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Ceren Ozgen, Peter Nijkamp and Jacques Poot

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Evidence from Dutch Firm-Level Data*

Ceren Ozgen[a], Peter Nijkamp[b] and Jacques Poot[c]

Abstract

Due to the growth in international migration in recent decades, the workforce of firms in host countries has become considerably more diverse, both demographically and culturally. It is an important question for firms and for governments to ask whether there are some productivity-enhancing externalities gained from this growing diversity within firms. In recent years migration research has demonstrated positive economic impacts of cultural diversity on productivity and innovation at the regional level. However, there is a dearth of research on the links between innovation and migrant diversity at the firm level. In this paper we construct and analyse a unique linked employer-employee micro-dataset of 4582 firms, based on survey and administrative data obtained from Statistics Netherlands. Excluding firms in the hospitality industry and other industries that employ low-skilled migrants, we use the local number of restaurants with foreign cuisines and the historical presence of migrant communities as valid instruments of endogenous migrant settlement. We find that firms in which foreigners account for a relatively large share of employment are somewhat less innovative. However, there is strong evidence that firms that employ a more diverse foreign workforce are more innovative, particularly in terms of product innovations.

JEL code: D22, F22, O31

Keywords: immigration, innovation, cultural diversity, knowledge spillovers, linked employer-employee data, Netherlands

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[a] Corresponding Author. Department of Spatial Economics, VU University Amsterdam, De Boelelaan 1105, 1081 HV Amsterdam, The Netherlands. (c.ozgen@vu.nl)
[b] Department of Spatial Economics, VU University Amsterdam, De Boelelaan 1105, 1081 HV Amsterdam, The Netherlands.
[c] National Institute of Demographic and Economic Analysis, University of Waikato, Private Bag 3105, Hamilton 3240, New Zealand.

1. Introduction

One of the major mechanisms for the transfer and diffusion of knowledge is the mobility of people. The geographic mobility of high-skilled labour causes a relocation of human capital that essentially contains embodied knowledge combined with personal experiences (Döring and Schnellenbach, 2006). Moreover, multinational firms also play a specific role in transmitting institutionalized knowledge in the form of the experience and work practices of internationally transferred employees.

On the one hand, the global economy is creating an unprecedented demand for a diversified and open-minded work force while, on the other hand, highly-skilled workers are seeking opportunities to enhance their human capital and increase their income and experience. For example, an estimated 900,000 highly-skilled professionals entered the US between 1990 and 2000. Moreover, temporary workers account for one-sixth of the total IT workforce in the US (OECD, 2002). Such phenomena increase the rate of circulation of talent over space and across firms, leading to much greater cultural diversity of the workforce than a few decades ago. Today, large, and often export-oriented, companies are seeking knowledge workers from all over the world (Saxenian, 2006; Page, 2007). It is an important question for firms and for governments to ask whether there are some productivity-enhancing externalities gained from this growing diversity within firms.

It is widely argued that the knowledge available in localities with a diverse population generates positive externalities for economic growth, especially in the form of greater innovativeness. Contrary to the *complete* knowledge spillover assumption of neoclassical theory, persistent regional inequalities and migration of highly-skilled workers to globally-connected cities suggest that knowledge is neither instantaneously nor evenly dispersed across space, and that more attention should be drawn to the complex mechanisms that drive knowledge spillovers. Regions that do not generate or absorb new productive ideas often fall behind in development (Romer, 1993), while others that are able to attract "global minds" benefit from the circulation of tacit and codified knowledge. Besides the circulation of knowledge, the circulation of ideas and the encouragement of creativity also generates growth. The latter are often enhanced by culture-specific skills.

A recent branch of migration literature has been focusing on the association between innovation and the presence of foreign workers, generally reporting a statistically significant positive relationship, reviewed in, e.g., Ozgen et al. (2011). The main argument of this literature is that immigrant workers not only contribute to innovation by means of their high skills and innate abilities, but that they also bring into firms and host countries new ideas and perspectives from their different cultural backgrounds. The empirical evidence supports this hypothesis explicitly with data at the regional level or at the level of micro-data on individual workers.

However, the innovation literature to date has tended to treat high-skilled R&D workers as a rather homogeneous group of employees. The cultural features, skill complementarities, and ethnic background of the employees have not been explicitly taken into account. Most studies use various firm

characteristics as determinants of innovation and estimate a so-called knowledge production function (e.g., Audretsch and Feldman, 2004; Cohen and Levinthal, 1990). Yet, such studies have often overlooked the characteristics of the individual *workers*. The latter are clearly needed to assess the impact of worker diversity on the innovativeness of firms.

Consequently, in this paper we focus on the effects of knowledge and creativity of foreign employees with diverse backgrounds, and the spillovers of these effects for productive capacity through reported technological improvements at the firm level. To date – with the exception of Parotta et al. (2011), Lee and Nathan (2010), Simonen and McCann (2008) and Almeida and Kogut (1999) – there has actually been very little empirical evidence which addresses the determinants of innovation at the firm level, and which either takes the presence and characteristics of foreigners into account, or considers labour mobility as a source of new knowledge.

In addition to knowledge flows, there are also other types of externalities resulting from immigrant diversity. The presence of a diverse group of immigrants increases the demand for goods from the home country. The resulting increase in the variety of consumption goods and services also benefits the host population. A stream of literature focuses on this issue (Clark, 2002; Shapiro, 2003; Florida, 2003). While the presence of consumption externalities is not central to our study, it is clear that a diverse workforce may facilitate the development of a new range of cultural goods or services that may be reflected in measures of innovation.

We utilize high-quality linked employee-employer data at the firm-level, obtained from the Central Bureau of Statistics for the Netherlands (hereafter Statistics Netherlands). We combine survey and administrative information from four different collections, relating to the period 2000-2002. By means of the resulting unique micro-dataset of 4582 firms, we study whether the presence, or relative numerical importance, of migrants influences the innovative capacity of a firm. We also test whether cultural diversity among the migrants is more conducive to innovativeness. As far as we are aware, this is the first study in the Netherlands that analyses the innovation effects of foreign employees by means of a representative micro-dataset at the firm level.

Clearly, a potentially important issue is that of reverse causality: foreign knowledge workers may self-select into regions and seek employment in firms that are innovative and have a diverse workforce. We address this issue by an instrumental variable approach. Excluding firms in the hospitality industry and other industries that employ low-skilled migrants, we use the local number of foreign restaurants and the historical presence of migrant communities as valid instruments for endogenous migrant settlement. We find that, in general, firms that employ a relatively large share of foreigners are less innovative, but there is clear evidence that a greater diversity of the foreign workers significantly enhances product innovation.

2. Theoretical Links between the Presence of Foreigners and Innovation

An innovation is the introduction of something new that is primarily built by means of analytical knowledge. It must lead to *radical, major and dramatic change.*[1] In addition, improvement of an existing product can also be viewed as an innovation. All industries and sectors can be innovative, since innovation is not equal to, but more than, R&D intensity. Subsequently, all innovations have complex technological, human, and organizational dimensions.

Technological advances come from things that people do (Romer, 1990). People carry, bring in and add to knowledge, or take knowledge with them. Many workers' characteristics, such as age, education, occupation, cultural background and language may affect their knowledge acquisition and their mobility (Poot, 2008). Even when people belong to the same occupational group, any differences in their cultural backgrounds may influence their outlook, as well as their productivity, in carrying out their work or doing business. If one considers the presence of more than 200 million immigrants in the world, the massive flows of knowledge, cultures, and languages through the mobility of these people create opportunities that can help firms in being innovative. Current knowledge is the outcome of accumulated efforts. Each inventor begins from where its predecessors left off. The inventor explores the latest generation of products, and makes use of market knowledge that embodies a cumulative investment in time to develop products and processes (Grossman and Helpman, 1994). The presence of foreigners with diverse backgrounds in a labour market may serve to enrich this cumulative effort.

