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**Working Paper**

## The Role of the Human Capital and Managerial Skills in Explaining the Productivity Gaps between East and West

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# **The Role of the Human Capital and Managerial Skills in Explaining the Productivity Gaps between East and West<sup>1</sup>**

## **Abstract**

This paper assess determinants of productivity gaps between firms in the European transition countries and regions and firms in West Germany. The analysis is conducted at the firm level by use of a unique database constructed by field work. The determinants tested in a simple econometric regression model are focussed upon the issue of human capital and modern market-oriented management. The results are novel in as much as a solution was established for the puzzling results in related research with respect to a comparison of formal qualification between East and West. Furthermore, the analysis was able to establish that the kind of human capital and expertise mostly needed in the post-socialist firms are related to the particular requirements of a competitive market-based economic environment. Finally, the analysis also finds empirical support for the role of capital deepening in productivity catch-up, as well as the case that the gaps in labour productivity are most importantly rooted in a more labour-intensive production, which does not give rise to a competitive disadvantage.

JEL-classification: L6, M2

Keywords: Productivity gap, Central East Europe, East Germany, firm-level analysis

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## Zusammenfassung

Diese Arbeit stellt Determinanten der Produktivitätslücke zwischen Firmen in europäischen Transformationsländern und westdeutschen Regionen fest. Durchgeführt wird die Analyse auf Unternehmensebene unter Nutzung einer speziellen Datenbasis, die durch Feldforschung erstellt wurde. Die Determinanten, getestet in einem einfachen ökonometrischen Regressionsmodell, sind auf die Problematik Humankapital und modernes, marktorientiertes Management ausgerichtet. Die Studie führte zu ganz neuen Ergebnissen und einer Lösung für die unerklärlichen Resultate ähnlicher Studien in Bezug auf einen Vergleich formaler Bedingungen in Ost und West. Darüber hinaus wurde in der Untersuchung post-sozialistischer Firmen festgestellt, dass Humankapital und Fachwissen bezogen auf die besonderen Anforderungen einer wettbewerblichen, marktbasieren ökonomischen Umwelt am meisten gebraucht wird. Schließlich wird die Rolle der verbesserten Kapitalausstattung im Aufholprozess der Produktivität empirisch bestätigt. Weiterhin zeigt sich, dass die Diskrepanz in der Arbeitsproduktivität im wesentlichen durch eine arbeitsintensivere Produktion begründet wird, was allerdings nicht zu einem Wettbewerbsnachteil führt.

Schlüsselwörter: Produktivitätslücke, Zentral-/Osteuropa, Ostdeutschland, Unternehmensanalyse

JEL-Codes: L6, M2

# The Role of the Human Capital and Managerial Skills in Explaining the Productivity Gaps between East and West

## 1 Introduction

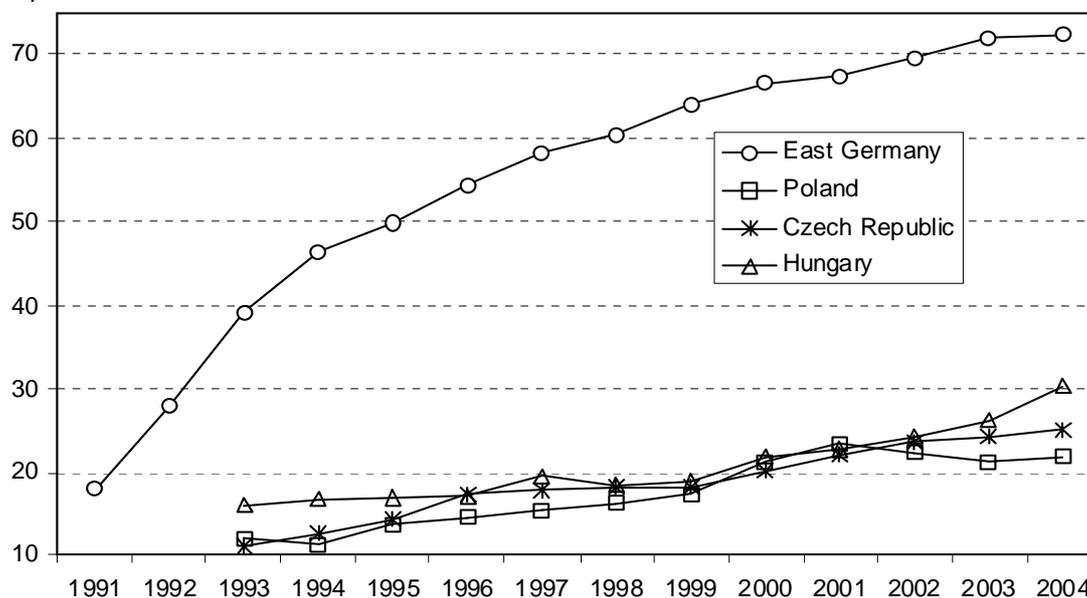
As a result of the particularities of socialist planning, companies in Central East European countries (CEECs) were not able to participate in technology upgrading and have lost ground in terms of competitiveness, highlighted by large gaps in firm-specific productivity levels. Nearly 15 years since the start of systemic transition, most of the necessary systemic, structural, and organisational adjustments have taken place and most economic distortions have been removed, so that competitive market conditions prevail today. According to theory, we would expect companies in CEECs to catch up to the levels of productivity common amongst their competitors in the West. In the usual case, lagging regions tend to catch up (mainly by absorbing already existing technology) with a speed of convergence averaging 2 per cent of closing of gaps per year (Barro / Sala-i-Martin, 1992).<sup>2</sup> In the case of Central East European economies, this speed of convergence may be expected to be higher, this not least due to the high levels of (formal) qualification of workers, the free trade opportunities with the European Union, their attractiveness for foreign direct investment from the West, and the financial assistance for infrastructure development through the EU structural funds.

