

Stephan, Johannes; Szalai, Karin

Working Paper

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

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

Dr Johannes Stephan and Karin Szalai

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Corresponding author: Dr Johannes Stephan
Department for Central East Europe
Johannes.Stephan@iwh-halle.de
Tel.: (0345) 7753-835 (-831 Secr.)

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Herausgeber:

INSTITUT FÜR WIRTSCHAFTSFORSCHUNG HALLE (IWH)

Postanschrift: Postfach 11 03 61, 06017 Halle (Saale)

Hausanschrift: Kleine Märkerstraße 8, 06108 Halle (Saale)

Telefon: (03 45) 77 53-60

Telefax: (03 45) 77 53-8 20

Internet: <http://www.iwh-halle.de>

Abstract

Industrial productivity levels of formerly socialist economies in Central East Europe (including East Germany) are considerably lower than in the more mature Western economies. This research aims at assessing the reasons for lower productivities at the firm level: what are the firm-specific determinants of productivity gaps.

To assess this, we have conducted an extensive field study and focussed on a selection of two important manufacturing industries, namely machinery manufacturers and furniture manufacturers, and on the construction industry. Using the data generated in field work, we test a set of determinant-candidates which were derived from theory and prior research in that topic. Our analysis uses the simplest version of the matched-pair approach, in which first hypothesis about relevant productivity level-determinants are tested. In a second step, positively tested hypothesis are further assessed in terms of whether they also constitute firm-specific determinants of the apparent gaps between the firms in our Eastern and such in our Western panels.

Our results suggest that the quality of human capital plays an important role in all three industrial branches assessed. Amongst manufacturing firms, networking activities and the use of modern technologies for communication are important reasons for the lower levels of labour productivity in the East. The intensity of long-term strategic planning on behalf of the management turned out to be relevant only for machinery manufacturers. Product and process innovations unexpectedly exhibit an ambiguous picture, as did the extent of specialisation on a small number of products in the firms' portfolio and the intensity of competition.

JEL: L6, M2

Keywords: Productivity gap, East German industry

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Contents

Introduction.....	5
1 Prior analysis on firm-specific determinants of productivity gaps between East and West German industrial firms	6
2 The methodology of our analysis	7
2.1 Our set of hypothesis	7
2.2 The matched-pair approach.....	9
2.3 Our five samples.....	10
3 The results of the analysis of generated data.....	11
3.1 Firm-specific productivity determinants in machinery manufacturing.....	12
3.2 Firm-specific productivity determinants in furniture manufacturing.....	16
3.3 Firm-specific productivity determinants in construction.....	19
Summary of main results	21
Bibliography	22

Introduction

In the economic system of the former GDR, economic 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 kins in the West. Back in 1991, aggregate labour productivity levels in manufacturing reached a mere 17.8 *per cent* of the West German level, in the construction industry 48.4 *per cent*. By 2002, the levels have clearly converged, however, at a low pace and stagnating in their catch up process towards the end of the 1990s. In the construction industry, however, we can observe a strong divergence trend between 1996 and 2001 (see chart 1).

