DISCUSSION PAPER SERIES

IZA DP No. 6973

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October 2012

Forschungsinstitut
zur Zukunft der Arbeit
Institute for the Study
of Labor

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Discussion Paper No. 6973
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IZA Discussion Paper No. 6973
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ABSTRACT

Does Labor Diversity Affect Firm Productivity?*

Using a matched employer-employee data-set, we analyze how workforce diversity in terms of cultural background, education and demographic characteristics affects the productivity of firms in Denmark. Implementing a structural estimation of the firms' production function (Ackerberg et al. 2006), we find that labor diversity in education significantly enhances a firm's value added. Conversely, diversity in ethnicity and demographics induces negative effects on firm productivity. Therefore, the negative effects, which are derived from the communication and integration costs associated with a more culturally and demographically diverse workforce, seem to outweigh the positive effects of creativity and knowledge spillovers.

JEL Classification: J15, J16, J24, J61, J81, L20

Keywords: labor diversity, skill complementarity, communication barriers, total factor productivity

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* We thank Sandra E. Black, Holger Bonin, Tor Eriksson, Jozef Konings, Michael Rosholm, Vanormelingen Stijn, Chad Syverson and Frederic Warzynski (alphabetical order) for their helpful comments and suggestions. Additionally, we appreciate the comments from participants at seminars organized by the Copenhagen Business School, University of Bergamo, Aarhus School of Business, University of Lausanne and ZEW (Mannheim) and from participants at the following conferences: ESPE 2010, The 5th Nordic Summer Institute in Labor Economics, The 2010 Ratio Young Scientist Colloquium, ESEM 2010 and CAED/COST 2010 in London. Pierpaolo Parrotta acknowledges financial support from the Graduate School for Integration, Production and Welfare, and the Swiss National Centres of Competence in Research LIVES. Mariola Pytlikova gratefully acknowledges funding from the NORFACE Migration Programme. The usual disclaimer applies.

1 Introduction

Diversity in the labor force is a increasing a reality in many developed countries. This diversity results from, among other things, the following major factors: policy measures that counteract population aging, anti-discrimination measures, the growth in immigration from diverse countries experienced in recent decades and the educational and skill upgrading of workforces.[1] All of these factors lead to increasing diversity within the labor force in terms of age, gender, ethnicity and skills.

We observe increasing diversity across many workplaces and often hear about the importance of further internationalization and demographic diversification for firms. In many countries, firms' hiring decisions are affected by governmental affirmative action policies. Additionally, firms are often under pressure to be more diverse because this is how they should appear socially. At the same time, firms are challenged by the constantly changing demand for goods and services, as well as by new customers and markets, in today's globalized world. A diverse workforce may be a key factor in helping firms to understand and meet these new needs.

The popular press usually emphasizes workforce diversity as beneficial for firms, but is this really true? Do firms benefit from labor diversity, and does it generate competitive advantage? What is the relationship between workplace labor diversity and firm performance? Although the issue is very important, there is considerable ambiguity surrounding this topic.

The current theory suggests that there are two opposing types of effects of demographic and cultural diversity on firm performance: (1) diversity can create negative effects due to poor communication, lower social ties and trust, and poor cooperation among workers (Becker, 1957; Lang, 1986; Lazear, 1998 and 1999), and conversely, (2) diversity can be beneficial to firm performance due to better decision making, improved problem solving, more creativity, and increased information about global product markets (Alesina and La Ferrara, 2005; Hong and Page 2001 and 2004; Berliant and Fujita, 2008; Glaeser et. al. 2000; Osborne, 2000; Rauch and Casella, 2003). Conversely, diversity in skills, education and tenure may generate knowledge spillover and complementary skills among employees. Thus, diversity in terms of skills and education is

[1] Demographic projections by the United Nations suggest that during the next four decades, populations in Europe might *ceteris paribus* decline by 12 per cent (United Nations, 2000). The main factor responsible for population aging is a large decline in the total fertility rate over the last half century. As a consequence of this trend, governments have often adopted a number of measures to counteract the problem of population aging, including policies that encourage people to work longer, increase female labor participation and attract skilled immigrants. In many countries, governments have increased the regular and early-retirement age, restricted access to early retirement by changing economic incentives and promoted anti-discrimination measures related to age. Female labor participation has grown in most of the world during the last century (OECD, 2005). This growth is partly due to policies encouraging women to work, e.g., better childcare and parental leave provisions and gender anti-discrimination measures. Furthermore, we can observe an increase in immigration, including to developed countries, and a broader diversity of immigrants with respect to their countries of origin (Adsera and Pytlikova, 2011; Pedersen et al. 2008). As a result of this change, the diversity of the workforce with respect to gender, age and ethnicity has increased. Finally, as a consequence of the worldwide globalization process and skill-biased technological changes, governments in many countries have taken a number of steps to increase the skill level of the workforce (e.g., by increasing the supply of university-educated people and enhancing the availability of lifelong learning).

predicted to have a positive effect on firm performance (Lazear, 1998 and 1999).

To the best of our knowledge, the empirical evidence concerning diversity and economic performance is fairly scarce, and most of the previous work in this area has employed case studies of one firm (e.g., Hamilton et al. 2003, 2004; Kurtulus, 2011; Leonard and Levine, 2006) or has used aggregate regional data (e.g., Ottaviano and Peri, 2006 and 2011; Suedekum et al., 2009). The use of more comprehensive data in this field is fairly rare (Barrington and Troske, 2001; Iranzo et al. 2008; Navon, 2009; Grund and Westergaard-Nielsen, 2008). Furthermore, most of these studies have focused on only one dimension of diversity, with the studies by Barrington and Troske (2001), Kurtulus (2011) and Leonard and Levine (2006) being the only exceptions, and none of these studies has determined the effect of diversity on firm performance. Within this largely "explorative" and "descriptive" literature, there seems to be some consensus with respect to skill diversity as a positive factor in firm performance (Hamilton et al., 2003, 2004; Leonard and Levine, 2006; Iranzo et al. 2008; Navon, 2009; Kurtulus, 2011), but the evidence regarding diversity along ethnic and demographic lines is rather mixed. Case studies, for example, find that diversity with regard to age and race is negatively associated with firm performance (Hamilton et al. 2003, 2004; Leonard and Levine, 2006; Kurtulus, 2011), whereas studies using aggregated regional data find a positive correlation between ethnic diversity and performance (e.g., Ottaviano and Peri, 2006 and 2011; Alesina and La Ferrara, 2005; Sparber, 2009; Suedekum et al. 2009; Peri, 2011).

In this article, we use a unique register-based linked employer-employee data-set (LEED) from Denmark, which allows us to overcome many limitations of previous studies and to contribute to the literature in several ways. First, we investigate the effect of labor diversity by looking at three relevant dimensions of diversity: cultural background, education and demographics. We attempt to capture the multi-dimensionality of labor diversity and the different implications of each of these dimensions for productivity. Given that firms may be aware of the importance of labor diversity and may leverage diversity to improve their performance, the relationship under investigation is very likely to be affected by simultaneity and endogeneity. Thus, we employ a recent structural estimation technique suggested by Ackerberg, Caves and Frazen (2006). [2] In this model, firms are allowed to observe productivity shocks before deciding the optimal level of diversity, which ensures that the causal impact of factor on productivity is properly estimated. Last but not least, we dig deeper into possible mechanisms through which workforce diversity affects firm outcomes by testing different hypotheses derived from existing theories. Specifically, we look at whether diversity plays a different role for distinct occupational groups because we expect that diverse problem-solving abilities and creativity will

[2] In a previous version of this study (Parrotta et al. 2010), we employed an instrumental variable (IV) approach to address the potential for simultaneity and endogeneity with firm-level diversity indexes, and we consider Total Factor Productivity (TFP, thereafter) as a measure of firm productivity. Specifically, we use an index of labor diversity measured for the commuting area in which a given firm operates for the firm-level diversity index in the TFP equation. The results that we obtain using this identification strategy are similar to those reported in this article and are available from the authors upon request.

generate a greater positive effect on productivity in white-collar occupations than in blue-collar occupations. Additionally, we test the importance of communication costs and the costs of "cross-cultural dealing" by excluding certain groups of foreigners (i.e., individuals with tertiary education or those who speak a Germanic language) in calculating the ethnic diversity measures. Finally, we evaluate the effects of the different dimensions of diversity on productivity for firms operating in more innovative or industries that are more open to trade.