However, even after more than a decade since the demise of the economic system of planning, we still observe sizeable productivity gaps both at the aggregate level of economies and at the firm level and hence a rather sobering performance in labour productivity catch-up (see the Figure). This, to some degree, reflects wage differences: in a rational decision, firms may choose a lower capital/labour ratio due to comparatively low wage costs. The observed gaps, however, appear to be larger than wage differences would suggest and in our contribution, we aim to find out what other factors that are specific to the firm-level may account for the observed productivity gaps. By establishing the main reasons why firm-level labour productivities in East are still much lower than in the West, we are able to contribute to answering the puzzling question as to why productivity convergence was such a sobering experience in the post-socialist economies.

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<sup>2</sup> In fact, *Lee et al. (1997)* provides a higher estimate of 10 per cent per year, also by use of a Solow growth model framework.

Figure:  
Average apparent productivity levels in manufacturing industry (not PPP)  
in per cent of West German level



Sources: National Statistical Offices, authors' calculations.

Prior research suggests that reasons for observed aggregate productivity gaps are rather manifold, no dominant factors could be established so far. Factors include differences in sectoral structures (e.g. larger share of labour intensive sectors), differences in functional structures (smaller share of more sophisticated tasks between the same sectors), differences in size-structures (relative lack of large companies), and differences in the prices that firms in the East are able to achieve due to a lower market value of 'produced in the East'.<sup>3</sup> Focussing on the East German investment goods industry, Lay (1996 and 1998) and Mallok (1996) establish deficiencies in quality of productive capital and its technological upgrading and in the efficiency of use of updated capital stocks. Eickelpasch (1996) and Bernhardt et al. (1997) hold that East German productivity differences also root in market positions and access to markets, measured in prices in sales and in procurement. In two sets of microeconomic analyses using existing databases on East Germany, Bellmann/Brussig (1998) establishes deficiencies in company organisation and in the integration of the firm into the enterprise as a whole (where establishments form part of a system of enterprises with several subsidiaries). Czarnitzki, 2005, indicates deficiencies related to innovation. Each of those determinants alone, however, do not account for much of the observed lower levels in the East, large gaps in explaining

<sup>3</sup> See Ragnitz (1999), and Ragnitz et al. (2000), and Ragnitz (2001) for a review of results of empirical studies as well as for their own assessment of determinants conducted in a comprehensive project comparing East and West Germany. For an analysis of determinants of productivity gaps between CEECs and the West Europe, see Stephan (2003).

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differences in levels remain a challenge for empirical research. Firm-level determinants of labour productivity gaps are the focus of this analysis.

Research into the main drivers of productivity catch-up establishes that the shedding of excess labour (reducing the vast levels of overstaffing in previously socialist firms) appeared to be dominant for productivity convergence in CEECs, this particularly during the early periods of systemic transformation and integration with the West; only at later stages did technology play a more prominent role (Stephan 2003 for CEECs and Fritsch / Mallok, 1998a and 1998b for East Germany). Analysing the protracted narrowing of productivity gaps between East and West Germany, Barrell / te Velde (2000) hold that further productivity growth will depend on the quality of human capital whilst potentials from organisational changes and privatisation are already depleted. Focussing on the machinery manufacturing industry, Mallok (2005) establishes that the recent productivity growth in the firms that he assessed originated mainly from internal learning effects of firm staff.

Operating in a new system of economic governance, firms in transition economies are today confronted with the necessity to supply human capital in general, and in particular qualification that is related to the market-oriented management of companies. This kind of change in expertise may well be an issue not easily resolved after nearly half a century of economic governance by planning and we use our unique firm-level database to test this issue in a set of hypothesis. The novelty of our analysis into the human capital issue is that we do not only measure the extent of formal qualification (in our case augmented by above-average job-experience and training), but also assess the use of management expertise in specific business functions (like e.g. networking, strategic planning, and the use of modern communication technologies). The data was gathered by a questionnaire involving four distinct manufacturing industries, namely machinery, furniture, cosmetics, and electrotechnics and in the form of a cross-section in 2003/2004, i.e. nearly 15 years after the start of the systemic change. Our database consists of nearly 1000 firms in East and West Germany, Poland, the Czech Republic, and Hungary.

The paper starts with developing the set of hypothesis to be tested in the empirical analysis. This is followed by a brief discussion of the methodology of our analysis, including a description of data and the regression model. Section four presents the results of our empirical analysis, and the final chapter discusses our main results and puts them into perspective of what the relevant literature holds.

## 2 The set of hypothesis

From the modern management and human resources literature, we deduct that firms can be expected to perform well, if they are well endowed with a high quality of human capital and if they are at the same time able to motivate qualified management and personnel to make productive use of their abilities. Hereby, use of abilities is not restricted to the production process in the narrow sense but also to management. For firms in transition economies, it is mainly the management kind of expertise that tends to be new and with learning consuming time, efficiency lags may well persist for some time. Whilst we are able to observe efficiency differences between East and West in labour productivity gaps, some of these gaps are not efficiency-related at all and are rooted in a more labour-intensive production in the East due to lower relative capital-labour costs. Firms may substitute capital with relatively cheaper labour along a given efficient production technology frontier.

