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DOES LABOR DIVERSITY AFFECT FIRM PRODUCTIVITY?*

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Abstract

Using an employer-employee dataset, we analyze how diversity in cultural background, skills and demographic characteristics affects total factor productivity (TFP) of firms in Denmark. Implementing structural estimation of firms' production function, we find evidence that labor diversity in skills/education significantly enhances firm performance as measured by firm TFP. Conversely, diversity in demographics and ethnicity brings mixed results – both dimensions of workforce diversity have either no or negative effects on firm TFP. Hence, it seems as if the negative effects, coming from communication and integration costs connected to a more demographically and culturally diverse workforce, counteract the positive effects of diversity on firm TFP, coming from creativity and knowledge spillovers. However, we find that ethnic diversity is valuable for firms operating in industries characterized by above-average trade openness, giving support to the hypothesis that an ethnically diverse workforce provides information and access to global markets.

JEL Classification: C23, J24, L20.

Keywords: Labor diversity, skill complementarities, communication barriers, total factor productivity.

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1 Introduction

Diverse labor force is increasingly a reality in many developed countries. This results, among other things, from the following major factors: policy measures to counteract population aging, anti-discrimination measures, the growth in immigration from diverse origins experienced during the latest decades (Pedersen et al., 2008) and educational and skill upgrading of workforces. All that leads to an increasing diversity of labor force in terms of age, gender, ethnicity and skills.

From the demand side, we observe increasing diversity across many workplaces and we often hear about the importance of further internationalization and demographic diversification. In many countries firms' hiring decisions are affected by governmental affirmative action policies.[1] Besides that, firms are often under pressure to be more diverse, because this is how they should socially look. At the same time, firms are challenged by constantly changing demand for goods and services, new customers and markets in today's globalized world. The diverse workforce may be a key factor in helping firms to understand and to meet the new needs.

Popular press usually emphasizes workforce diversity to be beneficial for firms, but is it really true? Do firms benefit from the labor diversity, so that it is translated into their competitive advantage? What is the relationship between workplace labor diversity and firm performance? Although the issue is very important, there is considerable ambiguity surrounding the topic.

So far the theory suggests that demographic and cultural diversity may affect firm performance negatively due to worse communication, lower social ties and trust, and worse cooperation among workers (Becker, 1957; Lang, 1986; Lazear,

[1] Countries that do not pursue affirmative actions have at least some kind of anti-discrimination law and often an agenda to promote equality on the labor market.

1998 and 1999). On the other hand the diversity can be beneficial to the firm performance due to better decision making, improved problem solving, more creativity and innovation, and more information about global products 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). Diversity in skills, education and tenure may generate knowledge spillovers and skill complementarities among the employees and thus it has a positive effect on firm performance (Lazear, 1998 and 1999). In the empirical literature, there seems to be some consensus on the positive contribution of skill diversity to firm productivity, whereas the evidence of diversity along ethnic and demographic lines on firm performance is rather mixed. Nevertheless, most of the previous studies were based on case studies within one firm (e.g. Hamilton et al., 2003, 2004; Kurtulus, 2009; Leonard and Levine, 2006), or on aggregate regional data (e.g. Ottaviano and Peri, 2006; Sparber, 2009, 2010; Suedekum et al., 2009). Evidence using more comprehensive micro-data is typically fairly scarce, and refers to single dimensions of diversity.

In this paper, we use a register-based linked employer-employee dataset (LEED) from Denmark, which provides us with a wide collection of information on individuals and firms' characteristics. Merged with a firm-level financial accounting dataset for the years 1995-2005, this LEED allows us to overcome many limitations of the previous studies and shed some light on the rather unexplored research questions. In fact, this paper introduces several contributions to the literature. Firstly, we investigate the effect of labor diversity on firm productivity by looking at three relevant dimensions: cultural background, skills/education and demographics. It implies that we try to capture the multi-dimensionality of labor diversity and the eventual different implications related to each of these dimensions in terms of productivity. Secondly, we implement a plausible IV

strategy to deal with the potential endogeneity related to the degree of labor diversity characterizing a given firm. Specifically, we instrument the firm labor diversity by using the workforce diversity calculated at the commuting area level. Thirdly, we follow a recent structural estimation technique suggested by Wooldridge (2009) to cope with simultaneity and endogeneity problems in the computation of firm TFP. This method allows us to produce reliable estimation of firm TFP as it properly takes into account the influence of unobservable productivity shocks. Fourth, we test different hypotheses derived from the existing theory, in particular whether the inter-cultural learning and knowledge spillovers occur more frequently in firms with a younger and more educated workforce, and in more creative and more trade-open industries. Specifically, we evaluate either potential interaction effects between all couples of diversity dimensions or their effects for given levels of shares of younger workers or highly skilled employees. In addition, we distinguish between blue- and white-collar workers, too. Further, we evaluate the effects of the different dimensions of diversity on firm TFP for firms operating in more creative industries, industries where communication is important and for trade-open industrial sectors.

We find evidence that labor diversity in skills/education significantly enhances firm performance as measured by firm TFP. Conversely, diversity in demographics and ethnicity brings mixed results – both dimensions of workforce diversity bring either no or negative effects on firm TFP. These results are mostly in line with past relevant works by Lazear (1999), Glaeser et. al. (2000), and Alesina and La Ferrara (2002). However, it seems that the negative effects (if any) coming from communication and integration costs are outweight by positive effects of diversity for companies belonging to industries characterized by above-average trade openness. This finding supports the theory by Osborne (2000) and Rauch and Casella (2003), according to which workforce diversity

provides useful information to firms about products/ markets, and in this way it enhances firms' ability to compete in national and global markets.

The structure of the paper is as follows: section 2 reviews related literature and derives hypotheses, section 3 briefly describes the data, section 4 provides details on the empirical strategy, section 5 explains results of our empirical analyses and section 6 offers some concluding remarks.

2 Background discussion, previous literature and hypotheses development

Over the past couple of decades, Denmark experienced, similarly to other countries, many changes in the composition of the workforce, which contributed to an increased diversity of labor force. Among the most significant changes, there has been an increase in the female labor participation, increased immigration and skill upgrading of the Danish workforce. This is partly a result of policies adopted to counteract the problem of population aging, anti-discrimination measures, immigration and the worldwide globalization process.

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, 2001). The main factor responsible for the population aging is a large decline in the total fertility rate over the last half century. Although projections for Denmark are less extreme than for other European countries, Denmark will still suffer from the population aging. According to the DREAM projections[2], it is expected that by 2040 the aging effects will reduce the labor force by around 7 per cent (Markeprant et al. 2003). As a

[2]Danish Rational Economic Agents Model, DREAM, is a dynamic computable general equilibrium (CGE) model for population forecasting, see more on http://www.dreammodel.dk/ or Markeprant et al. 2003.

consequence the government has adopted a number of measures to counteract the problem of population aging such as policies encouraging people to work longer, e.g. by increasing the regular and early-retirement age to 67 and 62 years, respectively, and by restricting access to early retirement by changing economic incentives, and age anti-discrimination measures (Danish Ministry of Finance). Female labor participation in Denmark has grown in the last century, ranking among the highest in OECD countries (OECD, 2005).[3] This is partly due to policies encouraging women to work, e.g. better childcare and parental leave provisions, and gender anti-discrimination measures. Subsequently, diversity of workforce with respect to gender and age has increased. Furthermore, Denmark has experienced large inflows of immigrants during the latest decades and became a net immigration country as from the 1970s. In 2009, the share of the population born outside Denmark reached 7,5 per cent and together with the second generation of foreigners, the share of foreigners reached almost 10 per cent (www.dst.dk). Last but not least, as a consequence of the worldwide globalisation process and skill biased technological change the government took a number of steps to increase the skill level of the workforce, by e.g. increasing the supply of university educated people and by enhancing the availability of lifelong learning. All that leads to an increasing diversity of the Danish labor force.

In many countries governments introduce affirmative action policies in addition to the general ban on discrimination in order to promote equality and in this way affect firms' hiring decisions. Conversely, some countries hesitate with introduction of any affirmative policies arguing that affirmative action could be counterproductive for both the discriminated groups and for businesses. Denmark does not have any binding affirmative programs to address discrimination

[3]In 2008, the female labor participation rate reached 61 per cent compared with the OECD average of 53 per cent, see World Development Indicators (World Bank).

in personnel policies. So far, Denmark's anti-discrimination policy is based on an anti-discrimination legislation (the law on prohibition against difference of treatment on the labor market adopted in 1996) without any obligation to initiate an active requirement. Besides some other institutions and NGOs work in order to promote greater equality especially in the gender area.[4] Even though Denmark does not have any legally binding affirmative program for the private sector, firms can often be under pressure to be more diverse, because this is how they should socially look[5], possibly since not being diverse may be an evidence of discrimination. Businesses viewed as discriminatory can be harmed by customer preferences or by preferences of their business partners, whereas more diverse firms signalling non-discriminatory behavior may on the contrary benefit from customers' support or brand loyalty. At the same time, firms are challenged by a constantly changing demand for goods and services, new customers and markets in today's globalized world. The diverse workforce may represent a strategy for firms to understand and to meet the new needs.

Economic theory suggests that workforce diversity may affect firm performance differently and through various channels. Diversity in skills, education and tenure may generate knowledge spillovers and skill complementarities among the employees within a firm (as long as workers' information are relevant), which affects firm performance positively (Lazear, 1999). Similarly, diversity in age can be beneficial to firms because there are complementarities between the human capital of younger and older workers. Younger employees have knowledge of new technologies and IT and older employees have a better

[4] In particular, a new general complaints board called Equality Board was established in 2009 to consider individual complaints regarding discrimination based on gender, race, color of the skin, religion or faith, age, disability or national, social or ethnic origin, political views or sexual orientation. This board replaced The Gender Equality Board, which, as the title says, was only for gender-related individuals' complaints (www.ligenaevn.dk).