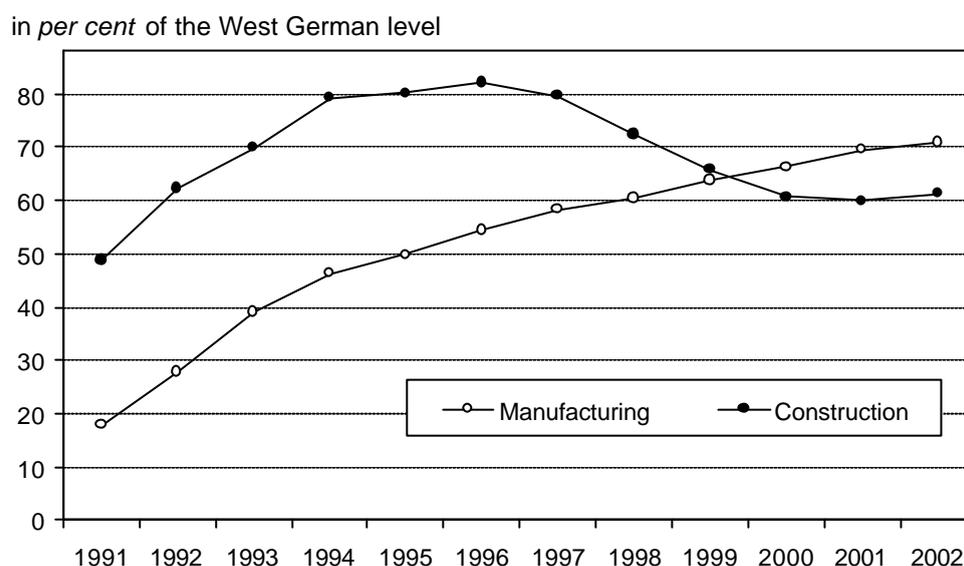


Chart 1 East German labour productivity levels in manufacturing and construction

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

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), and differences in size-structures (lack of large companies).¹ Structures alone, however, do not account for the full gap 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 Rothfels/Ragnitz/Wölfl (1998), Ragnitz (1999), and Ragnitz et al. (2000) for an empirical assessment of those determinants conducted in a larger project.

The objective of this assessment is to add to the body of existing research on the most important determinants of labour productivity² gaps at the firm-level (*i.e.* the determinants to be found within firms) by focussing explicitly on the quality of firm management. This is of course beyond the realm of political influence: such determinants obviously reduce the scope for economic policy in terms of assisting a closure of the productivity gap, be such at EU or national levels. 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 or integrated markets. 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.

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

1 Prior analysis on 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 which, however, is mainly focused on technology and the quality of the capital stock (*e.g.* Mallok 1996), and on market positions and access to markets, measured in prices in sales and in procurement (*e.g. ibid.*; Eickelpasch, 1996; and Bernhardt, 1997).

Two microeconomic analyses use existing databases (Bellmann/Brussig, 1998 with the IAB establishment panel; and Czarnitzki, 2003 with the Mannheim Innovation Panel) are more comprehensive in terms of productivity-determinants: the former additionally establishes deficiencies in company organisation and in the integration of the firm into the enterprise as a whole. The results of the latter analysis indicate deficiencies in innovation-intensities in the East and the significance of Eastern *vs* Western firm ownership, indicating in particular that managerial skills play an important role for the explanation of productivity gaps. This research, however, did not pinpoint deficiencies in specific managerial functions.

The literature on firm-specific determinants of productivity gaps still lacks insight into the more tacit patterns of behaviour of firm managers, *i.e.* the quality of management.

² This research focuses on labour productivity; the efficiency of use of capital has not been assessed, mainly because firms were reluctant to provide that kind of data, and because of difficulties in the precise valuation of capital stocks.

2 The methodology of our analysis

Research conducted at the IWH aims to close this gap. This is a unique focus in the literature, albeit difficult to measure.³ We set out to enquire the quality of management by focussing on (i) the effective, not necessarily formal, qualification of all groups of firm-staff and the intensity of further and re-qualification 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 management's perception about the intensity of competition, the intensity of use of capital *vis-à-vis* labour, and the intensity of investment as control-variables.⁴ The corresponding hypothesis are:

2.1 *Our set of hypothesis*

- 1 Extent of qualification of personnel, measured by the share of the firms' staff in three categories (management, administration, and workers) with higher qualification and extraordinary work experience in the field of work: it goes without saying that the level of efficiency of the firm will tend to increase with the qualification of the firms' staff.
- 2 Intensity of further and re-qualification of personnel, measured by the share of employees (or the costs invested: obviously consistent within each panel) into further and re-qualification of staff: we assume that not only the improvement of qualification profiles will affect productivity levels positively. We also expect that such a personnel policy will develop a heightened consideration of individual qualification profiles and hence result in more efficient allocation of labour to the heterogeneous tasks in the firm and improved quality of selection in the procurement of new staff.
- 3 Intensity of strategic planning by the management: we assume that the ability of firm managers to think strategically, *e.g.* if firms have a sufficient degree of division of labour to allow managers to reflect on future opportunities in a strategic manner, will be able to achieve higher levels of productivity.