After controlling for a wide set of additional variable inputs and firm-specific characteristics and performing different robustness checks, we find that labor diversity in education significantly enhances firm productivity. More specifically, a standard deviation increase in educational diversity increases productivity by approximately 2%. This result supports the existing theory about knowledge spillover (Lazear, 1998 and 1999). Conversely, ethnic and demographic heterogeneity does not positively impact productivity. The latter findings are consistent with earlier research by Lazear (1999), Glaeser et. al. (2000), and Alesina and La Ferrara (2002) and show that the negative effects of the communication and integration costs that are associated with a more demographically and culturally diverse workforce counteract the positive effects of diversity on firm productivity (i.e., the effects of creativity and knowledge spillover).

The structure of the article is as follows: section 2 derives the main hypotheses; section 3 briefly describes the data; section 4 provides the details of our empirical strategy; sections 5 and 6 explain the results of our empirical analysis; and section 7 offers concluding remarks.

2 Hypothesis development

Economic theory suggests that workforce diversity may affect firm performance differently and through various channels. Diversity in skills and education may generate knowledge spillover and complementary skills among the employees within a firm (as long as the workers' knowledge sets do not overlap and are relevant to one another), which positively affects firm performance (Lazear, 1999). Similarly, diversity in age can be beneficial to firms because the human capital of younger and older workers can be complementary. Younger employees have knowledge of new technologies and IT, and older employees have a better understanding of (and more experience with) intra-firm structures and the operating process (Lazear, 1998). However, Becker's (1957) model of co-worker discrimination suggests that demographic heterogeneity among workers may create communication friction if workers are prejudiced and, thus, may result in some productivity costs.

The expected contribution of ethnic and cultural diversity to firm performance is unclear. Ethnic-cultural diversity may affect firm performance negatively because it may (i) hinder potential knowledge transfer among workers due to linguistic and cultural barriers, (ii) reduce peer pressure by weakening social ties and trust, and

(iii) create non-pecuniary disutility associated with joining or remaining in a demographically diverse firm (Lazear, 1999). A similar point regarding trust is made by Glaeser et. al. (2000) and Alesina and La Ferrara (2002), who show that people often distrust members of other ethnic groups and tend to prefer interacting in culturally homogeneous communities. Conversely, ethnic diversity can be beneficial to firm performance, improving decision making and problem solving (Hong and Page, 2001 and 2004). In these authors' models, diverse groups of problem solvers consistently outperform the homogeneous groups of individuals who are best at solving problems. The reason is that the diverse groups become stuck less often than homogeneous groups of high-ability solvers, who tend to think similarly. The authors argue that more diverse groups have a broader spectrum of perspectives, which improves their decision-making (Hong and Page, 2001 and 2004). Berliant and Fujita (2008) also refer to the significance of cultural diversity in the creation of new ideas and knowledge as well as in knowledge transfer. Furthermore, Alesina and La Ferrara (2005) propose a simple theoretical framework in which the skills of ethnically heterogeneous groups of individuals are complementary in the production process for a private good, generating more innovation and creativity and thus translating diversity into increased productivity. However, because individual utility also depends on the consumption of a shared public good and because heterogeneous ethnic groups may have different preferences regarding public goods, increased diversity lowers the utility from public good consumption (Alesina and La Ferrara, 2005, Bandiera and Levy, 2011). Finally, workforce diversity may provide useful information to a firm about a product market, which can enhance the firm's ability to compete in global markets (Osborne, 2000; Rauch and Casella, 2003).

Based on the different theoretical approaches and predictions, we attempt to derive hypotheses regarding the effect of diversity on firm productivity. From the existing theory, it is clear that there are two opposing effects. On the one hand, demographic and ethnic diversity can generate a more diverse spectrum of problem-solving abilities, greater creativity and more knowledge spillover, which, in turn, can foster firm productivity (Lazear, 1998; Hong and Page, 2001 and 2004; Berliant and Fujita, 2004; Alesina and La Ferrara, 2005). We expect inter-cultural learning and knowledge spillover to materialize more easily for white-collar occupations than for blue-collar occupations. We also expect these effects to be more prevalent for firms operating in more creative industries or in industries that are more open to trade (Osborne, 2000; Rauch and Casella, 2003). Conversely, demographic and ethnic diversity may also reduce productivity due to the greater costs that are associated with communication barriers and higher distrust levels, which arise if people of different cultural backgrounds, gender and ages have to interact and work together on projects (Lazear, 1999; Glaeser et. al., 2000; Alesina and La Ferrara, 2002). Specifically, we expect these costs associated with "cross-cultural dealing" to be more important when we exclude certain groups of foreigners who most likely speak English (highly educated workers) or Danish in calculating the ethnic diversity measure. Regarding skill diversity,

there is a consensus in the existing theory: that because of knowledge spillover, skill-related diversity will have a positive effect on firm productivity as long as the workers' knowledge sets do not overlap and are relevant to one another (Lazear, 1999).

3 Data

3.1 Data description

The data-set for this empirical investigation is created by merging information from two different main sources. The first source is the "Integrated Database for Labor Market Research" (henceforth IDA), provided by Statistics Denmark. The IDA is a longitudinal employer-employee register that contains valuable information (age, education, other demographic characteristics, labor market experience and earnings) about each individual employed in the recorded population of Danish firms during the period 1980-2005. Only attrition due to death and permanent migration is included in the data-set. The labor market status of each person is his or her status as of the 30th of November of each year. The retrieved information is aggregated at the firm level to obtain such variables as firm size, workforce composition (including average firm tenure; shares of managers, middle managers, men, highly skilled workers, and technicians; and the shares of employees belonging to each age distribution quartiles), labor diversity (see the next section for more details) partial/total foreign ownership and whether the firm is a multi-establishment firm.

The second data source (henceforth referred to as REGNSKAB) provides information on the firms' business accounts and is also compiled and provided by Statistics Denmark. These data cover the construction and manufacturing industries beginning in 1994, manufacturing beginning in 1995, wholesale trade beginning 1998 and the remaining portions of the service industry from 1999 onwards. From REGNSKAB, the following accounting items are used to estimate the production function: value added [3], materials (intermediates), capital stock (fixed assets) and related industries.[4]

3.2 Firm level labor diversity

This section focuses on employee diversity at the firm level. Labor diversity is quantified using information regarding workers' gender, age, work experience, highest level of education completed and nationality. We use the Herfindahl index to measure the degree of diversity at the firm level. Unlike traditional diversity measures such as the percentage of employees belonging to a specific group, the Herfindahl index combines two

[3] Computed as the difference between the total sales and the intermediate costs.

[4] The following sectors are excluded from the empirical analysis: i) agriculture, fishing and quarrying; ii) electricity, gas and water supply and iii) public services.

quantifiable measures: the "richness" (the number of categories represented within the firm or the workplace) and "equitability" or evenness (how even the numbers are for the individual categories). We calculate three separate indexes to measure the cultural, skill and demographic dimensions of diversity.