In an empirical analysis of data generated in field work specifically for this purpose, we should be able to determine which of the human capital, expertise, management, and production factor substitution determinants are most relevant in explaining the productivity gaps still observable today between East and West:

### 1 *Qualification and training of personnel*

The qualification of personnel alone may not be sufficient to make a difference in terms of productivity, and this may in particular be relevant for post-socialist economies. Here, qualification profiles were always significantly high, not least due to the high industrialisation level of the socialist economies. Yet, new tasks in the new environment of economic governance are often considerable different to what they were during socialist times. Some old competencies tend to have become obsolete. Hence, qualification in training programmes is needed to prop up the already existing qualification profiles of personnel. Training alone may also prove to be insufficient: absorptive capacities amongst personnel for training of new expertise will tend to be higher the higher the initial level of qualification is. Furthermore, training programmes may well be applied most intensively in firms where personnel is least qualified, so that neither qualification nor training programmes alone might be sufficient to explain increases in labour productivity levels. To control for this, we test in an interaction term whether a simultaneously high intensity of qualification and training at the firm level significantly explains productivity levels.

**Hypothesis 1.** The extent of qualification only increases productivity levels if paired with simultaneous training of personnel at the firm level.

## 2 *Intensity of networking with suppliers, customers, and other stake-holders*

In an increasingly fragmented structure of division of labour between firms, networking with suppliers of intermediate products and services becomes a pivotal instrument to achieve competitive advantages. The intuition is derived from Industrial Organisation Theory, where firms balance inner-firm coordination costs with transaction costs in their relations with other firms: networking allows firms to reduce costs associated with searching, negotiating, and contracting by establishing trust and experience via long-term relationships. A high intensity of networking with suppliers may not only reduce risks associated with the conditions of delivery (e.g. time, quality) but also allows firms to intensify division of labour between the firm and networking partners (e.g. the outsourcing issue). Frequent supply shortages prevalent in the socialist times were one important reason for low levels of efficiency. Long-term networking with customers may likewise involve cost advantages and may form part of a marketing strategy geared towards securing prices and quantities: firms may achieve competitive advantages by designing their products and services to what the market demands. Socialist planned economies were characterised by a dominant producers' market where customers had to take what and how much they could procure. Networking with other stake-holders of the firm may involve all business-related services from consulting to financial services. In a modern competition-governed economy, access to the right kind of services clearly improves efficiency and productivity.

Regular networking in daily operations of the firm command a particular kind of expertise is but another form of human capital. Advantages derived from these sources can be assumed to translate into productivity increases.

**Hypothesis 2.** Firms that intensively network with suppliers, customers, and other stake-holders achieve higher levels of productivity.

## 3 *Intensity of use of modern communication technologies*

Modern technology provides formidable opportunities to increase efficiency in production, administration, management, and in communicating with the market. We are particularly interested in technologies that reduce transaction costs by facilitating and speeding up communication, because here, the gaps to socialist times may be assumed to be largest. This includes the use of Email, the Internet, and so-called e-business platforms on which firms not only present their products and services but also allow customers to order and purchase, and suppliers to interconnect with the logistics of the firm. Modern communication technologies may also be used in search for new productive knowledge (e.g. technical solutions), administrative information (legal information, administrative forms, etc.), and may reduce transaction costs in searching for suitable partners. The use

of modern communication technologies demands a particular kind of expertise from firm staff and is hence an important factor expressing the quality of human capital available to the firm. We assume firms that firms using such technologies more intensively will be able to improve their efficiency in production, administration, and management, and are hence also able to achieve higher levels of productivity.

**Hypothesis 3.** The level of productivity increases with intensity of use of modern communication technologies.

#### 4 *Intensity of strategic planning by the management*

In a competitive environment, firms' managements has to explore future opportunities, assess associated risks, and consider the behaviour of competitors and markets for substitutes to remain in business. Hence, management has to devote some time to non-continuous tasks targeted at increasing market (shares) and exploring new markets, increasing sales prices via product or service quality, and targeted at possible ways of how to reduce production costs. We assume that the ability of firm managers to spend time 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 be able to achieve higher levels of productivity.

**Hypothesis 4.** The intensity of strategic planning by the management influence the level of productivity positive.

#### 5 *Market share and innovations*

Market shares are an important indicator of a firm's competitive position. A large market share provides the ability to control access to a market place and may be a reflect of past innovative activity. On the other hand, a low market share can be a sign of intense competition, forcing firms to be innovative to stay competitive. The market share may hence either translate into higher level of productivity or rather *vice-versa*, our analysis may provide an answer to this question. In line with the most commonly accepted case in Industrial Organisation theory, we assume that firms will tend to be more efficient and achieve higher labour productivity levels if either having a small market share or if they combine past innovations with a large market share.

**Hypothesis 5.** Firms with low market shares and firms with simultaneously high shares and past innovative activity achieve higher levels of productivity.

## 6 *Investment into fixed assets*

Most of the productive capital that was installed during socialist times has become merely obsolete after access to Western technology was made possible with the removal of the iron curtain. Investment into new assets tend to be of particular relevance for firm-competitiveness in the East. This reflects the capital-deepening issue of the convergence problem: with a better endowment of workers with capital stock like machinery, labour productivity can be expected to be higher (see Barrell / te Velde, 2000, for the significance of this in the case of East Germany).

**Hypothesis 6.** The intensity of investment into fixed assets increases the probability that the firm achieves a higher level of labour productivity.

## 7 *Substitution of capital with labour*

The most important determinant of lower levels of labour productivities in the East can be expected to be a result of differences in relative labour/capital costs between East and West. As a rational substitution decision, firms in the East will target lower capital-labour ratios in production to correspond to relatively lower wages whilst capital costs can be assumed to either be the same in the integrated European economic area (financial integration) or to be even higher in the East. Firms substituting capital by a more labour intensive production will hence have lower labour productivities that do not diminish competitiveness.

