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Firm-Specific Determinants of Productivity Gaps between East and West German Industrial Branches

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Abstract

This research assesses the firm-specific reasons for lower productivity levels between West and East German firms. The study is based on a unique data-base generated by field work in the two particularly important sectors of machinery manufacturers and furniture manufacturers. Our results suggest that the quality of human capital plays an important role in explaining lower productivity levels, as well as particularly networking activities, and the use of modern technologies for communication. Classifying those as management-functions beyond the

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organisation of the production process itself, we identify management-deficits as the main firm-specific determinants of productivity gaps between West and East German firms.

KEYWORDS: Productivity gap, East German industry, firm-level analysis

JEL classification: L6, M2

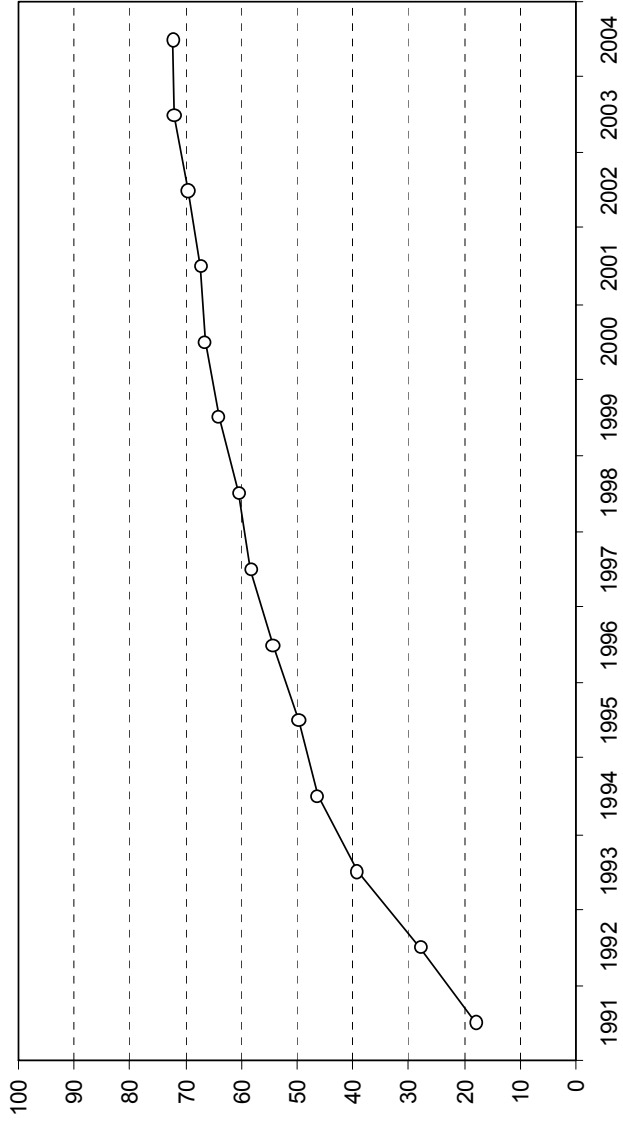
Introduction

In the economic system of the former GDR, success at the firm-level was measured in political terms rather than in competitiveness of firms. Even after more than a decade of systemic change, integration with West Germany, and substantial financial transfers, industrial firms in East Germany on average exhibit much lower levels of labour productivity than their competitors in the West. Back in 1991, aggregate labour productivity levels in manufacturing reached a mere 17.8 *per cent* of the West German level. By 2002, the levels have clearly converged, however, stagnating in their catch up process towards the end of the 1990s (see chart 1).

At the most general level, reasons for those productivity gaps are manifold and include differences in sectoral structures (*e.g.* larger share of labour intensive sectors), differences in functional structures (smaller share of more sophisticated tasks, labour intensive production technology), differences in size-structures (relative lack of large companies)¹, and differences in spatial structures and the resulting differences in agglomeration advantages (Kronthaler, 2005). Sectoral structures alone, however, do not account for many of the gaps between observed productivity levels at the aggregate level: a comparison at the firm level highlights that firms that belong to the same industrial branch and that are comparable in terms of size still exhibit significant gaps. Such firm-specific determinants are the focus of this analysis.

¹ See Ragnitz (1999), and Ragnitz *et al.* (2000) for a review of results of empirical studies as well as for own assessments of determinants conducted in a larger project. The analysis and results presented here form an extension of this project. We built upon the questionnaire and the method applied in one subset of that research project.

Chart 1: East German labour productivity levels in total manufacturing in *per cent* of West German level



Source: Arbeitskreis „VGR der Länder“, Arbeitskreis „Erwerbstätigenrechnung des Bundes und der Länder“, IWH-calculations

Not only would we have expected a faster convergence of labour productivity levels due to technology and knowledge transfer, the transfer of institutions, substantial investment in infrastructure, and the restructuring of enterprises to align to the new criteria for successful economic performance in a competitive environment of the newly integrated economic area (*cf.* convergence literature), but labour productivity catch-up was also amongst the prime political objectives with a view to putting a halt to westward labour migration and with a view to convergence in earnings and wages. Whilst regional labour productivity differences at aggregate levels will always remain within integrated economic areas, not least because of different sectoral and functional specialisation patterns, we would nevertheless expect that firms in the same industry and operating on the same markets should achieve comparable levels of productivity: inefficient firms would eventually exit the market. So far, even this narrower concept of productivity-convergence still appears to be a long way off in the case of East German manufacturing.

