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Are Firms in Business Groups More Productive? An empirical analysis based on German micro-level data with a special emphasis on the roles of regional and sectoral diversity

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# Are Firms in Business Groups More Productive?

An empirical analysis based on German micro-level data with a special emphasis on the roles of regional and sectoral diversity<sup>a</sup>

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Preliminary version, please do not quote

## Abstract

The present paper analyses whether and how the affiliation of a firm to a business group affects its productivity. Based on novel data consisting of official firm data from the German Business Register including ownership information from *Bureau van Dijk's* MARKUS database and from the Cost Structure Panel we assess differences in productivity (1) between independent firms and firms affiliated to groups and (2) affiliated firms controlled by German owners and affiliated firms controlled by foreign owners. Controlling for a series of determinants like, for example, the internal diversity of firms and groups, region, sector and size of firms, it is shown that group members have a productivity premium between 6 and 28% depending on the considered subsample. Furthermore, affiliates under foreign control are more productive than firms controlled by domestic owners.

**JEL-Classification:** J24, L10, L25

**Keywords:** Business Groups, Productivity, Foreign Ownership, Diversity

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# 1 Background and Motivation

Although the recent economic crisis has brought about a considerable decline of the volumes of mergers and acquisitions from 22,800 to 18,500 between 2007 and 2009<sup>1</sup>, both the number and the economic power of firms in domestic and multinational business groups and conglomerates is constantly on the rise. This is a consequence of the ongoing tendencies of internationalization and globalization accompanied by the continuous expansion of worldwide networks of communication and transportation with a steady increase of international trade flows and production networks.

In Germany, for example, the amount of foreign direct and indirect investments increased from EUR 85 billion in 1990 to EUR 470 billion in 2009. In relation to the gross domestic product this equals an increase from 6.5 % to 19.6 %. The volume of direct and indirect investments of German firms abroad is even larger and it rose from EUR 116 billion in 1990 to EUR 985 billion in 2009 – representing rates of 8.8 % and 41.1 % of the gross domestic product in both years, respectively (see Table 1).<sup>2</sup> Another outstanding example are the fast growing outsourcing activities of mainly knowledge intensive services (cf. Abramowsky and Griffith, 2009).

**Table 1: Inward and Outward FDI in Germany (direct and indirect investments)**

|      | Inward FDI     |                  | Outward FDI    |                  |
|------|----------------|------------------|----------------|------------------|
|      | in million EUR | Share of GDP (%) | in million EUR | Share of GDP (%) |
| 1990 | 84,966         | 6.49             | 115,788        | 8.84             |
| 2000 | 291,900        | 14.15            | 582,338        | 28.23            |
| 2009 | 469,745        | 19.60            | 984,540        | 41.07            |

Source: Deutsche Bundesbank and Statistisches Bundesamt. Own Calculations

But also on the national level, tendencies of increasing inter-firm linkages can be observed (e.g. Hauschild and Wallacher, 2004 or Kleber et al., 2010). These processes mainly do not lead to new independent firms, but rather to new entities which are more or less controlled by other companies or individuals (cf. Deutscher Bundestag, 2006, p. 92). In Germany, for example, a recent study has shown that 6% of *all* firms are part of a national or international business group – either as an affiliate or as a head of the group (data for 2005). More importantly, these firms account for every second job in Germany and for more than two thirds of the total turnover achieved in the country (cf. Koch, 2010, p. 11).

The affiliation of a company to a group or a network may have various reasons: efficiency, competitiveness, reduction of transaction costs, access to knowledge and other resources may be among the most important motivations (cf. Kim, 1999). Definitely, the integration of a

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<sup>1</sup> Mergers and acquisitions with majority participation, cf. Bureau van Dijk's press release from January 26, 2010 at <http://www.bvdep.net/de/press1035.html>, download July 16, 2010.

<sup>2</sup> cf. Deutsche Bundesbank Eurosystem, data available at [www.bundesbank.de](http://www.bundesbank.de), download February 17, 2012.

company into a group of firms – either as a part of a multiunit firm, as a part of a business group or in a more informal way as a member of a network of production – has consequences for the firm, and, certainly, for the group as whole:<sup>3</sup> it may provide access to knowledge, it may enhance customer and supplier relationships, and, finally, it may boost productivity. This may be valid for firms in business groups acting solely at the national level, and it may be even more accentuated for groups with an international orientation. A series of empirical studies have analyzed the differences between foreign and domestic firms in recent years (e.g. Backer and Sleuwagen, 2002, Doms and Jensen, 1998, Hake, 2008, Temouri et al., 2008).

There are various arguments why firms in business groups might be more productive than their “independent” counterparts.<sup>4</sup> The most important argument is, certainly, firm size (cf. Majumdar, 1997, Miller, 1978): by the integration into a business group a firm can virtually increase its size which potentially enables it to exploit economies of scale more effectively. Furthermore, large firms may have more and better resources and they may have easier access to new resources, not only due to their market power, but also due to the availability of more and more diverse access channels (Penrose, 1959). However, there is also a downside of size as inefficiencies increase in huge organizations due to higher transaction costs.

A second important argument why firms in business groups should be more productive is partially associated to size: diversification (for overviews, see Jacquemin and Berry, 1979 or Schoar, 2002). Diversity may help reduce risks, it may open up different and new channels of distribution and knowledge access, it may favor access to networks and strengthen the ties of firms (cf. Granovetter, 1973). For example, scholars have shown that diversification promotes productivity (e.g. Miller, 2004 or Schoar, 2002).

However, data availability in most countries has been scarce until recently and many of the above mentioned studies are based on small samples or even on rather anecdotal evidence. This is less striking in studies on foreign ownership, foreign direct investments or on multinational firms, but it is very much relevant in the case of general assessments of business groups, where data until recently did not allow for in-depth or even representative analyses, and mostly not even for a simple identification and quantification of business groups.

In Germany (as in other European countries), data availability has improved significantly in the last few years. This concerns many parts of the data infrastructure on economic data for firms and establishments (for a recent overview, cf. Wagner, 2009), and it is also relevant with respect to the coverage and analysis of business groups. Only most recently, data on business groups is available within the official statistics in Germany (cf. section 2).

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<sup>3</sup> It has to be stressed here that our data do not allow for dynamic aspects of productivity, i.e. for the *causal* question whether group membership has an *impact* on firms' productivity or whether rather the more productive firms select into groups. For an account of ownership changes on firm performance cf. for example Bellak et al. (2006) or Benfratello and Sembenelli (2006).

<sup>4</sup> Independence is a relative concept. Although we are able to measure formal involvement structures (via ownership and/or control, see section 2), we cannot assess informal linkages between firms – e.g. research cooperation, project-based contracts etc. – which might equally impact on performance and productivity measures.

The present paper makes use of these new data and it addresses the question whether firms in business groups are more productive than independent firms. Although we are not (yet) in the position to account for dynamic aspects (e.g. does the affiliation to a group *enhance* productivity?), we can draw a first static picture for Germany. Based on a unique firm-level representative sample of manufacturing firms and making use of two datasets which were merged together, we address the rather simple questions (1) whether firms in business groups are more productive than their counterparts outside such groups and (2) whether firms in business groups controlled by foreign firms are more productive than firms controlled by domestic owners.

The remainder of the paper is structured as follows: Section 2 describes the data, whereas section 3 introduces our model and discusses measurement issues. The results are presented in section 4 and, finally, section 5 concludes.

## 2 Data

For the analyses of the contribution at hand, we use a novel dataset combining information from two different sources: the German Business Register (*Unternehmensregister*) and the Cost Structure Survey (*Kostenstrukturerhebung, KSE*), which will be introduced in the following.

The **German Business Register** is a dataset held by the Statistical Offices which contains information on all economically active firms (legal units) and establishments (local units) located in Germany. Its contents are based on information from different providers (essentially the Statistical Offices themselves, the Federal Employment Agency and the tax authorities) continuously compiled by the Statistical Offices on an annual basis. The main contents of the Business Register are employment and turnover figures. The data contains also detailed information about the entities' sectoral and regional affiliation. In principle, the Register contains data on all economic sectors, although data quality and relevance are inferior in some areas (e.g. agriculture, public sector) due to reporting procedures or due to a minor significance of the market mechanism in these sectors.

The greatest benefits of the Business Register are its ample coverage of the private economy, its reliability and the possibilities to link it to other datasets (as we do in the present paper). A distinctive feature of the Business Register is that it not only includes information on both local and legal units, but also on the relations between those units. Although nearly 98% of the firms are single-site firms (=coincidence of local and legal unit, cf. Koch/Krenz, 2010), particularly in manufacturing and among bigger entities, a significant percentage of units is also part of multi-site firms consisting of various local units (e.g. branch plants). In the following, we will refer to a legal unit as a *firm* and to a local unit as an *establishment* (for further information, cf. Koch/Migalk, 2007 or Koch/Krenz, 2010).

Another important content of the Business Register with particular relevance for the study at hand is its information with regard to business groups.<sup>5</sup> Since 2005, the Statistical Offices annually acquire information concerning ownership and control relations of all German firms from different data files (mainly from the MARKUS file) of the private data provider *Bureau van Dijk* (BvD, see also [www.bvdep.com](http://www.bvdep.com)) and they integrate these data into the Business Register. *Bureau van Dijk* is a large and globally operating private provider of firm-level data and it systematically collects, acquires and trades information on e.g. the structures and dynamics of businesses, balance sheets or ownership of and between companies (see [www.bvdep.com](http://www.bvdep.com)). Although BvD's principal aim is trading information on private firms, within the last few years, its datasets are also increasingly being used for scientific and public purpose (for further information see Koch, 2010 and Sturm et al., 2009).<sup>6</sup>

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<sup>5</sup> This is particularly a consequence of the increasing significance of Pan-European standards regarding the availability and contents of Business Registers. In the present context, the EC Regulation No. 177/2008 requires that all Business Registers across EU members henceforth have to contain information on the links of control between business enterprises. This meets also the concerns of the constantly increasing (national and international) interdependencies between companies.