[5] As mentioned by human resource managers of key firms in Denmark at the Centre for Corporate Performance meeting on "Internationalisation within Firms from an HR perspective" in November 2009.

understanding and experience with the intra-firm structures and the operating process (Lazear, 1998). On the other hand, Becker's (1957) model of co-worker discrimination suggests that demographic heterogeneity among workers may create communication frictions if workers are prejudiced, and thus bring some cost connected to the frictions.

The theoretical contribution on the effect of ethnic and cultural diversity on firm performance brings mixed conclusions. Ethnic-cultural diversity may affect firm performance negatively as it may (i) hinder potential knowledge transfers among workers due to linguistic and cultural barriers , (ii) reduce peer pressure by weakening social ties and trust among them, and (iii) create non-pecuniary disutility of joining or remaining in a demographically diverse firm (Lazear, 1999). A similar point on trust is made by Glaeser et. al. (2000), and Alesina and La Ferrara (2002) showing that people often distrust members of other ethnic groups and tend to prefer interacting in culturally relatively homogeneous communities. On the other hand, ethnic diversity can be beneficial to the firm performance through better decision making and improved problem solving (Hong and Page, 2001 and 2004). In their models, diverse groups of problem solvers consistently outperform the homogeneous groups of the individuals who are best at solving problems. The reason is that the diverse groups get stuck less often than homogenous groups of high-ability solvers, who tend to think similarly. The authors argue that it is because more diverse groups have a broader spectrum of perspectives improving their decision-making (Hong and Page, 2001 and 2004). Berliant and Fujita (2008) also refer to the significance of cultural diversity for creation of new ideas and knowledge, and knowledge transfer. Further, Alesina and La Ferrara (2005) propose a simple theoretical framework, in which skills of ethnically heterogeneous groups of individuals are complementary in the production process for a private good, bringing more in-

novation and creativity, which translates diversity into increased productivity. However as individual utility also depends on the consumption of a shared public good and as heterogenous ethnic groups may have different public goods preferences, increased diversity lowers the utility from public good consumption (Alesina and La Ferrara, 2005). In addition, workforce diversity may provide useful information to the firm about the product's market, enhancing the firm's ability to compete in global markets (Osborne, 2000; Rauch and Casella, 2003).

To our knowledge, the empirical evidence concerning diversity and economic performance has been fairly scarce, and most of the previous studies were based on case studies within one firm (e.g. Hamilton et al., 2003, 2004; Kurtulus, 2009; Leonard and Levine, 2006), or on aggregate regional data (e.g. Ottaviano and Peri, 2006 and 2010; Suedekum et al., 2009), whereas evidence using more comprehensive data is almost non-existent. Moreover, the majority of the previous studies has focused on only one dimension of diversity on firm performance, with the studies by Kurtulus (2009) and Leonard and Levine (2006) being the only exceptions.

Summarising briefly the key findings of the studies: (i) the former group of case studies find that diversity with respect to skills and knowledge has a positive effect on worker performance, whether diversity in age and race lowers firm performance (Hamilton et al., 2003, 2004; Leonard and Levine, 2006; Kurtulus, 2009); (ii) studies using aggregated regional data find a positive effect of citizenship diversity on performance (e.g. Ottaviano and Peri, 2006 and 2010; Alesina and La Ferrara, 2005; Sparber, 2009b; Suedekum et al., 2009; Peri (2010); (iii) studies using the micro linked employer-employee data find a positive effect of skill diversity on firm performance (Iranzo et al., 2008; Navon, 2009), positive or no significant effect of ethnicity diversity on firm performance (Barrington and Troske, 2001) and inverse U-shaped relationship between age diversity and

firm productivity (Grund and Westergaard-Nielsen, 2008). So there seems to be some consensus with respect to skill diversity being positively related to firm performance,[6]whereas the evidence of diversity along ethnic and demographic lines on performance is rather mixed.

Based on the different theoretical approaches and their predictions, we try to derive hypotheses for the effect of diversity on firm performance as measured by firm TFP. From the existing theoretical contributions it is clear that there are two forces driving the effect in opposite directions. On the one hand the demographic and ethnic diversity can benefit the firm with a more diverse spectrum of problem solving abilities, creativity and knowledge spillovers, which in turn foster TFP (Lazear, 1998; Hong and Page, 2001 and 2004; Berliant and Fujita, 2004; Alesina and La Ferrara, 2005). We would expect the inter-cultural learning and knowledge spillovers to materialize more easily in firms with a younger and more educated workforce, and in more creative industries. We would also expect that the diversity will have stronger results for white collar occupations, where decision making, problem-solving abilities and creativity are especially valuable. In addition, workforce diversity may provide better information and access to global markets (Osborne, 2000; Rauch and Casella, 2003). Therefore we expect the ethnic workforce diversity to have a positive effect on firm performance especially in industries more open towards trade. On the other hand, the

[6]There is quite a large amount of literature on the role of skill distribution on firm performance and how it has changed over time, mostly due to skill biased technological change (SBTCH). Some argue that it is important to have few talented workers a la "superstar", which leads to more dispersed skill distribution of the workforce (Rosen, 1981). Others claim that tasks are performed at a certain level of competence leading to teams of workers with similar skills and more segregation (Kremer, 1993)). Some recent matching and sorting models argue that production has shifted from mode of hiring more diverse workers towards modes, where some firms hire only high-skilled (e.g. Microsoft) and other firms hire only low-skilled (e.g. McDonalds), resulting in segregation (Kremer and Maskin, 1996)). Some argue that SBTCH reduces communication costs and increases an optimal degree of skill dispersion (Garicano and Rossi-Hansberg, 2006). For some discussion and evidence of educational sorting see Eriksson et al. (2009). In our paper, we do not refer to skill diversity as overall educational distribution. By skill diversity we mean diversity in skill complementarity, i.e. we focus on different skill specializations, e.g. we distinguish between different sciences, see the skill diversity index described in the next section of the paper.

demographic and ethnic diversity may also lower TFP because of higher costs connected to 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). Some firm-level policies however can counteract the costs associated with the diversity, e.g. by introduction of the same "professional" language and implementation of diversity management and film-level integration practices. We would expect that these firm-level policies are more likely to materialize in larger firms, where the organizational and management structures and practices are well established. Regarding skill diversity, there is a consensus across the existing theoretical contributions that because of the knowledge spillovers skill-related diversity shall bring a positive effect on firm TFP.

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 one is the "Integrated Database for Labor Market Research" (IDA henceforth) provided by Statistics Denmark. IDA is a longitudinal employer-employee register containing valuable information (age, demographic characteristics, education, labor market experience and earnings) on each individual employed in the recorded population of Danish firms during the period 1980-2005. Apart from deaths and permanent migration, there is no attrition in the dataset. The labor market status of each person is recorded at 30th November each year. The retrieved information is aggregated at firm level to obtain variables like firm size, workforce composition characteristics (shares of managers, middle managers, males, highly skilled workers,

technicians, shares of employees belonging to each age distribution quartiles), labor diversity (see the next section for more details) and partial/total foreign ownership.

The second data source refers to firms' business accounts (REGNSKAB henceforth), which is also provided and compiled by Statistics Denmark. It covers the construction and the manufacturing industry from 1994, manufacturing from 1995, wholesale trade from 1998 and the remaining part of the service industry from 1999 onwards. From REGNSKAB, the following accounting items are retrived for the estimation of the production function: value added[7], materials (intermediates), capital stock (fixed assets) and related industry.[8]

3.2 Firms' labor diversity

This section focuses on the measurement of employees' diversity at firm level. Labor's diversity is quantified by using information regarding workers' gender, age, work experience, highest fulfilled education and nationality. We use the Herfindahl index to measure the degree of diversity at firm level. Contrary to the traditional diversity measures, like the percentage of employees belonging to a specific group, the Herfindahl index combines two quantifiable measures: the "richness" (number of categories represented within the firm or the workplace) and "equitability" or evenness (how even are the numbers of the individual categories). Specifically, we calculate three separate indexes to measure diversity along the cultural, skill and demographic dimensions.

Cultural diversity is represented alternatively by the employees' nationality or language spoken. The nationality has been grouped in the following categories: North America and Oceania, Central and South America, Africa, West

[7] Computed as the difference between total sales and intermediates.

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

and South Europe, Formerly Communist Countries, Asia, East Asia, Muslim Countries.[9] It has been argued in previous literature that linguistic distance serves as a good proxy for cultural distance (Guiso et al, 2009; Adsera and Pytlikova, 2010), therefore we have grouped the employees together by languages spoken in their country of origin. The linguistic classification is more detailed than the grouping by nationality. Specifically, we group countries (their major official language spoken by the majority) by 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 "Ethnologue: Languages of the World", see the Appendix section for more details about the list of countries and the linguistic groups included. The skill-related diversity is represented by 6 categories based on information on employees' highest achieved educational level (tertiary education, secondary and vocational education, and below secondary education). We divide tertiary education into 4 categories making a distinction between Bachelor, Master and PhD degrees in social science, humanities, engineering and natural sciences. In a more disaggregated specification, we also distinguish secondary education into general high school, business high school, short and long vocational education. Finally, the demographic index is built on the intersection of gender and age quartiles or age quintiles (8 or 9 categories in total, depending on the level of aggregation). To measure diversity at firm level for each dimension, we sum up the Herfindahl indexes calculated for each workplace belonging to the same firm, weighted by the number of employees employed in each workplace, as follows:

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

where $index_{hit}$ is the Herfindahl diversity index of firm i at time t calculated

[9]Second generation immigrants are not treated as foreigners or as a distinct group from the natives in the main analysis. As a robustness check, we also consider a specification where these individuals are considered as foreigners.

along the *h-th* dimension (skill-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, N_w and N_i are respectively 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}.[10] The diversity index has a minimum value equal to 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 of the variables included in the main analysis, it is important to stress that (a) firms with imputed accounting variables and (b) firms with less than 10 employees are dropped from the main sample. The first choice is obviously to reinforce the reliability of our empirical analysis. The second one is to allow all investigated firms to potentially reach the highest degree of ethnic diversity at least when an aggregated specification is used.[11] All in all, we are able to analyze the total factor productivity of about 24,000 firms for years 1995 to 2005.