Research on the sources of convergence between East and West Germany suggests that the process has so far been largely driven by increases in the share of value added in total production and in particular by the shedding of excess labour (*e.g.* Fritsch/Mallock, 1998a and b).² With those sources of convergence depleted, catch-up has come to a halt, and future productivity convergence would now have to be based on other factors.

The objective of this assessment is to add to the body of existing research on determinants of labour productivity³ gaps at the firm-level by focussing explicitly on the quality of firm management. To achieve that objective, we set out to compare firms from East and West that could potentially achieve the same levels of productivity, because they produce the same products, are of a comparable size and engage on the same markets (which implicitly assumes that the coordinates of demand are the same: price⁴, consumer preferences, *etc.*). In extensive field work by use of questionnaires, we generated the necessary data to test our hypothesis. In terms of method, we used a simple version of the matched-pair approach.

² This incidentally corresponds to experience in Central East European manufacturing (*e.g.*, Stephan, 2003).

³ This research focuses on apparent 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 precise valuation of capital stocks.

⁴ With respect to prices, previous research suggests that East German firms achieve on average slightly lower prices (to the tune of about 10-20 per cent on average in manufacturing industries in 1998: Ragnitz *et al.* 2000, p. 184). Reasons for this, however, are not to be found in a general preference for West German produce, rather, the prices achieved can be held to root in insufficient market orientation and can hence be treated firm-specific in our analysis.

The article starts with a short overview of the different *foci* of analysis available so far on the topic. In the subsequent section, we describe our method for field work and empirical assessment of data generated. In the following section, the results of our research are presented and discussed. The article closes with a summary and discussion of our most prominent and robust results pertaining to firm-specific determinants of the productivity gap.

Prior analysis of firm-specific determinants of productivity gaps between East and West German industrial firms

There is a significant body of empirical research into the phenomenon of firm-specific determinants of intra-German productivity gaps. We can identify four main strands: the first and earliest studies focused on technology, the quality of the capital stock (*e.g.* Lay, 1996 and 1998, Mallok, 1996), and the efficiency of use of capital (*e.g.* Mallok/Fritsch, 1997). The second is on market positions and access to markets, measured in prices in sales and in procurement (*e.g.* Eickelpasch, 1996 and Bernhardt, 1997).

Two microeconomic analyses use existing databases (*e.g.*, Bellmann/Brussig, 1998 with the Institute for Employment Research (IAB) establishment panel, and Czarnitzki, 2003 with the Mannheim Innovation Panel): the former 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). The results of the latter analysis indicate deficiencies related to innovation. This already indicates in particular that differences in managerial skills and expertise probably play an important role in explaining productivity gaps. Research so far, however, has not focused on deficiencies rooted in specific managerial functions. The literature on firm-specific determinants of productivity gaps hence still lacks insight into the more tacit patterns of behaviour of firm managers, *i.e.* the quality of management.

The methodology of our analysis

Research conducted at the Halle Institute (IWH) aims to close this gap. This is a unique focus in the literature, albeit difficult to measure. From the insights into growth and competition-determinants from the modern development literature on the role of scale effects and specialisation economies, we deduce that firms can be expected to perform well, if they are able to supply the preconditions for scale and specialisation economies (see *e.g.* Canning, 1996): we set out to investigate the quality of management by focusing on (i) the effective, not necessarily formal, qualifications of all groups of a firm's staff and the intensity of training of staff, as

conditions for a high quality of management and work in the firm, on (ii) the intensity of strategic planning on behalf of firm managers or owners, as an input-variable, on (iii) 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 finally on (iv) the intensity of competition, the intensity of use of capital *vis-a-vis* labour, and the intensity of investment as control-variables.⁵

In extensive field work, conducted between 2002 and 2003, we used sector-specific, yet identical, questionnaires for the regions to be compared. In terms of sectors, we selected two manufacturing branches thought to be representative with respect to our hypothesis, namely machinery and furniture manufacturing firms, and the construction industry. To allow comparability of firms for the matching exercise, we divided our panels into small and large firms. The West German panels were used as a benchmark in terms of labour productivity levels for the firms in East Germany. The criterion for membership in either the East German or West German panels is the location of the establishment. The field work attempted to question firms in the East that are not owned by West German headquarters, but in particular with respect to large firms, this was not always possible. Due to differences in the economic policy support schemes for entrepreneurs between East and West, we expect to find a number of West German entrepreneurs having established a firm in the East in our East German samples. The data generated does not allow us to distinguish between West German subsidiaries and originally East German firms.

Our set of variables

- 1 Extent of qualifications of personnel. Because of the problem of comparability of formal qualifications between diplomas and certificates awarded in the GDR and the West German education and training schemes (and the often counter-intuitive results generated in analysis simply using quantitative indicators of formal qualifications), we asked firm managers to identify not only the percentage share of firms' staff with higher qualifications, but also to consider extraordinary work experience in the field of work when defining the qualifications of its personnel. Firms' staff were categorised in three groups (management, administration, and workers).

