larger companies.

The clustering showed that the distance between smaller (East and West) German firms and other companies is not so large than that observed for larger companies.

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4 Research on East Germany suggests that this effect might be due to high formal qualification levels amongst managers which, however, are more of a technical kind and not necessarily match the demands in a competitive market economy.

WP 6.7.2.2 Machinery manufacturers

The results for the machinery manufacturers were rather similar to those observed in the furniture manufacturing. The results were even more characteristic. The first two factors in the group of larger companies could be interpreted similarly. This might suggests that the qualification plays an important role in all industries. The fact was highlighted again that the qualification of physical workers and of the administrative personnel is not less than that of the management. When ranking firms according to the first factor, the West German firms occurred again in the top ten. The Polish companies proved to be the less developed again. Generally, the polarisation of the observation units is more characteristic than in the furniture manufacturing. Among the firms of the Central and Easter European countries, the position of the Czech companies are relatively the best, but these companies are rather evenly distributed after the German ones. The heterogeneity of this group might explain this phenomenon.

The results of the cluster analysis in general reaffirmed the above results, but the East German firms are distributed between the clusters of the West German ones and of the rest.

The group of smaller companies showed only a different factor structure. Here the qualification also appeared as an independent factor, but this is only the third. The second one is the factor of networking. The first one can be interpreted in the same way, but the indices of the use of IT are distributed between the first two factors. It could be observed in the ranking that the scale is broader, *i.e.* the interval is larger between the lowest and the highest score. The West German firms are the best again. There are still three Hungarian firms among the best ones, but other Hungarian appeared only in the lower part of the list. This shows that even within a country there can be sharp differences, especially among the smallest firms. The East German and the Czech companies proved to be average, and the Polish ones could be found typically in the second half of the list.

The cluster analysis by factor scores and by standardised original variables showed a slightly different picture. In the first case, the German firms and the rest have been separated in two characteristic groups. In the second case, the Czech ones seemed to be closer to the cluster of the German firms.

WP 6.7.2.3 Electrotechnical industry

In the third round of the project we used a slightly different questionnaire to examine the productivity in the electrotechnical and in the cosmetics sector. Some new information was requested primarily on the infrastructure (accessibility by transport, *etc.*). Since the provided information seemed to be rather uncertain, we filtered some of the information on the basis of the correlation matrix; the statistical analysis was conducted only for the rest of the information.

Now we ranked again the observation units (firms). Firstly, we determined the classical index of productivity (*i.e.* value added divided by the number of employees), and we compared it with the ranking list according to the first factor. We find that in these two industries the factors could not be so clearly interpreted than in the case of the previous two industries.

In the case of the large electrotechnical companies, the results of the two rankings are very similar. There are eight German companies in the top 10 and five German companies in the bottom 10 of the two lists. In general one can observe that the advantage of large West German is comparable to the advantage in the case of small companies, while the less productive firms are mainly Hungarian. In the rank-list according to productivity levels, all German companies are in the upper third, and the West German firms are ranked higher than the East German ones. Less than one fifth of the Hungarian companies can be found in the first half. 33 *per cent* of the Czech and 58 *per cent* of the Polish companies are in the first half. The situation is similar in the case of the second rank-list. This means that unlike Hungarian companies, the Polish and Czech ones have already begun to catch up, while the Hungarian companies might preserve their disadvantage.

The cluster analysis did not provide any astonishing result. It just showed that the German firms belong into a separate group. This, however shows that there is no wide gap between East and West German firms. Most of the other firms could be found in one group, except for the Czech ones. This might suggest that they have the lowest disadvantage.

Since one of the main focuses of the project was to compare the productivity of earlier West German and Central and Eastern European companies, we first examined two characteristic groups in the discriminant analysis. We considered consequently two characteristic groups first (West Germans and others), and determined the most characteristic variables from the examined ones. In the group of the larger electrotechnical firms, the most characteristic indices were productivity levels, turnover per total costs, and labour costs per employees.

We also would have liked to know if there were other characteristic variables, if five groups corresponding to the examined countries were considered. In this case, the most typical indices were the qualification of workers, personnel training, and the intensity of use of e-mail.

Also a regression analysis has been performed to identify the relative effects of the different indices and the factors on productivity levels. When the original variables were considered as regressors, unit labour costs, value of fixed assets, long-term contracts with the suppliers, and accessibility by railway seemed to have a relevant effect on the productivity level. This was reaffirmed also by the factor regression.