There has been a massive number of studies that have analysed the impact of *infrastructural and organizational* aspects of firms on innovativeness. Yet, the importance of ideas rather than physical assets has only recently entered the economic agenda (Jones and Romer, 2010). The biggest change in the recent scientific literature is that it is now not the firm but the employees that are seen as a major source of innovation. One key focus of this new approach is the impact of foreign workers on the innovativeness and productivity of host firms and countries. Thus, one branch of this literature analyses the impact of foreign entrepreneurs, students or inventors on innovation (Kerr, 2010; Lobo and Strumsky, 2008; Faggian and McCann, 2008; Kerr and Lincoln 2010; Hunt and Gauthier-Loiselle, 2008; and Zucker and Darby, 2007). Such evidence of spillover benefits from skilled foreigners joining an organisation applies even to professional sports (see Alvarez et al. 2011 for the case of basketball in Europe). The merit of such studies lies in determining the success and spillover benefits of skilled immigrant on the host economies. These studies rely on detailed information about the 'inventors', which allows the researchers to control for education and knowledge acquisition of foreigners in the host countries.

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[1] Globalization has a major impact on spreading the effect of breakthrough innovations. The speed at which such innovations become known and available worldwide has been increasing fast. For example, Cooper and Edgett (2009) report that it took Sony 10 years to sell 50 million Walkmans, while about the same number of iPods were sold in only 4.5 years. Clearly, dramatic change may lead to dramatic economic gains for the innovators and a rapid change in product mix. Such examples are not restricted to the private sector only. The US Internal Revenue Service collected 33 percent more dollars from delinquent taxpayers with half of its former staff, and a third fewer branch offices after achieving major reductions in process cost or time, and improvements in quality and flexibility (Davenport, 1993).

Another branch of this literature discusses the innovative and productive effects of externalities created by clusters of immigrant groups with diverse backgrounds in particular regions (Ozgen et al., 2011; Niebuhr, 2010; Mazzolari and Neumark, 2009; Südekum, 2009). These analyses are mostly carried out at the regional level, and group immigrant populations into a number of sub-continental large area origins based on their place of birth/nationality. Hence, the major focus of the latter type of studies is the average effect of immigrant diversity on regional productivity or innovation.

On the innovation research side, the major methodological approach to analysing the innovativeness of firms has been through utilizing the knowledge production function (KPF) (Acs et al., 2002). This approach considers the number of R&D workers and the quantity of human capital generally (mostly accounted for by the educational attainment of the employees) as inputs into innovation, no matter what cultural background the workers have. The general KPF specification is as follows:

$$I_i = \alpha RD_i^{\beta} HK_i^{\gamma} \varepsilon_i,$$ (1)

Where the dependent variable *I* is the degree of innovative activity; the *RD* variable denotes all kinds of R&D inputs; and *HK* represents human capital inputs. The subscript *i* refers to the unit of observation, which is usually the firm or establishment.

However, the spatial dimension of innovation activity has led regional scientists to focus predominantly on the external forces and internal features of firms that stimulate innovations. Numerous studies scrutinize the significance of the external environment of a firm in terms of demand-supply links, industrial clusters, and diversity of production. The studies on the internal features of a firm emphasize the importance of a firm's resources for innovations, such as R&D expenditures and the presence of high-skilled workers. However, while the location of a firm matters in order to benefit from locally produced knowledge, the absorptive capacity of a firm is important to utilize this available information, as well as to improve it, and turn it into creative outputs (Cohen and Levinthal 1990; Caragliu and Nijkamp 2011). There are studies that focus on the role of inventors, and their networks, while taking inventors to be independent of the firms for which they work. These studies highlight the significance of spatial proximity, and knowledge exchange among diverse groups of inventors (e.g. Agrawal et al., 2008). In fact, very few studies undertake their analysis at the firm level, the smallest local production unit, where the transfer of tacit knowledge is most likely to take place.

Innovation is a major motivation for firms, since the possibility to invent 'things' with economic value provides monopoly rents to the firm. To increase the chance of innovating, firms need a more heterogeneous workforce to sustain diversified knowledge. As would be expected, the compositional structure of a firm is determined by the type of production and activities. For instance, if the firm comprises of various sub-units, and require good understanding and cooperation between these units, then this firm will be more concerned about the transferability of the knowledge across these units, rather than diversity (Prat, 2002). Therefore, it is important to control for firm structure when considering the innovation behaviour of firms in different sectors.

The firm is an important component of knowledge exchange, but knowledge accumulation that provides an input to innovation may appear within and outside the firm. For instance, the firms' investments in R&D, and machinery, and other fixed capital assets are examples of such internal inputs. However, firms can also import new knowledge via employing "talent" that already embodies such knowledge. Some firms are more likely to hire a foreign workforce, for example because they produce a wide range of products and services or because they sell to a wide range of countries (multinationals like Google are a perfect example). Alternatively, for many sectors spatial proximity provides a critical mechanism through which knowledge flows may take place. Hence, firms may enjoy the presence of cumulative knowledge that is present in their vicinity, and this knowledge may be enhanced by a diverse community.

3. Description of the Unique Dataset

This research analyses those Dutch firms which have responded to the Community Innovation Survey in the 2000-2002 period in the Netherlands, and specifically focuses on the effect of varying employee characteristics in addition to other determinants of innovation in these firms. For this purpose, several micro datasets are combined to create the Master dataset. All of the micro-datasets are obtained from Statistics Netherlands under a confidentiality agreement.[2] Combining these micro-datasets made it possible to identify the employees, on the one hand, by workplace (firm), job mobility, and industry/sector and, on the other hand, by various socio-economic and background characteristics. The firm is our unit of observation. Statistics Netherlands defines a firm as "a company with autonomous production and decision features, while there is a strong outward orientation" (Statistics Netherlands, 2009).

The micro-data sets that are used to create our Master dataset are as follows: (i) the Social Statistics Database (Sociaal Statistisch Bestand) that is composed of tax data (REOS) and Dutch municipality registrations (GBA); (ii) the Community Innovation Survey (CIS); (iii) the Dutch Labour Force Survey (EBB). Detailed information about these data sets is given in the Data Appendix.

By using this available information, we created a Master dataset in which we could identify firm-level information of the employees, their ethnic origin and location at the municipality level, while we also have extensive knowledge about the firms' fixed capital assets, and innovative resources/potentials. The Master dataset is created in three steps. Firstly, CIS is merged with REOS to identify the number of employees per firm by using firm ID as a key variable. Secondly, we merged this new data set with the municipality registrations, from which we obtain the birthplaces, and various other features of employees. Finally, because none of these data sets include information on the occupation and professional background of employees, the CIS_REOS data set is merged with the labour force survey EBB to retrieve skills information. However, this step reduces the data set from a census of firms to a survey of employees in Dutch firms. As a result of this final merge, 45 percent of the firms that are in the CIS

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[2] Access to the data is restricted to certain locations and data terminals.

2002 (referred to as CIS 3.5) version remain included in the Master dataset. This process of merging data sources is further detailed in Table 1.

Table 1 about here

Employees who are under 18 years old, and those who earn less than €10 a month are excluded from the database. The REOS database reveals information about people who were active in the labour market on 31 December 2000. They are assigned to the firm they worked for on that date, irrespective of when they started to work in that firm, or if they changed jobs subsequently. If the worker was observed in the dataset multiple times (multiple job), the job with the longest job spell was selected. Personal characteristics (age, marital status, citizenship, etc.) are those corresponding with the most recent residential location (in 2000), and each individual is counted only once. The data on personal characteristics were obtained from the municipality registrations (GBA). If an employee changed address more than once in one year, the most recent location defined the household address. The same methodology was applied to the observations from the EBB survey.

Since foreign employees are central to our analysis, a clear definition of foreigners is essential. During the life course, an employee may move from one country to another and obtain a second citizenship, or change citizenship. Moreover, countries may categorize non-natives in different ways. The Kingdom Act on Dutch Nationality identifies a Dutchman according to his parents' birthplace and/or the individual's birthplace. Thus, a person in The Netherlands is called 'allochtoon' if at least one parent was born abroad and/or that person was born abroad. The number of 'foreigners' clearly depends on the chosen definition. We use for non-native Dutch employees their country of birth as an exogenous indicator of cultural or ethnic identity, while we also observe acquired Dutch citizenship and time spent in the host country. In addition, we are able to identify non-native Dutch employees by their current citizenship, as well as their parents' place of birth, which we name "employee origin". Any employee who *was not* born in the Netherlands is referred to as a foreign employee in our analyses.