⁵ *It would have been desirable to also measure the extensiveness and effectiveness of marketing-efforts and intensity of R&D-activity, but this proved to be impossible in pre-tests of our field work. Product and process innovations produced ambiguous results (as is often the case: e.g. Czarnitzki, 2003) and are hence not reported here.*

- Whilst it goes without saying that the level of efficiency of the firm will tend to increase with the relevant qualifications of its staff, we are interested in the respective relevance of the three categories.
- 2 Intensity of training of personnel. This was measured by the percentage share of employees who received training during the year previous to the survey of the firm.⁶ 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 a more efficient allocation of labour to the heterogeneous tasks in the firm and improved quality of selection in the recruitment of new staff.
 - 3 Intensity of strategic planning by the management, measured by the estimated percentage share of time invested by firms' managers for non-continuous tasks targeted at mainly increasing market (shares) and exploring new markets, increasing sales prices via product or service quality and targeted at reducing production costs *vis-a-vis* time invested for daily operational activities targeted at improving efficiency in regularly recurring activities (both adding up to 100 *per cent*). 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 manner⁷, will be able to achieve higher levels of productivity.
 - 4 Intensity of networking with suppliers, customers, and other stake-holders. In our questionnaire, we asked firms to estimate the intensity of networking with suppliers, customers, and other stake-holders on a scale between 0 and 100. Networking was further specified as contractual relationships with a history of at least two years. 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 and other stake-holders 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). Long-term networking with customers may likewise involve cost advantages and over and above may form part of a marketing strategy geared towards securing prices and quantities. Advantages

⁶ 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).

⁷ 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 East and West German firms and within sub-samples.

- derived from these sources can be assumed to translate into productivity increases.
- 5 Intensity of use of modern communication technologies. This was measured in our field work by the estimated intensity of use of Email, internet, and e-business on a scale between 0 and 100. In order to network efficiently, 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.
 - 6 Diversification *vs* concentration on expertise, measured by the number of types of products in relation to total staff numbers. 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 equate to higher profits or sustainability on the market, however, because diversification can be a method of risk-reduction in case of demand-shifts. The association between either of the two strategies can take a positive or negative sign, and we are interested in what strategy prevails in what industry and whether adherence to a given strategy in fact influences productivity levels.
 - 7 Intensity of competition, measured by the firm's own perception about its market share on a scale between 0 and 100 *per cent.*⁸ Next to the pro-competitive effect (with the intensity of competition increasing, firms are 'pushed' to strengthen their attempts to increase productivity with a view on securing competitiveness, *e.g.* Pilat, 1998), we used this mainly as a control variable: do managers who sense a high intensity of competition invest more or less in staff training, spend more or less time for strategic planning, *etc.*
 - 8 Intensity of use of capital *vis-a-vis* labour as a control variable. We are able to infer this from the field-work data by correlating labour costs *per* employment in the firm with the percentage rate of automatisation in production; a positive significant correlation would then indicate substitution of labour by capital in the West and *vice versa* in the East: 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 conscious decision of managers.

⁸ *There are numerous possibilities to measure the intensity of competition faced by a firm. Because we expect managers' actions to be influenced more by its subjective perception rather than perhaps unfelt objective criteria (cognitive dissonance), we deliberately asked firms to measure their own perceptions.*

The matched-pair approach

Production functions are the most common method to assess productivity. However, for our objectives, a production function approach would have effectively restricted the number of determinants to be tested (in the following: ‘candidate determinants’) as a large number of ‘production factors’ would have resulted in insufficiently robust estimations. Furthermore, such an approach would have only allowed us to test for input-variables as productivity-determinants, but not the above listed output variables. Those, however, we were most interested in. In the particular case of comparing East and West German firms within one integrated economic area, with one set of rules, with one system of relative prices, *etc.*, it is possible and more promising to use the method of matching pairs. It is typically the preferred method in analyses of firm-specific determinants of productivity or growth gaps (*e.g.* Mallok/Fritsch, 1997, and Czarnitzki, 2003).⁹

The matched-pair method would typically match pairs of firms from the West and the East that are comparable in terms of most characteristics and yet are distinct in terms of the performance indicator; remaining differences are then tested as to whether they can explain performance gaps. This, however, would necessitate a careful selection of firms to be assessed in deep-level interviews. The results would then largely depend on the particular selection of firms. We therefore decided rather to spread our field work as wide as possible within selected industrial branches, so as to reduce the selection-bias. Hence, we match the average of all small (large) East German firms of one industry with the average of all small (large) West German firms of the same industry. This way, we arrive at four sub-samples, or ‘average-pairs’: small and large machinery firms in East and West Germany, and small and large furniture manufacturers in East and West Germany.

Even if, strictly speaking, results cannot be generalized methodologically, they do offer valuable insights into the firm-level conditions within the selected manufacturing branches. As long as our sample of firms, on average, achieve a productivity gap comparable with that for the whole respective industrial branch, our results can claim some weight; this is in fact comfortably fulfilled. 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.

⁹ *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).*

In the analysis of data generated in our field work, we first test whether the shape of the candidate-determinant of the productivity gap is positively correlated with the productivity level between all firms in one panel (East and West of one product group and one size group). A statistically significant positive correlation would suggest that the candidate is in fact a good firm-specific determinant of the productivity level.¹⁰ A bi-variate correlation analysis, however, disregards interaction between explanatory factors: correlations might turn out to be rooted in a third (hidden) factor, underlying the process (collinearity). We control for the possibility of having established a nonsense correlation in our bi-variate tests by adding a partial correlation analysis where collinearity between explanatory variables seems plausible. Because most of the data generated for the candidate determinants is on an ordinal scale, and because we could not assume that our data is necessarily normally distributed, we used a non-parametric correlation analysis of the Spearman-Rho specification (and typically, applications of matched-pair analyses based on field studies do rely on non-parametric methods). The levels of firm-specific labour productivities are calculated individually by the firm's gross value added *per* number of employees. What remains to be assessed in the second step is the distribution of the size of each determinant between firms in the West and in the East. In case Eastern firms are in fact weaker with respect to a determinant candidate, we hold that we positively tested this candidate as a firm-specific determinant of the productivity gap between the Western and Eastern firms within our samples.¹¹