<sup>6</sup> Major problems of the BvD data can be seen in their coverage rates across different sectors and firm sizes as well as in their up-to-dateness: generally, BvD acquires its information from nationally operating "Information Providers" (IPs, in Germany this is the "Verband der Vereine Creditreform", cf. [www.creditreform.de](http://www.creditreform.de)). These

After integrating BvD's information into the official registry data since 2005, the Business Register includes two variables containing information on ownership and control for every firm: the first variable states whether a firm is part of a business group or not, and, if so, whether it is the leader of that group or whether it is an affiliate firm; since 2007, there is an additional information stating whether an affiliate is part of a business group controlled by a domestic or by a foreign owner.<sup>7</sup> In general, it has to be noted that all information except the linkages to the ultimate owners end at the German borders and that the data do not contain information on potential group members outside Germany. Thus, it is impossible to assess the real size and extension of the business groups and it is most probable that their size and scope are underestimated in the available data.

The second dataset used for the study at hand is the Cost Structure Survey in Manufacturing, Mining and Quarrying (KSE-VG, for detailed information, cf. Fritsch et al., 2004 or Statistisches Bundesamt, 2010). This dataset is based on a yearly representative random sample survey of nearly 18,000 firms from the producing sectors, consisting of the subsectors of mining and quarrying and the manufacturing industry in Germany.<sup>8</sup> The data contain all firms with 500 or more employees and a sample of firms with 20 to 499 employees; smaller firms are excluded. The information in the KSE is highly reliable as the selected firms are obliged to participate in the survey. The KSE is organized as a rotating panel, as smaller firms (below 500 employees) are normally surveyed during four consecutive years and then replaced by other firms. As the sample is stratified along the size of the firms (employment) and the sectors of the economy, weighting factors allow for a direct assessment of results.

The main contents of the survey is information on the main economic activity of the firms, employment, outputs (e.g. turnovers, stocks of goods and products, own produced assets), stocks of raw material, stocks of goods for resale, costs of production (e.g. wages, rents, taxes), subsidies, billed and deductible VAT as well as information on R&D activities (number of employed personnel and expenditure for Research and Development).

For the present paper, information from the Business Register has been merged with the Cost Structure Survey. As information on business groups is only available for years since 2005, we restrict our data to the years 2005-2007. Furthermore, we restrict our sample to the firms that are included in both datasets; however, we use some information on linked establishments from the Business Register before excluding them from the data (see below).

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IPs collect information on existing and new firms from trade registers, newspapers and other data providers. Firms enter the data when they are newly founded and they stay in the data when their credit rating remains over a certain threshold level and when another firm or person asks for information about the credit rating of that firm. From a rigorous scientific point of view, BvDs data are problematic in the sense that the primary objective of the provider's data collection are commercial reasons. However, the Statistical Offices are acting with extreme caution and the BvD data are thoroughly verified before matching it to the Business Register (for further information, see Koch 2010).

<sup>7</sup> The original BvD data acquired by the Statistical Offices also contains information about the location of the controlling company (Federal State for German firms, country for foreign firms). However, due to nondisclosure it has not been possible to get access to these data for the purpose of the paper at hand.

<sup>8</sup> This number of surveyed firms corresponds to about 40% of all firms above the size threshold in the surveyed sectors (cf. Fritsch et al., 2004).

### 3 Specification of the Model and Estimation Strategy

Using a matched dataset from the German Business Register, two main questions are addressed in the present paper: first, are firms in business groups more productive than their counterparts outside such groups? And, second, can we observe productivity differences between group affiliates controlled by domestic (=German) firms and those controlled by foreign firms? As our data comprises only three years and as information on the nationality of ultimate owners is only available for 2007, we abstain from estimating dynamic panel models – e.g. regarding the questions which, when and how firms become group members or on the impact of group entry and exit on productivity.

What we do instead is an analysis of the above outlined questions by performing regression analyses using the productivity of firms as the dependent variable and controlling for a series of firm characteristics, the most important of which is group membership. In the following, we will first present the variables of our model and then introduce the model itself.

#### 3.1 The Measurement of Productivity

Productivity, our dependent variable, is measured as gross value added at factor costs per member of the workforce (see below). The underlying data of the Cost Structure Survey contains exhaustive information on the firms' input and output and is thus appropriate for the measurement of the gross value added (for a detailed description cf. Fritsch et al., 2004). Regarding the underlying measure for employment, our data does not contain information on hours worked, but only on the total workforce, which certainly somewhat constrains our results.

#### 3.2 Independent Variables

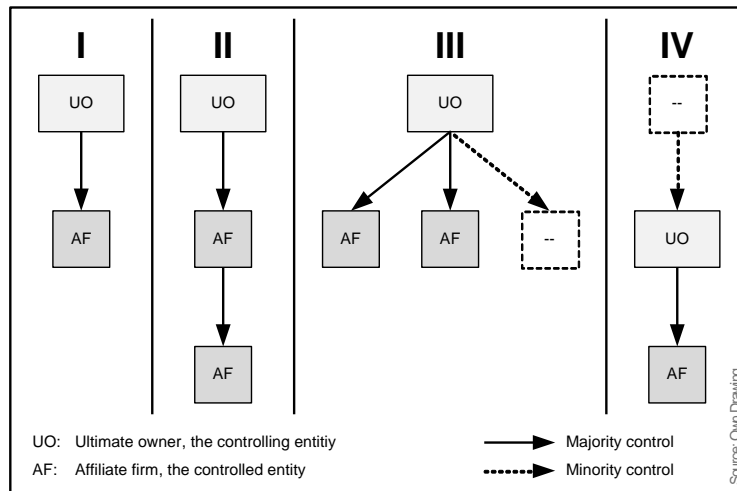
##### Group Affiliation

Group affiliation is in principle defined as being part of a group of at least two firms where one firm – the ultimate owner – controls and/or owns the majorities of one or more other firms (the affiliate firms). Some examples for possible structures are given in Figure 1 below. Our data also covers chain structures (examples II and IV), where control is not directly executed between ultimate owner and affiliate firm. Our data covers all ultimate owners and affiliate firms as long as they are located in Germany and included in the Business Register (vast majority of German firms, criteria see above). Since 2007, the data also comprises information on the linkages between the group members in such a way that it declares whether the ultimate owner of an affiliate is located in Germany or abroad.<sup>9</sup>

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<sup>9</sup> The original data used to construct the variable on group affiliation in the Business Register contains much more information about the group members and their inter-firm linkages (e.g. a common group identifier, more exact information about the location of the ultimate owner, information about the type of the ultimate owner etc.).





**Figure 1: Examples for Structures of Control in Business Groups**

In the present contribution, we use two different variables on the group affiliation of firms. The first one is a simple dummy variable taking the value 1 if a firm is member of a business group, either as an ultimate owner or as an affiliate firm. This variable is available for all years of observation. For 2007, we dispose of an additional variable which distinguishes between:

- firms non-affiliated to groups,
- members of groups with German ultimate owners<sup>10</sup> and
- German affiliates with foreign owners.

### Workforce, Employment and Firm Size

A firm's workforce is measured as the total number of employed persons (*tätige Personen*) in the firm at a given time. This concept of the workforce includes all employees subject to social security obligation independently of their workload or professional status (e.g. white-collar, blue-collar, interns, students, trainees etc.). Moreover, it also comprises all owners which are actively working in the firm, nonpaid family members, marginal employees etc. (for a complete assessment cf. Statistisches Bundesamt, 2007). The information on the firms' workforce originates from the Cost Structure Survey.<sup>11</sup>

### Diversity

As outlined above, we suppose that the diversity of a firm and/or its integration into diversified structures is an important determinant of productivity. With regard to the operationalization of diversity, we do not dispose of measures of the internal structure of the entities in our data (like, for example, the product portfolio, the diversity of the skills of

<sup>10</sup> Certainly, it would be more accurate to also distinguish between German ultimate owners and German affiliates being controlled by German owners. However, the number of German ultimate owners is rather low in the data and not sufficient for a viable analysis.

<sup>11</sup> The Business Register also contains a variable on employment. This variable, however, only includes employees subject to social security obligation and marginal employment. Nevertheless, there is a high and significant correlation between the employment variables of both datasets ( $r^2=0.985$ ).

employees or an internal structuring into departments etc.) and we thus have to restrict our diversity measures to firms consisting of various plants (multi-site firms).<sup>12</sup>

Three aspects of diversity are considered in our model – size structure, sectoral structure and regional structure. The basis of the measurement of the three variables is information contained in the Business Register. As this dataset comprises all active firms and establishments in Germany as well as information on their linkages (i.e. information about all local units of the legal units in the data), we are able to see whether a firm consists of one (single-site firm) or more establishments (multi-site firm) and which characteristics these establishments have (e.g., size, sector, location).

Diversity regarding the **size structure** of the different entities of a firm is measured by a firm-level concentration index  $D_H$  following the principle of a Herfindahl-Index:

$$D_H = \sum_{i=1}^n \left( \frac{x_{ij}}{\sum_i x_{ij}} \right)^2 \quad (1)$$

where  $x_{ij}$  is the number of the workforce in establishment  $i$  of firm  $j$ . In case of a single-site firm the index takes the value 1 and it decreases with the number of (small) establishments.