Cultural diversity is represented either by the employees' nationality or by the language they speak. The various nationalities have been grouped into the following categories: North America and Oceania, Central and South America, Africa, West and South Europe, formerly Communist countries, Asia, East Asia, and Muslim countries. [5]It has been argued in the previous literature that linguistic distance serves as a good proxy for cultural distance (Guiso et al. 2009; Adsera and Pytlikova, 2011). Therefore, we have grouped the employees together by the languages spoken in their countries of origin. This linguistic classification is more detailed than grouping by nationality. We group countries (using the major official language spoken by the majority) at the third linguistic tree level, e.g., Germanic West vs. Germanic North vs. Romance languages. The information on languages is drawn from the encyclopedia of languages entitled Ethnologue: Languages of the World (Lewis, 2009); see the Appendix for more details about the list of countries and the linguistic groups included. Education-related diversity is represented by 6 categories based on the information concerning the employees' highest educational level completed (tertiary education, secondary and vocational education, or pre-secondary education). We divide tertiary education into 4 categories, making a distinction between bachelors, masters and PhD degrees in the social science, the humanities, engineering and the natural sciences. In a more disaggregated specification, we also decompose secondary education into general high school, business high school and short and long vocational education programs. Finally, the demographic index is built from the intersection of gender and the age quartiles or quintiles (8 or 9 categories in total, depending on the level of aggregation).

To measure diversity at the firm level for each dimension, we sum the Herfindahl indexes calculated for each workplace belonging to the same firm, which are weighted by the number of employees employed in each workplace:

$$index_{hit} = \sum_{w=1}^{W} \frac{N_w}{N_i} \left(1 - \left(\sum_{s=1}^{H} p_{swt}\right)^2\right)$$

where $index_{hit}$ is the Herfindahl diversity index of firm i at time t calculated along the *h-th* dimension (education-related and demographic), W is the total number of workplaces belonging to firm i, H is the total number of categories of the related diversity dimension and N_w and N_i are the total number of employees of workplace w and of firm i. The proportion of the workplace's labor force that falls into each category s of the *h-th* dimension at time t is represented by the term p_{swt}.[6] The diversity index has a minimum value equal to

[5]Second-generation immigrants are not treated as foreigners in the main analysis. However, we employ a specification in which second-generation immigrants are included in the group of foreigners in the section on the mechanisms driving the effect of workforce diversity on firm productivity.

[6]For ethnic diversity, the shares of foreign workers of different nationalities/linguistic groups in each workplace have been

0 if there is only one category represented within the workplace, and a maximum value equal to $\left(1-\frac{1}{H}\right)$ if all categories are equally represented. The index is interpreted as the probability that two randomly drawn individuals in a workplace belong to different groups.

3.3 Descriptive statistics

Before discussing some descriptive statistics for the variables included in the main analysis, we should stress that (a) firms with imputed accounting variables and (b) firms with fewer than 10 employees have been omitted from the main sample. The former choice was clearly made to reinforce the reliability of our empirical analysis. The latter was made to allow all of the investigated firms to potentially reach the highest degree of ethnic diversity when an aggregated specification is used. [7] All in all, we are able to analyze the productivity of approximately 24,000 firms for the years 1995 to 2005.

Table 1 provides basic descriptive statistics for all of the variables used in our analysis for the main sample by firm size. We split the sample into two main groups: firms above and below 50 employees. Consistent with the overall character of the Danish private sector, 78% of the observations correspond to small firms.[8] Compared with larger firms, smaller companies are characterized by lower levels of value added, materials and capital stock. [9] Moreover, small firms feature larger shares of middle managers, relatively younger employees and personnel with vocational education, firms with more than 50 employees feature larger proportions of managers, women and foreigners. The two groups of firms are comparable in terms of average employee tenure and firm ownership.

[Insert Table 1 and 2 around here]

Table 2 presents detailed descriptive statistics for all of the diversity indexes by industry, year and firm size. We observe greater values for diversity for firms within the manufacturing and the financial and business service sectors, whereas we observe lower diversity in all dimensions for small firms no matter the level of aggregation used. Finally, diversity is slightly increasing over time, especially ethnic diversity. This result is

calculated as follows:

$$p_{swt} = \frac{foreigners_{swt}}{foreigners_{wt}}.$$

[7] When a linguistic classification is adopted, we adjust the ethnic diversity to take firm size into account. Specifically, we standardize the index for a maximum value equal to (1-1/N) when the total number of employees (N) is lower than the number of linguistic groups (H).

[8] According to the OECD (2005), the population of Danish firms is mainly composed of small and medium-sized companies; firms with fewer than 50 employees account for 97 per cent of firms and provide 42 per cent of the total employment in manufacturing and services.

[9] Accounting values are reported in thousands of real DKK. Monetary values are deflated by using the GDP deflator for the base year 2000 retrieved from the World Bank database.

consistent with the increasing immigration to Denmark in recent decades.

4 Empirical strategy

4.1 Productivity estimation

As noted in the literature concerning firm production functions, the major issue in the parameter estimation in this context is the possibility that there are factors that influence production that are unobserved by the econometrician but observed by the firm. In such a case, firms may use asymmetrically observed shocks to maximize their profits or minimize their costs. More specifically, it is expected that firms respond to positive (negative) productivity shocks by expanding (reducing) their output, which requires a higher quantity and/or quality of production inputs. Thus, the OLS estimates of the coefficients of the inputs that are observed by econometricians may be biased and inconsistent, and error terms and regressors may be correlated. Moreover, it is widely acknowledged that whereas fixed-effects (FE) estimation techniques (Mundlak, 1961) consider firm heterogeneity, FE techniques do not solve the simultaneity problem when productivity shocks fluctuate over time.

Several ways to address simultaneity have been proposed, such as the recent structural approach advocated by Olley and Pakes (1996) (OP henceforth) and Levinsohn and Petrin (2003) (LP henceforth).[10] Both OP and LP suggest semi-parametric methods based on (i) the identification of a proxy variable, which is assumed to be a function of time-varying productivity shocks (total factor productivity) and (ii) the definition of conditions under which this function is invertible. The aim is to infer the total factor productivity by using the observed firms' input choices (Wooldridge, 2009). [11]Although, OP and LP are broadly used approaches to the structural identification of the production function, they suffer from collinearity and even identification problems, as noted by Ackerberg, Caves and Frazen (2006) (henceforth ACF). Given the timing and dynamic implications of input choices, these researchers raise questions about the LP estimation techniques

[10]See Ackerberg et al. (2006) for a survey.

[11]The approach advocated by Olley and Pakes (1996) is a two-step estimation method. In the first step, semiparametric methods are used to estimate the coefficients of the variable inputs along with the nonparametric function linking productivity to capital and investment. In the second step, parameters of capital inputs are identified based on the assumed the dynamics of the productivity process (where productivity is assumed to follow a first-order Markov process), see Wooldridge, 2009. However, OP's estimation method presents two major drawbacks. First, because adjustment costs create lumpiness in the investment levels, these levels may not respond smoothly to productivity shocks. Second, OP's approach excludes firms that report zero investment levels: it induces a de facto truncation bias. To overcome these drawbacks, LP use a measure of intermediate inputs as a proxy for investment levels. This choice has any benefits. First, changes in the intermediate inputs do not typically involve adjustment costs, and the intermediate inputs therefore respond better to productivity shocks than investments. Second, the intermediate inputs provide a simple link between the estimation strategy and the economic theory because they do not typically represent state variables. Third, because intermediate inputs are almost always used in production, the LP approach circumvents the above-mentioned data truncation problem. Moreover, the LP approach suggests three specification tests for evaluating the proxy's performance (Petrin et al. 2004). However, the coefficient of the proxy is recovered during the second stage rather than the first (as in the OP approach).

in particular. Therefore, ACF propose an estimation method built on OP's and LP's approaches that does not suffer from potential collinearity problems: the coefficient of labor is no longer estimated during the first stage (in a value added production function).