4. Methodology

In this section, we briefly explain the techniques used by the Statistics Netherlands to sample firms in the CIS 3.5 from the population of firms. Moreover, we provide details of how the sample was modified. Finally, we describe the econometric modelling methodology used.

To create the sample used for the CIS 3.5, firms were selected from the General Business Register (ABR) maintained at Statistics Netherlands. Only firms with SBI (business activity code) 1 through 74, 90, 92 and 93 were included. The excluded codes refer mainly to public-sector and NGO-type of activities. A further selection was made based on firm size. Firms employing less than 10 persons were not included in the sample. Firms employing more than 50 persons were all included in the sample. For firms employing 10 to 50 persons, only a fraction was randomly selected into the sample. The size of this fraction depends on

the SBI code and firm size. After the survey, a weighting factor is calculated per stratum. A stratum is defined on the basis of two indicators: namely the 2-digit SBI and firm size.[3]

To estimate the impact of foreign workers on firms' innovations we utilize a binomial logit model of the data in the constructed cross-sectional sample for 2000-2002. In our model the probability that a firm reports any innovation is a function of various firm characteristics as well as employee characteristics (summary statistics are given in Table 3). The dependent variable takes the value of 1 when the firm is an innovator and 0 otherwise. The CIS survey provides information on innovation generally, but also sub-categories of innovation (product and process innovations). Hence we will estimation logit regression models for three different innovation categories (innovations in general; product innovations; and process innovations). The econometric specification we estimate is as follows:

$$Pr\ (Innovate)_i = f\ (Firms\ characteristics,\ Employee\ characteristics)_i + \varepsilon_i, \qquad (2)$$

where the dependent variable is one of the three innovation types mentioned above, and i stands for a firm, i= 1,2,…..N. The independent variables include firm size, firms' fixed capital resources, organizational changes made in the last two years, human capital stock, and a set of other variables on foreign employees. The firms are more likely to employ foreign workers if they are more export-oriented and internationally connected. We control for the international orientation of firms by adding the location of the firm's headquarters into the econometric modelling. Moreover, 22 macro-sector fixed effects account for sector-specific shocks and unobserved heterogeneity.[4]

Cooperation for innovation is an important source of knowledge acquisition of firms. Therefore, we estimate the effect of international and domestic cooperation on firm-level innovation. We utilize the reported obstacles to the innovation process to account for the availability of innovation inputs.[5] Hence, we take account of whether a firm reports a lack of good personnel or technology as a constraint to innovation. Long-term planning of a knowledge acquisition strategy is an important factor for the success of innovation activity. We include knowledge acquisition strategy planning as another control factor in our estimations.[6]

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[3] To correct for a possible sample selection issue, we reweight all of our observations by using the total sum of weights for each stratum in the CIS 3.5 based on the two criteria given in the text. Therefore, it is possible to compare the distribution of firms in our sample with that of the population. This exercise reveals that our estimations are based on a sample in which firms with more than 50 employees are somewhat overrepresented, and those with less than 50 employees are fairly underrespresented. For that reason, the results are more representative of the impact of foreigners on large firms, rather than capturing their impact on small firms. Additionally, non-responses are treated as an absence of innovation. This imputation makes little difference.

[4] 2-digit sector codes are adjusted to the Standard Industrial Classification (SIC).

[5] Other input variables, such as total R&D expenditures, predict innovation activity perfectly. In other words, in our sample, all firms that reported R&D expenditures between 2000-2002 were innovative.

[6] The detailed description of the variables used in the estimations is given in Table A.1 in the Data Appendix.

The employee features considered in the analysis include the ethnic, demographic and occupational characteristics of the workers. The age composition of a firm's workforce, measured by the shares of specific age groups in total employment, is used to test whether more youthful firms are more innovative (e.g. Poot, 2008). Similarly, the shares of various skill categories in total employment are used to test the impact of skills on innovation. We use the ratio of the number of foreigners to the total number of employees per firm as an indicator of the firm's overall ethnic structure. Additionally, we complement this 'share of foreigners' measure with measures of diversity, in which the country of birth composition is more explicitly taken into account.

The impact of diversity within firms is an important aspect of our analysis. The literature suggests various diversity measurements. The selection of a diversity measure depends on the research question and the nature of the data. Our main measure is a diversity index which is referred to as the fractionalization index by Alesina et al. (2003). This index accounts for the share of various groups of foreigners in the firm's employment. We exclude the native population from calculating the diversity index, i.e. the measure reflects diversity *among* immigrant employees, not *between* the native born and immigrants. If natives are included in the measure, the diversity index is in practice (given that in most cases the native born account for 80 to 90 percent of employment) highly correlated with the share of migrants in total employment. However, the diversity among migrants index and the share of migrants in total employment are only weakly correlated (see also Ozgen et al., 2011). The index is calculated as follows:[7]

$$Div_i = 1 - \sum_{j=1}^{N} s_{ji}^2 , \qquad\qquad (3)$$

in which s_{ij} is the share of the group j ($j=1, ..., N$) in employment of firm i. The diversity of a firm increases with an increasing value of the index. The index value can range between 0 (all migrants originate from the same country) and 1-1/N (there are an equal number of migrants from each of all N countries).

The innovativeness of a firm may also be influenced by a different form of diversity: that is to say, not a unique composition of employment, but simply the maximum variety of people present. If one considers that each country has its own distinct features, the way people think, act, and work will vary with the number of countries represented in each firm. Therefore, a simple count of the unique number of countries of birth represented in each firm might be an alternative measure of diversity at the firm level:

$$Unique_i = \sum_{j}^{N} U_{ji} \qquad\qquad (4)$$

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[7] The diversity index is also sensitive to the presence of dominant migrant groups among all foreign born. Consequently, we measure the diversity index by dividing the world into 6 supra-national regions: EU15, other European countries, North America, South-east Asia, East Asia and Oceania, Rest of the world. Hence N is 6 in equation (3), but about 200 in equation (4).

in which U_{ji} is a dummy variable that is equal to one when country j is represented in firm i and zero otherwise. The value of *Unique* increases with the increasing number of countries represented in each firm. Its value ranges between 1 and N.[8] The value 1 means that the firm is solely composed of Netherlands born workers.

5. Descriptive Statistics

Description of Firms

Our dataset consists of 4638 firms out of the 10,533 firms surveyed in CIS 3.5 over the period 2000-2002. As mentioned before, the main reason why the dataset only captures 44 percent of the number of CIS 3.5 firms is due to the merging of the dataset with the Dutch Labour Force Survey; but this was the only way to obtain the occupation of the employees.[9] The total number of employees in the dataset is 1.3 million (about 10 percent of the active working population) and total number of foreign employees is 187,277 (about 13 percent of the employees in the sample). 50 percent of firms have 100 employees or more (see Figure 1).

Figure 1 about here

Manufacturing accounts for 31 percent of the firms (Macro-sectors 2 to 8, see Table 2) and 55 percent are in the services sector. The most common macro-sector is Wholesale Trade and Repair (15 percent of firms), followed by Other Business Services (14 percent) and construction (11 percent). Many of these firms are located in the large agglomerations of the country. The primary agglomeration is the 'Randstad' region.[10] Besides Randstad, there are two other large clusters of firms: in the South-east, the s'-Hertogenbosch-Maastricht corridor, and in the North-east around Groningen. Summary statistics on the firms and their employees are given in Table 3.

Table 2 about here

The CIS survey recorded 3 types of innovations: a) product/services innovations, b) process innovations, and c) marketing innovations. Deleting some firms with missing information, 38 percent of the remaining 4582 firms innovate with respect to at least one of these categories. If a firm is innovating in one of these categories, it is often active in the other categories as well. Overall, 28 percent of firms report new product or services innovations and 21 percent report new process innovations. The five most innovative

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[8] The number of countries of birth represented in a firm varies between 1 (Netherlands only) and 197. The average is ten countries.