**Hypothesis 7.** The higher firms' share of labour costs in total costs, the lower will be labour productivity levels.

### 3 The methodology of field work and analysis

This is a challenging focus for empirical analysis, mainly due to the fact that the quality of human capital is not only difficult to measure but also because in field studies, firm managers tend to attach varying levels of importance to this issue or are reluctant to provide unbiased answers. The quality of empirical analysis hence decidedly depends on the design of the field work exercise. This includes in particular the selection of proxies to measure human capital, expertise on the shop floor and in management.

#### 3.1 The design of the field work exercise

In our field work, we used a concise two-page questionnaire. It was sent out in 2003/2004 to firms established in East and West Germany, in Poland, the Czech Republic, and in Hungary. Because we wanted to cover such a large geographical region, we decided to focus on only a few distinct manufacturing industries thought to be particularly conducive to our hypotheses: by randomly selecting firms from national firm-registers in the machinery, furniture, cosmetics, and electrotechnics industries in all countries/regions, our analysis can compare a sufficiently large number of similar firms across those countries/regions. Most of the interrogations were done via the telephone, some firms preferred to fill out the questionnaires on paper or on the internet.

In our questionnaire, we aligned the selection of proxies to the hypothesis that we wanted to test. We asked managers of firms to provide data on levels of annual turnover, share of intermediate consumption, and total employment, to calculate labour productivity levels for each firm. Experience tells us that a pure comparison of formal qualifications between East and West typically produces counter-intuitive results (see Czarnitzki, 2005): formal qualifications for diplomas and certificates awarded in the in the different countries and regions assessed here are not comparable. Hence, we asked firm managers to identify not only the percentage share of firms' staff with higher qualification, but also to consider extraordinary work experience in the field of work when defining the qualification of its personnel. In an attempt to further improve our estimates of the supply of staff qualification, we also asked firms to tell us the percentage share of employees who received training during the year previous to the interrogation of the firm.<sup>4</sup>

To find out whether firms are able to motivate qualified personnel to make productive use of their abilities and to find out to which extent managers consider market-oriented business functions, we asked for the intensities of specific efforts that would typically require some extent of qualification on behalf of personnel and management:

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<sup>4</sup> It is owed to the problem of low rates of return in a field study by use of questionnaires that we were unable to devise a quantitative indicator for training (like *e.g.* the amount of time in training programmes, or the total amount spent for training programmes by firms).

- the ability to keep up networking activities with customers, suppliers and stake-holders. In our questionnaire, we asked firms to estimate the intensity of long-term networking with suppliers, customers, and other stakeholders of the firm on a scale between 0 and 100. Networking was further specified as contractual relationships with a history of at least two years;
- the ability to make use of modern communication technologies in the daily operation of the firm. This was measured in our field work by the estimated intensity of the use of email, the internet, and e-business platforms on a scale between 0 for very low intensity and 100 for very high intensity.
- the ability to strategically plan the fate of the firm in the long term. This was measured by the estimated percentage share of time (adding up to 100 per cent) invested by managers for non-continuous tasks targeted at increasing market (shares) and exploring new markets, increasing sales prices via product or service quality, and targeted at possible ways of how to reduce production costs.<sup>5</sup>

Further questions to test other possible determinants included an estimate of the firm's own market share in the main product (between 0 and 100 per cent), or alternatively the intensity of competition (again between 0 for extremely low competition to 100 per cent for extremely fierce competition). Because market shares alone often do not tell the full story, we also asked firm managers to estimate the number of product innovations generated during the last three years. For the capital deepening issue, we asked firms to estimate the amount of investment into fixed assets during the last financial year.

Finally, to control for the extent to which the level of labour productivity is a result of a rational decision of firms' managers substituting relatively more expensive capital for relatively more abundant and cheap labour, we use the financial data firms provided for labour costs (wages plus social security contributions) and total costs.

### **3.2 The firm-samples and the data**

In each country or region, we set ourselves a target to collect at least 20 filled-out questionnaires in each of the eight subsamples, categorised by the product group (or industrial branch at a NACE 3 digit level) and by the size of the firm or establishment. Only in few cases, we were not able to collect a sufficient number of filled out questionnaires, in particular in the groups of large firms. This is mainly due to the fact that in some countries the overall population of large firms in those narrowly defined industries is al-

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<sup>5</sup> This conceptualisation is the result of several test runs of field work. It obviously remains riddled with the problem that we have to assume comparable efficiency in the use of time for either task between sub-samples.

so very low indeed. In total, we were able to collect filled-out questionnaires from an overall number of 925 firms.<sup>6</sup>

Table 1 lists productivity levels for all subsamples as percentage of the respective West German subsamples (data denominated in current € per employment can be accessed in the annex). In most of our subsamples, the productivity gaps are in fact lower than what the official statistics suggest for the whole industry. This is particularly pronounced for the electrotechnical samples. It was to be expected that preferably more successful firms would answer our questionnaire. The opposite is true mainly for the East German cosmetics manufacturers, only here have East German firms on average achieved a higher level of productivity compared to the West German average which is mainly due to large foreign investments (as e.g. south-west of Leipzig) receiving the latest technology available for the industry.

Table 1:  
Labour productivity levels in per cent of West German levels

	Machinery (NACE 290)			Furniture (NACE 361)		
	Our samples		Official Stats	Our samples		Official Stats
	Small	Large	Total	Small	Large	Total
East Germany	61.7	71.4	52.9	63.4	74.0	62.5
Poland	28.3	24.6	20.2	11.2	18.0	21.2
Czech Republic	22.3	26.4	19.7	34.4	19.2	24.0
Hungary	29.2	17.9	23.0	8.8	10.2	16.1

	Cosmetics (NACE 245)			Electrotechnics (NACE 310)		
	Our samples		Official Stats	Our samples		Official Stats
	Small	Large	Total	Small	Large	Total
East Germany	79.3	76.3	104.3	74.2	77.0	41.6
Poland	22.6	78.0	31.9	28.3	41.1	16.2
Czech Republic	30.1	39.5	29.8	22.6	20.9	14.6
Hungary	11.4	28.6	26.1	10.5	17.0	14.6

Note: Labour productivity levels in our subsamples are calculated as turnover minus intermediate consumption (corresponding to value added) per employment. The size-classes are defined as larger and smaller than 50 employees. The values have been calculated by use of all 925 firms of all subsamples. In the official statistics, the productivity levels are calculated as current value added, corrected by annual average market exchange rates, per employment.