4.2 Methodology used

Referring to the literature concerning the identification of the production functions, we use the structural techniques suggested by Ackergberg et al. (2006). In our analysis productivity is obtained from a Cobb-Douglas production function containing the real value added, Y, the labor, L, the capital, K, and a set of additional variable inputs: the workforce diversity indexes for each *h-th* dimension, $index_{hit}$, and a vector, X, of workforce composition characteristics (the shares of foreigners coming from a given group of countries under the aggregate diversity specification[12], managers, middle managers, males, workers with either tertiary or secondary education, and workers belonging to various age distribution quartiles, average firm tenure).[13] The log-linear production function is specified as follows:

$$lnY_{it} = cons + \alpha lnL_{it} + \beta lnK_{it} + \gamma(index_{hit}) + \delta(X_{it}) + u_{it}$$

The error term u_{it} consists of a time-varying firm specific effect v_{it} (unobserved by econometricians) and an idiosyncratic component ε_{it}. Following Ackergberg et al. (2006), we assume that

$$E\left(\varepsilon_{it} \mid l_{it}, k_{it}, index_{hit}, X_{it}, m_{it}, l_{it-1}, k_{it-1,}, index_{hit-1}, X_{it-1}, m_{it-1}, ..., l_{i1}, k_{i1}, index_{hi1}, X_{i1}, m_{i1}\right) = 0\,,$$

with $t = 1, 2, ..., T$, and where m refers to our proxy variable (materials). The lower-case letters to log-variables. Because past values of ε_{it} are not included in the conditioning set, we allow for serial dependence in the pure shock term. However, we need to restrict the dynamics of the productivity process:

$$E\left(v_{it} \mid v_{it-1}, v_{it-2}, ..., v_{i1}\right) = E\left(v_{it} \mid v_{it-1}\right) = f\left(v_{it-1}\right)$$

with $t = 1, 2, ..., T$, and for given functions $f(\cdot)$. As in ACF's approach, we assume that the material input is selected after the labor input. Additionally, we assume that our diversity indexes and the other additional variable inputs, X , are set before or at the same time as the material input is chosen. As a result, material demand will be a function not only of capital and productivity, but also of l, $index_h$ and X:

[12] More specifically, the shares of foreigners from North America and Oceania, Central and South America, Africa, Western and Southern Europe, former Communist countries, East Asia, Other Asia, and Muslim countries.

[13] We also use other control variables—partial/total foreign ownership, a multi-establishment dummy, year, the firm's 3-digit industry classification and regional dummies—because these variables can potentially affect productivity.

$$m_{it} = f(k_{it}, v_{it}, l_{it}, index_{hit}, X_{it})$$

and assuming that the material demand function is strictly increasing in productivity shock v_{it} , we obtain

$$v_{it} = f^{-1}(k_{it}, m_{it}, , l_{it}, index_{hit}, X_{it}) .$$

The key advantage of this approach is that it allows, for example, our key variables,$index_{hit}$, to have dynamic implications or to depend on unobserved input price shock that could potentially be serially correlated over time. In fact, it seems reasonable to assume that the hiring and firing costs for labor or the fixed costs of diversifying the workforce can last longer than a period (Parrotta et al. 2011). Plugging the inverse material demand into the production function, we obtain the first-stage equation, which here serves only to separate v_{it} from ε_{it} ,

$$y_{it} = cons + \alpha l_{it} + \beta k_{it} + \gamma index_{hit} + \delta X_{it} + f^{-1}(k_{it}, m_{it}, l_{it}, index_{hit}, X_{it}) + \varepsilon_{it} .$$

The function $f^{-1}(\cdot)$ is proxied with a polynomial in materials, capital, labor, $index_{hit}$ and X_{it}. Therefore, the estimated net output of the idiosyncratic component is used to identify parameters for the inputs in the second stage. Recalling that v_{it} is a first-order Markov process, we define a_{it} as an innovation that can be correlated with the current values of the proxy variable m_{it} and inputs l_{it}, $index_{hit}$ and X_{it}:

$$a_{it} = v_{it} - g\left(v_{it-1}\right) ,$$

where a_{it} is mean independent of all information known at $t-1$ and $g\left(\cdot,\cdot\right)$ is also proxied with a low-degree polynomial in the dependent variables. Given our timing assumption, we proceed by using the moments:

$$E\left[\begin{array}{c} \\ a_{it}| \\ \\ \end{array}\begin{array}{c} k_{it} \\ l_{it-1} \\ index_{hit-1} \\ X_{it-1} \end{array}\right] = 0$$

to identify coefficients for k ,l , $index_{hit}$, and X.

5 Results

5.1 Effect of diversity on firm productivity

Our main results are shown in Table 3. As explained in section 3, we performed the analysis using two different aggregation levels for the categories included in our diversity indexes. The results obtained using the more aggregate level are shown in columns (1) to (6), whereas the results obtained using the disaggregated categories are presented in columns (7) to (12). Columns 1, 2, 7 and 8 do not include the variable inputs, X, in addition to our diversity indexes, $index_h$; these variable inputs are instead used in the remaining columns to determine whether our parameters of interest change in terms of their sign, size or significance level. [14]

[Insert Table 3 around here]

Columns 1 and 7 in Table 3 show the results obtained using standard OLS regression, whereas the other columns include the estimates obtained using the ACF algorithm, which allows us to properly address both endogeneity and simultaneity issues in identifying all of the input coefficients. The first two rows report the labor and capital elasticity, which are fairly stable over the specifications. More specifically, labor elasticity is approximately 0.74, whereas the capital stock parameter fluctuates approximately 0.26. Like other researchers (Ackerberg et al. 2006; Konings and Vanormelingen 2009; Parrotta et al. 2011), we obtain a slightly lower (higher) labor (capital) contribution using OLS than we do using the ACF algorithm.[15]

The coefficients of ethnic and demographic diversity are generally negative, whereas educational diversity positively affects productivity. When the additional input variables are included in the production function, only ethnic diversity remains statistically significant independent of the level of aggregation. More specifically, a standard deviation increase in ethnic diversity reduces firm productivity by 1% (3%) when an aggregated (disaggregated) index is considered. Educational diversity significantly affects productivity only in the disaggregated specification. The results obtained using this specification show that a standard deviation increase in educational diversity enhances firm productivity by 2%. Finally, the effects of demographic diversity are insignificant in the full model specification. [16] Next, we run models with separate diversity dimensions one by one to verify whether one dimension of diversity is actually responsible for the effects that are apparently associated with other indexes. For instance, ethnic diversity may appear to have certain effects that are actually due to skill diversity because individuals coming from different countries may have varying degrees

[14] However, all specifications include a foreign-ownership dummy, a multi-establishment dummy and a full set of 3-digit industry, year and county dummies.

[15] Qualitatively similar results are obtained using the procedure suggested by Wooldridge (2009).

[16] The results included in the article are qualitatively similar to those obtained using an IV approach, in which the commuting area diversity is used an instrument for firm level diversity in the TFP equation.

of educational heterogeneity, as well. Columns 4, 5 and 6 (9, 10 and 11) in Table 3 show the results for the aggregate (disaggregate) indexes for ethnic, educational and demographic diversity, respectively, with the models entered separately. In those models, the coefficients of ethnic and educational diversity have lower magnitudes than they have in the models with all three dimensions of diversity included. This finding gives support to the hypothesis that the data for ethnic diversity may also capture the effects of heterogeneity at a specific educational level.