[9] Given that the Labour Force Survey is a representative random sample of the Dutch workers, the final dataset is broadly representative of Dutch firms (with 10 or more employees) as well.

[10] The Randstad region is a large conurbation which is composed of four major Dutch cities (Amsterdam, Rotterdam, The Hague, and Utrecht) and their hinterlands. The region generates 46 percent of the total GDP and houses 41 percent of the population in the Netherlands.

sectors in the dataset are Research and Development; Machinery and Equipment; Electricity, Gas and Water, Chemicals; and, finally, Computer and related activities.

Table 3 about here

Multi-national firms are more likely to employ foreign workers, and larger firms are more innovative than small firms. In our dataset 83 percent of the firms' headquarters are in the Netherlands, while the rest are predominantly in neighbouring countries such as the UK, Germany, and France. Obviously, some sectors are more likely to operate internationally than others. The largest number of firms with headquarters abroad can be found in the Mining and Quarrying, Chemicals, and Machinery and Equipment sectors, in that order.

The survey provided also information on whether the firms cooperated with one or more partners in the product or process development stages. About 17 percent of all firms (or 44 percent of firms that are innovators) reported such cooperation and most of these firms cooperated with domestic partners (enterprises, universities, semi-public or semi-private institutions, suppliers and consultants). Another important pillar of the innovation process is the availability of R&D inputs. Not all firms employ R&D researchers or have R&D expenditures. Only 31 percent of firms reported the presence of R&D personnel (researchers with or without a PhD, and research assistants). On average, firms employ close to 300 employees among which 23 R&D personnel. The variable total R&D expenditure is a perfect predictor of whether a firm is an innovator or not. All firms with zero R&D expenditure are not innovating while those with positive R&D expenditure are. Consequently, the R&D variable cannot be used as an explanatory variable in a model that tests the impact of the presence of migrants on the likelihood that the firm reported to be innovative.

Description of Foreigners

As noted earlier, a foreigner is defined as a person who was born outside the Netherlands. The total number of foreign employees in our data set is 187,277, which is approximately 13 percent of the total workforce of 1,362,139 employees (see Table 1). However, the occupation of only 15,453 employees (including 1373 foreigners) could be traced with the labour force survey EBB. As expected, most of the foreign employees are concentrated in the large firms in our sample.

About 17 percent of the foreign born originate from the EU 15, 6 percent from Central and Eastern European and Balkan countries, and 9 percent from South-East Asia. The three most commonly referred source countries of migrants in The Netherlands are Suriname (14 percent), Turkey (12 percent) and Morocco (10 percent) (see Figure 2). The Netherlands has a long tradition of attracting foreigners from its former colonies Indonesia and Suriname, from countries like Turkey and Morocco where the initial flows were initiated by the bilateral guest worker agreements and, moreover, from Eastern European countries. The European continent experienced highly transformative political events in the 1990s, just a decade before our period of analysis. These included the fall of the Iron Curtain, the unification of East

and West Germany, as well as prolonged wars in the Balkan area. These events created substantial migration flows in an East-West direction, although recent statistics suggest that not all of these migrants became permanent settlers. Notwithstanding that, these events would have had an impact on the composition of our sample.

Figure 2 about here

In general, the foreign born in the Netherlands are relatively young and low-skilled. 53 percent of the foreigners are less than 35 years old, while 80 percent of them are less than 45 years old (for all employees the corresponding percentages are 45 and 72 respectively, see Table 3). These values are substantially higher than those of the natives in the corresponding categories. Many of the foreign employees are working in low-skilled jobs in the Other Business Services, Retail Trade and Wholesale Trade and Repair sectors. Common jobs include secretarial, agricultural, and cleaning services. Compared with the natives, the foreigners are mainly employed in the large companies with more than 250 employees.

6. Results of Multivariate Analysis

Logit regression Analysis

This section presents the results of the multivariate analysis. First, we show the results for the full sample. We also discuss the effects of various employee diversity measures on the different innovation categories. Subsequently, we re-estimate the regressions models with a sub-sample that excludes the sectors that employ most of the unskilled immigrants (Other Business Services and Retail Trade). Finally, we account by means of instrumental variables estimation for the endogeneity and bias due to the self-selection of foreigners to particular firms.[11]

Logit models estimated with the full sample are reported in Table 4. The first column reports the results for firms reporting innovation activity generally, the second column refers to product innovation and the third column to process innovation. In accordance with the literature, we find that firm size is an important determinant of the innovativeness of the firms. Larger firms have more resources for innovation, and perhaps have a greater ability to appropriate returns to their innovation efforts. Cooperation for innovation has also a positive effect on product and process innovations.[12] The impact of whether the firm is part of a group or has its headquarters abroad is statistically less conclusive. The firm being part of a group is significantly positive in product innovation, whereas having headquarters abroad positively impacts on process innovation.

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[11] All the estimations are carried out with Stata 11.

[12] All firms cooperating for innovation were innovative. The variable therefore dropped out of the first regression. It is also possible to distinguish between cooperation domestically and internationally. However, the correlation between these two variables is high. The simple correlation coefficient is 0.7.

Table 4 about here

In all three logit models, the openness of the firm to change its organizational structure appears to be a very positive and strong indicator of innovation. The effect is significant at the 1 percent level. Although it may sound counterintuitive, lack of personnel or technology are also shown to boost firms' innovativeness generally. Firms suffering from lack of personnel and technology are forced to innovate by circumstances. A lack of personal is also positively associated with product and process innovations. This is not the case with a lack of technology. Finally, the firms that have a prepared knowledge acquisition strategy for the present or for the coming two years are significantly more likely to innovate. The effect of a prepared knowledge strategy is statistically significant and positive at the 1 percent level.

All equations include sector dummies. As expected, some sectors are more prone to innovate compared with others. The coefficients of sector fixed-effects (not included in Table 4) show that the sectors Wood, Paper and Pulp; Chemicals; Metals; and Machinery and Equipment have a higher probability to innovate than the reference category Agriculture, Forestry and Fishery. Labour intensive sectors, such as Wholesale Trade and Repair; Retail Trade; and Hotels and Restaurants, are less likely to innovate.

Moving on to the employee variables, the skill level of employees appears to be an important determinant of innovation overall. In particular, the medium and highly-skilled workforce has a positive and significant effect on product innovations at, respectively the 5 and 1 percent levels. However, we did not find any statistically significant effect of skill categories on the process innovations. On the other hand, the results based on the age composition of the employees of the firm show that a more youthful workforce generates more innovation. Among the four age categories included in the regressions[13], the age groups 25-34 and 35-44 turn out to have a very considerable effect on all innovation categories. Interestingly, a statistically significant positive effect is also found for employees aged 55-64 in the case of innovativeness as a whole. However, the coefficient is smaller than the corresponding coefficients for employees aged 25-34 or 35-44.

Table 4 shows that a greater share of foreigners in employment is associated with lower innovation as a whole. This result was also found in Ozgen et al. (2011) for aggregate data at the NUTS 2 level. Brunow et al. (2011) found a similar effect with respect to firm productivity, using micro-level firm data from Germany. The negative effect of a relatively larger share of foreigners in overall employment is plausible when one considers that the reservation wages of the migrant workers are likely to be lower than those of the native born population. Consequently, by recruiting more foreign workers, firms lower the cost of labour relative to capital. This induces more labour-intensive production, which is less likely to be encouraging innovation than capital-intensive production technologies.

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[13] Employees aged 18-24 is the reference category.

However, the benefit from migration for innovativeness of the firm may come from the diversity of the foreign workforce. This effect is tested by adding diversity measures to the logit regressions that are reported in Table 4. The results are in Table 5. The first measure we use is the natural logarithm of a measure called 'unique', which stands for the total number of unique birthplaces of foreigners for each firm, and which was explained in Section 4. The idea behind this measure is that every country has its own way of functioning, thinking, and performing; therefore, an employee composition based on a variety of birthplaces should induce new ideas and heterogeneous perspectives into a firm. However, we find that for innovations as a whole, and also for product and process innovations, an increasing number of birthplaces does not have a statistically significant effect on the probability to innovate for firms.