Our four samples

The field work forms part of a larger study of firm-specific determinants of productivity gaps between West Germany and East Germany, Poland, the Czech Republic, and Hungary. All data generated in field work was collected by questionnaires. Most of the interviews were done via the telephone, some firms preferred to fill out the questionnaires on paper. In any case, full confidentiality was guaranteed. In each country or region, we set ourselves a target to collect at least 20 completed questionnaires in each of the four panels, categorised by the

¹⁰ *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 caveat is inherent to the methodology applied here and we can only rely on plausibility in interpreting results.*

¹¹ *Another disadvantage of our method is that a correlation analysis only tests for linear associations: if productivity first increases with the value of a determinant candidate but then falls again with even higher determinant values (hat-shaped correspondence), our method would reject our hypothesis. It is conceivable that with respect to determinants like e.g. the intensity of use of capital or investment activity, there could exist a single or multiple optimal intensities.*

product group (or industrial branch at a NACE 3 digit level) and by the size of the firm or establishment. In total, we were able to collect completed questionnaires from an overall number of 959 firms.

In this article, we report the results generated from 102 German furniture manufacturing firms and from 89 German firms in machinery manufacturing. In the group of large German machinery manufacturers, we collected some 45 completed questionnaires, 25 from East Germany, and 20 from the West. In the group of small German machinery manufacturers, we collected 44 questionnaires, evenly distributed between East and West German firms. In the panels for furniture manufacturers, we collected questionnaires from 20 large firms in the East, some 25 large firms in the West, and the questionnaires from some 29 small East German firms and 28 small West German firms. Those numbers form a unique data-base sufficiently large for empirical analysis.

The results of the analysis of generated data

On a broader sectoral level of aggregation, the average labour productivity level of all East German machinery manufacturers of NACE 29 (measured as value added per employment) amounts to some 53 *per cent* of the levels achieved by West German firms in 2001 (DIW, 2002). This is well represented by our panels with labour productivity levels of small Eastern firms reaching some 62 *per cent* of the levels of their Western pairs and some 71 *per cent* by large firms (see chart 2). However, our machinery manufacturers-panels appear to be slightly biased towards more successful firms.

In the panels of furniture manufacturers, the sectoral aggregated labour productivity level of all Eastern NACE 36 firms amounts to some 61 *per cent* of the levels achieved by West German firms in 2001 (DIW, 2002). In our samples, the gaps were comparably high with small Eastern firms mastering a level of some 63 *per cent* of their Western pairs and some 74 *per cent* by large firms. Here, the bias is only significant for large firms.

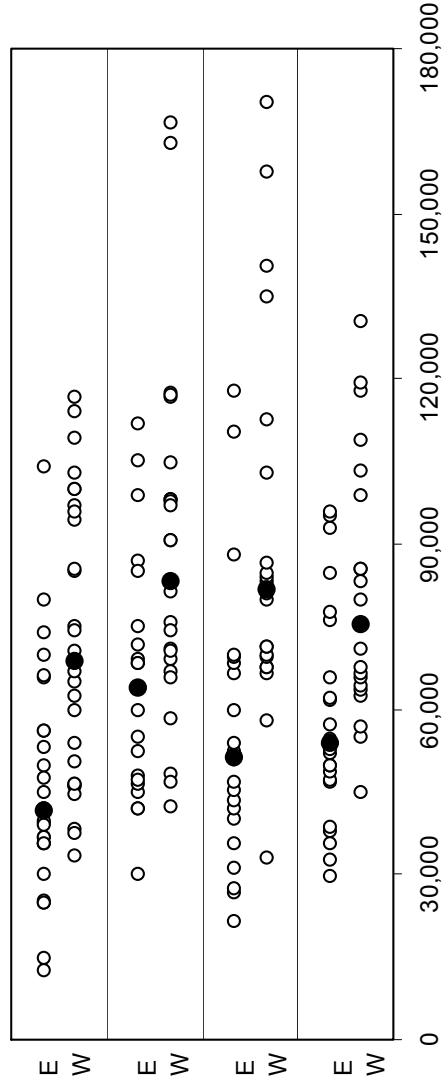
Machinery manufacturers are producers of typically non-mass products. Whilst their final products are often not comparable between firms, their production processes are. Hence, the method of matching comparable pairs is viable. Machinery manufacturers often produce a small number of very specified, non-standardised 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 (*i.e.* networking may be more intense with other stake-holders than with suppliers and customers), 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 typically produce more standardised products, in some cases probably even mass-produced, large-scale products. In this industry, products and production processes are sufficiently comparable to warrant the use of a matched-pair analysis. Furniture manufacturers are typically considered rather labour intensive with a comparatively less skill-intense personnel, and typically derive their endogenously created firm-specific advantages from intangible investments in 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 with predominantly suppliers and customers (Kaniovski/Peneder, 2001). Within our sample, firms mainly produce goods as *e.g.* kitchen furniture, office furniture, and other furniture such as mainly living room chairs and tables.

Not all of our eight variables were tested positively in terms of constituting a significant determinant for productivity levels or gaps. In general, however, we observe that the quality of human capital appears to play an important role, as well as networking activities, and the use of modern technologies for communication turn out to be significantly associated with productivity levels. The intensity of long-term strategic planning on behalf of the management turned out to be significant only for machinery manufacturers. The extent of specialisation of a small number of products in the firms' portfolio and the intensity of competition exhibit an ambiguous picture. Our control variables pertaining to the reaction of managers to intense competition are rather sketchy, and the assumption that with lower wage-costs, managers would substitute capital with labour, produced the right sign in correlations, however often insignificant. Despite our expectation that intense product and process innovation should play a particularly important role in productivity performance at the firm level, we could not establish significant correlations between the intensity of either form of innovation and productivity levels.