5.2 Testing alternative hypotheses

In the next steps, we test the different hypotheses derived in section 2. In these analysis, we use disaggregated indexes only because we believe that the indexes based on a detailed categorization may more appropriately represent workforce diversity. [17] First, we separately calculate the diversity indexes for white- and blue-collar occupations. We use this strategy based on the supposition that diversity could play a different role for distinct occupational groups and could consequently have diverse effects on firm productivity. In particular, we expect that diverse problem-solving abilities and creativity will generate higher productivity for white-collar occupations than for blue-collar occupations. Second, we exclude or include certain groups of foreigners in calculating ethnic diversity to test the importance of communication costs and the costs of "cross-cultural dealing". The results regarding the effects of diversity on firm productivity calculated separately for the two occupational groups are presented in the first two columns of Table 4. Our results show that the contribution of educational diversity to productivity is indeed much more important for white-collar occupations than for blue-collar ones. Moreover, the negative effect of ethnic diversity among the white-collar workers is lower than the effect associated with blue-collar occupations. Conversely, the effect of demographic diversity is insignificant for both occupational groups. Therefore, our results support the creativity hypothesis proposed in the theoretical frameworks developed by Hong and Page (2001 and 2004) and Berliant and Fujita (2008). To test the role of "cross-cultural dealing," we exclude either foreigners with tertiary education or foreigners that speak a Germanic language. Alternatively, we include second-generation immigrants in calculating ethnic diversity. All of these groups of foreigners are likely to absorb Danish or English (which is the communication language in many businesses in Denmark) more quickly. Therefore, it is plausible that the communication costs associated with ethnic diversity may increase (decrease) after we remove (include) these foreigners, who are likely to speak Danish or English. The results presented in Table 4, columns 3, 4 and 5 are obtained when the second generation of immigrants is treated as non-native and

[17] The results obtained using the aggregate indexes are qualitatively similar to those obtained using the detailed categorization and are available from the authors upon request.

when foreigners with university education or those who speak a Germanic language are included as natives, respectively. Interestingly, the negative effect of ethnic heterogeneity on productivity strengthens (weakens) once we exclude (include) foreigners who most likely speak Danish or English [18], which confirms the hypothesis that the communication costs and the costs of "cross-cultural dealing" within ethnically heterogeneous workforces have an impact on firm outcomes.

[Insert Table 4 around here]

In the next step, we examine different mechanisms by which diverse workforces affect firm productivity by looking at different industries and firm categories. First, we look at whether the effect of diversity on productivity is different for firms in high-tech industries, which tend to require higher levels of creative and problem-solving activities. Specifically, we divide industries into two groups defined by whether their aggregate level of R&D expenditure is above or below the average R&D level recorded for the overall economy. [19] As shown in Table 5, columns 1 and 2, the hypothesis on creativity is only partially supported because the coefficient of education diversity is significantly positive only for industries with below average-expenditures on R&D, which is contrary to what we would expect. Conversely, the coefficient of ethnic diversity is insignificant and has a smaller magnitude for firms in industries with above-average expenditures on R&D, whereas it is significantly negative and has a much larger magnitude for industries with below-average R&D expenditures. We also investigated whether the coefficients of the diversity indexes differ for firms in industries that are more open to trade in line with the Osborne (2000) and Rauch and Casella (2003) hypotheses. Therefore, we sort the industries according to their openness to trade, creating categories with above- and below- average trade flows.[20] The results shown in Table 5, columns 3 and 4 reveal that the coefficient of ethnic diversity is significantly negative for both types of industries; however, the coefficient is smaller for industries that are more open to trade. Therefore, we cannot clearly reject or accept the hypothesis that workforce diversity provides beneficial information to firms from other countries and markets and, in this way, creates positive effects on firm productivity. Finally, we determine whether the effect of diversity varies across industries with increasing or declining employment. It is reasonable to expect that growing firms are more likely to benefit from diversity because they more often hire younger people and foreign individuals than do shrinking firms. Columns 5 and 6 in Table 5 support this hypothesis; the positive (negative) effects of educational (ethnic) diversity are stronger (weaker) in the subsample of industries with increasing employment.

[Insert Table 5 around here]

[18] According to the existing literature, individuals have an easier time acquiring a foreign language if their mother language is linguistically closer to the foreign language (Isphording and Otten, 2011; Chiswick and Miller, 1995).

[19] Source: The Analytical Business Enterprise Research and Development Database ANBERD (OECD).

[20] Trade openness is measured as the sum of total exports and imports divided by the value added. Data were retrieved from the Structural Analysis database (OECD).

In summary, we find evidence of the positive effects of heterogeneity in education, which is consistent with the theory regarding knowledge spillover, creativity and problem-solving abilities (Lazear, 1999; Hong and Page, 1998 and 2001; Berliant and Fujita, 2004; Alesina and La Ferrara, 2005). However, for ethnic and demographic diversity, the coefficients are either negative or insignificant. The effects of both demographic and ethnic diversity are contradictory. A more culturally or demographically diverse workforce will have better problem-solving abilities, creativity and knowledge spillover, as Hong and Page (1998 and 2001), Berliant and Fujita (2004) and Alesina and La Ferrara (2005) have suggested, but this positive effect is counteracted or even offset by the negative effect of diversity on firm productivity that accrues because of communication and integration costs, as suggested by Lazear (1998 and 1999).

6 Sensitivity analysis

In the next step, as a part of our sensitivity analysis, we will evaluate the variations in the effects of labor diversity that result when diversity is computed in various ways. In particular, we use two alternative diversity indexes: the Shannon-Weaver entropy index and the richness index. The entropy index is considered to be one of the most profound and useful diversity indexes in biology (Maignan et al. 2003). The richness index includes a number of categories observed for each dimension of interest; it does not include the "evenness" dimension. The results are shown in Table 6, columns 1 and 2, respectively, and both sets of results are consistent with those of our main analysis.

We then divide firms by size and evaluate whether there is any change in the coefficients of workforce diversity for small firms (those with fewer than 50 employees), medium-sized firms (those with 50-100 employees) and large firms (those with more than 100 employees). The effects of demographics and ethnic diversity could be more beneficial to larger firms because the organizational and management structures and practices of such firms are well established, and thus, they are more likely to introduce policies that can help to counteract the potential costs associated with diversity. Conversely, large firms are likely to require many different types of jobs and occupation, in which diversity might affect firm productivity in different ways. As reported in Table 6, columns (4)-(6), the coefficients of the ethnic diversity index are significantly negative for medium-sized and large enterprises, with the largest coefficient associated with large firms. The results show that educational diversity is more important for medium-sized firms than for large firms. Interestingly, the diversity in all three dimensions is insignificant for firms with fewer than 50 employees, as seen in Table 6, column 4.

Given that large cities usually have many immigrants and highly skilled workers and also house a high

percentage of productive firms, we conduct an additional sensitivity check by removing firms from large cities from our analyses. Because the only real agglomeration area in Denmark is Copenhagen, we remove Copenhagen and its environs from the analysis. The results of this robustness check are reported in column 7, Table 6 and do not qualitatively differ from the main results.

Furthermore, because labor diversity has been computed at the firm level (by weighting the average of the Herfindahl indexes computed at the workplace level), we evaluate how the results change if multi-establishment firms are excluded from the sample. The last column of Table 6 reports the results. These findings do not significantly differ from the main results.

[Insert Table 6 around here]

Finally, we determine whether the effect of diversity on productivity varies across different industries. Estimations by industry also allow us to rule out the possibility that workplace diversity only reflects an industry technology choice. The main analysis presented in the previous section imposes the same basic technology and labor and capital elasticities on all industries. However, factor intensities and the mix of capital and labor may vary substantially across industries. For example, some technologies might require a set of highly skilled workers working in concert with a set of mid-level employees and a set of low-skill workers. Other technologies might only require high-skill or low-skill labor. Considering industry-specific results will therefore ensure that variations in the observed diversity of education levels across firms within the same industry will also reflect cross-firm differences in the makeup of the workforce, rather than merely reflecting which type of technology the firm has chosen. The industry-specific results are shown in Table 7, columns (1) to (5). We observe that for most industries, the effects of workforce diversity are not significant. However, a few industries stand out, and the effect of educational diversity is significantly positive for firms in manufacturing and in financial and business services. Ethnic diversity negatively affects firm productivity in the transport, manufacturing and financial and business services industries. [21]

[Insert Table 7 around here]

7 Conclusions

Using a comprehensive linked employer-employee data-set, this article investigates the effect of diversity

[21] Prior academic research suggests that diversity leads to economic gains or losses depending on industry characteristics (Sparber, 2009, 2010). More specifically, diversity seems to increase productivity in sectors that require creative decision making, problem solving, and customer service, but ethnic diversity may decrease productivity in industries characterized by high levels of group work or teamwork and efficiency. Our current industry categorizations, however, are too rough for us to test the hypothesis, as there are likely to be jobs of both types (jobs that require creativity and efficiency) in those aggregate industries. Unfortunately, our model did not allow us to use a more detailed industry categorization system.

in workers' ethnic-cultural, educational and demographic characteristics on firm productivity in Denmark. Unlike the majority of previous empirical studies, which focused on single aspects of labor diversity, we provide a number of findings that concretely address the overall consequences of firm workforce heterogeneity for firm performance. In our analysis, we use the well-known Herfindahl index to measure thoroughly the three dimensions of workforce diversity mentioned above. We use the methodological approach suggested by Ackerberg et al. (2006) to address the issues of simultaneity and endogeneity for the diversity indexes.

