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FOREIGN WORKERS ARE ASSOCIATED WITH INNOVATION, BUT WHY?

INTERNATIONAL NETWORKS AS A MECHANISM

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Abstract

While there is a wealth of empirical research examining the potential effects of foreign workers, immigration and cultural diversity on wages, employment, economic growth and â?? in recent years â?? innovation, very little of this research has provided a convincing empirical demonstration of the mechanisms through which foreign workers would affect innovation.

Most accounts hypothesise that foreign workers provide a different perspective that contributes to a diversity of ideas in the firm, while some also add the idea that foreign workers might help a firm build international networks. Nonetheless, these mechanisms have for the most part remained entirely theoretical, with few attempts being made at uncovering the intermediary relationships. This paper contributes to filling this gap by focusing on the second of these mechanisms, asking whether firms which employ foreign workers also have broader international networks and whether this may, in turn, promote innovation.

The relationship between foreign workers and innovation has been a hot topic in the literature in recent years, as growing international mobility is making firms and regions more diverse. This diversity is thought to promote new ideas and perspectives (Ottaviano and Peri, 2006; Nathan and Lee, 2013), but also potentially to increase conflicts and reduce trust (Jehn et al, 1999; Bandiera et al, 2005). Previous studies have addressed this issue at various scales, from work groups (Chatman and Flynn, 2001; Joshi and Roh, 2009) via firms (Lee and Nathan, 2010; Ã?stergaard et al, 2011) to regions (Niebuhr, 2010; Kemeny, 2012) and countries (Easterly and Levine, 1997; Hart, 2007). While the majority of contributions tend to find support for the idea that foreign workers and/or the cultural diversity being produced as a consequence are conducive to innovation (e.g. Shore et al, 2009; Ã?zgen et al, 2013), the bag of evidence is still

somewhat mixed, with other studies showing negative effects (e.g. Easterly and Levine, 1997) or effects that depend on characteristics of the immigrants, such as their skill levels (Borjas, 1990; Suedekum et al, 2014). Part of the problem is that while many studies can show a positive empirical association between cultural diversity and innovation, the theoretical understanding of this relationship is based on a number of hypotheses about potential mechanisms through which the causal effect might work. These mechanisms have, however, not been subjected to the same level of empirical scrutiny. As Kemeny (2014: 34) notes in an extensive review of the literature on this topic, â??[t]he appeal of demonstrating positive effects of immigration in cities is clear. But as social scientists, the primary goal must be to improve our understanding of the underlying mechanismâ?•. Until research in this area can demonstrate the mechanisms at play in the relationship between immigration and innovation, the hypothesis will remain a nice, but perhaps somewhat naÃ¨ve idea, based on potentially spurious empirical associations.

The literature on the relationship between immigration and innovation focuses on two main mechanisms. The first, and by far the most prevalent, is that foreign workers bring cultural diversity, which is though to provide a new and different view to the company and the region (Cox, 1993; Shore et al, 2009). Foreign workers add skills and perspectives which are new to the firm, providing a variety of perspectives which are important in triggering new knowledge, or what Kanter (1968) has termed kaleidoscope thinking. This is related to Schumpeterâ??s classical definition of innovation, in which innovation is seen as new combinations of new and existing knowledge and resources. However, as Kemeny (2014: 32) notes, a major issue with this line of thinking is that â??it is assumed that oneâ??s birthplace indicates in some meaningful way oneâ??s manner of approaching the worldâ?•. This is an assumption that has never been convincingly tested, and none of the literature on this has empirically demonstrated either the relationship between birthplace and a different way of thinking, or between within-group differences in ways of thinking and innovation. An equally probable mechanism might be that â??rather than some inbuilt culture-specific characteristics, foreign-born individuals enjoy international social connections to which natives lack accessâ?• (Kemeny, 2014: 33). Indeed, other contributions have also shown that a more diverse workforce can help the firm to exploit and make use of external knowledge and extract it from more diverse source bases (Ã?stergaard et al, 2011).