Table 1 provides some basic descriptive statistics on all variables used in our analysis for the main sample and by firm size. More specifically we split the

[10] For the ethnic diversity, the shares of foreign workers of different nationalities/linguistic groups in each workplace have been calculated as follows:

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

[11] When a linguistic classification is adopted, we adjust the ethnic diversity to take account of the firm size. 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).

sample into two main groups referring to firms above and below 50 employees. Consistently with the Danish industrial structure within the private sector, 78% of the observations is represented by small-sized firms.[12] Compared with larger firms, small enterprises are characterized by lower levels of value added, materials and capital stock.[13] Moreover, whereas higher shares of middle managers, younger employees and personnel with vocational education characterizes small firms, larger proportions of managers and foreigners distinguish companies with more than 50 employees. The two groups of firms are comparable in terms of average tenure of employees and firm ownership.

[Insert Table 1 and 2 around here]

Table 2 reports detailed descriptive statistics of all diversity indexes by industry, year and firm size. We observe higher values of diversity indexes for firms within the manufacturing and the financial and business services sectors, and lower diversity in all dimensions for small firms, no matter the level of aggregation used to measure workforce heterogeneity. Finally, diversity is slightly increasing over time, especially in terms of ethnicity. That is in line with the trend of growing immigration to Denmark during the latest decades.

4 Empirical strategy

In the next section we describe our empirical strategy with respect to the

[12] According to the OECD (2005), the structure of the Danish firm population is mainly composed of small and medium-sized companies as enterprises with less than 50 employees account for 97 per cent of the total number of firms and represent 42 per cent of the total employment in manufacturing and services.

[13] Values of accounting 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.

estimation of the effects of labor diversity on firm productivity. Whereas in the first subsection we discuss different production function estimation approaches, we describe our preferred empirical model in the second one. The third subsection discusses identification concerns related to the effect of labor diversity on firm productivity and the tools we use to address them.

4.1 Productivity estimation

As pointed out by the literature on the identification of firm production functions, the major issue in the estimation of parameters is the possibility that factors influencing production are unobserved by the econometrician but observed by the firm. In such case, asymmetrically observed shocks may be taken into account by firms to maximize their profits or minimize their costs. Specifically, it is expected that firms respond to positive (negative) productivity shocks by expanding (reducing) output, which requires higher quantity/quality production inputs. Thus, OLS estimates of coefficients on the inputs observed by the econometrician are biased: there is a clear endogeneity problem. Potential and earlier proposed solutions have been the instrumental variables (IV) and fixed-effects (FE) estimation techniques (Mundlak, 1961). However, these methodologies do not seem to be successful in practice for two main reasons. First, it is really difficult to find variables fulfilling the IV requirements or having asymmetrically observed shocks fixed over time. Second, fixed-effect estimators exploit only the across time variation, leaving unused a substantial part of information, which is incorporated into the cross-sectional dimension. In the latter case, the coefficients could be weakly identified. More recent techniques follow the GMM and structural approach mainly advocated by Olley and Pakes (1996) (OP henceforth) and Levinsohn and Petrin (2003) (LP henceforth), (see Ackerberg et al, 2008, for a survey). The GMM system estimator due to Blundell and

Bond (2000) is a suitable estimation method in case of endogenous variables. It requires a long time span, since lagged values and differences are used as instruments. In practice, the presence of weak instruments is quite frequent. The poor performances of these estimators have roots in their underlying statistical assumptions. Furthermore, the eventual absence of a number of lagged values may turn into a non-random selection of the dataset, introducing therefore some sample bias. OP propose a correction for the presence of attrition bias in the sample. In particular, it might be that firms are recorded for few years because they drop out of the market. More generally, they introduce survival probabilities to deal with such sample selection problems. Moreover, OP suggest a novel approach to address the endogeneity problem related to the estimation of production function parameters. They design a semi-parametric estimation method that uses investment levels to proxy for time-varying productivity shocks observed only by the firm. It is based on the assumption that future productivity is strictly increasing with respect to such term, so firms that observe a positive productivity shock in period t will invest more in that period, for any value of capital and labor. However, OP's method presents a relevant drawback, too. This disadvantage comes from the nature of the investment variable, which is very lumpy due to the related considerable adjustment costs. LP argue that the investment proxy may not smoothly respond to the productivity shock and then estimate parameters may be inconsistent. Thus, LP propose to proxy the asymmetrically observed time-varying productivity shock by using intermediate inputs. This approach may not be associated with additional computational costs if the intermediate inputs are also used to get the value added variable.

Although, OP and LP are broadly used methods for the structural identification of production function, they could suffer from collinearity and even identification problems as pointed out by Ackerberg, Caves and Frazen (2006)

(ACF henceforth). Referring to the timing and dynamic implications of input choices, they cast doubts especially on the LP estimation techniques. Thus, ACF propose their estimation method built upon OP and LP approaches but not suffering from potential collinearity problems: the coefficient on labor is no longer estimated at the first stage (in a value added production function).

Whereas ACF's extension deals with potential collinearity, it still relies on a two-stage procedure, which may incur loss of efficiency. In fact, the mentioned two-step approaches (i) ignore the potential contemporaneous correlation in the errors across the two equations and (ii) do not allow for serial correlation or heteroskedasticity in the error terms. In this regard, Wooldridge (2009) introduces a more efficient alternative based on a single-step GMM estimation approach in line with the ACF's correction and dealing with the drawbacks (i) and (ii) just mentioned above. This alternative implementation estimates the first and second stage conditions simultaneously, capturing de facto the identifying information for parameters on the variable inputs like labor, which typically come from the OP or LP' first stage (Wooldridge, 2009). Given the discussion above, Wooldridge (2009) is our preferred estimation approach.

4.2 Methodology

Referring to the literature on the identification of the production functions, we implement the structural techniques suggested by Wooldridge (2009). The relatively long time span we observe for each firm in our population sample allows us to use this more data demanding but optimal approach to retrieve the firm TFP values. Specifically, the productivity is obtained from a Cobb-Douglas production function containing the real value added (Y), labor (L) and capital (K). Since input characteristics differ across industries, production function parameters are estimated for each 3-digit sector j separately (Syverson,

2010). The log-linear production function is specified as follows:

$$lnY_{ijt} = cons + \alpha lnL_{ijt} + \beta lnK_{ijt} + u_{ijt}$$

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 Wooldridge (2009), we assume that

$$E\left(\varepsilon_{ijt} \mid l_{ijt}, k_{ijt}, m_{ijt}, l_{ijt-1}, k_{ijt-1,}, m_{ijt-1}, ..., l_{ij1}, k_{ij1}, m_{ij1}\right) = 0\,,$$

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

$$E\left(v_{ijt} \mid v_{ijt-1}, v_{ijt-2}, ..., v_{ij1}\right) = E\left(v_{ijt} \mid v_{ijt-1}\right) = f\left(v_{ijt-1}\right) = f\left[g\left(k_{ijt-1}, m_{ijt-1}\right)\right]$$

with $t = 1, 2, ..., T$, and for given functions $f(\cdot)$ and $g(\cdot, \cdot)$. Furthermore, it is imposed that

$$E\left(a_{ijt} \mid k_{ijt}, k_{ijt-1}, l_{ijt-1}, m_{ijt-1}, ..., k_{ij1,} l_{ij1}, m_{ij1}\right) = 0$$

$$with \quad a_{ijt} = v_{ijt} - E\left(v_{ijt} \mid v_{ijt-1}\right).$$

It implies that the innovation a_{ijt} can be correlated with current values of the proxy variable m_{ijt} and variable inputs l_{ijt}. We approximate $f(\cdot)$ and $g(\cdot, \cdot)$ by low-degree polynomials in dependent variables. Thus, we can use the contemporaneous state variable k_{it} , lagged inputs and functions of these as instruments Z for a GMM efficient estimation of parameters α and β.

Using the estimates of production function parameters, the firm i TFP, at time t in industry j , is defined as

$$tfp_{ijt} = y_{ijt} - \alpha l_{ijt} - \beta k_{ijt}$$

Next to the computation of TFP values, the relationship between these and alternative measures of diversity can be estimated in the following equation:

$$tfp_{ijt} = \gamma_0 + \gamma_1(index\_ethnic_{it}) + \gamma_2(index\_skill_{it}) + \gamma_3(index\_demo_{it}) +$$

$$+\gamma_z(C_{it}) + \gamma_t + \gamma_j + \xi_i jt \tag{1}$$

where γ_1, γ_2, and γ_3 are respectively the labor diversity effects associated with employees' diversity in terms of ethnicity, skill and demographic characteristics; C_{it}, is a full set of firm specific characteristics of employees while γ_t, and γ_j are time and industry controls respectively.