Table 5 about here

The second measure of diversity we utilize is what is called the diversity index as defined in equation (3) in Section 4. The index excludes the native born, and, therefore, signals diversity among the migrant population. This is quite a different way of measuring diversity than counting the number of countries of birth present in the firm, but the two measures are nonetheless correlated: the correlation coefficient of the natural logarithm of the number of birthplaces represented in the firm and the diversity index is 0.75. We find that the diversity index has a positive effect on the likelihood of product innovations that is statistically significant at the 5 percent level. The effect is inconclusive for innovations as a whole and process innovations.

Robustness Checks

We re-estimate the models with a sub-sample that excludes the two sectors that recruit predominantly unskilled immigrants: Other Business Services and Retail Trade. The purpose of this is to check whether the impact of the presence of foreigners and the impact of diversity among the foreigners are different in sectors that do not employ predominantly unskilled migrants. The sub-sample consists of 3645 firms. The results are reported in Table 6. Many firm and worker characteristics that have a statistically significant and positive effect on the firms' probability to innovate are also valid for the sub-sample; namely, product/services, and process innovations. Firm size, cooperation for innovation, openness to change, lack of personnel, and prepared knowledge strategy all prove to be important inputs for innovation. All these variables are positive and significant at the 1 percent level. Additionally, having headquarters abroad is now also significant for product innovation, but only at the 10 percent level.

Table 6 about here

Interestingly, while Table 4 suggested that the share of foreign employees in total employment has a negative effect on the innovativeness of firms in the Netherlands, when a sub-sample is taken from the dataset, the impact of the share of foreigners becomes statistically insignificant for innovations as a

whole, and product innovations. However, the same coefficient becomes positive and significant at the 1 percent level for process innovations.

With respect to the different skill and age categories, the results are somewhat different from those in Table 6. The fraction of scientifically-skilled employees is no longer significant for innovation as a whole. Similarly, while the share of employees aged 35-44 is still statistically significant in all three columns, the age group 25-34 is no longer statistically significant in product and process innovations. The share of high-skilled employees in overall employment level proves to be an important determinant of product innovations. However, the skill categories do not have an effect on process innovations. This result is consistent with all the other estimations, and rather plausible, since it could be argued that product innovations require more technical and scientific knowledge compared with process innovations.[14]

Our results reconfirm that younger employees make a positive contribution to innovation generally. Employees between ages the 25-34 and 35-44 are shown to improve the likelihood of a firm to innovate, although the effect of the former group is not statistically significant for product and process innovations. On the other hand, the share of employees aged 45-54 has a negative and statistically significant coefficient for innovations as a whole and process for innovations. This reinforces the expectation that more youthful firms tend to be more innovative (see also Poot 2008).

With respect to the migration related variables, the share of foreigners is now positive and statistically significant only in the case of process innovations. Moreover, diversity as measured by the natural logarithm of the number of countries represented in the firm has a statistically significant positive impact on process innovation (but only at the 10 percent level). This can be seen in Table 7. Similarly, the effect of within-firm labour diversity among migrants on product innovations is again positive and statistically significant at the 5 percent level.[15] Hence, we conclude that, concerning the process innovations, every different culture counts as a positive input, while for product innovation a unique combination of these different cultures are more relevant in boosting innovativeness. Finally, we also consider a potential interaction between firm size and the migration variables to test whether the impact of the presence, and diversity of immigrants differs between large firms and small firms. It was found that the interaction between the share of foreigners and the natural logarithm of firm size is statistically insignificant.

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[14] We show in other regressions, not included due to space constraints, that the effect of high-skilled *foreign employees* (quality of foreign stock at the firm level) on innovativeness is inconclusive on firm level innovativeness. Moreover, the entry year of foreigners does not have an effect on their contribution to innovation. The coefficient of time spent in the Netherlands is statistically insignificant. Many immigrants enter the host country at a young age, and therefore, the age variables might have captured the effect of time spent at the destination. These results are available on request.

[15] If these two variables are included at the same time in the three estimations in Table 7, the coefficients of the unique variable and the diversity index are both insignificant for innovations as a whole and for product innovations. Only for process innovations, the natural logarithm of the number of birthplaces has a coefficient of 0.306 which is statistically significant at the 5 percent level; whereas the coefficient of diversity index is -0.582, which is also statistically significant at the 5 percent level.

However, the interaction between the diversity index and the log of firm size has a negative coefficient that is statistically significant at the 5 percent level for product innovations only.

Table 7 about here

Treating Endogeneity Issues

The self-selection of immigrants into the more innovative firms, that perhaps pay better or offer better career opportunities, can introduce a biased estimation of the relationship between innovativeness and the foreign employees. To control for the possible bias, we apply a two-stage least squares estimation, where we employ a couple of instruments to treat the endogeneity of the share of foreigners.

The literature suggests the past stock of immigrants should be used to account for the current stock, arguing that the economic conditions that attracted the earlier immigrants would not be same as today. On the other hand, it is widely accepted that new immigrants follow "well trodden paths" in terms of their location preferences. Consequently, we use the number of allochtoon population by municipalities in 1996 as the first instrument. That year is the earliest date for which the allochtoon population of the Netherlands can be disaggregated to the municipal level.

Secondly, the concentration of foreigners in certain localities may create demand for "home goods". The migrants can import these products themselves or start producing them in the host country, for example, by opening restaurants and shops specialized in ethnic cuisines. Although one may argue that the native population will increasingly demand the same goods due to the demonstration effect, the presence of such products and services is an externality resulting from the concentration of foreigners in a certain region. However, at the firm level there is no reason to expect that the innovativeness of firms determines the location of restaurants offering foreign cuisine. We will, therefore, use the total number of foreign restaurants per municipality in the year 2000 as an indication of the localization of immigrant groups. If the total number of foreign restaurants in a region is relatively high, then the number of foreigners is expected to be high as well. The dataset comes from the HORECA database in the Netherlands, and was made available at no cost.[16]

Together, the two instruments passed the formal exogeneity test, and turn out to to be strong instruments with *t*-values equal and higher than 4.8 (i.e. F values greater than 10). Two instruments together explain about 8 percent of the variation in share of foreigners, and they have no correlation with any of the dependent variables that are the innovation categories.

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[16] HORECA is an acronym for Hotels, Restaurants and Cafes. This dataset covers the registered bars, restaurants, hotels and all the other businesses in this sector. The data coverage is good. The data are currently available from 1995 until 2007. The number of foreign restaurants is counted at the municipal level by the nationality of the cuisine, at the time of registry. For each restaurant, the main topographical area is registered; therefore no side kitchens are registered. This leads to unique listing, and excludes double counting.

Table 8 presents the results of instrumental variables estimations. The IV estimations include again all the previous control variables. We include both the diversity index and the share of foreign born employees. The IV estimation shows that, as in Table 4, the sheer share of foreigners is not a beneficial input that increases the firms' probability to innovate. The coefficient of share of foreigners is negative, and statistically significant for innovations as a whole and product innovations. The other covariates included in all of the estimations are quite robust to previous findings. However, within firm diversity of foreign employment impacts always positively and is significant at the 5 percent level for innovations as a whole and 1 percent for product innovations.

Given the non-linear nature of the probability model, we calculate the magnitude of changes in the probabilities by plugging in two values that are equally distant from the mean of share of foreigners as well as the mean of the diversity index. For example, the probability to innovate products rises by 4 percentage points, as a result of going from 0.1 below the mean (0.45) of the index to going to 0.1 above the mean, holding all other variables at their means. For innovations as a whole, the corresponding increase is 3 percentage points.[17] On the other hand, when the share of foreigners in the firm's employment goes from a 1 percentage point decrease to a 1 percentage point increase from its mean of 0.1, the predicted probability to innovate products and innovate overall decreases by 2.4 and 2.6 percentage points respectively. Overall, we observe that when foreigners account for a large share of employment, a firm is less likely to report innovative activities, but the effect is quantitatively small. However, diversity among these foreign workers is a very significant booster of innovation.[18]

Table 8 about here

7. Conclusion

In this paper we have focussed on estimating the impact of immigrant employees on the innovativeness of Dutch firms. The core data on innovation were obtained from the Community Innovation Survey (CIS) of 2002. However, this survey provides little information on the size and composition of the workforce of the firms. Such information was obtained by linking the CIS with administrative data; namely, the Social

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[17] Ozgen et al. (2011), by using a panel data of 170 NUTS 2 level in twelve European countries, showed that a 0.2 increase around the mean of the diversity index (0.49) increases the regional patent applications by about 4 percent. Here we find that the same increase in the diversity index at the mean increases the probability of all innovation and product innovation by 3 and 4 percentage points respectively.