Second, we measure two diversity indices  $D_R$  and  $D_S$  regarding the internal regional and sectoral structures of a firm describing whether and how a firm is active in different sectors or regions of the economy.<sup>13</sup> In contrast to the above employment-based index, this measure is based on establishment counts (for a more detailed account of diversity indices see, for example, Jaquemin and Berry, 1979).<sup>14</sup>

$$D_R = \sum_{r=1}^{n_{jr}} \left( \frac{z_{jr}}{\sum_r z_{jr}} \right)^2 \quad (2)$$

$$D_S = \sum_{s=1}^{n_{js}} \left( \frac{z_{js}}{\sum_s z_{js}} \right)^2 \quad (3)$$

$z_{jr}$  and  $z_{js}$  are the numbers of establishments in region  $r$  / sector  $s$  in firm  $j$ .  $n_{rj}$  and  $n_{js}$  are the numbers of regions or sectors, respectively, in which establishments of firm  $j$  exist.<sup>15</sup>

As diversity is, in principle, supposed to be conducive to a firm's productivity up to certain threshold, while too much diversity may hamper productivity, e.g. due to a lack of focus on its core competencies, we also include the squares of the productivity measures in order to account for possible non-linear effects.

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<sup>12</sup> As the share of multi-site firms is low in the total economy (in our full dataset of the Business Register it amounts to 2.27% in the average of the years 2005-2007), but significantly higher in manufacturing and among bigger firms (among the firms included in the Cost Structure Survey their share adds up to 22.6%), this proceeding seems legitimate with regard to our sample.

<sup>13</sup> The principles of these indices are based on diversity indices used in population ecology, see, for example, Shannon (1948) or Simpson (1949).

<sup>14</sup> This seems legitimate due to the consideration that diversity is rather driven by *having* parts of a firm in different sectors and/or regions than by the size of those parts.

<sup>15</sup> In order to display rather complete firm structures, the three above indices are calculated on the basis of data for the whole German economy taken from the Business Register. We use German NUTS-2 regions (39 government regions) for the regional index and the two digit sectoral classification of industries for the sectoral index.

## Research and Development

The data of the Cost Structure Survey also contain information about whether and how much of its revenues a firm invests in research and development (R&D) activities.<sup>16</sup> We include this information as a dummy variable taking the value 1 if a firm makes any investments in R&D and 0 otherwise.

## Further Control Variables (Sector, Region, Time)

To control for sector-specific determinants of the firms' productivity as e.g. for differences in an industry's minimum efficient scale, in industry growth, market size, market dynamics or technological conditions, sector-specific dummy variables are added on the 4-digit level of the German Industry Classification (*Wirtschaftszweigsystematik, WZ*). To account for a possible impact of regional market conditions on the productivity, we also include regional dummy variables on the level of the Federal States of Germany. These variables control for e.g. differences in regional supply and demand side conditions.<sup>17</sup> A possible impact of macroeconomic conditions is controlled by running separate regressions for the years 2005 to 2007 as well as by including annual dummy variables in a pooled model for all the years.

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<sup>16</sup> Furthermore, the data also contain a variable including the number of "salaried staff in research and development" which we did not use due to a share of missing values.

<sup>17</sup> A more disaggregate classification of the regional variables would be certainly desirable, however, due to low number of cases and subsequent nondisclosure issues, we did not get access to the regional identifiers below the level of Federal States.

## 4 Empirical Results

### 4.1 Descriptives

In this section, we present descriptive statistics on the differences between independent firms and firms that are members of business groups. Given that data on group affiliation are not released for the German Federal States of Bremen and Lower Saxony, both regions cannot be included in our analysis.<sup>18</sup>

Our extrapolated dataset includes total numbers of 29,513 firms in 2005, 28,194 in 2006 and 27,319 firms in 2007. Table 2 provides the distribution of firms in groups across the federal states of Germany. North Rhine-Westphalia (26%), Baden-Württemberg (22%) and Bavaria (17%) host by far the highest shares of group affiliated firms, whereas only 1% of them are located in Saarland, 1.5% in Mecklenburg-West Pomerania and Hamburg, respectively, and about 2% in Berlin. The variation across the three considered years is rather small.

**Table 2: Distribution of affiliated firms across federal states, shares in %**

|                            | 2005 | 2006 | 2007 |
|----------------------------|------|------|------|
| Schleswig-Holstein         | 2.9  | 2.8  | 2.8  |
| Hamburg                    | 1.5  | 1.6  | 1.5  |
| North Rhine-Westphalia     | 25.7 | 25.8 | 25.5 |
| Hesse                      | 7.5  | 7.2  | 7.3  |
| Rhineland-Palatinate       | 4.9  | 4.9  | 4.9  |
| Baden-Württemberg          | 21.7 | 22.0 | 22.0 |
| Bavaria                    | 17.2 | 17.2 | 17.2 |
| Saarland                   | 1.1  | 1.2  | 1.2  |
| Berlin                     | 1.8  | 1.8  | 1.7  |
| Brandenburg                | 2.1  | 2.0  | 2.0  |
| Mecklenburg-West Pomerania | 1.5  | 1.5  | 1.5  |
| Saxony                     | 5.5  | 5.5  | 5.8  |
| Saxony-Anhalt              | 2.7  | 2.6  | 2.7  |
| Thuringia                  | 3.9  | 3.9  | 3.9  |
| Germany*                   | 100  | 100  | 100  |

\* excluding Bremen and Lower Saxony

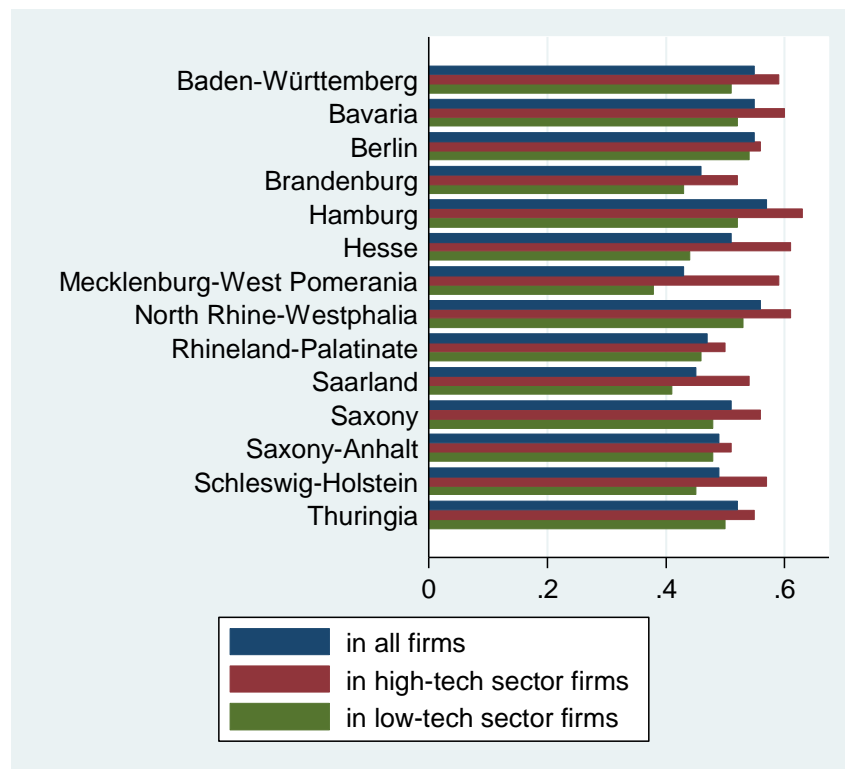
Source: Research Data Centre of the Statistical Offices of the German Länder, Site Berlin/Potsdam.  
Business Register and Cost Structure Survey, 2005-2007. Own Calculations

<sup>18</sup> With regard to firm numbers, Bremen is the smallest Federal State (0.8% of all firms in Germany in 2005); with a share of 8.5% of all German firms, Niedersachsen ranges among the medium sized states (cf. Koch, 2010, p. 63). For the following calculations, we presume only a minor influence of the exclusion of these two states on our results.

Table 3 displays the particular role of affiliated firms in each federal state and it thereby also distinguishes between high-tech and low-tech firms.<sup>19</sup> The share of affiliate firms on all firms varies between 41% (Mecklenburg-West Pomerania) and 56% (Berlin and Hamburg) in 2005 and 54% in North Rhine-Westphalia in 2006. In 2007, the percentage of firms that are group members increases in all federal states and lies between 47% (Mecklenburg-West Pomerania) and 62% (Hamburg). Thus, on average, almost every other firm belongs to a business group.

Furthermore, Figure 2 reports the shares of group affiliate firms in high-tech and low-tech sectors separately. We observe a higher share of affiliates in high-tech sectors of about 57% on average vs. 48% in low-tech sectors.

**Figure 2: Shares of group members in total firm numbers, averages 2005-2007**



\*excluding Bremen and Lower Saxony

Source: Research Data Centre of the Statistical Offices of the German Länder, Site Berlin/Potsdam. Business Register and Cost Structure Survey, 2005-2007. Own Calculations

<sup>19</sup> The differentiation between high-tech and low-tech firms follows a classification of low-tech, medium-tech and high-tech sectors in manufacturing of the European Union, given, for example, in the Regulation No 716/2007 of 20 June 2007 on Community statistics on the structure and activity of foreign affiliates, p. 15. The following sectors are classified as high-tech in the present contribution: Manufacture of chemicals and chemical products (24), manufacturing of machinery and equipment (29), Manufacture of office machinery and computers (30), Manufacture of electrical machinery and apparatus n.e.c. (31), Manufacture of radio, television and communication equipment and apparatus (32), Manufacture of medical, precision and optical instruments, watches and clocks (33), Manufacture of motor vehicles, trailers and semi-trailers (34) and the Manufacture of other transport equipment (35) except building and repairing of ships and boats (35.1).