4.3 Identification

One may argue that the relationship between firm performance and diversity could be affected by simultaneity or endogeneity. This issue might arise because there could be unobserved firm specific factors influencing both TFP and labor diversity. Successful firms might be aware of the beneficial effects associated with a diversified workforce and thus implement recruitment strategies aimed at this purpose. For instance, it is generally known that multi-national enterprises (MNE) and exporting firms tend to be doing well in terms of TFP. Those firms especially may look for a more diverse workforce in order to cope with needs for information on different customers and product requirements, and different markets. Also certain workers may self-select into certain well-performing

firms, and so the firm diversity level may be driven by firm productivity rather than the other way around.[14] To address these concerns we follow an instrumental variable (IV henceforth) approach. A good instrument for each diversity dimension should be correlated with the variable of interest but uncorrelated with our outcome variable, i.e. TFP.

Specifically, we consider an index of labor diversity measured at the commuting area level, in which a given firm operates,[15]as an instrument for firm level diversity index in the TFP equation. The so-called functional economic regions or commuting areas are identified by using a specific algorithm based on the following two criteria. Firstly, a group of municipalities constitute a commuting area if the interaction within the group of municipalities is high compared to the interaction with other areas. Secondly, at least one municipality in the area must be a centre, i.e. a certain share of the employees living in the municipality must work in the municipality, too (Andersen A. K., 2000). In total there are 51 commuting areas identified, see Figure 1.

[Insert Figure 1 around here]

We believe that diversity at the commuting area level presents a suitable supply driven instrument for workplace level diversity because they (apart from the area including Copenhagen) are rather thin in terms of population. That

[14]However, regarding the latter, it is less likely in our case that endogeneity would be determined by selection of highly skilled or more productive workers. If this would be the case, we could in fact observe more segregation rather than heterogeneity in a firm labor force composition. Moreover, the data show that the firm diversity indexes do not vary much over time, so it seems that there is no systematic selection mechanism. The tables with variation in indexes over time are available from the authors upon a request.

[15]In our dataset it is possible to observe the location of firms, but not the location of each establishment. Thus, for the multi-establishment firms, the information about the location is only provided for the headquarter. However, we do not think this represents a serious problem as multi-establishment firms constitute only 26 % of our sample. This is reinforced by the fact that we always reject the hypothesis that our instrument is weak. Finally, we obtain similar IV estimates when multi-establishment firms are excluded. The latter results are available from the authors upon request.

may imply that firms usually recruit workers from a given local supply of labor, which is characterized by a certain degree of heterogeneity. This argument is further reinforced by the role of networks in the employment process (Montgomery, 1991, Munshi 2003). Thus firms placed in areas with a high labor diversity are also more likely to employ more a diverse workforce. In the context of Denmark, where residential mobility rates are low, our assumption that the labor supply at the county level is given seems to be quite appropriate (Deding, Filges and Van Ommeren, 2009). To rule out the possibility that firms choose the commuting area endogenously, we exclude firms changing their location in the period from 1990 to 2005 from the IV estimation.[16] To reinforce the exogeneity of our instruments we exclude each firm workforce from the computation of labor diversity at the related commuting area.

5 Results

5.1 Effect of diversity on firm productivity

As mentioned in the section above, measures of TFP are computed as residuals from the first step estimation, in which the firms' value added is regressed on their capital and labor stocks.[17] Our main results are instead shown in Table 3 where OLS estimates are reported for two TFP model specifications: a parsimonious one with diversity indexes only, and a full specification with all relevant firm specific characteristics included.

[16] Furthermore, one may point towards potentially endogenous location behavior of immigrants. The validity of our instrument may be reinforced by the spatial dispersion policy implemented for immigrants between 1986 and 1998 by the Danish authorities. The dispersal policy implied that new refugees were randomly distributed across locations in Denmark, see e.g. Damm A.P. (2009).

[17] The calculated industry-specific elasticities of capital and labor are available on request from the authors.

[Insert Table 3 around here]

All specifications contain year dummies to account for macroeconomic fluctuations. We perform analyses by using two different aggregation levels of categories used for our diversity indexes as explained in the section above. Results from more aggregate categories are shown in columns (1) to (3), whereas results using more disaggregated categories are presented in columns (4), (5) and (6). The first and fourth columns in Table 3 show the unconditional effect of diversity on firm TFP. The coefficients to ethnic and demographic diversity are negative, whereas skill diversity is significantly positive in both model specifications. To make sure that the coefficients attached to the diversity indexes do not reflect effects coming from firm workforce composition or other firm specific characteristics, we add controls for firm ownership, multi-establishment dummy, firm size, firm industry, shares of middle managers and managers, share of foreigners, shares of workers with secondary and tertiary education, share of males, four age categories and employees' average tenure in the most full model specification. Adding those controls, see columns (2) and (5), reduces the magnitude of all the diversity effects but leaves their sign unchanged. Skill diversity is positively associated with productivity, while neither ethnic nor demographic diversity seems to provide financial benefits.

As described above, we pursue an IV approach in order to address potential simultaneity and endogeneity of diversity indexes in our analyses. The IV strategy uses a supply-driven instrument in the form of a diversity index at the commuting area level. The results from the IV specifications are presented in Table 3, columns (3) and (6) for more and less aggregated diversity, respectively. Besides the economic motivation for the instruments presented in the identification section above, their statistical validity is largely confirmed by the F-statistics reported in the notes below Table 3. The estimation adopting IV

strategy yields similar results: we find again a positive effect of skill diversity and a negative effect of demographic diversity. More specifically, a standard deviation increase in skill diversity implies a 1% (1.5%) rise in productivity, when an aggregated (disaggregated) index is considered. The same effect is about -3.6% (-2.8%) if we focus on the demographic diversity. The coefficient of the ethnic diversity is significantly negative in aggregate specification, but it turns out to be insignificant in the more disaggregated level. Thus the IV approach supports the economic implications associated with findings suspected to be affected by simultaneity or endogeneity.

In the next steps we test the different hypotheses derived in the previous section. In the analyses, we use disaggregated indexes only, as we think that the indexes based on a detailed categorization may be more adequate to represent workforce diversity[18]. We start with the investigation of whether the effects of a particular dimension of diversity can be influenced by other forms of labor heterogeneity. For instance, more demographically diverse firms might be more tolerant and accept a more ethnically diverse workforce, hence attenuating eventual communication and integration costs associated with ethnic diversity. Furthermore, there might be complementarities among different skills and demographic groups. In particular, young workers, who are most likely characterized by more up-to-date technological knowledge, can together with a more diverse workforce stimulate innovation and creativity through knowledge transfers and in this way generate intra-firm spillover effects. Young workers can also better deal with cultural and linguistic differences: they typically have higher willingness to learn and adapt than older workers. We may also expect that the more educated a firm workforce is, the more flexible workers are in sharing their knowledge and in coping with a more diverse workforce in the firm.

[18]The results using the aggregate indexes are qualitatively similar to the detailed categorization, and they are available from the authors upon request.

To test the hypothesis we augment equation (1) with all the relevant interactions as described in Appendix 2, all the interactions are reported in graphs. Figure 2 shows marginal effects of all possible interaction couples between the diversity indexes. Marginal effects of interactions between diversity indexes and shares of highly skilled and younger workers are depicted in Figures 3 and 4, respectively.

[Insert Figure 2, 3 and 4 around here]

As shown in Figure 2, there is a significant positive interaction effect between ethnic and skill diversity, which means that higher skill diversity turns the negative effect into a positive effect of ethnic diversity. Conversely, the negative effect of ethnic diversity gets even weaker with higher demographic diversity. This suggests that more diverse workers with respect to demographics might be more tolerant and accepting in the case of a more ethnically diverse workforce, thus lowering the communication costs associated with the latter. The rest of the cross interactions turn out to be mostly insignificant. Furthermore, we do not find any evidence of complementarities between labor diversity and the workforce composition in terms of skills and age. As we can see from Figures 3 and 4, the diversity effects on productivity are never significantly affected by the shares of either young employees or skilled workers.

To sum up, we find evidence of positive effects of heterogeneity in skills and education, which are somewhat consistent with the theory on knowledge spillovers, creativity and problem solving abilities (Lazear, 1999; Hong and Page, 1998 and 2001; Berliant and Fujita, 2004; Alesina and La Ferrara, 2005). However, in the case of ethnic diversity, the coefficients are mostly insignificant and if statistically significant then they are attaching a negative coefficient. Hence, this might be a mixture of two distinct forces pulling the effect of demographic

and ethnic diversity in different directions: more culturally or demographically diverse workforce can have better problem solving abilities, creativity and knowledge spillovers, but these positive effects are counteracted or even offset by the negative effects of diversity on firm TFP coming from communication and integration costs (Lazear, 1998 and 1999).

6 Sensitivity analysis

Next as a part of robustness checks we examine whether the labor diversity indexes differ between different categories of firms. Firstly we check whether there is any difference in the effect of diversity on TFP across different industries. Prior academic research suggests that diversity leads to economic gains or losses depending on the industrial characteristics (Sparber, 2009b, 2010). More specifically, diversity seems to increase productivity in sectors that require creative decision-making, problem solving, and customer service, but it may decrease it in industries characterized by high levels of group or team work. The results are shown in Table 4, columns (1)-(5). We observe that for most industries the effects of workforce diversity are insignificantly different from zero. But few industries stand out above all - the effect of skill diversity is significantly positive for firms in wholesale and retail trade industry and in financial and business services. Ethnic diversity is instead negatively associated with firm performance in transport and positively associated in construction industry. If we focus on the skill dimension only, these results support the argument that diversity is beneficial for less traditional sectors heavily reliant upon creative decision-making, problem solving, and customer service, like the service sectors.

A further test on whether the workforce diversity brings larger positive ef-

fects into more creative industries is to divide them into two groups defined on 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 4, columns (6) and (7), the hypotheses on creativity is not supported, as both ethnic and demographic diversity indexes are insignificant, and skill diversity is only significantly positive for industries with below mean expenditure on R&D.