Sources: Official stats for Germany: DIW, 2003, for Poland, the Czech Republic, and Hungary: national statistical offices, authors' calculations.

<sup>6</sup> Having approached some 100 firms in each subsample (totalling 4000 firms) and having received collected some 925 filled out questionnaires, our rate of return for the whole sample amounts to some 23 per cent, well in the typical range for field studies.

The gaps to West German levels are uniformly lowest amongst East German firms and uniformly much larger for East European industries. The largest gaps in official statistics are reported for the electrotechnical industry with around 85 per cent in Central East Europe and 60 per cent in East Germany. The gaps in the other industries are around 70 to 80 per cent in Central East Europe and 40 to 50 per cent in East Germany (with the notable exception of the cosmetics industry).

Table 2:  
Descriptive statistics of the data used

	West Germany	East Germany	Poland	Czech Republic	Hungary
Share of qualified personnel (in %)	45.0	42.3	45.7	37.3	63.8
Share of employees in training (in %)	37.1	30.6	21.1	25.3	20.1
Networking intensity with suppliers (in %)	69.0	63.3	33.9	64.4	52.3
Networking intensity with customers (in %)	72.5	66.6	39.2	59.5	50.8
Networking with other stake-holders (in %)	61.0	48.2	15.2	30.9	30.2
Intensity of use of e-mail (in %)	76.2	67.4	18.1	73.6	46.3
Intensity of use of internet (in %)	73.1	65.3	13.9	60.6	38.9
Intensity of use of e-business (in %)	54.6	35.9	6.7	24.1	25.2
Strategic planning (in % of time)	49.0	45.1	18.3	23.1	23.5
Market share (in %)	46.4	50.8	32.4	40.8	23.8
Product innovations (numbers in 3 years)	3.7	2.7	3.6	3.9	2.2
Rate of investment (in € per employment)	19 636.0	10 225.0	10 129.0	3 761.0	3 404.0
Share of labour costs in total costs (in %)	35.7	33.5	26.6	27.6	25.7

Source: own database.

Table 2 provides averages of data used in our analysis, split for each country/region (levels of standard deviation in each country sub-set can be accessed in the annex). As expected, our data for the share of qualified personnel is higher in some of Central East European countries than in West Germany: Hungary has by far the highest share of formal qualification/work experience and Poland's share is still slightly higher than the one of West Germany. The share of employees in training is highest in West Germany, a puzzling result when we consider the perceived need for increasing the human capital profile in the East and the necessity to replace obsolete qualifications (explainable, however, by the fact that firms in those countries may not have the same financial strength to shoulder such additional costs). Networking intensities as well as the intensity of use of modern communication technologies are all highest in West Germany with clear and vast gaps in the East and in particular in Poland. The share of time invested in strategic planning is highest in East Germany, and clearly lower in Central East Europe than in West Germany. If we use market shares as an indicator for the perceived intensity of

competition, then intensity is highest in Hungary, followed by Poland, the Czech Republic, and West Germany. The East German managers perceived competition to be fierce.

The number of product innovations produced in the last three years is highest in Poland, the Czech Republic and West Germany, whilst the numbers are clearly lower in East Germany and Hungary. Again counter-intuitive is the result obtained for the rate of investment per employment: here, the Central East European countries achieve much lower levels, this despite the fact that they can be expected to be in need of particular intense replacement of obsolete capital and the build-up of new capital to catch up in terms of competitiveness. This may also be due to the weaker financial abilities of firms in the East. The shares of labour costs are clearly highest in West Germany, which is the net effect between the clearly much higher costs for wages and social security contributions on the one hand and the presumed lower labour intensity in production. Unfortunately, we are unable to disentangle this effect into its constituencies.

### 3.3 The regression models

To analyse firm-specific determinants of productivity gaps between firms of two regions, the method of ‘matching pairs’<sup>7</sup> is often applied (e.g. Mallok/Fritsch, 1997, and Czarnitzki, 2005). Firms from either region that are comparable with respect to most determinants (industrial branch, size, location in agglomerations vs in the periphery, etc.) are paired to compare the sizes of the determinants that analysis tries to test. This had been done in a prior analysis and produced largely comparable results for the two German subsets of this database (Stephan, 2004). Whilst this method allows us to analyse field data without prior assumptions on functional distributions, significant correlations may still turn out to be rooted in a third (hidden) factor underlying the process. To solve this issue, we apply a simple regression analysis of determinants that we hypothesised to be relevant for the size of labour productivity levels in an explorative manner. The raw data was transferred into logs<sup>8</sup> and we account for country or region differences, industrial branch, and size differences by use of dummies. We are interested to find out whether these dummies turn out to be significant. The regression formula reads in its basic empirical form:

$$\begin{aligned} \ln \rho = & C + \beta_1 \ln E^{qual} + \beta_2 \ln E^{train} + \beta_3 \ln Net^{supl} + \beta_4 \ln Net^{cust} + \beta_5 \ln Net^{stakehold} \\ & + \beta_6 \ln Use^{email} + \beta_7 \ln Use^{www} + \beta_8 \ln Use^{e-bus} + \beta_9 \ln SP + \beta_{10} \ln MS + \beta_{11} \ln MSI \\ & + \beta_{12} \ln Inv + \beta_{13} \ln LC + \text{Country dummies} + \text{Branch dummies} + \text{Size dummy} + \varepsilon \end{aligned}$$

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<sup>7</sup> The method of ‘matching pairs’ originates from clinical surveys in which treatment effects are controlled for by use of a non-treatment control group. For a description of the method, and an early application for British and German manufacturers, see e.g. *Daly, Hitchens, Wagner* (1985).