Comparing the sizes of independent and affiliated firms as expressed in the number of employees (Table 4), we observe that affiliate firms are considerably larger. The average number of employees in group members is 243 in 2005, 256 in 2006, and 257 in 2007, and, therefore, approximately 150% higher than in independent firms with mean numbers of employees of 91 in 2005, 99 in 2006, and 92 in 2007. Though the median is lower than the mean, the affiliated firms remain almost twice as large as independent firms (83 vs. 43 in 2005, 86 vs. 46 in 2006 and 88 vs. 46 in 2007). These differences between mean and median reflect the presence of large firm outliers.

The differences in firm size between group members and independent firms are particularly high in West Germany (see Table 3). Further, both the affiliates and the independent firms are smaller in East Germany. However, the differences between affiliated and non-affiliated firms are not as strong as in West Germany. A comparison of high-tech and low-tech sectors also shows that the average firm size of affiliate firms in high-tech industries is larger (see Table 3).

**Table 3: Number of employees by type of firm**

|                      | 2005 |        | 2006 |        | 2007 |        |
|----------------------|------|--------|------|--------|------|--------|
|                      | mean | median | mean | median | mean | median |
| All firms            |      |        |      |        |      |        |
| non affiliated firms | 91   | 43     | 99   | 46     | 92   | 46     |
| affiliated firms     | 243  | 83     | 256  | 86     | 257  | 88     |
| West Germany         |      |        |      |        |      |        |
| non affiliated firms | 97   | 44     | 105  | 46     | 98   | 47     |
| affiliated firms     | 263  | 86     | 277  | 88     | 277  | 91     |
| East Germany         |      |        |      |        |      |        |
| non affiliated firms | 62   | 39     | 68   | 43     | 67   | 46     |
| affiliated firms     | 124  | 71     | 132  | 75     | 140  | 76     |
| High-tech sectors    |      |        |      |        |      |        |
| non affiliated firms | 122  | 46     | 137  | 49     | 122  | 50     |
| affiliated firms     | 334  | 95     | 352  | 102    | 355  | 108    |
| Low-tech sectors     |      |        |      |        |      |        |
| non affiliated firms | 75   | 42     | 80   | 44     | 77   | 45     |
| affiliated firms     | 178  | 75     | 186  | 78     | 188  | 79     |

\* excluding Bremen and Lower Saxony

Source: Research Data Centre of the Statistical Offices of the German Länder, Site Berlin/Potsdam.  
Business Register and Cost Structure Survey, 2005-2007. Own Calculations

For 2007, the data allow to distinguish between firms which are members of business groups with a German owner and firms under foreign ownership or control. Therefore, Table 4

provides the number of employees in affiliate firms distinguishing between German and foreign-owned firms. The average employee number (mean) in firms controlled or owned by foreign firms is 357 and therefore approximately 50% larger than in affiliates controlled and/or owned by German firms (235 employees). In terms of the median, the former are even twice as large as members of German groups (158 vs. 79 employees). Furthermore, the differences in firm size between West and East Germany as well as between high- and low-tech industries are notable (see Table 4).

**Table 4: Number of employees in group-affiliated firms in 2007**

|                   | mean               |                     | median             |                     |
|-------------------|--------------------|---------------------|--------------------|---------------------|
|                   | German group owner | Foreign group owner | German group owner | Foreign group owner |
| Germany total     | 235                | 357                 | 79                 | 158                 |
| West Germany      | 254                | 386                 | 81                 | 173                 |
| East Germany      | 129                | 191                 | 72                 | 103                 |
| High-tech sectors | 344                | 393                 | 94                 | 169                 |
| Low-tech sectors  | 167                | 316                 | 72                 | 145                 |

\* excluding Bremen and Lower Saxony

Source: Research Data Centre of the Statistical Offices of the German, Länder Site Berlin/Potsdam. Business Register and Cost Structure Survey, 2005-2007. Own Calculations

Looking at the values of labor productivity defined as gross value added per employee (Table 5), we can see that, on average, the affiliated firms are more productive than independent firms. Affiliated firms achieve labor productivities that average to € 54,088 in 2005, € 55,985 in 2006, and € 56,135 in 2007 per worker and firm. In West Germany, group members' productivity was 25% higher in 2005 and 2007 (24% in 2006) than the productivity of group affiliates in East Germany. The labor productivity in low-tech sectors is smaller than in high-tech sectors for both group affiliates and non-group members. In 2005 and 2006, independent firms in high-tech sectors created a gross value added per employee that was 31% (in 2007 even 40%) above those in low-tech firms. For affiliated firms we got smaller differences in labor productivity between high-tech and low-tech sectors (about 17% in 2005, 22% in 2006, and 28% in 2007). Furthermore, the gap between affiliates and their independent counterparts turned out to be smaller in high-tech industries.

**Table 5: Gross value added per employee, in €**

|                           | 2005   | 2006   | 2007   |
|---------------------------|--------|--------|--------|
| <b>Germany* total:</b>    |        |        |        |
| non affiliated firms      | 40,992 | 43,063 | 42,636 |
| affiliated firms          | 54,088 | 55,985 | 56,135 |
| <b>West Germany:</b>      |        |        |        |
| non affiliated firms      | 42,454 | 44,691 | 44,617 |
| affiliated firms          | 55,690 | 57,606 | 57,838 |
| <b>East Germany:</b>      |        |        |        |
| non affiliated firms      | 33,864 | 34,727 | 33,347 |
| affiliated firms          | 44,552 | 46,438 | 46,156 |
| <b>High-tech sectors:</b> |        |        |        |
| non affiliated firms      | 48,609 | 51,014 | 52,508 |
| affiliated firms          | 59,109 | 62,631 | 64,377 |
| <b>Low-tech sectors:</b>  |        |        |        |
| non affiliated firms      | 37,208 | 38,996 | 37,607 |
| affiliated firms          | 50,484 | 51,206 | 50,278 |

\* excluding Bremen and Lower Saxony

Source: Research Data Centre of the Statistical Offices of the German Länder, Site Berlin/Potsdam. Business Register and Cost Structure Survey, 2005-2007. Own Calculations

In 2007, members of foreign business groups achieved productivity levels (see Table 6) that exceeded those of affiliates in German ownership by 30% (with exception for low-tech sectors, where the gross value added per worker generated in foreign-owned affiliates lay about 19% above those in German groups). The highest values of labor productivity were achieved in firms with foreign group owners in high-tech sectors (€ 77,986 per employee).

**Table 6: Gross value added per employee in group-affiliated firms in 2007, in €**

|                   | German group owner | Foreign group owner |
|-------------------|--------------------|---------------------|
| Germany total*    | 53,310             | 69,035              |
| West Germany*     | 54,923             | 71,118              |
| East Germany      | 43,879             | 56,680              |
| High-tech sectors | 60,188             | 77,986              |
| Low-tech sectors  | 48,964             | 58,346              |

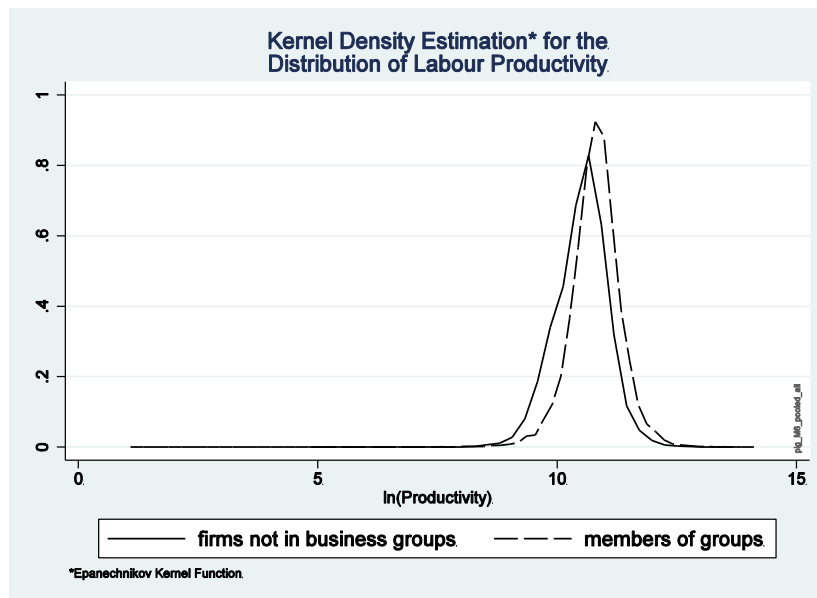
\* excluding Bremen and Lower Saxony

Source: Research Data Centre of the Statistical Offices of the German Länder, Site Berlin/Potsdam. Business Register and Cost Structure Survey, 2005-2007. Own Calculations



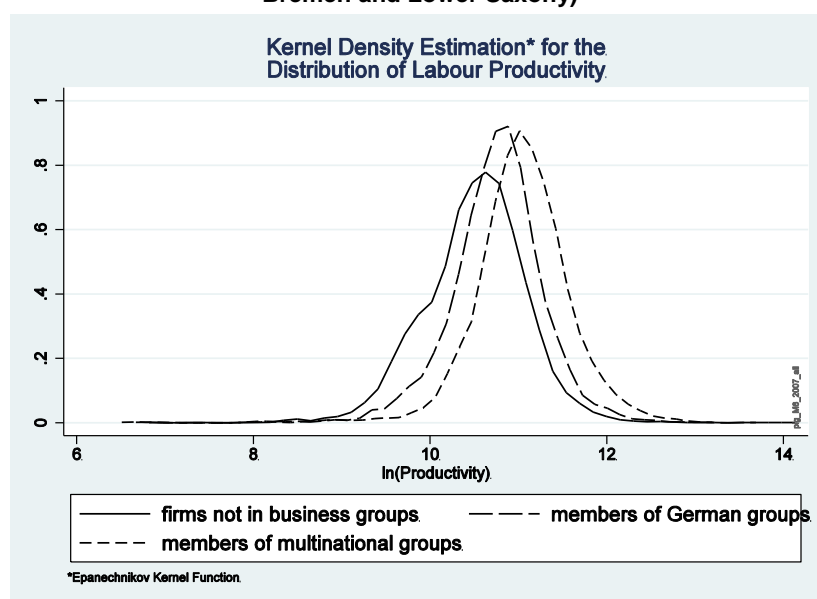
In the next step, we plot comparative kernel density functions of labor productivity for firms affiliated to a business group and for non-affiliated firms. These plots show that the productivity distribution of group members is rightward-shifted with respect to the reference group (Figure 3), and that of foreign group members is to the right of that of firms with a German owner (Figure 4). Again, this indicates higher productivity levels for firms belonging to a business group compared with „independent” firms.