[18] We also predicted the interaction effects between the diversity of the workforce and the share of foreigners in employment. The interaction effects are statistically inconclusive, while the positive and significant impact of workforce diversity persists for product innovations. Moreover, the negative effect of share of foreigners persists as well. The instrumental variables interaction effects are calculated by means Stata, whereby in the first stage the endogenous variable is regressed on all the covariates and instruments; and in the second stage, the predicted value of the endogenous variable is used to create the interaction term, and then included in the logit estimation.

Statistics Database, which – in turn – is made up of tax data, and population registration data at the municipality level. However, while this linked dataset provided measures of the presence and diversity of migrants, it provided no direct information on the skill level of the migrants. The latter was obtained by linking the data to the Dutch Labour Force Survey (EBB). Because the EBB is a representative sample survey, but not a census, many observations are lost in the linking process. Ultimately, the analysis had to be restricted to a sample of 4582 firms, employing around 1.3 million workers (and around 15000 workers with known occupations) of whom about 13 percent are foreign born.

The results of the regression analysis confirm many of the determinants of innovation that have been found repeatedly in previous studies. Larger firms are more innovative. This is true in general, but also specifically with respect to product innovations and process innovations. Firms that are more open to change provide a business environment that nurtures creativeness, and that is more conducive to innovation. However, on the other hand, obstacles to business expansion and profitability also force firms to seek solutions by means of innovative business practices. Such obstacles can be either a lack of personnel or a lack of technical know-how. Those businesses that explicitly develop a knowledge strategy are those that reap the fruits in terms of implementing new product and process innovations. The regressions showed that such activity requires the relative abundance of medium and high-skilled employees. In terms of age composition, a relative abundance of employees aged 35-44 boosts innovativeness, but, intriguingly, an older workforce, particularly in terms of staff aged 45-54, is an impediment to innovation.

All these factors that determine innovation do not refer specifically to the role of migrants in the workplace. However, given that migration is highly age-selective, with the majority of adult migrants being aged between 25 and 45, the results do suggest that firms employing migrants have a more youthful workforce. The regression results show that this contributes to better outcomes with respect to innovation.

However, the main purpose of the paper was to investigate whether the explicit presence and diversity of migrants boosts the innovativeness of firms. Generally speaking, a larger share of foreigners among a firm's employees lowers the innovativeness of firms. Only in a sub-sample of firms that excluded other business services and retail trade (the two sectors in which immigrants are the most unskilled) do we find a positive effect of an increasing presence of foreign workers on process innovations, significant at the 1 percent level. This is only the case, however, when there is no control for reverse causality, i.e. the fact that the most innovative firms may be more inclined to recruit workers from a wider labour market, including those born overseas. Once endogeneity is controlled for by means of valid instruments (the number of foreign restaurants per municipality, and the historical presence of migrant communities in the municipality), the impact of the share of foreign workers on the firm's workforce becomes negative and statistically significant. This finding is, of course, consistent with neoclassical economic theory: when there is an abundance of migrant workers with lower reservation wages, firms will develop expansion strategies that involve the use of labour-intensive production technologies. These technologies tend to be

older and well-established. Following existing blueprints for production will imply that fewer resources will be devoted to innovation.

On the other hand, there is some evidence that greater diversity among the foreign workers stimulates product or process innovations. Intriguingly, the results are sensitive to the measurement of diversity. A simple measure of the unique number of foreign countries of birth represented among the firm's staff, assumed to be exogenous to the innovation outcomes, has a positive impact on process innovations (at the 10 percent significance level), but has no impact on product innovations. Conversely, our diversity index, the opposite of the Herfindahl index of concentration, is with IV estimation positively associated with innovations generally as well as with product innovations, but not with process innovations. Given the ever-increasing ease of accessibility to the micro-data in various countries, further research is encouraged to disentangle the components of diversity measures and the role of migrants in the innovation process to uncover the causes of this difference.

One of the major limitations of the present study was the small sample size that resulted from the merging of the firms surveyed in the CIS with the employees surveyed in the Dutch Labour Force Survey. To overcome this problem, it may be more fruitful to identify additional migrant characteristics from only the administrative data. Moreover, since the CIS is conducted every two years a panel data set may also be constructed. This would allow accounting for firm heterogeneity and an alternative means of establishing causal relationship. These ideas, and the exploration of a wider range of measures of diversity, are the objective of our future research.

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Data Appendix

Social Statistics Survey

The unit records of the Social Statistics Survey database are very detailed and informative about 10 million jobs per year (a job is a matched combination of employer/business entity data with employee data and recorded start/end date, if applicable). The job data include the location of residence and work of an employee, information on the labour market and income level. In the case of a non-native employee, we are informed about the year of entry in the Netherlands. Municipality registrations (GBA) are a natural extension of the Social Statistics Survey provided by Statistics Netherlands, and allow us to calculate the exact number of employees per firm at the municipal level, when combined with the tax data (REOS).

Community Innovation Survey

The Community Innovation Survey (CIS) is conducted every two years (in even years). Sets of micro-data available cover the decade 1996 to 2006. To create the sample used for the CIS 3.5, enterprises were selected from the Business Registers maintained at Statistics Netherlands. The sample selection was described in the Methodology section of this paper. CIS provides extensive information on the innovating activities of firms in the Netherlands; and their resources, and motivations and problems. In this study we use the CIS 3.5 version, in other words, the survey conducted in the period 2000-2002, where the final reporting year is 2002. This version of the survey includes 10533 firms. Each firm has a *firm identification number* 'BEID'. The continuity of surveys provides a regular snapshot of various aspects of innovation. It is not only informative about technological innovations on new products/services and goods, but also includes a certain amount of information on non-technological/business/organizational changes and newness. The survey allows us to classify firms by 5-digit 'SBI93' codes that stand for Standard Industrial Classification of Statistics Netherlands, and these codes are directly analogous with the 2-digit NACE codes. The survey in principle addresses the characteristics of the firms in terms 5 themes. These are:

1. General Business Information;
2. Product (Goods/Service) Innovation;
3. Process Innovation (new or significantly improved *methods* for the production or supply of products);
4. Innovation Related Activity (R&D, cooperation for innovation, marketing innovations);
5. Strategic Innovation (new management techniques, organisation structure, marketing concepts or strategies).

The questions that inquire about the innovativeness of the firms are measuring innovation as an activity rather than as an output (Godin, 2002). There are no particular questions regarding the number of inventions. However, the survey is informative about the ongoing innovation processes, cancellations, and reasons for cancellations, or postponed activities.