Regarding the small electrotechnical companies, the group of the top 10 are similar: there are five German companies that can be found among the best in both list. However, the bottom 10 are different. When companies have been ranked according to the factor score, mainly Polish companies – one third of all Polish companies – got to this group. This might suggest that although these companies reached a relatively good productivity value in the examined year, the other factors of productivity are not favourable, which may have a negative effect on their productivity in the future. The opposite might be true for almost one third of the Czech companies. In the top, the advantage of West German firms is unambiguous. 60 *per cent* of them can be found in the top 10 of both lists. All German (East and West) companies are in the upper third, when the companies are ranked according to the productivity index. The West German companies are typically better than the East German ones. Only about one third of the Hungarian and Czech companies can be found in the first half of this list. If one considers the rank-list of factor scores, it is found that most of German companies stay in the upper half. The Hungarian ones are ranked relatively better, since 60 *per cent* of them are in the first half.

The result of the cluster analysis was similar in this group to that of the larger firms. The disadvantage of the Central and Eastern European firms was however even more apparent.

When two groups were considered, the discriminant analysis identified productivity levels, labour costs per employees, and fixed assets per employees as the most group-creating indices. In the case of five groups, the most characteristic indices were the level of qualification, long-term contracts, and the intensity of use of e-mail.

The regression analysis in this group showed that unit labour costs, the training of personnel, and again the accessibility of railway transport had the largest effects. The factor regression also underlined the role of railway transportation facilities and in this latter examination, the qualification levels also played an important role.

WP 6.7.2.4 Cosmetics industry

The most astonishing result in the ranking emerged in the case of large cosmetics companies. As it was mentioned above, the small Polish firms have obvious disadvantages in this industry. According to our results, the opposite is true among large companies. In both lists, about one third of Polish companies can be found in the top 10, and one third of them got into the first half. However, we also found Polish firms in the bottom 10. This means that in Poland, this industry might have a dual character. Some large companies have already reached or even exceeded the productivity level of the Western companies, while several – mostly small ones – cannot catch up. Also the Czech companies show such a division. The Hungarian companies are not so different, and their productivity level is average. In the productivity rank-list 62 *per cent* of Polish companies are in the first half, while only less than one third of the Hungarian ones can be found here. There were only four West German companies in the sample, three of them got into the first half. The productivity of the East German companies proved to be average. In the rank-list of factor scores, their position is worse.

The cluster analysis supported the conclusions drawn from the ranking analysis. Here, the West and East German companies are not unambiguously separated. On the contrary, Polish companies form a separate group owing to their high productivity. The Hungarian and Czech ones are rather evenly distributed.

In the case of two groups, the discriminant analysis identified the following characteristic indices: turnover per total costs, and unit labour costs. In the case of five groups, the only characteristic index was the intensity of use of e-mail.

Also for the cosmetics industry, both the usual and the factor regression were applied. Unit labour costs, the intensity of use of e-mail, and railway-indicator proved to be the most relevant indices. The factor regression pointed out the effect of the qualification level as well.

In the case of small cosmetics companies, the advantage of German companies is apparent, too, and the top and bottom 10 is very similar in the two lists. 86 *per cent* of East Germans and 67 *per cent* of West Germans are in the top 10 of the productivity index. In the sample were only three West German companies, but all of them can be found here in both lists. Only a couple of Czech companies reached the productivity level of the German ones. In general, all of the German companies are in the upper third of the rank. 60 *per cent* of the Czech companies can be found in the first half of the productivity rank-list, while only 9 *per cent* of the Hungarian ones are ranked here. The disadvantage of the Polish firms are apparent. When the companies are ranked according to factor scores, the bottom 10 consists of only Polish firms. In this second list, the Hungarian companies reached somehow better results.

When clustering firms, the West and East German companies are together separated from the others. In this case, most of the Czech and Hungarian form one group. The majority of Polish companies got into a separate group. This supports the result of the ranking according to factor scores, which showed an unambiguous disadvantage for the Polish small cosmetics companies.

When the discriminant analysis was made for the case of two groups, the group-creating indices were productivity levels and unit labour costs. In the case of five groups, the selected indices were intensity of competition, fixed assets per employees, intensity of long-term contracting, and the e-mail use.

Both, the factor and the usual regression, showed the important effect of the unit labour costs and the qualification level.

WP 6.7.2.5 Innovation

We examined the relation of innovation and other indices in the selected industries. This has been done by testing a logit model. It was observed that the use of IT had the most important effect. The other important factor is the human capital stock. In this analysis, the firm size did not prove to be very important, but its coefficient was certainly positive.