**Figure 3: Distribution of labor productivity, Germany, pooled for 2005-2007 (excluding Bremen and Lower Saxony)**



Source: Research Data Centre of the Statistical Offices of the German Länder, Site Berlin/Potsdam. Business Register and Cost Structure Survey, 2005-2007. Own Calculations

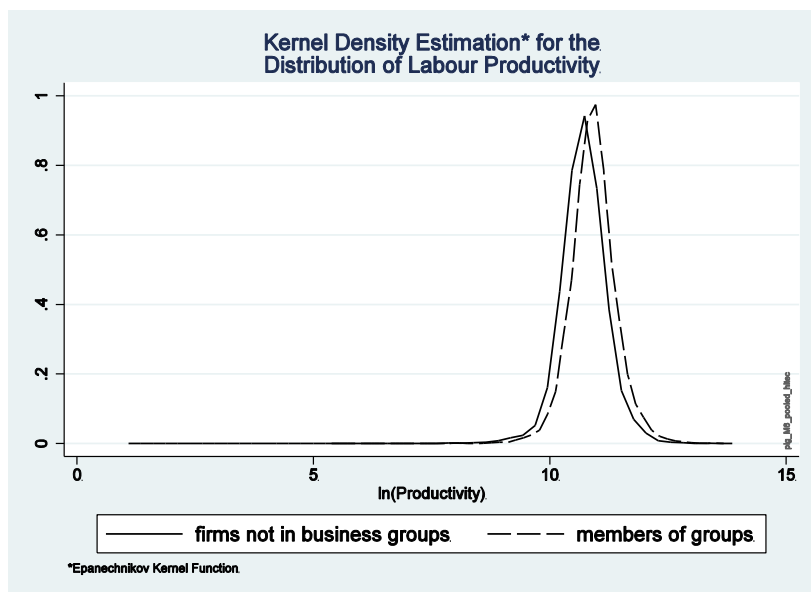
**Figure 4: Distribution of labor productivity, Germany, 2007 (excluding Bremen and Lower Saxony)**



Source: Research Data Centre of the Statistical Offices of the German Länder, Site Berlin/Potsdam. Business Register and Cost Structure Survey, 2005-2007. Own Calculations

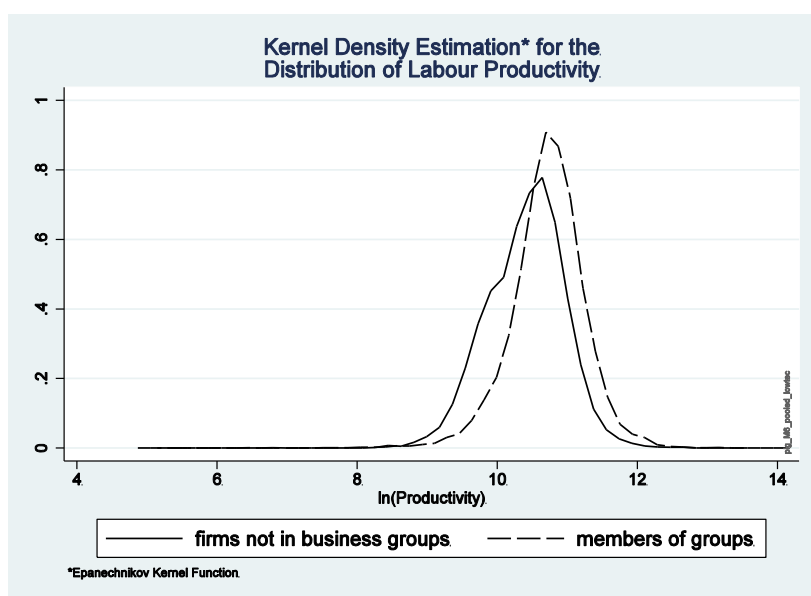
The productivity distributions described by kernel density functions for high- and low-tech industries also follow the results reported in the tables above (see Figures 5 and 6). Results indicate that for both high-tech and low-tech sectors the group members are likely to be more productive than non-member firms. However, the differences in the productivity distributions are not significantly large between affiliated and non-affiliated firms in high-tech branches and are more distinct in low-tech sectors.

**Figure 5: Distribution of labor productivity in high-tech sectors, pooled for 2005-2007 (excluding Bremen and Lower Saxony)**



Source: Research Data Centre of the Statistical Offices of the German Länder, Site Berlin/Potsdam. Business Register and Cost Structure Survey, 2005-2007. Own Calculations

**Figure 6: Distribution of labor productivity in low-tech sectors, pooled for 2005-2007 (excluding Bremen and Lower Saxony)**



Source: Research Data Centre of the Statistical Offices of the German Länder, Site Berlin/Potsdam. Business Register and Cost Structure Survey, 2005-2007. Own Calculations

In order to test whether the differences in labor productivity between group affiliated and non-affiliated firms are statistically significant we first ran a t-test for differences in means of the two firm groups. For all cases (the whole of Germany, West and East Germany, high- and low-tech industries as well as for all three years), the t-test indicates high significant differences between the group members and non-affiliated firms in favor of the first group. However, the t-test is aimed at testing the differences in means of variables. Nevertheless, due to firm heterogeneity it would be useful to test the differences in distribution of labor productivity between group affiliated and non-affiliated firms which can be tested using the Kolmogorov-Smirnov test. The Kolmogorov-Smirnov test is a nonparametric test for the equality of distribution functions.<sup>20</sup> According to the results of this test, we reject that the productivity distributions are equal between group members and independent firms in all considered cases.<sup>21</sup>

Summing up, using descriptive statistics and some test-results we observe large differences between firms that are members of business groups and firms that are independent. Firms affiliated to a group tend to be larger in terms of number of employees and generate higher gross value added per worker per year. Furthermore, affiliated firms with a foreign group owner were bigger and more productive in 2007 than those with a German owner.

However, from the pure descriptive analysis it is still not clear whether the differences in labor productivity between affiliated and non-affiliated firms are caused by group affiliation itself or if they are induced by some other firm characteristics. For example, the group members may be more productive because they are larger or are settled in more productive industry branches. In order to determine the causal effect of group affiliation on productivity, a multivariate analysis of the relationship between group membership and productivity is necessary.

## 4.2 Productivity Premia

In the following section, we examine the relationship between productivity and group affiliation and calculate productivity premia for firms that are part of a business group. We estimate a linear model of labor productivity on the membership in a business group and some other control variables using an ordinary least squares estimation. Because the time horizon is not sufficient for an estimation of a panel model we estimate our model using cross-sectional data for each of the three years (2005, 2006 and 2007). The model is defined as follows:

$$Prod_i = c + \beta GA_i + \gamma' C_i + \varepsilon_i, \text{ with } i = 1, \dots, N \quad (4)$$

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<sup>20</sup> For a more detailed description and the advantages of the Kolmogorov-Smirnov test see e.g. Wagner (2010).

<sup>21</sup> Results of t-test and Kolmogorov-Smirnov-test are available upon request.

The dependent variable  $Prod_i$  stands for labor productivity of firm  $i$  that has been calculated as value added per employee. The productivity variable enters the model in logarithmic form. The regressor  $GA_i$  is a dummy variable for the affiliation status that takes on the value 1 if a firm is a member of a business group and 0 otherwise.  $C_i$  is a vector of other control variables which have an effect on the labor productivity, i.e. firm size measured by number of employees and its square, R&D dummy (1 if a firm invests in research and development activities, and 0 if a firm does not undertake R&D) as well as three different types of diversity indices (cf. section 3.2): (a) regional diversity, (b) sectoral diversity, and (c) size-based diversity. In order to take into account a nonlinear development of the indices, squared indices are also included. All continuous variables are logarithmised.

We also add sector dummies on the four-digit level and dummy variables for each federal state. Due to incomplete information on group affiliation in Bremen and Lower Saxony we could only include the remaining 14 German federal states in our econometric analysis.  $\varepsilon_i$  is a classical error term. The model is estimated separately for West and East Germany, high-tech and low-tech industries.

Further, following the approach of Wagner (2007) – who estimates the productivity premia for exporting firms – we compute the productivity premia for group members using the coefficient  $\beta$ :

$$P_i = (\exp(\beta) - 1) \cdot 100, \text{ with } i = 1, \dots, N \quad (5)$$

Therefore, the productivity premia can be interpreted as the average percentage difference in labor productivity between group-affiliated and independent firms (see Wagner, 2010 related to exports).

Tables C-E in the annex report the econometric results of the least squares estimation of model (1) estimated separately for each year (2005, 2006, and 2007 respectively).<sup>22</sup> Between 24% and 40% of variation of the dependent variable can be explained by the regressions (see  $R^2$  in tables). The coefficient of the group affiliation dummy is always positive and statistically significant indicating higher performance of group members compared to non-members. The firm size has – except for East Germany and high-tech sector in 2007 where the coefficients are insignificant – a positive effect in all models and years. Therefore, an increase in employee numbers will, *ceteris paribus*, result in better productivity, especially in low-tech industries, e.g. the raise in workforce of an average firm by 1% implies the rise in productivity by about 11% in high-tech and about 14% in low-tech branches in 2005. However, in all regressions the coefficient of the squared firm size variable is insignificant, so that an inverted-U-relationship for instance could not be confirmed.