Table A.1: The description of the variables used in the estimations

Firm related variables	Description of the variables
Firm is an innovator in 2000-2002	A dummy variable equal to '1' if the firm reported any innovation in 2000-2002
Firm innovated new products in 2000-2002	A dummy variable equal to '1' if the firm innovated new products/services or significantly improved existing products/services in 2000-2002
Firm innovated new processes in 2000-2002	A dummy variable equal to '1' if the firm innovated new processes or significantly improved the existing processes in 2000-2002
Number of sampled employees per firm	Number of employees in a firm
Cooperation for innovation	A dummy variable equal to '1' if the firm has cooperated for innovation in 2000-2002
Firm is part of a group	A dummy variable equal to '1' if the firm is part of a company group
Headquarters is abroad	A dummy variable equal to '1' if the headquarters of a firm are located outside of the Netherlands
Openness to change	A dummy variable equal to '1' if the firm has applied organizational changes with respect to its operations in 2000-2002
Obstacles: Lack of personnel	A likert scale from 1-7; 0= no problem, 1=minor, and 7=severe: Lack of personnel has been reported as an obstacle to innovations of a firm in 2000-2002
Obstacles: Lack of technology	A likert scale from 1-7; 0= no problem, 1=minor, and 7=severe: Lack of technology has been reported as an obstacle to innovations of a firm in 2000-2002
Prepared knowledge strategy	A likert scale from 0-2; 0=No strategy, and 2=Firm has a strategy: Firm has prepared a knowledge management strategy in 2000-2002

Dutch Labour Force Survey

The Dutch labour force survey (EBB) is a *yearly* dataset with rotating panel data of the Dutch labour force. A single respondent in the panel is expected to be surveyed 5 times in total, over the course of 15 months. The survey has been conducted since 1996. Detailed socio-economic data on both individual and the household characteristics and characteristics of the current position in the labour market are collected. These data can be used to measure diversity in the Dutch labour market. The Labour Survey contains a variable called 'RIN' that stands for the *personal identification number* which allows researchers to combine various datasets such as the tax data extension of the Social Statistics Survey (REOS), Municipality registrations (GBA) by using this id. Therefore, the data can be linked to national data of regional economic growth and agglomeration. The survey includes fairly extensive number of questions in 28 categories on households as well as Dutch and foreign employees. Some of the modules in the EBB Overview are as follows: Household, Ethnicity, Birth country, Service (type of contract), Working hours, Commuting, Company, Job situation, Job searching, Trade Union, Education, Pension.
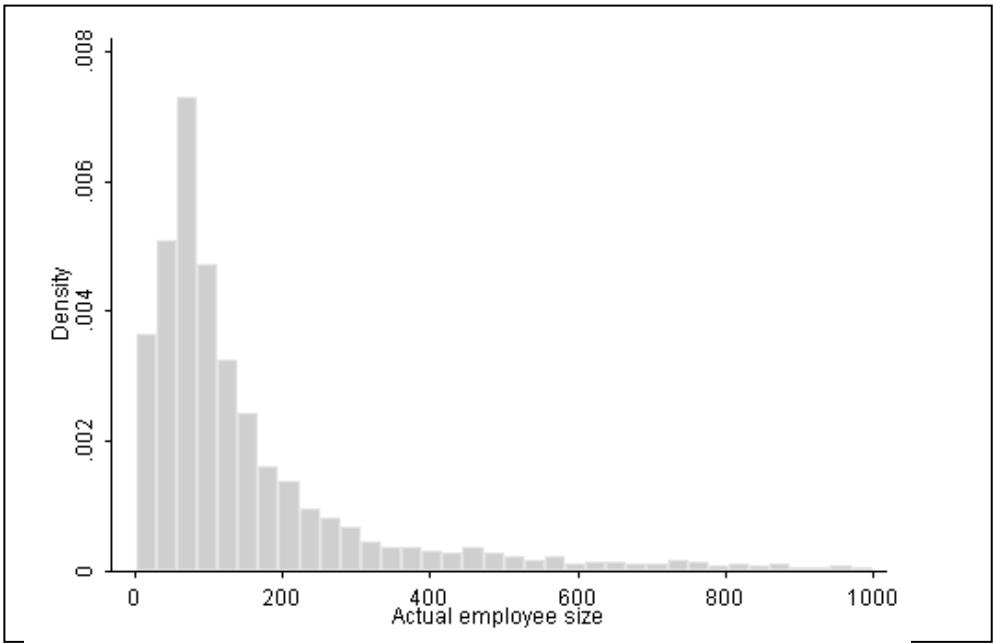
Figure 1: Histogram of the Firm Size Distribution
Note: Truncated to firms with 1000 employees or less. The largest firm in the full sample has 77,744 employees.
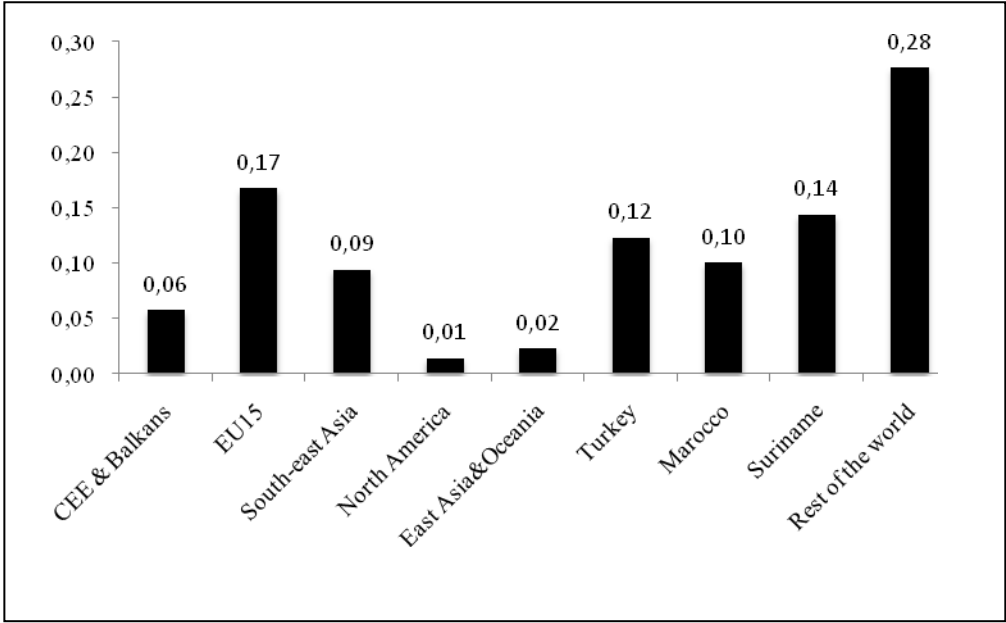

Figure 2: Distribution of Foreigners by Region of Birth

Table 1: The Stages of Data Merges and Number of Observations at Every Stage

Datasets	# of Employees	# of Firms	# of Foreign Employees
CIS 2002 (Version 2)[1]	NA	10533	NA
CIS_REOS_GBA	1603709	9687	217444
CIS_REOS_GBA_EBB	1362139	4638	187277
CIS_REOS_GBA_EBB with occupation identified	15453	4638	1373

[1] The response rate of firms in CIS 2000-2002 survey is 62%.

Table 2: The Distribution of Macro-sectors by the Number of Firms in the CIS_REOS_GBA_EBB dataset

Macrosectors	Sector Name	Number of firms	percent in Total Number of Firms
0	Agriculture, Forestry and Fishery*	78	0.02
1	Mining and Quarrying	12	0.00
2	Food, Beverage and Tobacco	181	0.04
3	Textile, Clothes and Leather	52	0.01
4	Wood, Paper and Pulp	204	0.04
5	Chemicals	277	0.06
6	Metals	223	0.05
7	Machinery and Equipment	376	0.08
8	Manufacturing n.e.c.	119	0.03
9	Electricity, Gas and Water	30	0.01
10	Construction	511	0.11
11	Wholesale Trade and Repair	693	0.15
12	Retail Trade	292	0.06
13	Hotels and Restaurants	123	0.03
14	Transport and Communication	398	0.09
15	Financial Intermediation	78	0.02
16	Real Estate and Renting of Machinery	115	0.02
17	Computer and Related	105	0.02
18	Research and Development	22	0.00
19	Other Business Services	655	0.14
20	Environmental Services	40	0.01
21	Other Services	54	0.01
	Total	4638	1.00

* This sector is the reference category in the multivariate analysis.