Controlling for a wide set of additional variable inputs and firm-specific characteristics and performing different robustness checks, we find that educational diversity significantly enhances firm productivity. More specifically, we find that a standard deviation increase in educational diversity increases productivity by approximately 2%. This finding supports the existing theory on knowledge spillovers. Conversely, diversity in demographics and ethnicity either does not affect or negatively affects firm productivity. Therefore, the negative effects of the communication and integration costs associated with a more demographically and culturally diverse workforce seem to counteract the positive effects of diversity (e.g., better problem-solving abilities and more creativity and knowledge spillover). These findings are partially consistent with those of past relevant studies by Lazear (1999), Glaeser et. al. (2000), and Alesina and La Ferrara (2002).

Although our empirical analysis clearly provides evidence of the positive contribution of educational diversity to firm productivity, it does not generally indicate that ethnic and demographic diversity are beneficial for businesses in terms of firm performance. Our findings may imply that if firms strengthened their efforts to decrease the "obvious" costs of workforce diversity (e.g., by implementing diversity management, modern techniques and integration practices), firms could turn workforce heterogeneity into a substantial competitive advantage.

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Appendix: Measurement of Ethnic Diversity

1) The different nationality groups are as follows: Denmark, Denmark (including second-generation immigrants); North America and Oceania: United States, Canada, Australia, New Zealand; Central and South America, Guatemala, Belize, Costa Rica, Honduras, Panama, El Salvador, Nicaragua, Venezuela, Ecuador, Peru, Bolivia, Chile, Argentina, Brazil; formerly Communist countries: Armenia, Belarus, Estonia, Georgia, Latvia, Lithuania, Moldova, Russia, Tajikistan, Ukraine, Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia, Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Rep. of Macedonia, Montenegro, Serbia, and Slovenia; Muslim countries: Afghanistan, Algeria, Arab Emirates, Azerbaijan, Bahrain, Bangladesh, Brunei Darussalem, Burkina Faso, Camoros, Chad, Djibouti, Egypt, Eritrea, Gambia, Guinea, Indonesia, Iran, Iraq, Jordan, Kazakstan, Kirgizstan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Malaysia, Maldives, Mali, Mauritania, Morocco, Nigeria, Oman, Pakistan, Palestine, Qatar, Saudi Arabia, Senegal, Sierra Leone, Somalia, Sudan, Syria, Tadzhikstan, Tunisia, Turkey, Turkmenistan, Uzbekistan, Yemen; East Asia: China, Hong Kong, Japan, Korea, Korea Dem. People's Rep. Of, Macao, Mongolia, Taiwan; Asia: all Asian countries not included in the East Asia or Muslim countries category; Africa: all African countries not included in the Muslim countries category; and Western and Southern Europe: all other European countries not included in the formerly Communist countries category.

2) Using linguistic grouping, the following groups are formed: **Germanic West** (Antigua Barbuda, Aruba, Australia, Austria, Bahamas, Barbados, Belgium, Belize, Bermuda, Botswana, Brunei, Cameroon, Canada, Cook Islands, Dominica, Eritrea, Gambia, Germany, Ghana, Grenada, Guyana, Haiti, Ireland, Jamaica, Liberia, Liechtenstein, Luxemburg, Mauritius, Namibia, Netherlands, Netherlands Antilles, New Zealand, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and Grenadines, Seychelles, Sierra Leone, Solomon Islands, South Africa, St. Helena, Suriname, Switzerland, Trinidad and Tobago, Uganda, United Kingdom, United States, Zambia, Zimbabwe), **Slavic West** (Czech Republic, Poland, Slovakia), **Germanic Nord** (Denmark, Iceland, Norway, Sweden), **Finno-Permic** (Finland, Estonia), **Romance** (Andorra, Angola, Argentina, Benin, Bolivia, Brazil, Burkina Faso, Cape Verde, Chile, Columbia, Costa Rica, Cote D'Ivoire, Cuba, Djibouti, Dominican Republic, Ecuador, El Salvador, Equatorial Guinea, France, French Guina, Gabon, Guadeloupe, Guatemala, Guinea, Guinea Bissau, Holy See, Honduras, Italy, Macau, Martinique, Mexico, Moldova, Mozambique, Nicaragua, Panama, Peru, Portugal, Puerto Rico, Reunion, Romania, San Marino, Sao Tome, Senegal, Spain, Uruguay, Venezuela), **Attic** (Cyprus, Greece)**, Ugric** (Hungary)**, Turkic South** (Azerbaijan, Turkey, Turkmenistan), **Gheg** (Albania, Kosovo, Republic of Macedonia, Montenegro), **Semitic Central** (Algeria, Bahrain, Comoros, Chad, Egypt, Irak, Israel, Jordan, Kuwait, Lebanon, Lybian Arab Jamahiria, Malta, Mauritiania, Morocco, Oman, Qatar, Saudi Arabia, Sudan, Syrian Arab Republic, Tunisia, Yemen**,** United Arabs Emirates**), Indo-Aryan (**Bangladesh, Fiji, India, Maldives, Nepal, Pakistan, Sri Lanka**), Slavic South (**Bosnia and Herzegovina, Croatia, Serbia, Slovenia**), Mon-Khmer East** (Cambodia)**, Semitic South** (Ethiopia)**, Slavic East** (Belarus, Georgia, Mongolia, Russian Federation, Ukraine)**, Malayo-Polynesian West** (Indonesia, Philippines)**, Malayo-Polynesian Central East** (Kiribati, Marshall Islands, Nauru, Samoa, Tonga)**, Iranian** (Afghanistan, Iran, Tajikistan)**, Betai** (Laos, Thailand)**, Malayic** (Malasya)**, Cushitic East** (Somalia)**, Turkic East** (Uzbekistan)**, Viet-Muong** (Vietnam), **Volta-Congo** (Burundi, Congo, Kenya, Lesotho, Malawi, Nigeria, Rwanda, Swaziland, Tanzania, Togo)**, Turkic West** (Kazakhstan, Kyrgystan)**, Baltic East** (Latvia, Lithuania)**, Barito** (Madagascar)**, Mande West** (Mali)**, Lolo-Burmese** (Burma)**, Chadic West** (Niger)**, Guarani** (Paraguay)**, Himalayish** (Buthan), **Armenian** (Armenia)**, Sino Tibetan** (China, Hong Kong, Singapore, Taiwan) and **Japonic** (Japan, Republic of Korea, Korea D.P.R.O.).