We also investigate whether the coefficients on diversity indexes differ for firms in more trade-open industries in line with the Osborne (2000) and Rauch and Casella (2003) hypothesis. Therefore, we divide industries according to their trade openness into above and below mean trade flows[20]. The estimates shown in Table 4, columns (8) and (9), clearly support the hypothesis, as the coefficient to ethnic diversity is significantly positive for industries with above average trade flows. Similarly, the skill and education diversity index has a large positive statistically significant effect on firm performance for industries with above average trade flows compared to industries with below such an average. This finding supports the hypothesis that workforce diversity provides beneficial information to firms about other countries and markets, and in this way it enhances firms' ability to compete in global markets (Osborne, 2000; Rauch and Casella, 2003).

[Insert Tables 4 and 5 around here]

In the next step, we then divide firms by size and check whether any change in coefficients to workforce diversity occurs for small (less than 50 employees), middle (50-100 employees) and big firms (more than 100 employees). We expect

[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 over value added. Data has been retrieved from the Structural Analysis database (OECD).

the effect of demographic and ethnic diversity to be more beneficial in larger firms as their organizational and management structures and practices are well established, and thus are more likely to introduce policies, which can help to counteract the potential costs associated with the diversity. Nevertheless, as reported in Table 5, columns (1)-(3), we do not find support for our hypothesis, as the ethnic and demographic indexes are insignificant across all three firm size categories. It seems that skill diversity is more important for small and medium sized firms compared to large firms.

Next, we calculate our diversity indexes for white- and blue-collar occupations and include both of them in the same regression. This is driven by the idea that diversity could play a different role for distinct occupational groups and consequently have heterogeneous effects on firm TFP. It is in fact plausible that white collar occupations are characterised by higher levels of creativity and communication compared to blue collar occupations. We would expect that for white collar occupations the positive effects of skill/educational diversity should be large, whereas the effects of demographic and cultural diversity can be ambigious depending on which effect prevails: the positive effect from better decision making, problem-solving abilities and creativity, or negative effect caused by communication and integration costs. The results of the effect of diversity indexes calculated separately for the two occupational groups, white- and blue-collar workers, are presented in Table 5, columns (4) and (5), respectively. It seems that workforce diversity among white-collar workers has much stronger effect on firm TFP than diversity among blue-collar workers. In particular, all three coefficients on workforce diversity are significant, with ethnic and demographic diversity having a negative effect, and skill diversity having a positive effect on firm TFP. That is in line with the notion by Lazear (1999).

As the main literature in the biology field has defined the Shannon entropy

as one of the most profound and useful diversity indexes,[21] we also use the exponential of Shannon-Weaver entropy index to measure labor diversity. The robustness check using the alternative diversity index show results similar to those presented in the main section. Finally, in the case of ethnic diversity only, we calculate the index by including the second generation immigrants into the category of foreigners (rather than natives). The coefficient to the cultural diversity turns out to be insignificant, although the sign and magnitude remains similar to the main results from Table 3 (column 5).

7 Discussion and conclusions

Using a comprehensive linked employer-employee dataset, this paper investigates the effect of labor diversity in ethnic-cultural, skill and demographic characteristics on firm productivity in Denmark. Contrary to the majority of previous empirical works, which focused on single aspects of labor diversity, we provide a number of findings that may concretely address as a whole the consequences of firm workforce heterogeneity on firm performance. For our analyses we use the well-known Herfindahl index to measure extensively the three above mentioned dimensions of diversity. Regarding methodology we follow the Wooldridge (2009) approach to deal with simultaneity and endogeneity problems in the computation of firm TFP. In addition, we employ an IV strategy to cope with potential endogeneity concerning the diversity indexes.

Controlling for a wide set of firm specific characteristics and performing different robustness checks, we find that diversity in skills/education enhances firm TFP significantly. Specifically, we find that a standard deviation increase in skill diversity increases productivity by approximately 1%. The result gives

[21] See Maignan et al. (2003).

support to the existing theory on knowledge spillovers. Differently, diversity in demographics and ethnicity brings mixed results – both dimensions of workforce diversity bring either no or negative effects on firm TFP. Thus, it seems as if the negative effects coming from communication and integration costs connected to a more demographically and culturally diverse workforce counteract the positive effects of diversity on firm TFP coming from better problem solving abilities, creativity and knowledge spillovers. These findings are consistent in part with past relevant studies by Lazear (1999), Glaeser et. al. (2000), and Alesina and La Ferrara (2002). Interestingly, we find that there are significantly positive effects of ethnic diversity on firm TFP for firms operating in industries, which are more open to trade. This gives support to the theory by Osborne (2000) and Rauch and Casella (2003), which states that workforce diversity provides useful information to the firm about national and foreign products/markets and in this way it enhances the firm's ability to compete in global markets.

Thus, if our empirical analysis clearly provides evidence of the positive contribution of educational diversity to firm TFP, it also does not support any general statement saying that diversity in ethnic and demographics is detrimental for businesses in terms of firm performance. The effects of the last heterogeneity dimensions are not robust across specifications and seem to contribute positively to TFP in case firms focus more on international trade. These findings might imply that firms strengthening their efforts to decrease the "obvious" costs associated with the workforce diversity, e.g. by implementing diversity management, modern techniques and integration practices, could turn workforce heterogeneity into a substantial competitive advantage. This allows us to draw the conclusion that governmental policies actively promoting greater equality will not bring any detrimental effects on businesses in terms of firm performance.

References

[1] Adsera, Alicia, and Mariola Pytlikova, "The Role of Language in Shaping International Migration: Evidence from OECD Countries 1985-2006," Unpublished manuscript, 2010.

[2] Ackerberg, Daniel A., Kevin Caves, and Garth Frazer, "Structural Identification of Production Functions," Unpublished manuscript, 2006.

[3] Ackerberg, Daniel A., Lanier Benkard, Steven Berry, and Ariel Pakes, *Econometric Tools for Analyzing Market Outcomes*, in James Heckman and Edward Leamer (eds) Handbook of Econometrics Volume 6A, (Amsterdam, North-Holland, 2008).

[4] Alesina, Alberto, and Eliana La Ferrara, "Who Trusts Others?," Journal of Public Economics, 85 (2002), 207-234.

[5] Alesina, Alberto, and Eliana La Ferrara, "Ethnic Diversity and Economic Performance," Journal of Economic Literature, 43 (2005), 762-800.

[6] Andersen, Anne K., *Commuting Areas in Denmark,* (Copenhagen, AKF forlaget, 2000).

[7] Becker, Gary, *The Economics of Discrimination,* (Chicago, University of Chicago Press, 1957).

[8] Barrington, Linda, and Kenneth R. Troske, "Workforce Diversity and Productivity: An Analysis of Employer-Employee Matched Data," Economics Program Working Papers No. 01-02, 2001.

[9] Berliant, Marcus, and Masahisa Fujita, "Knowledge Creation as a Square Dance on the Hilbert Cube," International Economic Review, 49 (2008), 1251–1295.

[9] Blundell, Richard, and Stephen Bond, "GMM Estimation with Persistent Panel Data: An Application to Production Functions," Econometric Review, 19 (2000), 321-340.

[10] Damm, Anna P. (2009): "Ethnic Enclaves and Immigrant Labor Market Outcomes: Quasi-Experimental Evidence," Journal of Labor Economics, 27 (2009), 281-314.

[11] *Danish Ministry of Finance* (http://www.fm.dk).

[10] *Danmarks Statistics* (http://www.dst.dk).

[13] Deding, Mette, Trine Filges, and Jos Van Ommeren, "Spatial Mobility and Commuting: the Case of Two-Earner Households," Journal of Regional Science, 49 (2009), 113-147.

[11] Desmet, Klaus, Ignacio Ortuño and Shlomo Weber, "Linguistic Diversity and Redistribution," Journal of the European Economic Association, 7 (2009), 1291-1318.

[14] Markeprant, Tobias E., Peter Stephensen, and Lars H. Pedersen, *DREAMs Disaggregerede Befolkningsfremskrivning til År 2100, Metode of Resultater,* (Copenhagen, DREAM, 2003).

[15] Eriksson, Tor, Mariola Pytlikova, and Frederic Warzynski, "Increased Sorting and Wage Inequality in the Czech Republic: New Evidence Using Linked Employer-Employee Dataset," ASB Working Paper No. 09-14, 2009. Submitted.

[16] Garicano, Luis, and Esteban Rossi-Hansberg, "Organization and Inequality in a Knowledge Economy," The Quarterly Journal of Economics, 121 (2006), 1383-1435.

[17] Glaeser, Edward, David I. Laibson, José A. Scheinkman, and Christine L. Soutter, "Measuring Trust," The Quarterly Journal of Economics, 115 (2000), 811-846.

[18] Grund, Christian, and Niels Westergaard-Nielsen, "Age Structure of the Workforce and Firm Performance," International Journal of Manpower, 29 (2008), 410-422.

[19] Guiso, Luigi, Paolo Sapienza, and Luigi Zingales, "Cultural Biases in Economic Exchange?," Quarterly Journal of Economics, 124 (2009), 1095-1131.

[12] Hamilton, Barton H., Jack A. Nickerson, and Hideo Owan, "Team Incentives and Worker Heterogeneity: An Empirical Analysis of the Impact of Teams on Productivity and Participation," Journal of Political Economy, 111 (2003), 465-497.

[20] Hamilton, Barton H., Jack A. Nickerson, and Hideo Owan, "Diversity and Productivity in Production Teams," Manuscript, Washington University in St. Louis, 2004. Under review in Strategic Organization.

[21] Hong, Lu, and Scott E. Page, "Problem Solving by Heterogeneous Agents," Journal of Economic Theory, 97 (2001), 123-163.