Chart 2: East and West German labour productivity levels of individual sample firms



Note: Productivity levels in EUR, medians are represented in bold and filled points.
 Source: Data from own field work.

Firm-specific productivity determinants in machinery manufacturing

Amongst the indicators we selected, the strongest firm-specific determinants of the productivity gaps between our East and West German machinery manufacturers pertain to their level of intensity of use of modern communication technologies. This result holds irrespective of the size of the firm. We find a statistically significant and positive correlation between the level of intensity of use of Email, internet, and e-business, and the firms' productivity levels. The correlations also turned out to be quite strong: coefficients amount to between 0.52 and 0.65, with the group of small firms exhibiting slightly smaller coefficients (see table 1). In the partial correlations analysis, we controlled for interaction between the intensity of use of communication technologies and (i) the qualifications of personnel in the three groups, (ii) the intensity of networking, and (iii) the perceived intensity of competition. The corrected correlation coefficients, however, all turn out to be quite different from the bi-variate coefficients with deviations of less than 10 *per cent*.

Not only do all correlations show the right sign, hence within the methodology applied here, we assume that those indicators qualify as performing determinants of productivity levels, but also, firms in the East on average make less intense use of all three communication instruments as compared to our West German firms: the gaps in the intensity of use of those technologies are particularly strong for the group of small firms. Supply of services for those technologies as well as the infrastructure governing modern communication technologies are well developed in East Germany: gaps in intensity of usage can hence be attributed to the decisions of firms rather than to location disadvantages. According to our methodology, we conclude that the group of communication technologies significantly and strongly serve to explain some of the productivity gaps observed between the machinery manufacturing firms from East and West Germany of our samples.

Table 1 Summary of results of analysis of firm-specific determinants: small and large machinery manufacturers

	Correlations ^{a)}			Average values of determinants in ...			Ranking ^{b)}
	Significance	Strength	East Germany	West Germany	East in % of West		
Small machinery manufacturers:							
1.1		0.28	67	43	156	(x)	
1.2	***	0.56 ^{e)}	33	43	77	4 ^{e)}	
1.3	***	0.49	20	20	100	10	
2	**	0.19	44	40	110	(x)	
3	***	0.46	44	53	83	6	
4.1	***	0.44	45	50	90	7	
4.2	**	0.34	51	56	91	8	
4.3	**	0.36	26	37	70	5	
5.1	***	0.52	55	74	74	3	
5.2	***	0.64	56	78	72	2	
5.3	***	0.53	33	54	61	1	
6	*	-0.28	6.1	5.6	109	9	
Observed labour productivity			55.5	89.9	61.7		
Large machinery manufacturers:							
1.1	***	0.47	77	60	128	(x)	
1.2	***	0.51	36	33	109	(x)	
1.3	***	0.30	23	21	110	(x)	
2	*	0.29	43	48	90	5	
3	**	0.57	50	51	98	8	
4.1	***	0.66	51	53	96	6	
4.2	***	0.61	52	54	96	7	
4.3	***	0.54	32	38	84	4	
5.1	***	0.61	66	80	83	2	

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5.2	Intensity of use of communication technologies: internet	***	0.64	63	77	82	1
5.3	Intensity of use of communication technologies: e-business	***	0.65	52	60	87	3
6	Diversification vs concentration on expertise	-	n/s	3.8	2.6	146	-
Observed labour productivity				58.2	81.6	71.3	

Note: ^{a)} Levels of significance are defined as usual: *** for error probability at the 1 *per cent* level, ** for 5 *per cent* level, and * for 10 *per cent* level.

^{b)} The ranking order has been established by calculating a 'composite indicator', derived as the product of correlation coefficient (the strength) and the size of the gap.

^{c)} The partial correlation analysis established collinearity with networking and use of communication technologies. This warrants a slightly lower ranking.

In a combination of results of correlation strengths and intensity gaps between East and West, we devise a ranking order for each determinant by calculating a simple composite indicator.¹² The group of determinants related to communication technologies rank at the top of the order in both size categories of machinery manufacturers. Within this group of determinants, the use of e-business appears to be the strongest determinant amongst the smaller firms (yet at a low intensity of use in both size-groups), and the use of the internet turned out to be the strongest determinant in the group of larger firms. The use of Email turned out to be second amongst large firms and third amongst small firms.

The second most telling result in both the small and the large machinery manufacturers relate to the firms' networking activities: the more intense the firms network with either of the three potential networking partners, suppliers, customers, or other stake-holders, the higher turn out to be their levels of productivity. The strength of correlations, are clearly higher in the group of the large firms (between 0.54 to 0.66) as compared to the group of small firms (between 0.34 and 0.44). The association between labour productivity and the three kinds of networking activities was further controlled for collinearity with (i) the qualifications of personnel in the three groups, (ii) the intensity of training of personnel, and (iii) the intensity of strategic planning by the firms' management. Significant adjustments of correlation coefficients appear only in the sample of small firms for the association between qualifications and networking with customers (here, the coefficient turned out to be half as large after controlling for this kind of interaction). The correlation between training and networking, as well as the corrections to be made for the interaction with strategic planning remained too low to alter the order of ranking.