The coefficient of the R&D dummy is almost always highly statistically significant and shows a positive influence on productivity. That means that a decision of a firm to invest in R&D activities will result in higher labor productivity. Again, this does not hold for East Germany in

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<sup>22</sup> All models are estimated with robust standard errors.

2005, where the R&D coefficient is insignificant. In order to calculate the size of the R&D effect we have to carry out the transformation  $(\exp(C) - 1) \cdot 100$  – where  $C$  is the coefficient of the R&D dummy variable – given that our dependent variable is used in logarithmic form. The advantages in participating in R&D accounts then for 12%, 15%, 14% in West Germany in 2005, 2006, and 2007, respectively; 6%, 8% and 10% in East Germany; 11% (2005), 15% (2006), 14% (2007) in high-tech branches; 10% (2005), 11% (2006 and 2007) in low-tech firms. Thus, the R&D activities have larger effects on productivity in West vs. East Germany and in high-tech vs. low-tech industries.

The effect of firm diversity is rather mixed depending on the used diversity index. Note that the coefficients of the indices in our regressions must be interpreted in the reverse way. A marginal increase in the variable is associated with the decline in diversity. Therefore, a positive sign of the diversity index indicates a positive effect of the *decreasing diversity* or *increasing concentration* of firms. Besides the linear form, we also use a quadratic specification of diversity indices in order to capture nonlinear developments.

In the models for West Germany, the regional diversity index is statistically significant (except for squared index in 2005) and has a negative sign. Thus, the diversity of plants of a firm across regions positively affects firm performance. This effect actually magnifies with rising diversity as indicated by the negative and statistically significant coefficient of the squared regional diversity index. On the other hand, the diversity measure based on branches proved to be statistically insignificant in all regressions. The index of internal firm concentration is only statistically significant in its linear specification at different significance levels. A positive coefficient suggests that if the plants of a firm are of similar size, it would positively impact the productivity.

In models for East Germany many coefficients of diversity indices are insignificant. This may be due to a relatively low number of firms in this case. Only the regional diversity index is negative and statistically significant in 2006 in linear as well as quadratic form, and in 2007 in linear specification.

In the high-tech industries, only the linear form of the index of internal firm concentration is positively significant in 2005 and 2006. In 2007, the regional diversity index becomes significant at the 10% level. In low-tech sectors the diversity across regions is an important factor that influences the productivity. Firms with plants in several regions are therefore, *ceteris paribus*, more productive.

Additionally, for 2007 we distinguish between the affiliated firms with German and foreign business group owners (see Table B in annex). In this case, instead of a single dummy for group affiliation we include two dummy variables: one dummy each for German- and foreign-affiliated firms. Both dummies are significantly associated with labor productivity – only the coefficient of the German-affiliated firm dummy in East Germany is statistically insignificant – meaning that firms in German groups as well as foreign-affiliated firms are more productive than non-members, whereas the effect is larger for groups with a foreign owner. The explanation power of the models where the nationality of the group owner is controlled for rises, again, suggesting significant differences between German and foreign groups.

Finally, we also estimate the model described above using pooled data (see Table A in the Annex). The time dummy variables are highly significant in models for West Germany and high-tech sectors showing in these cases an increase in productivity in 2006 and 2007 compared to the reference year 2005. The other coefficients are close to the estimates found in cross-sectional regressions. However, the pooled model does not control for unobserved heterogeneity due to time-invariant firm characteristics. Unfortunately, the time dimension of our data set does not allow for estimation of panel models using, e.g., a fixed effects estimation which also allows the correlation of the individual effects (unobserved heterogeneity) with other control variables in the empirical model.

In the next step, using the coefficients of the group affiliation dummies we are able to calculate the productivity premia. Table 7 reports the premia for all estimated models. In each case, the premia have a positive sign indicating that firms affiliated to a business group, on average, have higher labor productivity than independent firms. The results show some changes throughout the period 2005-2007. The premium is larger in 2005 (at about 11% in Germany) and decreases in the following years (to about 9% in 2006 and 2007). Between West and East Germany we can observe only slight differences in 2005, whereas in 2006 the size of the productivity premium is about 3 percentage points larger in West Germany and 4 percentage points in 2007. In high-tech sectors group-affiliated firms outperform the non-affiliated firms at about 9% in 2005, in low-tech industries the average difference in productivity between these two firm types is even larger (12%). This indicates that group affiliation yields more benefits in low-tech industries, while the performance between group members and non-members is differing less in high-tech sectors.

**Table 7: Productivity premia, in %**

|                   | 2005  | 2006 | 2007               |              |               |
|-------------------|-------|------|--------------------|--------------|---------------|
|                   |       |      | group affiliation* | German owner | foreign owner |
| Germany total     | 11.01 | 9.09 | 9.18               | 6.90         | 24.99         |
| West Germany      | 11.02 | 9.35 | 9.62               | 7.40         | 25.11         |
| East Germany      | 10.65 | 6.15 | 5.27               | 3.04         | 20.68         |
| High-tech sectors | 9.13  | 8.71 | 9.28               | 6.45         | 22.38         |
| Low-tech sectors  | 12.33 | 9.36 | 9.25               | 7.31         | 28.34         |

\* In this case only the dummy variable for group affiliation was used, i.e. without considering the nationality of the group owner

Source: Research Data Centre of the Statistical Offices of the German Länder, Site Berlin/Potsdam.  
Business Register and Cost Structure Survey, 2005-2007. Own Calculations

If we distinguish between business groups with German and foreign owner – which is only possible for 2007 (columns 5 and 6 in Table 7) –, we observe very high premia for foreign-affiliated groups between 22 and 28%, whereas firms of German groups achieve an average premium between only 3 (East Germany) and 7% (West Germany, high-tech sectors). These results indicate that it is appropriate to control for the nationality of the group owner, otherwise the productivity effect is overestimated for members of German and underestimated for members of foreign groups.

## 5 Conclusions and Outlook

On the basis of a representative dataset from the German manufacturing sector for the years 2005-2007, the paper at hand analyzed whether firms in business groups are more productive than their independent counterparts outside such groups. Additionally, but due to missing data for earlier years only for 2007, we addressed the question whether firms in business groups with foreign owners are more productive than firms in domestic groups.

For our analysis, we had access to a comprehensive dataset on German manufacturing firms from two main sources, which have been matched together for the purpose of our analyses: the business register which contains data on all German firms and establishments which are economically active (i.e. which have employees or which generate revenues in a given year) and the Cost Structure Survey containing information on inputs and outputs on a sample of more than 15,000 manufacturing firms with more than 20 employees in Germany. For the first time in Germany, we had access to information on the affiliation of firms to business groups stemming principally from Bureau van Dijk's Markus database which has been recently incorporated in the business register. All data can be classified as highly reliable and representative.

In line with our presumptions, it can be shown that firms in business groups are more productive than their counterparts outside business groups. This can be shown both in our descriptive analyses as well as in multivariate models including a series of control variables, e.g. firm size, diversity, R&D and several sectoral and regional controls. With regard to the spatial distribution of group affiliates, our data reveal that group members are unequally distributed across the German Federal States. They are particularly concentrated in the large Länder in West Germany: North Rhine-Westphalia, Baden-Württemberg, Bavaria. However, due to the nature of our sample (manufacturing, firms above a size threshold of 20 employees), the shares of group members range at about 50% in all states. It can also be observed that firms in high-tech sectors are more likely to be group members.

The main characteristics of firms affiliated to business groups are that they are larger, more diversified and more productive. Moreover, West German group members are larger and more productive than their counterparts from the Eastern parts of the country; affiliates in high-tech sectors are also larger than affiliates in low-tech manufacturing industries. The differences in productivity between group affiliates and independent firms are smaller in high-tech compared to low-tech industries. The reason therefore might be that in high-tech industries also independent firms already have high levels of productivity and thus an affiliation in a business group yields not as much as in low-tech sectors. This result is confirmed by the multivariate analyses.

In the multivariate part of the analyses of the contribution, we also address the question whether firms in business groups are more productive than firms outside such groups. Thereby, we control for potential influences of firm size, R&D activities and the diversity of firms regarding size, sector and region. We also include sectoral and regional dummies to control for potential industry- and region-specific effects.

Our results show positive effects of group affiliation, firm size, R&D, and regional diversity (i.e. the dispersion of a firm's branch plants across different regions) on the productivity of firms. In the case of sectoral diversity (i.e. the dispersion of a firm's branch plants across sectors), however, we could not find significant effects on productivity. Intra-firm concentration (measured as a Herfindahl-Index across branch plants), on the other hand has a positive influence on productivity, i.e. firms which have large parts of their employees concentrated in few plants are more productive.

We also find interesting differences between the Eastern and the Western parts of Germany: in the pooled model, for instance, the impact of group affiliation on productivity is larger in West Germany – this is also valid for a perspective differentiating between foreign and domestic owners. The same applies for the impact of R&D activities. Noticeable is the impact of the firms' regional diversification which by far larger for firms in the Eastern parts of the country – maybe this can be explained by the underlying links of the firms to other parts of Germany.

Regarding differences between firms in high-tech sectors and their counterparts in low-tech sectors, further interesting differences can be observed: Whereas the effect of group affiliation is rather equal with regard to group affiliation in general and to the affiliation to a German group, the affiliation to a foreign group seems to be particularly effective for firms in low-tech sectors (see Table B in the Annex). The same holds for our index of regional diversification. R&D, on the other hand, is more conducive to the productivity of firms in high-tech sectors.