[13] Hong, Lu, and Scott E. Page, "Groups of Diverse Problem Solvers Can Outperform Groups of High-Ability Problem Solvers," Proceedings of the National Academy of Sciences, 101 (2004).

[22] Iranzo, Susana, Fabiano Schivardi, and Elisa Tosetti, "Skill Dispersion and Firm Productivity: An Analysis with Employer-Employee Matched Data," Journal of Labor Economics, 26 (2008), 247-285.

[23] Kremer, Michael, "The O-ring Theory of Economic Development," The Quarterly Journal of Economics, 108 (1993), 551-575.

[24] Kremer, Michael, and Eric Maskin, "Wage Inequality and Segregation by Skill". NBER Working Paper No. 5718, (1996).

[25] Kurtulus, Ana F., "The Effect of Heterogeneity on the Performance of Employees and Organizational Divisions of the Firm," Manuscrift 2009, Revise and Resubmit.

[26] Lang, Kevin, "A Language Theory of Discrimination," Quarterly Journal of Economics 101 (1986), 363-382.

[14] Lazear, Edward P., *Personnel Economics for Managers*, (New York, John Wiley & Sons, 1998).

[28] Lazear, Edward P., "Globalisation and the Market for Team-Mates," The Economic Journal, 109 (1999), 15-40.

[15] Leonard, Jonathan S., and David I. Levine, "Diversity, Discrimination, and Performance" Institute for Research and Employment Working Paper, No 147, 2006. Revise and Resubmit.

[29] Levinsohn, James, and Amil Petrin, "Estimating Production Functions using Inputs to Control for Unobservables," Review of Economic Studies, 70 (2003), 317-341.

[16] Maignan, Carole, Gianmarco Ottaviano, Dino Pinelli and Francesco Rullani, "Bio-Ecological Diversity vs. Socio-Economic Diversity: A Comparison of Existing Measures", Nota di Lavoro 2003, Fondazione Eni Enrico Mattei.

[30] Manning, Allan, *Monopsony in Motion: Imperfect Competition in Labor Markets*, (Princeton, Princeton University Press, 2003).

[31] Markeprand, Tobias E., Peter Stephensen, and Lars Haagen Pedersen, "DREAMs disaggregerede befolkningsfremskrivning til år 2100: Metode og Resultater," DREAM Report, Copenhagen, 2003.

[17] Montgomery, James D., "Social Networks and Labor Market Outcomes: Toward an Economic Analysis," American Economic Review, 81 (1991), 1408-1418.

[32] Mundlak, Yair, "Empirical Production Function Free of Management Bias," Journal of Farm Economics, 43 (1961), 44-56.

[33] Munshi, Kaivan, "Networks in the Modern Economy: Mexican Migrants in the US Labor Market," The Quarterly Journal of Economics, 118 (2003), 549-599.

[34] Navon, Guy, "Human Capital Spillovers in the Workplace: labor Diversity and Productivity," MPRA Paper No. 17741, 2009.

[35] OECD, *Economic Survey of Denmark*, (Paris, 2005).

[36] Olley, Steven G., and Ariel Pakes, "The Dynamics of Productivity in the Telecommunications Equipment Industry," Econometrica, 64 (1996), 1263-1297.

[37] Osborne, Evan, "The Deceptively Simple Economics of Workplace Diversity," Journal of Labor Research, 21 (2000), 463-475.

[38] Ottaviano, Gianmarco I. P. and Giovanni Peri, "The Economic Value of Cultural Diversity: Evidence from US Cities," Journal of Economic Geography, 6 (2006), 9-44.

[39] Ottaviano, Gianmarco I. P., and Giovanni Peri, "Rethinking the Effects of Immigration on Wages," Journal of European Economic Association, 2010, forthcoming.

[40] Pedersen, Peder J., Mariola Pytlikova, and Nina Smith, "Selection and Network Effects - Migration Flows into OECD Countries 1990-2000," European Economic Review, 52 (2008), 1160-1186.

[18] Peri Giovanni, "The Effect of Immigration on Productivity: Evidence from U.S. States," The Review of Economics and Statistics, (2010), forthcoming.

[19] Petrin, Amil, James Levinsohn, and Brian Poi, "Production Function Estimation in Stata Using Inputs to Control for Unobservables," Stata Journal, 4 (2003), 113-123.

[42] Rauch, James E., and Alessandra Casella, "Overcoming Informational Barriers to International Resource Allocation: Prices and Ties," Economic Journal, 113(2003), 21-42.

[20] Rosen, Sherwin, "The Economics of Superstars," American Economic Review, 71 (1981), 845-858.

[43] Sparber, Chad, "A Theory of Racial Diversity, Segregation, and Productivity," Journal of Development Economics, 87 (2009a), 210-226.

[44] Sparber, Chad, "Racial Diversity and Aggregate Productivity in US Industries: 1980-2000," Southern Economic Journal, 75 (2009b): 829-856.

[45] Sparber, Chad, "Racial Diversity and Macroeconomic Productivity across US States and Cities," Regional Studies, 44 (2010), 71-85.

[46] Suedekum, Jens, Katja Wolf and Uwe Blien, "Cultural Diversity and Local Labor Markets," IZA Discussion Paper No. 4619, 2009.

[21] Syverson, Chad, "What Determines Productivity?," Journal of Economic Literature, forthcoming.

[47] United Nations, *Replacement Migration: Is it a Solution to Declining and Aging Populations?*, New York, UN Population Division. Department of Economic and Social Affairs, 2001.

[22] Wooldridge, J.M. "On estimating firm-level production functions using proxy variables to control for unobservables." Economics Letters, 104 (2009), 112–114.

Appendix 1: Measurement of Ethnic Diversity

1) The citizens in the different nationality groups are: **Danish**, Danish native 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 the other Asian countries non included in both East Asia and Muslim Countries categories and **Africa,** all the other African countries not included in the Muslim Country; **West and South Europe**, all the other European countries not included in the Formerly Communist Countries category.

2) Using linguistic grouping: **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), **Japonic** (Japan, Republic of Korea, Korea D.P.R.O.).

Appendix 2: Interaction effects

The model with interaction effects between the diversity indexes is as below

$$tfp_{ijt} = \gamma_0 + \gamma_1(index\_ethnic) + \gamma_2(index\_skill_{it}) + \gamma_3(index\_demo_{it}) + \gamma_{12}(index\_ethnic_{it})(index\_skill_{it}) + \gamma_{13}(index\_ethnic_{it})(index\_demo_{it}) + \gamma_{32}(index\_demo_{it})(index\_skill_{it}) + \gamma_z(Z_i t) + \gamma_t + \gamma_j + \xi_i jt$$

where γ_{12}, γ_{13} and γ_{32} are the interaction effects of our diversity indexes. In such a model, we calculate the marginal effect of one index, for example $index\_ethnic$, and its variance as follows:

$$\frac{\partial tfp_{ijt}}{\partial index\_ethnic_{it}} = \gamma_1 + \gamma_{12}(index\_skill_{it}) + \gamma_{13}(index\_demo_{it})$$

and

$$var(\tfrac{\partial tfp_{ijt}}{\partial index\_ethnic_{it}}) = var(\gamma_1) + (index\_skill_{it})^2 var(\gamma_{12}) + (index\_demo_{it})^2 var(\gamma_{13}) + 2index\_skill_{it} cov(\gamma_1, \gamma_{12}) + 2index\_demo_{it} cov(\gamma_1, \gamma_{13}) + 2index\_skill_{it} index\_demo_{it} cov(\gamma_{12}, \gamma_{13}) .$$

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	0.762	0.841	0.242	0.773	0.857	0.244	0.727	0.797	0.231
Share of blue collars	blue collars as a proportion of all employees	0.226	0.263	0.147	0.178	0.254	0.112	0.233	0.271	0.132
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 Skill 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 Skill 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 Skill	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 Skill	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 Skill	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 Skill	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 $\leq$ 49; Middle size: 50 $\leq$ Employees $\leq$ 99; Big size: Employees $\geq$ 100.

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

	(1) OLS	(2) OLS	(3) IV	(4) OLS	(5) OLS	(6) IV
Index Ethnic Aggr	-0.195***	-0.037**	-0.035**	-	-	-
	(0.039)	(0.013)	(0.012)			
Index Skill Aggr	0.337***	0.038	0.061**	-	-	-
	(0.049)	(0.025)	(0.025)			
Index Demo Aggr	-0.235**	-0.076**	-0.204**	-	-	-
	(0.094)	(0.039)	(0.069)			
Index Ethnic Disaggr	-	-	-	-0.043**	-0.016*	0.013
				(0.026)	(0.009)	(0.011)
Index Skill Disaggr	-	-	-	0.190***	0.073***	0.090***
				(0.046)	(0.019)	(0.026)
Index Demo Disaggr	-	-	-	-0.335***	-0.036	-0.169**
				(0.098)	(0.038)	(0.075)
Foreign Ownership		0.147	0.264**		0.147	0.264**
		(0.113)	(0.089)		(0.113)	(0.090)
Multi-establishment		0.088***	0.070***		0.090***	0.073***
		(0.009)	(0.013)		(0.010)	(0.013)
Share of middle managers		-0.194***	-0.215***		-0.177***	-0.189***
		(0.016)	(0.020)		(0.017)	(0.025)
Share of managers		0.072*	-0.039		0.079*	-0.022
		(0.040)	(0.053)		(0.041)	(0.056)
Tenure		0.024***	0.014***		0.025***	0.015***
		(0.001)	(0.002)		(0.001)	(0.002)
Secondary education		0.259***	0.262***		0.254***	0.252***
		(0.020)	(0.030)		(0.014)	(0.021)
Tertiary education		0.436***	0.404***		0.437***	0.409***
		(0.040)	(0.044)		(0.040)	(0.044)
Age15-32		0.109***	0.109**		0.113***	0.109**
		(0.021)	(0.046)		(0.021)	(0.044)
Age33-41		0.277***	0.267***		0.272***	0.260***
		(0.022)	(0.039)		(0.022)	(0.038)
Age42-50		0.176***	0.188***		0.171***	0.181***
		(0.024)	(0.039)		(0.024)	(0.039)
Share of males		0.119***	0.120***		0.131***	0.137***
		(0.017)	(0.025)		(0.017)	(0.024)
Share of foreigners		-0.031	-0.039		-0.050	-0.096**
		(0.034)	(0.034)		(0.033)	(0.031)
Industry and firm size dummies	NO	YES	YES	NO	YES	YES
Year dummies	YES	YES	YES	YES	YES	YES
N	105942	105942	62272	105942	105942	62272
R2	0.025	0.846	0.879	0.025	0.846	0.879