Table 1: Descriptive statistics, main sample and by size

Variables	Definition	Total			Small size			Middle and big size		
IDA Variables:		**Mean**	**Median**	**Sd**	**Mean**	**Median**	**Sd**	**Mean**	**Median**	**Sd**
Share of males	men as a proportion of all employees	0.709	0.783	0.237	0.724	0.810	0.238	0.694	0.741	0.21
Share of foreigners	non Danish workers as a proportion of all employees	0.048	0.022	0.091	0.045	0	0.098	0.054	0.031	0.083
Age15-32	workers aged 15-32 as a proportion of all employees	0.232	0.105	0.25	0.315	0.294	0.178	0.299	0.275	0.144
Age33-41	workers aged 33-41 as a proportion of all employees	0.263	0.262	0.129	0.262	0.25	0.123	0.281	0.278	0.077
Age42-50	workers aged 42-50 as a proportion of all employees	0.253	0.25	0.126	0.205	0.200	0.112	0.214	0.217	0.070
Age51-65	workers aged 51-65 as a proportion of all employees	0.252	0.178	0.15	0.218	0.189	0.172	0.206	0.188	0.162
Basic education	workers with compulsory education as a proportion of all employees	0.272	0.164	0.128	0.272	0.178	0.324	0.298	0.169	0.333
Secondary education	workers with a secondary/ post-secondary education as a proportion of all employees	0.685	0.75	0.326	0.690	0.727	0.195	0.650	0.650	0.151
Tertiary education	workers with a tertiary education as a proportion of all employees	0.043	0	0.1	0.038	0	0.101	0.052	0.018	0.097
Tenure	average tenure	4.531	4.403	1.831	4.382	4.205	1.913	4.545	4.491	1.623
Share of managers	managers as a proportion of all employees	0.022	0	0.043	0.049	0.025	0.067	0.040	0.029	0.042
Share of middle managers	middle managers as a proportion of all employees	0.226	0.263	0.147	0.178	0.254	0.112	0.233	0.271	0.132
Share of blue collars	blue collars as a proportion of all employees	0.762	0.841	0.242	0.773	0.857	0.244	0.727	0.797	0.231
Index Ethnic Aggr	Herfindahl diversity index based on employees' nationality (10 categories)	0.072	0	0.116	0.067	0	0.176	0.285	0.301	0.267
Index Edu Aggr	Herfindahl diversity index based on employees' skills (6 categories)	0.544	0.564	0.165	0.363	0.396	0.148	0.425	0.460	0.112
Index Demo Aggr	Herfindahl diversity index based on employees' demographic characteristics (8 categories)	0.734	0.757	0.098	0.745	0.759	0.079	0.791	0.799	0.055
Index Ethnic Disaggr	Herfindahl diversity index based on employees' language (40 categories)	0.198	0	0.313	0.127	0	0.271	0.425	0.500	0.327
Index Edu Disaggr	Herfindahl diversity index based on employees' skills (9 categories)	0.543	0.561	0.161	0.522	0.538	0.166	0.610	0.616	0.121
Index Demo Disaggr	Herfindahl diversity index based on employees' demographic characteristics (10 categories)	0.882	0.896	0.075	0.891	0.885	0.077	0.920	0.928	0.053
Accounting Variables:										
Value added	(1000 kr.)	34891.84	10792.59	197860.4	9980.425	7695.536	22326.87	100039.1	39730.27	365373.2
Materials	(1000 kr.)	90729.84	18894.45	662175	27862.83	11496.38	137692	259226.9	75699.06	1220144
Capital	(1000 kr.)	107911.9	16889.7	1301386	29074.99	10885.32	580798	324841.5	73445.74	2408409
Foreign ownership	1, if the firm is foreign owned	0.004	0	0.0602	0	0.004	0.067	0.005	0	0.069
Multi-establishment	1, if the firm is multi-establishment	0.262	0	0.4397	0	0.033	0.179	0.412	0	0.492
N			104056			81151			25453	

Notes: All IDA and Accounting variables are expressed as time averages from 1995 to 2005. The industrial sectors included in the empirical analysis are the following: food, beverages and tobacco (4.05 %); textiles (2 %), wood products (6.19 %), chemicals (3.95 %), other non-metallic mineral products (1.94 %), basic metals (18.95 %), furniture (3.46 %), construction (15.07 %), sale and repair of motor vehicles (3.64 %), wholesale trade (14.67 %), retail trade (6.06 %), hotels and restaurants (2.08 %), transport (6.12 %), post and telecommunications (0.40 %), financial intermediation (1.17 %) and business activities (10.25 %). Small size: Employees ≤ 49; Middle and big size: Employees ≥ 50.

Table 2: Descriptive statistics of diversity indexes by industry, size and year.

			Aggregate specification			
	Manufacturing	**Construction**	**Wholesale and retail trade**	**Transport**	**Financial and business services**	**Others**
Index Ethnic	0.175	0.193	0.035	0.067	0.083	0.156
Index Edu	0.406	0.413	0.293	0.341	0.441	0.455
Index Demo	0.774	0.735	0.719	0.760	0.734	0.766
N	39039	4291	18470	25906	6274	10711
	Small size	**Middle size**	**Big size**	**1995**	**1999**	**2005**
Index Ethnic	0.037	0.093	0.282	0.093	0.108	0.128
Index Edu	0.348	0.377	0.424	0.382	0.379	0.381
Index Demo	0.729	0.760	0.791	0.743	0.758	0.735
N	39207	40660	24824	6014	10924	12083
			Disaggregate specification			
	Manufacturing	**Construction**	**Wholesale and retail trade**	**Transport**	**Financial and business services**	**Others**
Index Ethnic	0.258	0.319	0.085	0.142	0.168	0.278
Index Edu	0.564	0.611	0.417	0.528	0.548	0.686
Index Demo	0.901	0.854	0.849	0.885	0.862	0.888
N	39039	4291	18470	25906	6274	10711
	Small size	**Middle size**	**Big size**	**1995**	**1999**	**2005**
Index Ethnic	0.081	0.172	0.425	0.158	0.188	0.219
Index Edu	0.502	0.542	0.610	0.514	0.543	0.560
Index Demo	0.854	0.888	0.920	0.872	0.884	0.878
N	39207	40660	24824	6014	10924	12083

Notes: Small size: Employees ≤ 49; Middle size: $50 \leq$ Employees ≤ 99; Big size: Employees ≥ 100.

Table 3: The effects of labor diversity on firm productivity, main results.