<sup>8</sup> Where the original figure assumed the value of 0, we added an infinitesimal small value to allow logarithmisation. This is a usual method and will not distort our results.

where  $\ln \rho$  denotes firm-specific labour productivities,  $\ln E^{qual}$  the share of qualified/experienced personnel,  $\ln E^{train}$  the share of employees having participated in training programmes,  $\ln Net^{supl}$  the intensity of networking with suppliers,  $\ln Net^{cust}$  the intensity of networking with customers,  $\ln Net^{stakehold}$  the intensity of networking with other stake-holders of the firm,  $\ln Use^{email}$  the intensity of use of email,  $\ln Use^{www}$  the intensity of use of the internet,  $\ln Use^{e-bus}$  the intensity of use of e-business platforms,  $\ln SP$  the intensity of strategic planning invested by the firms' management,  $\ln MS$  the market share as perceived by the firms' management,  $\ln MSI$  the interaction between market share and innovations,  $\ln Inv$  the intensity of investment into fixed assets,  $\ln LC$  the labour cost share to test the substitution issue, and finally country and branch and size dummies, plus an error term for the residuals with the usual assumptions. We tested a variety of different specifications of the basic regression model, which are explained in the discussion of empirical results.

The results of this regression analysis may be interpreted as elasticities influencing the firm-level labour productivity levels in our sample of firms, because both independent and dependent variables have been transferred into logs.<sup>9</sup> A caveat of our method is that there is no check on the validity of the data provided by firms: some of the data may be biased, other data represents but the perception of managers and is therefore difficult to compare across firms. Whilst these are typical problems involved with field study analyses, we do hope that at the very least, manager's perceptions are comparable within countries/regions and industrial branches, remaining differences are caught by the dummies. Even if, strictly speaking, results are methodologically not generalizable due to the restricted number of firms and industries, they do offer valuable insight into the firm-level conditions within the selected manufacturing branches. In any case, an assessment of all firms active in the respective branches is impossible, because such data is simply not collected by statistical offices.

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<sup>9</sup> Without, however, being able to establish the direction of causality: is the firm's performance relatively weaker, because of the lower intensity in a positive determinant, or is the intensity of this determinant lower because of the difficult situation of the firm? This is inherent to the methodology applied here and we can only rely on plausibility in interpreting results.

## 4 Discussion of empirical results

In the following, the estimation results of the OLS-regressions are presented and discussed in terms of our hypotheses. In a first step, a comprehensive model is tested to capture as much information as possible without regard to robustness (see Table 3). Therefore, every independent variable is included. Departing from there, five augmented models on the basis of the opening model are estimated to test further hypotheses and to arrive at a final model that includes only significant determinants.

Table 3:  
OLS-regression results with log of labour productivity as dependent variable

Logs of variables	Model I	Model II	Model III	Model IV	Model V	Final model
Qualified employees	n.s.	n.s.	n.s.	n.s.	n.s.	
Training programmes	0.011***	0.011***				
...interaction term			0.011***	0.010***	0.011***	0.010***
Net. suppliers	n.s.					
Net. customers	n.s.					
Net. other stake-holders	0.011*					
...all networking		0.019***	0.019***	0.020***	0.018***	0.019***
Email	0.135***					
Internet	n.s.					
e-business	n.s.					
...all communication		0.023**	0.023**	0.023**	0.021**	0.023**
Strategic planning	n.s.	n.s.	n.s.	n.s.		
...and qualification				n.s.		
Market share	n.s.	n.s.	n.s.	n.s.	-0.027**	-0.029**
...market share squared					0.041**	0.042**
Market share and innova.	n.s.	n.s.	n.s.			
...and qualification				n.s.		
Investment	0.117***	0.117***	0.118***	0.118***	0.116***	0.118***
Substitution	-0.361***	-0.369***	-0.367***	-0.366***	-0.369***	-0.362***
D_machinery	0.280***	0.277***	0.280***	0.280***	0.255***	0.214***
D_cosmetics	0.264**	0.302***	0.302***	0.299***	0.285***	0.237***
D_elecrotechnical	n.s.	n.s.	n.s.	n.s.	n.s.	
D_size	n.s.	n.s.	n.s.	n.s.	n.s.	
D_east germany	-0.365***	-0.368***	-0.359***	-0.363***	-0.382***	-0.388***
D_poland	-1.234***	-1.285***	-1.275***	-1.276***	-1.296***	-1.276***
D_czech republic	-1.340***	-1.312***	-1.303***	-1.310***	-1.310***	-1.306***
D_hungary	-1.715***	-1.736***	-1.727***	-1.735***	-1.710***	-1.692***
Firms	549	549	549	549	562	<b>562</b>
Adjusted R square	0.664	0.657	0.658	0.657	0.668	<b>0.667</b>

Note: \* significant at the 10%-level; \*\* significant at the 5%-level; \*\*\* significant at the 1%-level.

As expected, the level of qualification/experience did not turn out to be significant by itself between eastern and western firms (see the first model). The intensity of personnel in training programmes, however, already at this stage displays a significant elasticity with respect to labour productivity levels of some 1.1 per cent. This already lends some support to our hypothesis 1. Networking activities turned out to be significant only for regular and long term contacts with stake-holders other than customers and suppliers, with an elasticity of again 1.1 per cent. This signifies that hypothesis 2 may be relevant in some cases only. In terms of the use of modern communication technologies, only the use of email turned out to be significant with an coefficient of 13.5 per cent, not allowing for a convincing support for hypothesis 3 as a whole but maybe for a part of it.