³ The results presented here form an extension of research into determinants of the productivity gap conducted at the IWH in 1999 and 2000 (refer to: Rothfels/Ragnitz/Wölfl, 1998; Ragnitz, 1999; Ragnitz *et al.* 2000 for their results). We built upon the questionnaire and the method applied in one subset of that research project.

⁴ 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 often) and are hence not reported here.

- 4 Intensity of networking with suppliers, customers and other stake-holders: firms balance inner-firm coordination costs with transaction costs in their relations with other firms (e.g. contracts). A high intensity of networking allows firms not only to reduce transaction costs, but also to sharpen division of labour within the firm and with networking partners. Specialisation advantages can be assumed to translate into productivity increases.
- 5 Intensity of use of modern communication technologies (Email, internet and e-business): in order to efficiently network, partners can make use of modern communications technologies. We assume firms that use such technologies more intensively to also benefit more from the advantages of networking - hence also to achieve higher levels of productivity.
- 6 Diversification *vs* concentration on expertise, measured by the number of types of products: the decision on the scope of products is firm-specific and we expect firms with a narrow line of products (*i.e.* strong concentration) to enjoy specialisation benefits. This does not necessarily equal with higher profits or sustainability on the market, however, as diversification can be a method of risk-reduction in case of demand-shifts.
- 7 The management's perception about the intensity of competition, measured by the firm's believed own market share: 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, see *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 into further and re-qualification, spend more or less time for strategic planning, *etc.*
- 8 Intensity of use of capital *vis-à-vis* labour, measured by the rate of automatisisation in production, and intensity of investment⁵, as control variables: do managers in firms where labour is relatively cheaper (measured by labour costs per staff number) substitute capital by labour, hence deliberately and in conformity with market conditions depressing their firms' 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.

In an extensive field work using specialised sets of questionnaires targeted at the particularities of each industrial branch interrogated, we generated the necessary data to test our hypothesis. In terms of sectors, we selected two manufacturing branches thought to be representative with

⁵ Of course, investment activities of firms not only reflect the firms' attempts to increase production efficiency, but also the necessity to replace or renovate outdated machinery or buildings. The typically discontinuous character of investment at the firm level demands particular care when assessing this.

respect to our hypothesis, namely machinery and furniture manufacturing firms, and construction firms. 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 productivity levels for the firms in East Germany.

2.2 *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, one set of rules, one system of relative prices, *etc.*, it is possible and more promising to use the method of matching pairs.⁶

The matched-pair method can either group several one-to-one matched pairs of firms from the West and the East to establish a comparison of likewise firms. 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 to rather spread our field work as wide as possible within selected industrial branches, so as to reduce the selection-bias on results. Even if, strictly speaking, results are methodologically not generalizable, they do offer valuable insight into the firm-level conditions within the selected manufacturing branches. In total, we were able to collect some 224 filled out questionnaires, partly with the help of an experienced market-research firm. As long as our sample of firms, on average, achieves a productivity gap comparable with the one for the whole industrial branch, our results can claim some weight. This is in fact comfortably fulfilled. In any case, an assessment of all firms is impossible even in selected industrial branches, as such data is simply not collected by statistical offices.