	(1) OLS	(2) ACF	(3) ACF	(4) ACF	(5) ACF	(6) ACF	(7) OLS	(8) ACF	(9) ACF	(10) ACF	(11) ACF	(12) ACF
Log(L)	0.694***	0.732***	0.759***	0.748***	0.740***	0.735***	0.694***	0.743***	0.756***	0.752***	0.740***	0.735***
	(0.010)	(0.032)	(0.022)	(0.020)	(0.022)	(0.021)	(0.010)	(0.038)	(0.021)	(0.021)	(0.022)	(0.021)
Log(K)	0.298***	0.270***	0.256***	0.260***	0.257***	0.263***	0.293***	0.259***	0.258***	0.260***	0.257***	0.263***
	(0.009)	(0.021)	(0.019)	(0.019)	(0.020)	(0.018)	(0.009)	(0.024)	(0.017)	(0.019)	(0.020)	(0.018)
Index Ethnic Aggr	-0.060***	-0.051***	-0.079***	-0.062***	-	-	-	-	-	-	-	-
	(0.013)	(0.010)	(0.014)	(0.011)								
Index Edu Aggr	0.187***	0.166***	0.058	-	0.090	-	-	-	-	-	-	-
	(0.025)	(0.021)	(0.072)		(0.085)							
Index Demo Aggr	-0.304*	-0.189***	-0.198	-	-	-0.223	-	-	-	-	-	-
	(0.163)	(0.038)	(0.282)			(0.278)						
Index Ethnic Disaggr	-	-	-	-	-	-	-0.054***	-0.077***	-0.089***	-0.069***		
							(0.008)	(0.014)	(0.013)	(0.011)		
Index Edu Disaggr	-	-	-	-	-	-	0.168***	0.164***	0.129**		0.090**	
							(0.021)	(0.033)	(0.060)		(0.035)	
Index Demo Disaggr	-	-	-	-	-	-	-0.215***	-0.359*	-0.249			-0.223
							(0.038)	(0.214)	(0.328)			(0.278)
Share of middle managers			-0.155**	-0.153**	-0.149**	-0.152**			0.063	-0.156**	-0.149**	-0.152**
			(0.053)	(0.054)	(0.052)	(0.054)			(0.078)	(0.055)	(0.052)	(0.054)
Share of managers			0.067	0.061	0.067	0.065			-0.137**	0.052	0.067	0.065
			(0.069)	(0.074)	(0.072)	(0.071)			(0.063)	(0.076)	(0.072)	(0.071)
Tenure			0.010***	0.010***	0.010***	0.010***			0.011***	0.010***	0.010***	0.010***
			(0.003)	(0.003)	(0.003)	(0.003)			(0.003)	(0.003)	(0.003)	(0.003)
Secondary education			0.276***	0.298***	0.263**	0.296***			0.303***	0.294***	0.263**	0.296***
			(0.081)	(0.053)	(0.087)	(0.051)			(0.059)	(0.055)	(0.087)	(0.051)
Tertiary education			0.427***	0.441***	0.447***	0.423***			0.399***	0.443***	0.447***	0.423***
			(0.075)	(0.082)	(0.065)	(0.087)			(0.079)	(0.085)	(0.065)	(0.087)
Age15-32			0.006	0.014	0.015	0.016			0.014	0.014	0.015	0.016
			(0.066)	(0.058)	(0.060)	(0.064)			(0.065)	(0.059)	(0.060)	(0.064)
Age33-41			0.226***	0.223***	0.227***	0.227***			0.230***	0.225***	0.227***	0.227***
			(0.062)	(0.061)	(0.064)	(0.059)			(0.051)	(0.062)	(0.064)	(0.059)
Age42-50			0.149**	0.140*	0.147*	0.154**			0.161**	0.144*	0.147*	0.154**
			(0.068)	(0.079)	(0.080)	(0.066)			(0.061)	(0.080)	(0.080)	(0.066)
Share of males			0.080	0.102***	0.104**	0.085			0.098	0.107***	0.104**	0.085
			(0.058)	(0.030)	(0.033)	(0.056)			(0.063)	(0.030)	(0.033)	(0.056)
N	105539	60405	49880	49928	49928	49928	105539	60405	49880	49928	49928	49928
R2	0.858	0.878	0.882	0.880	0.880	0.880	0.858	0.878	0.880	0.879	0.880	0.879

Notes: The dependent variable is the log of value added. All regressions include whether the firm is foreign-owned, a multi-establishment dummy, a full set of 3-digit industry, year and county dummies. Columns 3-6 and 9-12 also include the share of foreigners for each geographical area. Standard errors are computed using a block bootstrap procedure with 300 replications and are robust against heteroskedasticity and intra-group correlation. Significance levels: ***1%, **5%, *10%.

Table 4: Testing alternative hypothesis: estimates by occupation and alternative index definitions and "subtract-out" groups.

	(1)	(2)	(3)	(4)	(5)
	Occupation specific diversity		**2nd gen. Imm. as foreigners**	**University graduates as natives**	**Germanic group as natives**
	White collar	Blue collar			
Index Ethnic Disaggr	-0.084***	-0.117***	-0.072***	-0.108***	-0.098***
	(0.010)	(0.010)	(0.007)	(0.013)	(0.013)
Index Edu Disaggr	0.127***	0.065**	0.131**	0.128**	0.128**
	(0.003)	(0.003)	(0.053)	(0.060)	(0.060)
Index Demo Disaggr	-0.034	-0.369	-0.306	-0.248	-0.248
	(0.025)	(0.235)	(0.329)	(0.327)	(0.327)
Observations	49880	49880	49880	49880	49880
R2	0.881	0.882	0.882	0.882	0.882

Notes: All regressions include all the firm specific characteristics, year and three-digit industry dummies. Standard errors are computed using a block bootstrap procedure with 300 replications and are robust against heteroskedasticity and intra-group correlation. Significance levels: ***1%, **5%, *10%.

Table 5: Testing alternative hypothesis: estimates by relevant industrial aggregations.

	(1)	(2)	(3)	(4)	(5)	(6)
	Estimates by Industry RD expenses		**Estimates by Industry Trade Openness**		**Estimates by Industrial employment development**	
	Above mean	Below mean	Above mean	Below mean	Declining employment	Increasing employment
Index Ethnic Disaggr	-0.051*	-0.074***	-0.068**	-0.092***	-0.093***	-0.076***
	(0.026)	(0.009)	(0.026)	(0.013)	(0.020)	(0.020)
Index Edu Disaggr	0.138	0.123**	0.139	0.114*	0.055	0.165**
	(0.086)	(0.050)	(0.255)	(0.061)	(0.087)	(0.073)
Index Demo Disaggr	-0.280	-0.295	0.186	-0.212	-0.211	-0.323
	(0.323)	(0.315)	(1.812)	(0.336)	(0.580)	(0.489)
Observations	4043	45481	6611	42835	18907	30055
R2	0.919	0.872	0.925	0.871	0.879	0.883

Notes: The dependent variable is the log of value added. All regressions include all the firm specific characteristics, year and three-digit industry dummies. Standard errors are computed using a block bootstrap procedure with 300 replications and are robust against heteroskedasticity and intra-group correlation. Significance levels: ***1%, **5%, *10%.

Table 6: Robustness checks: estimates by size, under alternative samples and index definitions.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Shannon entropy index	**Richness**	**Edu and demo diversity as sd**	**Estimates by Firm Size**			**"Copenhagen" county is excluded**	**Mono-establishment firms**
				Small Firms	Medium Firms	Large Firms		
Index Ethnic Disaggr	-0.260***	-0.001***	-0.088***	-0.024	-0.139***	-0.077**	-0.095***	-0.048***
	(0.038)	(0.000)	(0.012)	(0.065)	(0.040)	(0.030)	(0.013)	(0.011)
Index Edu Disaggr	0.154**	0.013***	0.164***	0.089*	0.126***	0.140***	0.157**	0.127**
	(0.047)	(0.002)	(0.033)	(0.044)	(0.017)	(0.052)	(0.061)	(0.058)
Sd(years of education)			-0.018					
			(0.023)					
Index Demo Disaggr	-0.129*	-0.013*		-0.203	-0.237	-0.499	-0.222	-0.091
	(0.061)	(0.007)		(0.315)	(0.763)	(2.018)	(0.348)	(0.325)
Sd(age)			-0.009					
			(0.005)					
Share of males			0.120***					
			(0.036)					
Observations	49880	49880	49880	15380	14005	9654	46647	40482
R2	0.882	0.878	0.882	0.355	0.445	0.867	0.886	0.831

Notes: All regressions include all the firm specific characteristics, year and three-digit industry dummies. Standard errors are computed using a block bootstrap procedure with 300 replications and are robust against heteroskedasticity and intra-group correlation. Significance levels: ***1%, **5%, *10%.

Table 7: Robustness checks: estimates by industry

	(1)	(2)	(3)	(4)	(5)
	Estimates by Industry				
	Manufacturing	Construction	Wholesale and retail trade	Transport	Financial and business services
Index Ethnic Disaggr	-0.031**	0.012	-0.022***	-0.189***	-0.198***
	(0.015)	(0.186)	(0.010)	(0.037)	(0.048)
Index Edu Disaggr	0.108**	-0.156	0.032***	0.276	0.228***
	(0.043)	(0.464)	(0.009)	(0.180)	(0.054)
Index Demo Disaggr	-0.096	0.172	-0.220	-0.161	-0.592
	(0.796)	(2.670)	(1.419)	(0.791)	(1.323)
Observations	4377	2197	7699	6348	4010
R2	0.912	0.905	0.847	0.786	0.847

Notes: The dependent variable is the log of value added. All regressions include all the firm specific characteristics, year and three-digit industry dummies. Standard errors are computed using a block bootstrap procedure with 300 replications and are robust against heteroskedasticity and intra-group correlation. Significance levels: ***1%, **5%, *10%.