Notes: The dependent variable in all estimations is the productivity estimated from the Wooldridge (2009) approach. Estimated standard errors are shown in parentheses and are clustered at firm level in columns 1,2,5,6 and at commuting area level in columns 3 and 7. Significance levels: ***1%, **5%, *10%. Columns (3) and (7): Diversity indexes at firm level instrumented with the indexes calculated at commuting area level. The sample includes only firms not changing their location over the period 1990-2005. F-stats on excluded instruments for the aggregate (disaggregate) specification: i) Index Ethnic at commuting area level: 2010.80 (242.10); ii) Index Skill at commuting area level: 1770.04 (2297.96); iii) Index Demo at commuting area level: 3121.53 (54420.15).

Table 4: Robustness checks on the effects of diversity on productivity: estimates by industry and other relevant industrial aggregations.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Estimates by Industry					**R&D expenses**		**Trade Openness**	
	Manufacturing	Construction	Wholesale and retail trade	Transport	Financial and business services	Above mean	Below mean	Above mean	Below mean
Index Ethnic Disaggr	-0.006	0.029*	0.012	-0.092**	-0.016	-0.033	-0.011	0.051*	-0.025**
	(0.013)	(0.015)	(0.016)	(0.041)	(0.022)	(0.037)	(0.009)	(0.028)	(0.009)
Index Skill Disaggr	0.020	0.040	0.238***	-0.219	0.142**	0.080	0.080***	0.393***	0.058**
	(0.036)	(0.026)	(0.035)	(0.164)	(0.062)	(0.113)	(0.019)	(0.092)	(0.019)
Index Demo Disaggr	-0.095	0.016	-0.047	0.081	0.100	0.064	-0.047	0.093	-0.051
	(0.075)	(0.054)	(0.070)	(0.147)	(0.112)	(0.218)	(0.038)	(0.163)	(0.039)
Observations	39209	18592	29256	6755	12130	7350	98592	12402	93540
R2	0.888	0.115	0.823	0.752	0.670	0.942	0.818	0.925	0.819

Notes: All regressions include all the firm specific characteristics, year and three-digit industry dummies. Estimated standard errors are shown in parentheses and are clustered at firm level. Significance levels: ***1%, **5%, *10%.

Table 5: Robustness checks on the effects of diversity on productivity: estimates by size and under alternative index definitions.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Estimates by Firm Size			**Occupation specific diversity**		**Shannon entropy index**	**Second generation immigrants as foreigners**
	Small Firms	Middle Firms	Big Firms	White collar	Blue collar		
Index Ethnic Disaggr	-0.012	-0.002	-0.008	-0.026**	-0.010	-0.011**	-0.026
	(0.015)	(0.011)	(0.015)	(0.011)	(0.014)	(0.004)	(0.017)
Index Skill Disaggr	0.073***	0.085**	0.072	0.059***	0.020**	0.011**	0.120***
	(0.021)	(0.031)	(0.059)	(0.014)	(0.007)	(0.004)	(0.026)
Index Demo Disaggr	-0.014	0.029	-0.176	-0.039**	-0.026***	-0.000	-0.047
	(0.041)	(0.064)	(0.144)	(0.019)	(0.007)	(0.002)	(0.049)
Observations	40211	40449	25282	105942	105942	105942	105942
R2	0.822	0.835	0.905	0.846	0.846	0.846	0.846

Notes: All regressions include all the firm specific characteristics, year and three-digit industry dummies. Coefficients from columns (4) and (5) refer to one regression equation. Estimated standard errors are shown in parentheses and are clustered at firm level. Significance levels: ***1%, **5%, *10%.

Figure 1: Commuting areas,1995, Denmark.