The intensities of firms' networking activities not only turned out to be significantly associated with firms' productivity levels, but also -on average- Eastern firms exhibit **less** networking intensity as compared to their Western pairs. However, gaps in the intensity of networking in Eastern firms *vis-a-vis* their Western pairs are more pronounced amongst small firms; large firms appear to have caught up further in this field. Subsequently, the productivity gap-determinant of networking activities plays a stronger role for small firms than for large firms. It is, however, important to notice that a lower intensity of networking in the East may not exclusively be attributed to manager's skills and expertise in reaping potential benefits: the East German industrial environment is often still

¹² *Whilst the composite indicator indicates the role played by the candidate determinant in explaining observed productivity gaps, its size is not interpretable: we do not know the distribution of this indicator due to the fact that our original data was on an ordinal scale. We therefore only report the order of ranking of this indicator.*

characterised by a general lack of spatial concentration of interrelated activities. This will make it more difficult for East German managers to establish new and lasting networks of activities beneficial to the firm.¹³

For both small and large machinery manufacturers, regular networking with suppliers exhibits the strongest correlation with productivity. However, gaps in intensities are much higher for networking with other stake-holders, hence the latter productivity gap-determinant proved to be the strongest one in the group of networking-determinants in both size-groups. Networking with customers turned out to be last in this group.

Not surprisingly, the intensity of long-term strategic planning also turned out to be strongly associated with productivity levels. The strength of correlation turned out to be slightly higher for large firms, yet gaps in the East are larger for small firms. In sum, the intensity of long-term strategic planning appears to play a stronger role for small firms in explaining the productivity gap suffered by Eastern firms than for larger firms (we controlled for collinearity with (i) the qualifications of personnel, (ii) training, and (iii) intensity of competition. All deviations for corrected coefficients remained in the order of less than 6 per cent).

The last group of firm-specific determinant candidates that turned out to be significantly correlated with productivity levels pertain to the quality of human capital: our field work distinguished between the levels of qualifications (formal and working experience) and intensities of training of personnel. Staff, is divided in the personnel classes of management, administration, and workers. The correlation holds irrespective of the size category. Here, the partial correlation analysis does suggest some corrections: in particular in the case of small firms, the qualifications of management are sufficiently correlated with networking intensities and the use of communication technologies to reduce the original correlations coefficient to 52 per cent for the use of internet, to some 70 per cent for Email and e-business, and to 60 to 70 per cent for networking intensities. In the case of large firms, larger adjustments only occurred with respect to networking, here across the board of the three staff-categories and the three networking partners. With respect to training, the partial correlation analysis did not establish collinearity with levels of qualifications in either of the two sub samples.

¹³ *In a related empirical study by use of official statistical data, Kronthaler (2005) concludes that spatial concentration is lower in all East German regions as compared to West German ones, and that within East Germany, only regions like Greater Berlin, Dresden, and Leipzig can be considered to offer significant agglomeration advantages. In the same line, spill-over effects between foreign and domestic firms seem to be rather low (Günther/ Gebhardt (2005). This means that the results of this empirical analysis -unable to establish causality- have to be interpreted with due care.*

The extent of qualifications does however contribute to explaining the productivity gap only for the group of administrative staff and only amongst the group of small machinery manufacturers. In all other cases, the level of qualifications in the East turned out to be higher than average levels in the West. With the intensity of training of personnel being larger in the panel of small Eastern machinery manufacturers, this determinant only performs in the group of large machinery manufacturers as a determinant of the observed productivity gap. In the group of managers, Eastern firms appear to have a higher share of qualified managers irrespective of the size of the company. However, this result might still be due to the problem with the field of qualifications, despite our focus in the questionnaire on non-formal qualifications.

With respect to the strategic organisation of production, we could establish this determinant only for our small machinery manufacturers: the number of products in the firms' portfolio is negatively correlated with the same firms' productivity levels, and firms in the East appear to have a larger portfolio as compared to their Western competitors. Amongst large machinery manufacturers, the same holds true even to a much larger extent, however, we were not able to establish a significant correlation.

We furthermore tested our hypothesis that managers of firms under intense competition might increase their efforts in terms of strategic management (the pro-competitive effect). Amongst our machinery manufacturers, we could support this hypothesis foremost for product innovations: the more intense was competition, the more product innovations were generated. In the group of small firms, the correlation coefficient turned out to be 0.40, in the large-firm group 0.38. With firms in the East feeling on average a much lower intensity of competition, and with Eastern firms being less innovative, we can conclude that some insufficiency in the reaction of managers to intense competition does contribute to explaining productivity gaps in both size groups of our machinery manufacturers. Other means of strategic management as a countermeasure against intense competition, however, produced mixed results: a higher intensity of training of personnel was only significant for the group of large machinery manufacturers (with a coefficient of 0.35), and small firms in a particularly competitive environment appear to have larger product-portfolios.

Finally, we tested our control variable of substitution of capital by labour, motivated by lower labour costs per employment. First, in both our size groups of the machinery sample, labour costs *per* personnel were substantially lower in Eastern firms (54 *per cent* for small firms and 67 *per cent* for large firms). However, the correlation analysis was unable to establish a significant (negative)

correlation between the size of labour costs *per* employment and investment outlays or the intensity of use of capital in either size-group. This allows us to conclude that in our machinery manufacturers, rational substitution of capital with cheaper labour does not explain observed productivity gaps - reasons explaining gaps must lie in the other factors including the ones assessed above.