Table 3: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Firm is an innovator in 2000-2002	4582	0.3804	0.4855	0	1
Firm implemented product innovations in 2000-2002	4582	0.2828	0.4504	0	1
Firm implemented process innovations in 2000-2002	4582	0.2097	0.4072	0	1
Number of sampled employees per firm	4582	295.52	1751	2	77744
Cooperation for innovation	4582	0.1680	0.3739	0	1
The firm is part of a group	4582	0.6794	0.4668	0	1
Headquarters is in The Netherlands	4582	0.8320	0.3740	0	1
Openness to change	4582	0.1729	0.3782	0	1
Obstacles: Lack of personnel	4582	0.0949	0.5380	0	7
Obstacles: Lack of technology	4582	0.0746	0.4645	0	6
Prepared knowledge strategy	4582	0.7089	0.8404	0	2
Number of foreigners per firm	4582	40.59	351.91	0	15466
Share of foreigners in employment	4582	0.1024	0.1114	0	0.9091
Diversity index	4582	0.4477	0.2671	0	0.8125
Unique number of countries of birth in a firm	4582	10.19	12.91	1	197
Fraction of employees aged 18-24*	4582	0.1457	0.1413	0	0.9381
Fraction of employees aged 25-34	4582	0.3092	0.1186	0	0.7727
Fraction of employees aged 35-44	4582	0.2672	0.0888	0	0.6316
Fraction of employees aged 45-54	4582	0.1992	0.1010	0	0.6875
Fraction of employees aged 55-64	4582	0.0786	0.0639	0	0.6250
Fraction of low-skilled employees*	4582	0.3927	0.4226	0	1
Fraction of middle-skilled employees	4582	0.4155	0.4144	0	1
Fraction of high-skilled employees	4582	0.1417	0.2898	0	1
Fraction of scientific-skilled employees	4582	0.0438	0.1664	0	1
Allochtoon population in 1996 by municipality	4582	31487	68181	127	298256
Foreign restaurants by municipality	4582	60	142	0	726

* Reference categories in the multivariate analysis

Table 4: Multivariate Logit Analysis with Full Sample

Full- sample	innovative	product	process
Cooperation for innovation		2.592***	1.677***
		(0.120)	(0.102)
Log firm size	0.431***	0.138***	0.274***
	(0.0383)	(0.0438)	(0.0427)
Firm is part of a group	0.0177	0.233**	0.0483
	(0.0862)	(0.102)	(0.101)
Headquarters is abroad	-0.0559	0.184	0.226*
	(0.106)	(0.122)	(0.119)
Openness to change	1.120***	0.996***	0.816***
	(0.0990)	(0.108)	(0.103)
Obstacles: Lack of personnel	0.344***	0.251***	0.163**
	(0.0989)	(0.0918)	(0.0765)
Obstacles: Lack of technology	0.235**	0.123	-0.0412
	(0.105)	(0.103)	(0.0889)
Prepared knowledge strategy	0.454***	0.291***	0.246***
	(0.0468)	(0.0539)	(0.0538)
Share of foreigners in employment	-1.082***	-0.281	0.359
	(0.378)	(0.441)	(0.419)
Fraction of medium-skilled employees	0.149	0.294**	0.0392
	(0.104)	(0.123)	(0.123)
Fraction of high-skilled employees	0.406***	0.622***	0.136
	(0.141)	(0.161)	(0.165)
Fraction of scientific-skilled employees	0.638***	0.423	0.248
	(0.224)	(0.263)	(0.258)
Fraction of employees aged 25-34	2.518***	1.469**	1.297**
	(0.529)	(0.624)	(0.627)
Fraction of employees aged 35-44	3.867***	2.095***	1.789***
	(0.512)	(0.600)	(0.602)
Fraction of employees aged 45-54	-0.966	-0.303	-0.723
	(0.596)	(0.696)	(0.713)
Fraction of employees aged 55-64	2.499***	0.841	0.906
	(0.817)	(0.951)	(0.969)
Constant	-4.410***	-4.518***	-4.630***
	(0.480)	(0.584)	(0.577)
Sector Dummies	Yes	Yes	Yes
Observations	4582	4582	4582
Log-likelihood	-2209	-1741	-1765
LR Chi-square	1670	1976	1176
Pseudo R^2	0.274	0.362	0.250

Notes: Low skilled employees, and employees aged 18-24 are the reference categories in the above estimations. Cooperation variable predicts the success perfectly in column I and II, therefore the coefficients cannot be reported. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 5: Estimations with the Full Sample, including Diversity Measures

Full-sample[α]	innovative	product	process
ln(unique)	-0.054	0.045	0.048
	(0.066)	(0.078)	(0.08)
N	4582	4582	4582

	innovative	product	process
Diversity index (excl. Netherlands born)	0.266	0.417**	0.037
	(0.175)	(0.205)	(0.209)
N	4582	4582	4582

[α] These estimations include all the other variables in the Table 4. The results for these variables are robust to the introduction of the diversity measures. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Robustness Checks I - Multivariate Logit Analysis with Sub-Sample

Sub- sample[b]	innovative	product	process
Cooperation for innovation		2.375***	1.583***
		(0.128)	(0.111)
Log firm size	0.522***	0.169***	0.327***
	(0.0464)	(0.0511)	(0.0510)
Firm is part of a group	0.00841	0.148	0.0151
	(0.0974)	(0.111)	(0.112)
Headquarters is abroad	0.0594	0.217*	0.227*
	(0.115)	(0.128)	(0.125)
Openness to change	1.081***	0.939***	0.752***
	(0.112)	(0.118)	(0.113)
Obstacles: Lack of personnel	0.332***	0.317***	0.164**
	(0.107)	(0.103)	(0.0824)
Obstacles: Lack of technology	0.196*	0.107	-0.0702
	(0.114)	(0.112)	(0.0976)
Prepared knowledge strategy	0.456***	0.298***	0.241***
	(0.0523)	(0.0581)	(0.0587)
Share of foreigners in employment	0.0348	0.488	1.555***
	(0.450)	(0.502)	(0.489)
Fraction of medium-skilled employees	0.0603	0.265**	0.000
	(0.112)	(0.129)	(0.131)
Fraction of high-skilled employees	0.320**	0.570***	0.0921
	(0.158)	(0.175)	(0.182)
Fraction of scientific-skilled employees	0.387	0.214	-0.162
	(0.281)	(0.317)	(0.329)
Fraction of employees aged 25-34	1.668**	0.956	0.0802
	(0.663)	(0.754)	(0.777)
Fraction of employees aged 35-44	3.318***	1.682**	1.214*
	(0.605)	(0.688)	(0.704)
Fraction of employees aged 45-54	-2.007***	-1.209	-2.063**
	(0.699)	(0.797)	(0.834)
Fraction of employees aged 55-64	1.666*	0.527	0.308
	(0.917)	(1.041)	(1.075)
Constant	-4.284***	-4.137***	-4.062***
	(0.548)	(0.641)	(0.645)
Sector Dummies	Yes	Yes	Yes
Observations	3645	3645	3645
Log-likelihood	-1796	-1487	-1469
LR Chi-square	1365	1562	972.5
Pseudo R^2	0.275	0.334	0.249

Notes: Low-skilled employees, and employees aged 18-24 are the reference categories in the estimations above. [b] The sub-sample excludes the two sectors in which immigrants are the most unskilled. These are Other Business Services and Retail Trade. *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Robustness Checks II – Estimations with the Sub-Sample, including Diversity Measures

Sub-sample[α]	innovative	product	process
ln(unique)	0.07	0.137	0.170*
	(0.074)	(0.085)	(0.088)
N	3645	3645	3645
	innovative	product	process
Diversity index (excl. Netherlands born)	0.125	0.462**	-0.093
	(0.192)	(0.220)	(0.228)
N	3645	3645	3645

[α] These estimations include all the other variables in Table 6. The results for these variables are robust to the inclusion of the diversity measures. *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Instrumental Variables Estimations with Sub-Sample

IV Sub-sample[α]	innovative	product	process
Share of foreigners in employment	-2.945**	-2.991**	-1.902
	(1.018)	(1.117)	(1.159)
Diversity index (excl. Netherlands born)	0.414**	0.605***	0.175
	(0.159)	(0.171)	(0.181)
N	3645	3645	3645

[α] These estimations include all the other variables in Table 6. The results for these variables are robust to the introduction of instrumental variables. The share of foreigners is instrumented with the number of foreign restaurants and the natural logarithm of the allochtoon population in 1996. *** p<0.01, ** p<0.05, * p<0.1. The Wald test of exogeneity is rejected at least at the 5 percent level for all the reported estimations.