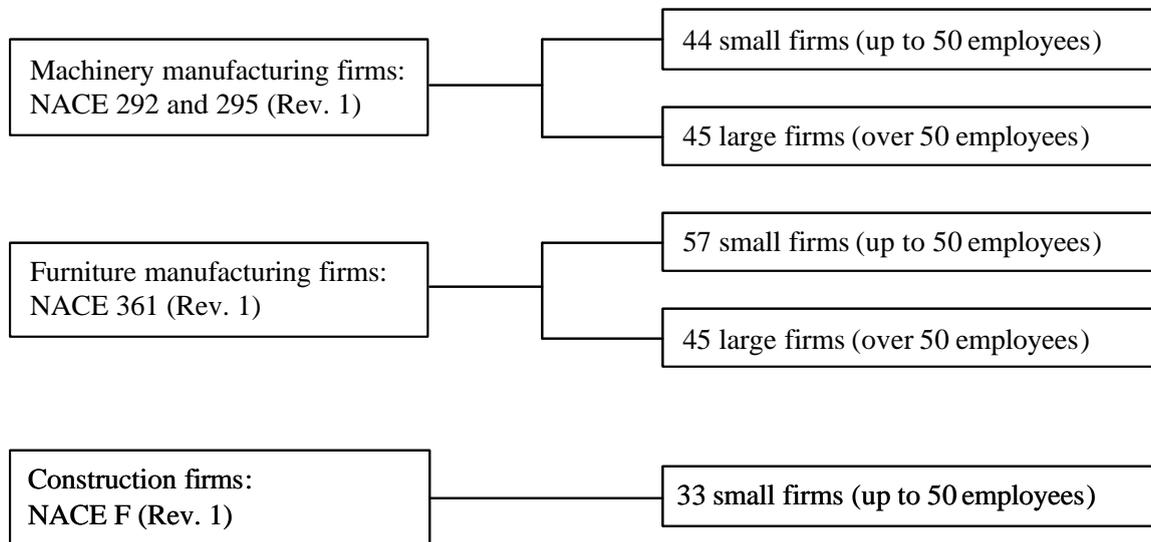
In the analysis of data generated in our field work, we first test whether the shape of the candidate-determinant of the productivity gap is positively correlated with the productivity level between all firms in one panel (East and West of one product group and one size group). A statistically significant positive correlation would tell us that the candidate is in fact a good firm-specific determinant of the productivity level. Because the data generated was typically on ordinal scales, and because we could not assume that our data would be normally distributed,

⁶ The matched-pair method was also used by Czarnitzki (2003), albeit with a different set of objectives. The results are not comparable with the ones generated here.

we used a non-parametric correlation analysis of the Spearman-Rho specification.⁷ What remained to be assessed in the second step was the distribution of the shape of determinant between firms in the West and in the East. In the case that Eastern firms are in fact weaker with respect to this determinant candidate, we positively tested this candidate as a firm-specific determinant of the productivity gap between the Western and Eastern firms within our samples.⁸

2.3 Our five samples

All data generated in field work was collected by questionnaires. Most of the interrogations were done via the telephone, some firms preferred to fill out the questionnaires on paper. In any case, full confidentiality was guaranteed. In each country or region, we set ourselves a target to collect at least 20 filled out questionnaires in each of the 5 panels, categorised by the product group (or industrial branch at a NACE 3 digit level) and by the size of the firm or establishment.⁹



In the group of large German machinery manufacturers, we were able to collect some 45 filled-out questionnaires, 25 from the East and 20 from the West. In the group of small

⁷ We decided to rather not normalise our data-sets, as the coefficients of variation and mean values resulting from our ordinal data would not be interpretable but rather accidental. So would the interpretation of correlation, or even regression results be of less quality.

⁸ One disadvantage with our method is that we measure only linear correlations: if, however, 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 an optimal intensity somewhere at medium values of the determinant amongst firms producing the same products and that are of comparable size.

⁹ In the case of construction firms, we selected only small firms, because the number of returned questionnaires from large construction firms was too small, and because most of the returned questionnaires suggested to us that the firms were but subsidiaries of West German firms.

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. In total, we report the results generated from 102 furniture manufacturing firms, from 89 firms in the machinery manufacturers, and from 33 construction firms.

3 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 amounts to some 53 *per cent* of the levels achieved by West German firms in 2001 (DIW 2002). This stylised fact 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. However, our machinery manufacturers-panels appear to have a pronounced bias 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.