Both intensities of strategic planning and the market share turn out to be insignificant, and this throughout all our regression models. We hence have to establish that our data is unable to find sufficient empirical support for hypothesis 4 that labour productivity levels increase with the ability of managers to reflect strategically about the fate of their firms. We also find that owning larger market shares vs trying to survive in an environment of a high intensities of competition by innovating appear to have ambiguous effects of labour productivity, leaving hypothesis 5 unanswered. Investment intensities, however, clearly turned out to be significant throughout all our regression model specifications, here with an elasticity of 11.7 per cent. We can hence safely assume that for firms in post-socialist countries or regions, capital deepening still appears to be an important issue, supporting hypothesis 6. The highest elasticities are recorded throughout all our regression models for the substitution-effect of diverging relative prices between labour and capital (35-36 per cent). We hence established the validity of hypothesis 7 on the relevance of relative factor prices.

Having included all candidate determinants, the first regression model, however, is riddled with the problem that some regressors are highly correlated (i.e. in excess of a coefficient of 0.5): networking with customers and with suppliers and with other stakeholders have correlation coefficients of around 0.54 to 0.66, and the use of email and the internet turn out to be correlated with a coefficient of nearly 0.8 (e-business platforms are correlated to email and internet only with 0.41-0.47). The second regression hence combines the groups of three networking variables and communication technology indicators into composite indicators: rather than drawing the averages which would have resulted in a loss of information, we multiply the individual indicators. In all regression models using those two composite terms, both turn out to be significant and with elasticities of around 2 per cent. This allows us to assume that hypotheses 2 on the role of networking activities and hypothesis 3 on the role of the use of modern communication technologies for labour productivity levels are tested positively. All other results remain unchanged which suggests that our regression models are robust.

In following our assumption that levels of staff qualification only increase labour productivity if existing formal qualification and extraordinary working experience is paired

with further training of staff, we test an interaction term between those indicators in model III. Because this term is however highly correlated with the training variable, we decided to omit the latter and include the interaction term. This way, we are still able to test our hypothesis. In fact, the interaction term turns out to be significant and with a coefficient of around 1.1 per cent, whilst the variable for qualified personnel alone remained insignificant. This establishes our hypothesis 1 that qualification alone does not make a difference and needs to be paired with training programmes. Again, all other regression results remain largely unchanged.

This leaves hypothesis 4 on the role of strategic planning and hypothesis 5 on the market share and innovations unsupported by our data and analysis. In a further step, we interact strategic planning with the qualification of management, testing whether strategic planning can only make a difference when done by a qualified manager, and we interact the market share and innovation variable with the qualification of all personnel for the same assumption of necessary complementarity. The two interacted terms remain insignificant (we had to take out the variable for qualification of personnel alone, because it was highly correlated with the market share/innovation/qualification interaction term).

We hence cannot find support for hypotheses 4 in any of the specifications, whereas hypothesis 5 is supported by our analysis in as much as the relationships appears to assume an inverted U-shape with labour productivity levels in model V: very low and very high market shares are associated with high productivity levels, each for its own reason. A very high market share provides the ability to control access to a market place, and a very low market share increases the competitive pressure to innovate, both leading to higher productivity levels.

Finally, we find that our dummy for the firm-size remains insignificant throughout all models I to V. Apparently, our selection of determinants of productivity levels are insensitive to the size of firms. Furthermore, the sector-dummy for the electrotechnical industry also remained insignificant throughout the regression model specifications. Our final regression model tests the regression omitting all other insignificant determinants. In fact, results remain the same and this way indicate robustness.

## 5 Conclusions

Amongst the indicators we tested in our regression models, the strongest firm-specific determinants of productivity levels between our Eastern and Western firms pertain to the substitution effect of relatively lower labour costs in the East. In fact, the average labour costs in all eastern regions and countries of our subsamples amount to € 11 397.- per employee (in East Germany € 23 807.-), whereas the corresponding value for West Germany amounts to € 35 492.-. Whilst this result dominates all other regression results, labour productivities are not only determined by factor price relations. Investment turned out to be the second most important determinant of labour productivities. This result corresponds to conventional wisdom and is well explained by theory (the capital deepening issue). Alas, some related literature holds that already as early as 1996 (and then again tested for 1998) insufficient endowment in terms of quality and amount of productive capital is not any more a significant issue for East German firms (see e.g. Lay, 1006, 1998). In our subsamples, East German firms invested much less into fixed assets as opposed to West German firms (see Table 2), and achieved on average clearly lower levels of labour productivity. This also is true for our Polish, Czech, and Hungarian firms. We hence conclude for our sample firms that by investing, eastern firms should be able to catch up significantly faster in terms of labour productivity.

With respect to our main interest into the extent and quality of human capital in post-socialist firms in the East, we may conclude that because eastern firms on average have high levels of formal qualification and often empirically higher than in the West (see Hungary and Poland in Table 2), such qualification, even if augmented and complemented by working experience, does not alone serve to achieve higher labour productivity levels. Rather, to significantly affect efficiency and competitiveness, firms have to additionally invest into the training of their staff to update and possibly specialise their qualifications. This result solves a so far disputed issue in empirical research, where the extent of human capital did not result in the expected positive effects at the firm level (see e.g. Czarnitzki, 2005).