Last but not least, productivity premia differ across subsamples and years. They are higher in the Western parts of Germany and they are also higher in low-tech sectors. Moreover, the differences between groups with German owners and groups foreign owners are striking. Whereas the premia for German groups amount to about 7% (for the whole country), they add up to 25% for firms being members of a group with foreign owner.

Certainly, the present paper and the performed analyses leave some space for future extensions. First, a further extension of the period of analysis would allow for performing panel data analyses with the aim to analyse also causal relationships between group membership and productivity. However, this will only be possible when data are available for further years.<sup>23</sup> Second, future analyses might also include further variables like, for instance, more detailed information on R&D. A promising aim could also be to obtain and to include information on firm age in the data, however, none of the actually included datasets does contain any information on that subject yet.

Last but not least, using a more detailed differentiation of the nationality of the ultimate owners is an auspicious line of research, as the impact of countries might differ. Thereby, in the medium-term it would also be desirable to have more complete information on business groups, i.e. not being disconnected at national borders. The precondition for that would be the creation of a pan-European or global micro-level database.

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<sup>23</sup> Normally, data are available at the Statistical Offices with a lag of 2-3 years. Another problem that might hinder future analyses of the outlined kind is the fact that the Cost Structure Survey is a rotating survey and that there might be a larger shift in the surveyed firms in 2008.



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## Annex

**Table A: Estimation results, pooled model (2005-2007)**  
(OLS, dependent variable: labor productivity)

|  | Total                   | West                    | East                    | High-tech               | Low-tech                |
|--|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| Group affiliation                        | 0.0927***<br>(0.00589)  | 0.0946***<br>(0.00634)  | 0.0713***<br>(0.01602)  | 0.0861***<br>(0.00860)  | 0.0978***<br>(0.00793)  |
| Firm size                                | 0.1056***<br>(0.01971)  | 0.0908***<br>(0.02087)  | 0.0305<br>(0.06864)     | 0.0785***<br>(0.02001)  | 0.1570***<br>(0.03967)  |
| Firm size <sup>2</sup>                   | -0.0021<br>(0.00201)    | -0.0013<br>(0.00211)    | 0.0111<br>(0.00736)     | 0.0012<br>(0.00184)     | -0.0081**<br>(0.00426)  |
| R&D (dummy,<br>1=yes)                    | 0.1149***<br>(0.00659)  | 0.1257***<br>(0.00706)  | 0.0754***<br>(0.01870)  | 0.1270***<br>(0.00889)  | 0.1021***<br>(0.00995)  |
| regional<br>diversity                    | -0.0961***<br>(0.02307) | -0.0889***<br>(0.02391) | -0.3023***<br>(0.11011) | -0.0648**<br>(0.02721)  | -0.1406***<br>(0.03642) |
| regional<br>diversity <sup>2</sup>       | -0.0314***<br>(0.00937) | -0.0287***<br>(0.00960) | -0.1947**<br>(0.08998)  | -0.0115<br>(0.01083)    | -0.0578***<br>(0.01659) |
| sectoral<br>diversity                    | -0.0155<br>(0.04253)    | -0.0091<br>(0.04495)    | 0.0073<br>(0.12856)     | -0.0101<br>(0.046885)   | -0.0318<br>(0.06891)    |
| sectoral<br>diversity <sup>2</sup>       | 0.0158<br>(0.03495)     | 0.0245<br>(0.03674)     | 0.0094<br>(0.11600)     | 0.0106<br>(0.039342)    | 0.0011<br>(0.06123)     |
| intra-firm<br>concentration              | 0.1141***<br>(0.02814)  | 0.1142***<br>(0.02934)  | 0.0079<br>(0.09970)     | 0.1335***<br>(0.037577) | 0.1093***<br>(0.03848)  |
| intra-firm<br>concentration <sup>2</sup> | 0.0167<br>(0.01359)     | 0.0202<br>(0.01396)     | -0.0555<br>(0.05237)    | 0.0130<br>(0.01834)     | 0.0203<br>(0.01850)     |
| Dummy 2006                               | 0.0222***<br>(0.00648)  | 0.0241***<br>(0.00699)  | 0.0107<br>(0.01664)     | 0.0452***<br>(0.00926)  | 0.0081<br>(0.00875)     |
| Dummy 2007                               | 0.0160**<br>(0.00652)   | 0.0188***<br>(0.00706)  | -0.0023<br>(0.01645)    | 0.0598***<br>(0.00934)  | -0.0112<br>(0.00880)    |
| constant                                 | 10.228***<br>(.04735)   | 10.2715***<br>(0.05049) | 10.0832***<br>(0.15358) | 10.3774***<br>(0.05219) | 10.0638***<br>(0.09014) |
| N  | 37,294                  | 31,653                  | 5,641                   | 15,090                  | 22,204                  |
| R <sup>2</sup>                           | 0.396                   | 0.383                   | 0.359                   | 0.278                   | 0.395                   |

\*, \*\*, \*\*\*: significance at 1, 5 and 10%-level

Robust standard errors in parentheses

All models include regional (Federal State Level) and  
sectoral dummies (4-digit industry classification)

Source: Research Data Centre of the Statistical Offices of the German Länder, Site Berlin/Potsdam.  
Business Register and Cost Structure Survey, 2005-2007. Own Calculations

**Table B: Estimation results including nationality of group owner, 2007**  
(OLS, dependent variable: labor productivity)

|  | Total                   | West-Germany            | East-Germany           | High-tech               | Low-tech               |
|--|-------------------------|-------------------------|------------------------|-------------------------|------------------------|
| Group affiliation:<br>German owner       | 0.0667**<br>(0.01064)   | 0.0714***<br>(0.01161)  | 0.0299<br>(0.02839)    | 0.0625***<br>(0.01540)  | 0.0705***<br>(0.01431) |
| Group affiliation:<br>Foreign owner      | 0.2231***<br>(0.01620)  | 0.2240***<br>(0.01747)  | 0.1880***<br>(0.04539) | 0.2019***<br>(0.02237)  | 0.2495***<br>(0.02364) |
| Firm size                                | 0.0964***<br>(0.03647)  | 0.0681*<br>(0.03882)    | 0.1521<br>(0.12521)    | 0.0351<br>(0.03576)     | 0.1919***<br>(0.07392) |
| Firm size <sup>2</sup>                   | -0.0011<br>(0.00368)    | 0.0010<br>(0.00390)     | -0.0015<br>(0.01306)   | 0.0052<br>(0.00327)     | -0.0116<br>(0.00785)   |
| R&D (dummy,<br>1=yes)                    | 0.1128***<br>(0.01144)  | 0.1212***<br>(0.01256)  | 0.0921***<br>(0.02887) | 0.1272***<br>(0.01513)  | 0.0978***<br>(0.01745) |
| regional<br>diversity                    | -0.0970**<br>(0.03800)  | -0.0865**<br>(0.03931)  | -0.3202*<br>(0.18468)  | -0.0674<br>(0.04539)    | -0.1423**<br>(0.05900) |
| regional<br>diversity <sup>2</sup>       | -0.0335**<br>(0.01600)  | -0.0304*<br>(0.01634)   | -0.1743<br>(0.13904)   | -0.0094<br>(0.01798)    | -0.0647**<br>(0.02831) |
| sectoral<br>diversity                    | -0.0200<br>(0.06615)    | -0.0087<br>(0.07017)    | -0.0193<br>(0.19824)   | -0.0699<br>(0.08066)    | -0.0711<br>(0.10320)   |
| sectoral<br>diversity <sup>2</sup>       | -0.0114<br>(0.05789)    | 0.0007<br>(0.06223)     | -0.0361<br>(0.16780)   | 0.00800<br>(0.06856)    | -0.0807<br>(0.09946)   |
| intra-firm<br>concentration              | 0.1308***<br>(0.04873)  | 0.1283**<br>(0.05074)   | 0.0646<br>(0.17500)    | 0.1372**<br>(0.06456)   | 0.1356**<br>(0.06644)  |
| intra-firm<br>concentration <sup>2</sup> | 0.0268<br>(0.02440)     | 0.0280<br>(0.02512)     | -0.0179<br>(0.09237)   | 0.0003<br>(0.03029)     | 0.0412<br>(0.03353)    |
| constant                                 | 10.2703***<br>(0.08841) | 10.3499***<br>(0.09445) | 9.8292***<br>(0.28728) | 10.5491***<br>(0.09360) | 9.9753***<br>(0.17009) |
| N  | 12,157                  | 10,310                  | 1,847                  | 4,956                   | 7,201                  |
| R <sup>2</sup>                           | 0.428                   | 0.393                   | 0.414                  | 0.316                   | 0.401                  |

\*, \*\*, \*\*\*: significance at 1, 5 and 10%-level

Robust standard errors in parentheses

All models include regional (Federal State Level) and  
sectoral dummies (4-digit industry classification)

Source: Research Data Centre of the Statistical Offices of the German Länder, Site Berlin/Potsdam.  
Business Register and Cost Structure Survey, 2005-2007. Own Calculations