The aggregate productivity gap in the construction industry of NACE F amounts to some 62 *per cent* of the West German level (Arbeitskreis volkswirtschaftliche Gesamtrechnung der Länder, 2002). This is not too far from the result of our own sample, in which our small construction firms in the East reach on average 72 *per cent* of the level of our small Western construction 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, and innovation by new technology (Kaniowski / 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-intensive personnel, and typically derive their endogenously created firm-specific advantages from intangible investments into marketing (Peneder 1999, p. 36-37). In terms of their competitive strategy, firms in this industry can be expected to favour innovation by variety, brand creation, as well as vertical integration, either within the firm or *via* networking (Kaniovski / Peneder 2001). Within our sample, firms mainly produce goods as *e.g.* kitchen furniture, office furniture and other furniture like mainly living room chairs and tables.

Construction firms also produce typically non-mass products. Whilst each building is typically unique, the production processes on a building site are comparable. Hence, the method of matching comparable pairs is viable. In terms of competitive management strategies, such industries would typically focus their attention on cost-cutting measures, starting with labour costs. Within our sample, construction firms offered key-ready construction for companies and households as well as specialised tasks on the building site, as *e.g.* roofing, bricklaying, and interior construction.

Not all of the hypotheses tested positively in terms of constituting a significant determinant for productivity gaps.¹⁰ In general, however, we observe that the quality of human capital plays an important role in all three industrial branches assessed. Amongst manufacturing firms, networking activities and the use of modern technologies for communication are important reasons for the lower levels of labour productivity in the East. The intensity of long-term strategic planning on behalf of the management turned out to be relevant only for machinery manufacturers. The extent of specialisation on 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 very sketchy, and the assumption that with lower wage-costs, managers would substitute capital with labour produced the right sign in correlation, however often insignificant.

3.1 Firm-specific productivity determinants in machinery manufacturing

Amongst the indicators we selected, the most important firm-specific determinants of the productivity gaps between our East and West German machinery manufacturers pertain to their intensities of use of modern communication technologies. This result holds irrespectively of the size of the firm. We find a statistically significant and positive correlation between the intensities of use of Email, internet and e-business, and the firms' productivity levels. The

¹⁰ Despite the fact that intense product and process innovation will play a particular role in *e.g.* the machinery manufacturing industry as well as in the furniture manufacturing branch, the results did not permit further exploration of this.

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).

Not only show correlations the right sign, hence those indicators qualify as performing determinants of productivity levels. 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. Hence, according to our methodology, we can 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.

In a combination of results of correlation strengths and intensity gaps between East and West, we devise a ranking order to each determinant by calculating a simple composite indicator.¹¹ 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 most important 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 most important determinant in the group of larger firms. The use of Email turned out 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 suppliers, customers and other stake-holders, the higher appear 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): apparently, large machinery manufacturers can benefit more from intense networking.

The intensity of firms' networking activities appear to be not only a determinant for firms' productivity levels: on average, Eastern firms exhibit lesser networking intensities as compared to their Western pairs. However, gaps in the intensity of networking in Eastern firms *vis-à-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 larger role for small firms than for large firms.

¹¹ 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. Er therefore only report the order of ranking of this indicator.