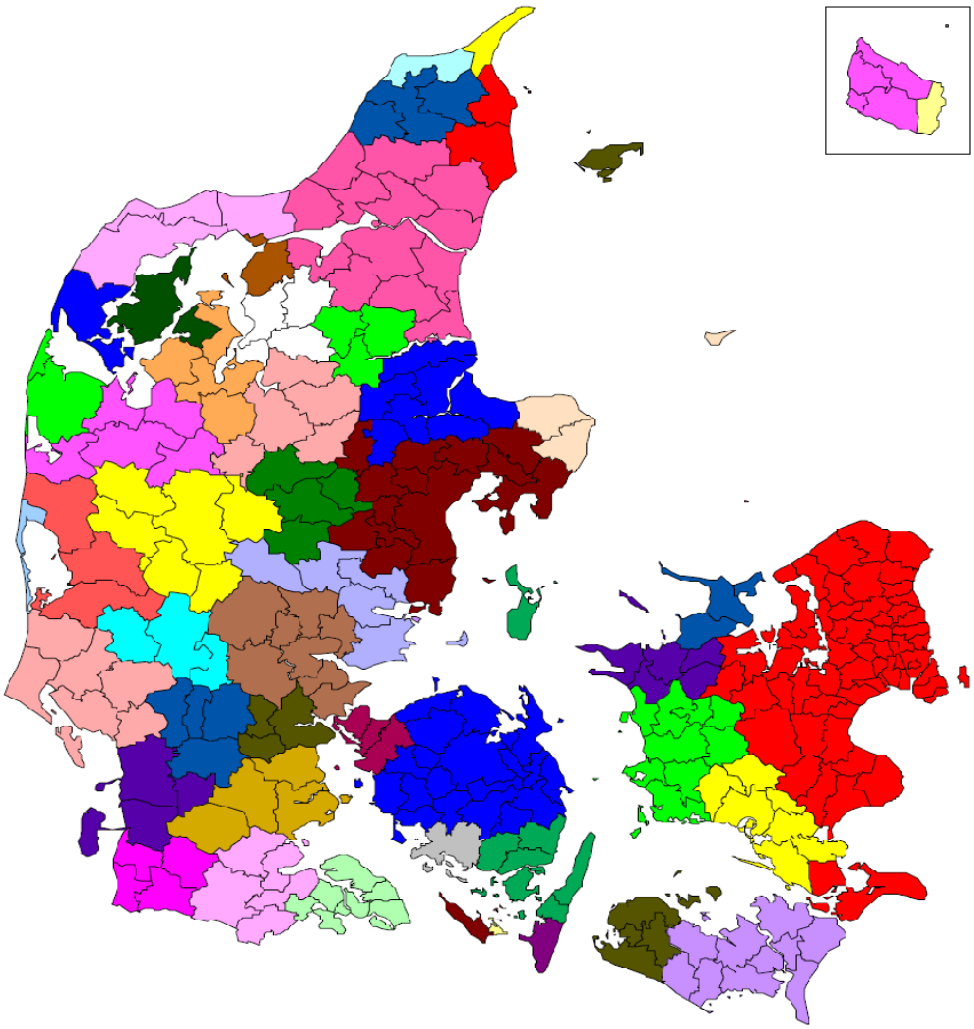
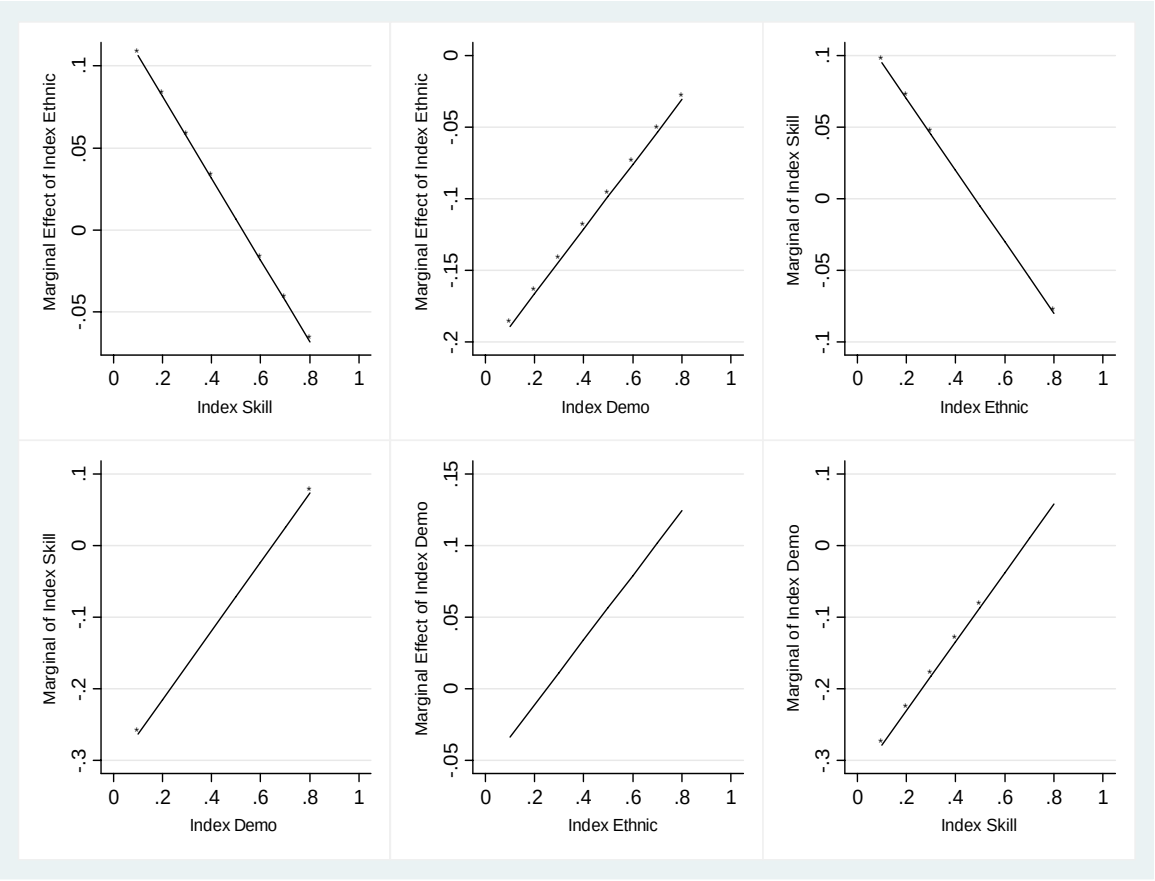
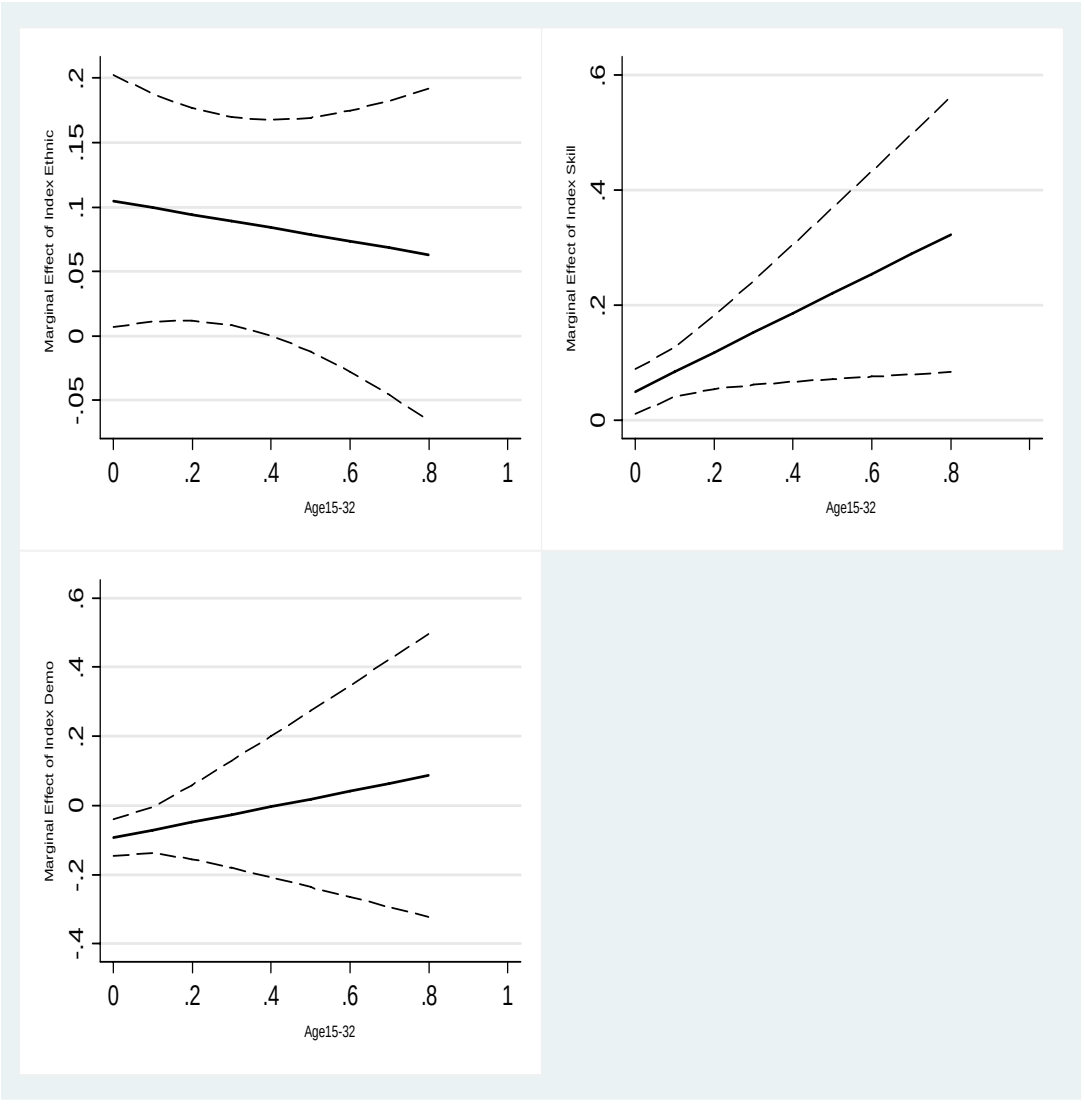


Figure 2: Marginal Effects of all disaggregated indexes, cross interactions, OLS estimates.



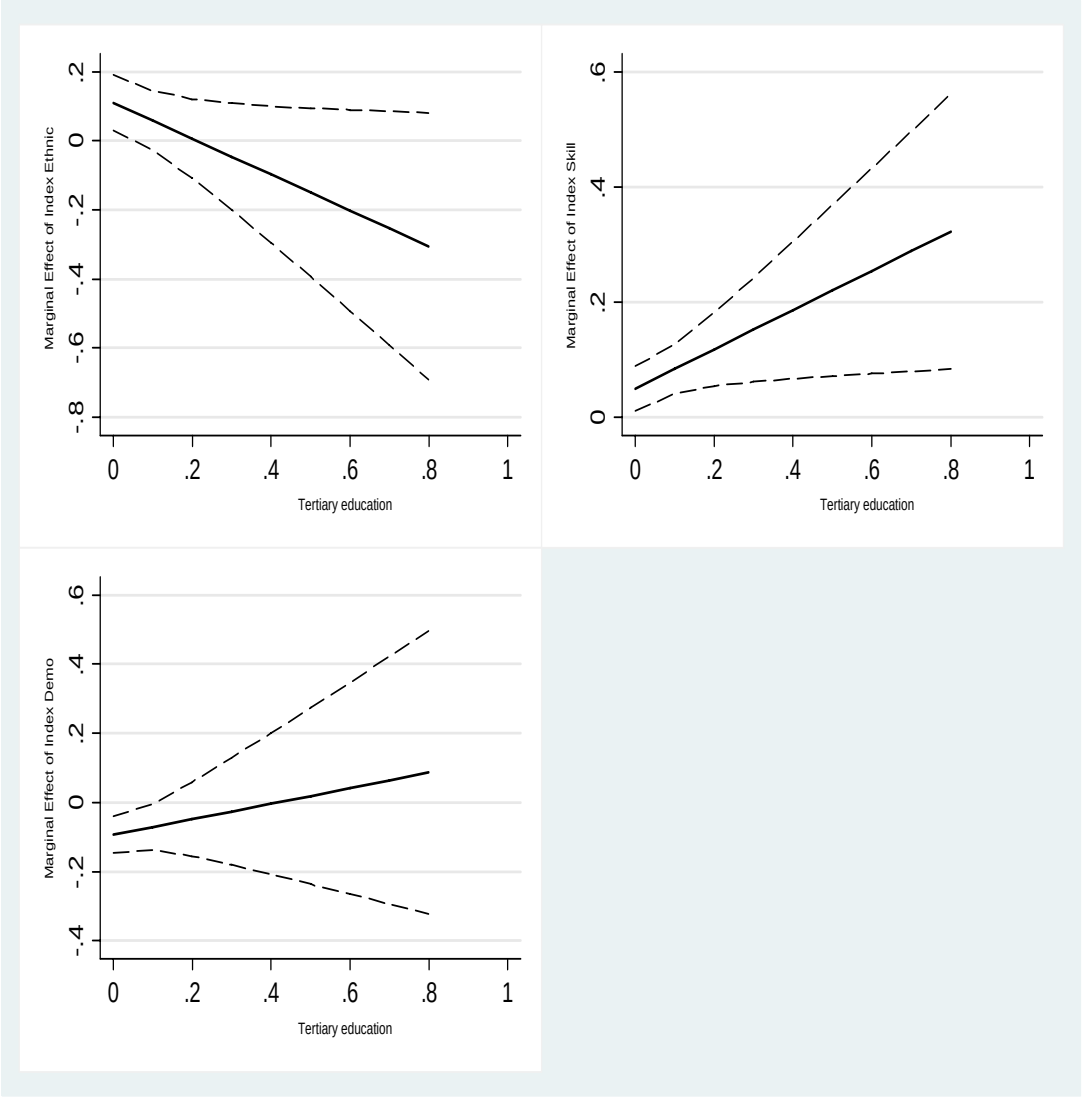
Notes: * indicates significance at the 95 % level; the excluded index is always at the 50th percentile of the index distribution.

Figure 3: Marginal Effects of all disaggregated indexes, interactions with the proportion of employees with a tertiary education, OLS estimates.



Notes: dashed lines indicate confidence intervals at the 95 % level.

Figure 4: Marginal Effects of all disaggregated indexes, interactions with the proportion of employees aged 15-32, OLS estimates.



Notes: dashed lines indicate confidence intervals at the 95 % level.

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