Firm-specific productivity determinants in furniture manufacturing

As in the panels of machinery manufacturers, we identified the intensities of networking and the intensities of use of modern communication technologies as amongst the strongest firm-specific determinants of observed labour productivity gaps: irrespective of the sizes of firms, the correlations with productivity levels turned out to be positive and significant at least at the 5 *per cent* level, a very robust result (see table 2). The control for collinearity by use of partial correlation analysis does not suggest significant corrections of bi-variate results: deviations all remain below a level of 20 per cent.

Moreover, intensities of networking as well as intensities of use of modern technologies for communication in East Germany turned out to be clearly lower as compared to the intensities in the West German firms (again, the difference in spatial concentration between East and West has to be considered here, and suggests a careful interpretation of these results). The highest ranking determinant was established in both size-groups for networking with other stake-holders: these results are mainly due to low average intensities in Eastern firms. Amongst the three groups of networking partners, the weakest one in terms of firm-specific determinants of productivity gaps turned out to be networking with suppliers. This, however, is mainly due to the fact that here, intensity-gaps are lowest.

For small firms, networking as such appears to be more important as an explanation of productivity gaps than the use of communication technologies, but *vice-versa* for large firms. According to our ranking, the intensity of use of e-business appears to be the strongest explanation for productivity gaps amongst the three communication technologies - again mainly due to the large intensity-gaps between East and West.

Table 2 Summary of results of analysis of firm-specific determinants: small and large furniture manufacturers

		Correlations ^{a)}			Average values of determinants in ...			Ranking ^{b)}
		Signi- ficance	Strength	East Germany	West Germany	East in % of West		
Small furniture manufacturers:								
1.1	Extent of qualification of personnel: management	***	0.66	33	51	65	2	
1.2	Extent of qualification of personnel: administration	***	0.45	40	41	98	9	
1.3	Extent of qualification of personnel: workers	**	0.36	28	35	80	8	
2	Intensity of re- and further qualification of personnel	-	n/s	22	23	96	-	
3	Intensity of strategic planning	-	n/s	40	47	85	-	
4.1	Intensity of networking: suppliers	***	0.73	44	56	79	4	
4.2	Intensity of networking: customers	***	0.71	42	58	72	3	
4.3	Intensity of networking: stake-holders	**	0.79	33	47	70	1	
5.1	Intensity of use of communication technologies: email	***	0.49	49	58	85	6	
5.2	Intensity of use of communication technologies: internet	***	0.54	52	60	87	7	
5.3	Intensity of use of communication technologies: e-business	**	0.34	30	45	67	5	
6	Diversification vs concentration on expertise	-	n/s	3.8	3.1	123	-	
Observed labour productivity				45.2	72.1	62.7		
Large furniture manufacturers:								
1.1	Extent of qualification of personnel: management	***	0.63	55	52	106	(x)	
1.2	Extent of qualification of personnel: administration	***	0.57	34	40	85	7	
1.3	Extent of qualification of personnel: workers	***	0.41	20	32	63	3	
2	Intensity of re- and further qualification of personnel	**	0.39	32	52	62	4	
3	Intensity of strategic planning	-	n/s	49	52	94	-	
4.1	Intensity of networking: suppliers	***	0.66	54	60	90	9	
4.2	Intensity of networking: customers	***	0.68	55	62	89	8	
4.3	Intensity of networking: stake-holders	***	0.77	34	57	60	1	

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5.1	Intensity of use of communication technologies: email	***	0.64	58	73	80	5
5.2	Intensity of use of communication technologies: internet	***	0.73	58	70	83	6
5.3	Intensity of use of communication technologies: e-business	***	0.54	40	59	68	2
6	Diversification vs concentration on expertise	-	n/s	2.9	2.2	132	-
Observed labour productivity				62.6	86.9	72.0	

Note: ^{a)} Levels of significance are defined as usual: *** for error probability at the 1 per cent level, ** for 5 per cent level, and * for 10 per cent level.

^{b)} The ranking order has been established by calculating a 'composite indicator', derived as the product of correlation coefficient (the strength) and the size of the gap.

With respect to the quality of human capital, the results are more conclusive than in the machinery-industry: in all categories of personnel and both size-groups, the share of qualified managers, administrative staff, and the share of workers with higher qualifications is significantly and positively correlated with the corresponding firms' productivity levels. Here, the partial correlation analysis does suggest some corrections: significant and strong correlation between the qualifications of administrative staff and networking activities reduces the partial correlation coefficient between productivity and qualifications to between 41 per cent for networking with suppliers amongst small firms and 15 *per cent* for networking with share holders amongst large firms.

East German furniture manufacturers on average have slightly lower shares of qualified personnel in all staff-categories bar the management-category amongst large firms. Here, the large Eastern firms have on average a higher share of qualified managers; hence this category does not perform as firm-specific determinant for the productivity gaps. In contrast, the management-category for small firms exhibits a strong correlation of some 0.66 and a gap suffered by Eastern firms of some 35 *per cent* of the West. In the ranking, this determinant hence reaches second place. The qualification profile of administration in both size-groups is not very different between Eastern and Western firms, albeit small gaps remain. In the case of workers, the gaps are larger, averaging some 20 *per cent* for small firms and even 38 *per cent* for the large firms in our panel.

As was the case in the machinery manufacturing industry, the assessment of training of personnel only detected a significant firm-specific determinant in the group of large firms with a gap of 38 *per cent* and a fourth place in ranking (equally, the partial correlation analysis does not suggest any adjustments). For small firms, the gap is negligible and the correlation turned out to be insignificant.