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	<i>Extent of qualification of personnel: management</i>	*	0.28	67	43	156	(x)
1.2	Extent of qualification of personnel: administration	***	0.56	33	43	77	4
1.3	Extent of qualification of personnel: workers	***	0.49	20	20	100	10
2	<i>Intensity of further and re-qualification of personnel</i>	**	0.19	44	40	110	(x)
3	Intensity of strategic planning	***	0.46	44	53	83	6
4.1	Intensity of networking: suppliers	***	0.44	45	50	90	7
4.2	Intensity of networking: customers	**	0.34	51	56	91	8
4.3	Intensity of networking: stake-holders	**	0.36	26	37	70	5
5.1	Intensity of use of communication technologies: email	***	0.52	55	74	74	3
5.2	Intensity of use of communication technologies: internet	***	0.64	56	78	72	2
5.3	Intensity of use of communication technologies: e-business	***	0.53	33	54	61	1
6	Diversification vs concentration on expertise	*	-0.28	6.1	5.6	109	9
	Observed labour productivity			55.5	89.9	61.7	
Large machinery manufacturers:							
1.1	<i>Extent of qualification of personnel: management</i>	***	0.47	77	60	128	(x)
1.2	<i>Extent of qualification of personnel: administration</i>	***	0.51	36	33	109	(x)
1.3	<i>Extent of qualification of personnel: workers</i>	***	0.30	23	21	110	(x)
2	Intensity of further and re-qualification of personnel	*	0.29	43	48	90	5
3	Intensity of strategic planning	**	0.57	50	51	98	8
4.1	Intensity of networking: suppliers	***	0.66	51	53	96	6
4.2	Intensity of networking: customers	***	0.61	52	54	96	7
4.3	Intensity of networking: stake-holders	***	0.54	32	38	84	4
5.1	Intensity of use of communication technologies: email	***	0.61	66	80	83	2
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/a	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. The ranking therefore indicates the respective roles played by candidate determinants in explaining the observed firm-specific productivity gaps.

For both small and large machinery manufacturers, regular networking with suppliers exhibits the strongest correlation with productivity; the gains in terms of productivity growth by increasing the intensity of networking with suppliers are indicated by our data to be most rewarding. However, gaps in intensities are much higher for networking with other stakeholders - hence the latter productivity gap-determinant proved to be the most important 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 an important determinant for productivity levels in general and for productivity gaps between firms in East and West Germany in particular. Again, this pertains uniformly to small and large firms. The strength of correlation turned out to be slightly higher for large firms, yet gaps in the East are larger for small firms. The intensity of long-term strategic planning plays a larger role for small firms in explaining the productivity gap suffered by Eastern firms than with large firms.

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 qualification (formal and working experience) and intensities of further qualification of personnel. The former is divided in the personnel classes of management, administration, and workers. The correlation holds irrespective of the size category.

However, the extent of qualification does not contribute to explaining the productivity gap amongst the group of large machinery manufacturers, here, the level of qualification in the East turned out to be higher as compared to the average levels in the West. Amongst small machinery manufacturers, the average qualification of administrative personnel and workers however does contribute to explaining the productivity gap. With the intensity of further and re-qualification of personnel being larger in the panel of small Eastern machinery manufacturers, this determinant only performs in the group of large machinery manufacturers as 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 qualification, despite our focus in the questionnaire on non-formal qualification.

With respect to the organisation of the production processes, 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 kins. 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 further and re-qualification 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 labour by capital, 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 assessed before.

3.2 *Firm-specific productivity determinants in furniture manufacturing*

Alike in the panels of machinery manufacturers, we identified the intensities of networking and the intensities of use of modern communication technologies as amongst the most important 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).

Moreover, intensities of networking as well as intensities of the 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. The highest ranking determinant was established in both size-groups for networking with other stake-holders: these results are mainly due to the low average intensities in Eastern firms. Amongst the three groups of networking partners, the least important 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.

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)}
		Significance	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/a	22	23	96	-
3	Intensity of strategic planning	-	n/a	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/a	3.8	3.1	123	-
Observed labour productivity				45.2	72.1	62.7	
Large furniture manufacturers:							
1.1	<i>Extent of qualification of personnel: management</i>	***	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/a	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
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/a	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. The ranking therefore indicates the respective roles played by candidate determinants in explaining the observed firm-specific productivity gaps.

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 most important explanation of productivity gaps amongst the three communication technologies- again, mainly due to the large intensity-gaps between East and West.

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 qualification is significantly and positively correlated with the corresponding firms' productivity levels. Moreover, 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 the 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 further qualification 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. 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 focussing of the product-portfolio on a small number with a view on 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 observe productivity gaps - reasons must again lie in the other factors assessed before. 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.