**Table C: Estimation results, 2005 (OLS, dependent variable: labor productivity)**

|  | <b>Total</b>            | <b>West-Germany</b>     | <b>East-Germany</b>     | <b>High-tech</b>        | <b>Low-tech</b>         |
|--|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| Group affiliation                        | 0.1045***<br>(0.01022)  | 0.1046***<br>(0.01094)  | 0.1012***<br>(0.03043)  | 0.0874***<br>(0.01535)  | 0.1162***<br>(0.01358)  |
| Firm size                                | 0.1052***<br>(0.03243)  | 0.0972***<br>(0.03434)  | -0.0208<br>(0.12518)    | 0.1054***<br>(0.03473)  | 0.1353**<br>(0.06377)   |
| Firm size <sup>2</sup>                   | -0.0026<br>(0.00333)    | -0.0023<br>(0.00350)    | 0.0154<br>(0.01378)     | -0.0014<br>(0.00322)    | -0.0069<br>(0.00694)    |
| R&D (dummy,<br>1=yes)                    | 0.1005***<br>(0.01170)  | 0.1106***<br>(0.01240)  | 0.0547<br>(0.03819)     | 0.1088***<br>(0.01602)  | 0.0924***<br>(0.01767)  |
| regional<br>diversity                    | -0.1097**<br>(0.04512)  | -0.1015**<br>(0.04675)  | -0.2046<br>(0.17877)    | -0.0657<br>(0.05171)    | -0.1650**<br>(0.07080)  |
| regional<br>diversity <sup>2</sup>       | -0.0363**<br>(0.01767)  | -0.0321*<br>(0.01811)   | -0.0967<br>(0.11200)    | -0.0166<br>(0.01967)    | -0.0646**<br>(0.03139)  |
| sectoral<br>diversity                    | 0.0178<br>(0.08159)     | 0.0197<br>(0.08727)     | 0.0485<br>(0.23055)     | 0.0315<br>(0.08425)     | -0.0093<br>(0.13058)    |
| sectoral<br>diversity <sup>2</sup>       | 0.0423<br>(0.06389)     | 0.0444<br>(0.06719)     | 0.0619<br>(0.21304)     | 0.0390<br>(0.07429)     | 0.0236<br>(0.10610)     |
| intra-firm<br>concentration              | 0.1078**<br>(0.05106)   | 0.1174**<br>(0.05332)   | -0.0894<br>(0.18348)    | 0.1346**<br>(0.06614)   | 0.0969<br>(0.07038)     |
| intra-firm<br>concentration <sup>2</sup> | 0.0122<br>(0.02380)     | 0.0184<br>(0.02437)     | -0.1120<br>(0.09588)    | 0.0271<br>(0.03210)     | 0.0070<br>(0.03254)     |
| constant                                 | 10.2323***<br>(0.07753) | 10.2598***<br>(0.08270) | 10.1966***<br>(0.27469) | 10.3135***<br>(0.09016) | 10.1223***<br>(0.14393) |
| N  | 12,782                  | 10,845                  | 1,937                   | 5,144                   | 7,638                   |
| R <sup>2</sup>                           | 0.380                   | 0.365                   | 0.269                   | 0.235                   | 0.391                   |

\*, \*\*, \*\*\*: significance at 1, 5 and 10%-level

Robust standard errors in parentheses

All models include regional (Federal State Level) and  
sectoral dummies (4-digit industry classification)

Source: Research Data Centre of the Statistical Offices of the German Länder, Site Berlin/Potsdam.  
Business Register and Cost Structure Survey, 2005-2007. Own Calculations

**Table D: Estimation results, 2006 (OLS, dependent variable: labor productivity)**

|  | <b>Total</b>            | <b>Wes-Germany t</b>    | <b>East-Germany</b>     | <b>High-tech</b>        | <b>Low-tech</b>         |
|--|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| Group affiliation                        | 0.0870***<br>(0.01008)  | 0.0894***<br>(0.01082)  | 0.0597**<br>(0.02861)   | 0.0835***<br>(0.01436)  | 0.0895***<br>(0.01374)  |
| Firm size                                | 0.1059***<br>(0.03389)  | 0.0941***<br>(0.03560)  | -0.0001<br>(0.13034)    | 0.0760**<br>(0.03370)   | 0.1502**<br>(0.06967)   |
| Firm size <sup>2</sup>                   | -0.0021<br>(0.00344)    | -0.0017<br>(0.00359)    | 0.0148<br>(0.01403)     | 0.0012<br>(0.00311)     | -0.0071<br>(0.00750)    |
| R&D (dummy,<br>1=yes)                    | 0.1250***<br>(0.01103)  | 0.1378***<br>(0.01171)  | 0.0804**<br>(0.03212)   | 0.1408***<br>(0.01497)  | 0.1080***<br>(0.01643)  |
| regional<br>diversity                    | -0.0688*<br>(0.03704)   | -0.0642*<br>(0.03829)   | -0.5091**<br>(0.25431)  | -0.0483<br>(0.04444)    | -0.1057*<br>(0.05851)   |
| regional<br>diversity <sup>2</sup>       | -0.0208<br>(0.01476)    | -0.0192<br>(0.01521)    | -0.4439*<br>(0.26457)   | -0.0037<br>(0.01853)    | -0.0431*<br>(0.02501)   |
| sectoral<br>diversity                    | -0.0343<br>(0.07274)    | -0.0332<br>(0.07515)    | 0.0912<br>(0.25902)     | -0.0384<br>(0.08024)    | -0.0153<br>(0.11984)    |
| sectoral<br>diversity <sup>2</sup>       | 0.0170<br>(0.05976)     | 0.0236<br>(0.06139)     | 0.1090<br>(0.24781)     | -0.0136<br>(0.06362)    | 0.0552<br>(0.10858)     |
| intra-firm<br>concentration              | 0.0915*<br>(0.04716)    | 0.0873*<br>(0.04887)    | 0.0368<br>(0.17602)     | 0.1192*<br>(0.06473)    | 0.0839<br>(0.06369)     |
| intra-firm<br>concentration <sup>2</sup> | 0.0057<br>(0.02271)     | 0.0091<br>(0.02321)     | -0.0387<br>(0.09379)    | 0.0078<br>(0.03311)     | 0.0070<br>(0.03004)     |
| constant                                 | 10.2490***<br>(0.08166) | 10.2869***<br>(0.08618) | 10.1478***<br>(0.29344) | 10.4272***<br>(0.08751) | 10.0855***<br>(0.15869) |
| N  | 12,355                  | 10,498                  | 1,857                   | 4,990                   | 7,365                   |
| R <sup>2</sup>                           | 0.401                   | 0.386                   | 0.305                   | 0.278                   | 0.387                   |

\*, \*\*, \*\*\*: significance at 1, 5 and 10%-level

Robust standard errors in parentheses

All models include regional (Federal State Level) and  
sectoral dummies (4-digit industry classification)

Source: Research Data Centre of the Statistical Offices of the German Länder, Site Berlin/Potsdam.

Business Register and Cost Structure Survey, 2005-2007. Own Calculations

**Table E: Estimation results, 2007 (OLS, dependent variable: labor productivity)**

|  | <b>Total</b>            | <b>West-Germany</b>     | <b>East-Germany</b>    | <b>High-tech</b>        | <b>Low-tech</b>        |
|--|-------------------------|-------------------------|------------------------|-------------------------|------------------------|
| Group affiliation                        | 0.0878***<br>(0.01046)  | 0.0919***<br>(0.01141)  | 0.0514*<br>(0.02776)   | 0.0887***<br>(0.01516)  | 0.0885***<br>(0.01412) |
| Firm size                                | 0.1076***<br>(0.03658)  | 0.0805**<br>(0.03894)   | 0.1607<br>(0.12497)    | 0.0533<br>(0.03572)     | 0.1929**<br>(0.07464)  |
| Firm size <sup>2</sup>                   | -0.0018<br>(0.00369)    | 0.0002<br>(0.00391)     | -0.0019<br>(0.01305)   | 0.0038<br>(0.00326)     | -0.0111<br>(0.00793)   |
| R&D (dummy,<br>1=yes)                    | 0.1198***<br>(0.01155)  | 0.1291***<br>(0.01268)  | 0.0929***<br>(0.02901) | 0.1317***<br>(0.01524)  | 0.1069***<br>(0.01765) |
| regional<br>diversity                    | -0.1084***<br>(0.03826) | -0.0989**<br>(0.03958)  | -0.3191*<br>(0.18594)  | -0.0770*<br>(0.04584)   | -0.1500**<br>(0.05933) |
| regional<br>diversity <sup>2</sup>       | -0.0363**<br>(0.01616)  | -0.0340**<br>(0.01650)  | -0.1773<br>(0.14114)   | -0.0127<br>(0.01847)    | -0.0648**<br>(0.02838) |
| sectoral<br>diversity                    | -0.0244<br>(0.06602)    | -0.0119<br>(0.06998)    | -0.0451<br>(0.19962)   | -0.0223<br>(0.07988)    | -0.0649<br>(0.10397)   |
| sectoral<br>diversity <sup>2</sup>       | -0.0101<br>(0.05721)    | 0.0043<br>(0.06132)     | -0.0594<br>(0.16930)   | 0.0059<br>(0.06701)     | -0.0750<br>(0.09996)   |
| intra-firm<br>concentration              | 0.1387***<br>(0.04875)  | 0.1359***<br>(0.05082)  | 0.0652<br>(0.17476)    | 0.1417**<br>(0.06507)   | 0.1430**<br>(0.06630)  |
| intra-firm<br>concentration <sup>2</sup> | 0.0304<br>(0.02431)     | 0.0322<br>(0.02506)     | -0.0204<br>(0.09213)   | 0.0021<br>(0.03079)     | 0.0454<br>(0.03329)    |
| constant                                 | 10.2361***<br>(0.08869) | 10.3127***<br>(0.09474) | 9.8077***<br>(0.28661) | 10.4994***<br>(0.09358) | 9.9625***<br>(0.17170) |
| N  | 12,157                  | 10,310                  | 1,847                  | 4,956                   | 7,201                  |
| R <sup>2</sup>                           | 0.422                   | 0.387                   | 0.409                  | 0.308                   | 0.395                  |

\*, \*\*, \*\*\*: significance at 1, 5 and 10%-level

Robust standard errors in parentheses

All models include regional (Federal State Level) and  
sectoral dummies (4-digit industry classification)

Source: Research Data Centre of the Statistical Offices of the German Länder, Site Berlin/Potsdam.  
Business Register and Cost Structure Survey, 2005-2007. Own Calculations