Whilst the firms of our Eastern panels on average spend less time on long-term strategic planning as compared to their Western pairs (and that regardless of the size of the firm), the intensity of long-term strategic planning is not significantly correlated with labour productivity levels in either of the two size groups. Probabilities of error in our correlation exercise turned out to be even larger than 50 *per cent*. This surprising result stands in clear contrast to the results generated in the panels of machinery manufacturers. We do not have any further insights into this to help in the interpretation of this result, but one possible explanation could be that furniture manufacturing is a rather standardised industry with respect to products, production technologies, and hence the market. Possibly, strategic management plays a lesser role here which is further supported by the fact that firms in this industry are less innovative as compared to firms in the machinery-

branch.

The same can be concluded for the determinant-candidate of a focusing of the product-portfolio on a small number with a view to reaping specialisation-advantages. In both size-groups, the number of products in firms' portfolios, were larger in the East, yet no significant correlation could be established.

Our test concerning the pro-competitive effect resulted in ambiguous results: whilst amongst the small firms, competition was felt to be fiercer in the East the opposite is true for large firms. Yet, within the large firm-panel, we could establish a significant correlation between intensity of competition and long-term strategic planning with a considerably large coefficient of 0.57. No other correlations turned out to be significant. Hence, our results could not establish inadequate strategic behaviour of managers as determinants of productivity gaps between East and West.

Finally, with respect to our control variable, the same result as for the construction industry holds in this manufacturing branch: rational substitution of capital with cheaper labour does not explain observed productivity gaps - reasons must again lie in the other factors assessed above. Yet, labour costs per employee in the East only reach *57 per cent* of the costs in our western firm of the group of small manufacturers, and *67 per cent* in the case of large furniture firms.

Summary and discussion of main results

To sum up, our research results turned out to be not always in line with our assumptions derived from related research and plausibility assumptions. However, we were able to establish for both industries assessed that the lower levels of labour productivity in firms in East Germany are not a result of a rational choice to substitute capital with cheaper labour. Rather, productivity gaps are rooted in distinct differences and in some case deficiencies at the firm level.

Our analysis does suggest that the quality of human capital plays an important role in both industries assessed. Due to the fact that the results were generated from field study using questionnaires, we are unable to determine whether firms in fact assessed their own qualifications in terms of 'work experience' rather than simply 'formal qualifications'. It is a well established fact that the East German population commands a much higher density of formal qualifications which, however, does not necessarily match the necessary qualifications requested by the current occupation: often firm managers and owners in the East have technical qualifications that do not serve to great lengths for management and market-related

activities. Despite this, as in most panels, we monitored a lower quality of human capital in East German firms - all the more robust are our results and their interpretation.

Moreover, some of the productivity gaps suffered by firms in East Germany appear to be rooted in deficiencies in strategic management: this pertains mainly to the intensity of networking with suppliers, customers, or other stake-holders in the firm, although we have to consider that location specifics in the East, namely a lesser spatial concentration can be assumed to make it more difficult for firms in the East to establish long-term networks of activities and to reap benefits from spill-over effects in terms of technology and knowledge. Furthermore, we were able to identify the use of the modern communication technologies of Email, Internet, and e-business as amongst the strongest firm-specific determinants of productivity gaps between East and West German machinery and furniture manufacturers alike.

Management-functions that yield beyond a pure organisation of the production process play a dominant role in explaining firm productivity levels, and because in our sample, East German firms exhibited on average lower levels of productivity, such management-functions are apparently still relatively less developed amongst our East German firms than our West German firms. In particular with respect to those latter determinants, we have to interpret the results carefully, because our method can not establish causalities.

Our results do suggest that deficiencies in market-orientation and strategic planning still prevail amongst firms in East Germany. Apparently, the shift in paradigms brought about by the systemic change of the East German economy from a planned system in the GDR to one that is governed by competition and markets in unified Germany has not yet fully been incorporated at the level of management amongst East German firms. Whilst this result was already hinted at by previous research, our field work and analysis is the first to explicitly test this assumption. If our results in fact capture the most important reason for lower levels of productivity amongst firms in East Germany, then the prospects for swiftly catching up are rather less bright: more than 10 years after the systemic change and the steep restructuring of the East German economy (demise of COMECON as the previous market orientation and the submission of East German firms to unfettered competition with the West), the individual learning curve will become increasingly flatter with diminishing returns. Without intensified eastward migration, the East German manufacturing economy might well need many more years to catch up.

The main caveat of our analysis, pertain to the causality-issue. Of significant

importance for the robustness of our results is also the fact that we are unable to identify which of our East German firms are but Western subsidiaries and hence can benefit from expertise originating in their close association with their West German headquarters. Those caveats are rooted in the limitations associated with the methodology of large-scale field work and further research can serve to deepen and complement our results.

This suggests that future research may increase our understanding of the roots of productivity levels by investigating more deeply the role of strategic planning, use of communication technologies and intensity of networking: with respect to strategic planning, we could dig deeper by investigating not only its intensity but also its (time-) efficiency; with respect to the use of communication technologies, we could attempt to retrieve quantitative information on *e.g.* the endowment of the firm with computers, points of access for internet, number of hours spent by employees servicing web-pages for the firm, *etc.* (in this respect, the author's attention was pointed to Electronic Data Exchange as an additionally important communication method by an anonymous referee); with respect to the intensity of networking, we could try to control for differences in location differences of firms (spatial concentration and agglomeration advantages). Those issues, however, cannot be satisfactorily tested by way of a large-scale questionnaire-based field work but rather necessitates deep-level structured interviews with the typical generality limitation associated with the method.

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