Our three additional tests for modern market-oriented management business functions turned out to be ambiguous: clearly, in what staff can do to use their qualification for networking and the ability to use modern communication technologies, both turned out to significantly explain productivity levels. Moreover, intensities are all lower in our eastern firms compared to our West German firms. This confirms those market-related management functions as determinants of productivity gaps. Only our test for the abilities of managers to devise strategic plans to steer the fate of their firms turned out to be insignificant, even though a simple Spearman-Rho rank-correlation analysis between the intensity of strategic planning and productivity levels turned out to be significant with a correlation coefficient of 0.38. Our analysis of market shares and innovation activity turned out to produce significant results only where we assume a non-linear relationship

with productivity levels: very high and very low are associated with high productivity levels, where “being stuck in the middle” apparently is associated with lower efficiency.

In sum, our field work and analysis did provide some additional evidence that human capital and market-orientation is an important issue in productivity convergence between East and West, even though post-socialist countries in Central East Europe are often quoted as enjoying the advantage of having a large supply of highly skilled workers. Alas, this qualification may well be of a technical nature whereas our indicators are related to the specific requirements of economic activity in an environment of competitive markets.

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## Annex

Table A1:  
Labour productivity levels in EUR per employment (current prices)

	Machinery (NACE 290)			Furniture (NACE 361)		
	Our samples		Official Stats	Our samples		Official Stats
	Small	Large	Total	Small	Large	Total
West Germany	89 871	81 594	62 243	72 132	88 518	43 287
East Germany	55 488	58 220	32 900	45 745	65 479	27 049
Poland	25 421	20 068	12 592	8 091	15 893	9 181
Czech Republic	20 034	21 520	12 261	24 787	16 957	10 410
Hungary	26 219	14 622	14 339	6 374	9 041	6 975

	Cosmetics (NACE 245)			Electrotechnics (NACE 310)		
	Our samples		Official Stats	Our samples		Official Stats
	Small	Large	Total	Small	Large	Total
West Germany	87 199	85 019	76 984	99 912	90 557	80 022
East Germany	69 143	64 827	80 266	74 179	69 714	33 326
Poland	19 705	66 306	24 549	28 295	37 228	12 931
Czech Republic	26 270	33 609	22 956	22 581	18 919	11 694
Hungary	9 953	24 308	20 106	10 536	15 358	11 670

Note: Labour productivity levels in our subsamples are calculated as turnover minus intermediate consumption (corresponding to value added) per employment. The size-classes are defined as larger and smaller than 50 employees. The values have been calculated by use of all 925 firms of all subsamples. In the official statistics, the productivity levels are calculated as current value added, corrected by annual average market exchange rates, per employment.

Sources: Official stats for Germany: DIW, 2003, for Poland, the Czech Republic, and Hungary: national statistical offices, authors' calculations.

Table A2a:  
Descriptive statistics of the data used

	West Germany		East Germany	
	Level	Stand. deviation	Level	Stand. deviation
Share of qualified personnel (in %)	45.0	30.7	42.3	30.2
Share of employees in training (in %)	37.1	25.9	30.6	21.3
Networking intensity with suppliers (in %)	69.0	22.3	63.3	23.6
Networking intensity with customers (in %)	72.5	22.6	66.6	24.9
Networking with other stake-holders (in %)	61.0	26.7	48.2	28.2
Intensity of use of e-mail (in %)	76.2	21.0	67.4	23.0
Intensity of use of internet (in %)	73.1	21.9	65.3	21.0
Intensity of use of e-business (in %)	54.6	27.8	35.9	27.4
Strategic planning (in % of time)	49.0	26.4	45.1	26.4
Market share (in %)	46.4	36.0	50.8	37.3
Product innovations (numbers in 3 years)	3.7	6.6	2.7	5.4
Rate of investment (in € per employment)	19 636.0	42 135.9	10 225.0	11 408.6
Share of labour costs in total costs (in %)	35.7	16.5	33.5	16.2

Source: own database.

Table A2b:  
Descriptive statistics of the data used

	Poland		Czech Republic	
	Level	Stand. deviation	Level	Stand. deviation
Share of qualified personnel (in %)	45.7	35.8	37.3	27.7
Share of employees in training (in %)	21.1	24.5	25.3	46.8
Networking intensity with suppliers (in %)	33.9	31.8	64.4	24.6
Networking intensity with customers (in %)	39.2	33.3	59.5	26.0
Networking with other stake-holders (in %)	15.2	24.9	30.9	24.9
Intensity of use of e-mail (in %)	18.1	20.2	73.6	25.8
Intensity of use of internet (in %)	13.9	14.3	60.6	29.5
Intensity of use of e-business (in %)	6.7	14.0	24.1	28.0
Strategic planning (in % of time)	18.3	17.5	23.1	16.2
Market share (in %)	32.4	33.4	40.8	32.8
Product innovations (numbers in 3 years)	3.6	6.3	3.9	6.6
Rate of investment (in € per employment)	10 129.0	5 863.2	3 761.0	5 382.9
Share of labour costs in total costs (in %)	26.6	20.2	27.6	17.9

Source: own database.

Table A2c:  
Descriptive statistics of the data used

	Hungary	
	Level	Stand. deviation
Share of qualified personnel (in %)	63.8	49.2
Share of employees in training (in %)	20.1	27.1
Networking intensity with suppliers (in %)	52.3	34.7
Networking intensity with customers (in %)	50.8	35.1
Networking with other stake-holders (in %)	30.2	30.3
Intensity of use of e-mail (in %)	46.3	35.1
Intensity of use of internet (in %)	38.9	31.7
Intensity of use of e-business (in %)	25.2	31.5
Strategic planning (in % of time)	23.5	17.9
Market share (in %)	23.8	25.1
Product innovations (numbers in 3 years)	2.2	4.7
Rate of investment (in € per employment)	3 404.0	13947.0
Share of labour costs in total costs (in %)	25.7	15.2

Source: own database.