3.3 Firm-specific productivity determinants in construction

For our firms from the construction industry, the results are very different from the ones reported for the two manufacturing industries: here, intensity of networking and the use of modern communication technologies play no significant or determinable role for the explanation of observable productivity gaps at the firm-level.

The only robust firm-specific determinants identified pertain rather to the quality of human capital: the qualification of personnel in the group of management and in administration did produce significant positive correlations with productivity levels. However, only for the managers can this explain productivity gaps, even if the share of qualified managers in the West is only slightly higher than in the East.

In the group of administrative staff, eastern firms appear to have a much higher share of qualified personnel than their western kins. The highest position in our ranking is assumed by the intensity of further and re-qualification of personnel: here, the values are naturally much lower than in the two manufacturing industries, yet clearly lower again in the eastern firms as compared to the western firms. Those results can tentatively suggest that human capital does play an important role in our construction firms.

Also in contrast to the results for the above two manufacturing branches, the productivity gap suffered by our construction firms in the East appear also root in capital-intensities: the intensity of use of capital (measured in the rate of automatisations in production), as well as investment-intensities turn out to be not only significantly correlated with productivity levels. Also, our construction firms in the East appear to work more intensively with labour

Table 3 Summary of results of analysis of firm-specific determinants: small construction firms

	Correlations ^{a)}		Average values of determinants in ...			Ranking ^{b)}
	Significance	Strength	East Germany	West Germany	East in % of West	
Small construction firms:						
1.1	***	0.57	78	80	98	4
1.2	*	0.29	39	22	177	(x)
1.3	-	n/a	2	19	11	-
2	**	0.44	1	3	33	1
3	-	n/a	31	47	66	-
4.1	-	n/a	54	77	70	-
4.2	-	n/a	42	70	60	-
4.3	-	n/a	37	23	161	-
5.1	*	-0.31	21	32	91	(x)
5.2	-	n/a	19	28	68	-
5.3	-	n/a	3	5	60	-
6	-	n/a	2.0	2.3	87	-
Additionally:						
	***	0.46	26	35	74	3
	**	0.38	2	4	50	2
			46.8	64.8	72.2	

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. The ranking therefore indicates the respective roles played by candidate determinants in explaining the observed firm-specific productivity gaps.

and have invested less intensively into new stocks of capital as compared to their pairs in the West.

However, if we test this result against the hypothesis that relatively cheaper labour in the East might be the root of this higher labour-intensity, then our results turn out to be insignificant. Yet, labour costs per employee in the East only reach *72 per cent* of the costs in our western firms. We are hence not able to decide empirically whether cheaper labour in fact served to substitute capital and thereby affecting lower labour productivity levels in the East.

Our test pertaining to the reaction of managers to intense competition also did not produce sufficiently robust results.

Summary of main results

To sum up, our research results turned out to be not always in line with our assumptions. However, our analysis does suggest that the quality of human capital plays an important role in all three industries assessed.¹² Moreover, some of the productivity gaps suffered by firms in East Germany appear to root in deficiencies in strategic management in the average of our East German firms. This pertains mainly to the intensity of networking and the use of modern communication technologies. Those turned out to be amongst the most important firm-specific determinants of productivity gaps between East and West German machinery and furniture manufacturers alike.

Additionally, we were able to establish for both manufacturing industries that the lower levels of labour productivity in firms in East Germany are not a result of a rational choice to substitute capital by cheaper labour.

¹² Due to the fact that the results were generated from field study using questionnaires, we are unable to say whether firms in fact assessed their own qualification in terms of ‘work experience’ rather than simply ‘formal qualification’. It is a well established fact that the East German population commands a much higher density of formal qualification which, however, does not necessarily match the necessary qualification requested by the current occupation: often firm managers and owners in the East have technical qualification which do not serve to great lengths for management and market-related activities.

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