This paper continues this line of reasoning by examining international networks as a potential mechanism in the relationship between immigration and innovation. We examine whether firms that employ foreign workers tend to engage to a greater extent with international partners in their innovation processes, and whether this is, in turn, associated with higher probability of innovation in these firms. Addressing this question might provide one building block in empirically establishing the mechanisms that can account for the observed relationship between immigration and innovation. We find evidence that firms with highly educated foreign workers collaborate more frequently with foreign partners, and a variety of foreign partners in turn has a positive effect on the probability of product innovation and new-to-market product innovation. The results lend support to the argument that Norwegian firms actively recruit the competence they need internationally as we see that highly educated foreign workers are the ones that influence networking the most.

The paper builds on firm-level survey data of approximately 500 Norwegian firms, including indicators of the innovative process, and whether or not the firm employs foreign workers and of which educational level. We use a set of regression models to examine the relationship between employing foreign workers and various indicators of the innovation development process, controlling for R&D investments, education levels, firm size and industry.

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While there is a wealth of empirical research examining the potential effects of foreign workers, immigration and cultural diversity on wages, employment, economic growth and – in recent years – innovation, very little of this research has provided a convincing empirical demonstration of the mechanisms through which foreign workers would affect innovation. Most accounts hypothesise that foreign workers provide a different perspective that contributes to a diversity of ideas in the firm, while some also add the idea that foreign workers might help a firm build international networks. Nonetheless, these mechanisms have for the most part remained entirely theoretical, with few attempts being made at uncovering the intermediary relationships. This paper contributes to filling this gap by focusing on the second of these mechanisms, asking whether firms which employ foreign workers also have broader international networks and whether this may, in turn, promote innovation. The paper builds on survey data from approximately 500 firms in Norway with more than ten employees, covering all sectors and regions. We find evidence that firms with highly educated foreign workers collaborate more frequently with international partners, and a variety of international partners in turn have a positive effect on the probability of product innovation and new-to-market product innovation. The results lend support to the argument that Norwegian firms actively recruit the competence they need internationally as we see that highly educated foreign workers are the ones that influence networking the most.

Introduction

The relationship between foreign workers and innovation has been a hot topic in the literature in recent years, as growing international mobility is making firms and regions more diverse. This diversity is thought to promote new ideas and perspectives (Ottaviano and Peri, 2006; Nathan and Lee, 2013), but also potentially to increase conflicts and reduce trust (Jehn *et al*, 1999; Bandiera *et al*, 2005). Previous studies have addressed this issue at various scales, from work groups (Chatman and Flynn, 2001; Joshi and Roh, 2009) via firms (Lee and Nathan, 2010; Østergaard *et al*, 2011) to regions (Niebuhr, 2010; Kemeny, 2012) and countries (Easterly and Levine, 1997; Hart, 2007). While the majority of contributions tend to find support for the idea that foreign workers and/or the cultural diversity being produced as a consequence are conducive to innovation (e.g. Shore *et al*, 2009; Özgen *et al*, 2013), the bag of evidence is still somewhat

mixed, with other studies showing negative effects (e.g. Easterly and Levine, 1997) or effects that depend on characteristics of the immigrants, such as their skill levels (Borjas, 1990; Suedekum *et al*, 2014).

Part of the problem is that while many studies can show a positive empirical association between cultural diversity and innovation, the theoretical understanding of this relationship is based on a number of hypotheses about potential mechanisms through which the causal effect might work. These mechanisms have, however, not been subjected to the same level of empirical scrutiny. As Kemeny (2014: 34) notes in an extensive review of the literature on this topic, "[t]he appeal of demonstrating positive effects of immigration in cities is clear. But as social scientists, the primary goal must be to improve our understanding of the underlying mechanism". Until research in this area can demonstrate the mechanisms at play in the relationship between immigration and innovation, the hypothesis will remain a nice, but perhaps somewhat naïve idea, based on potentially spurious empirical associations.

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However, as Kemeny (2014: 32) notes, a major issue with this line of thinking is that "it is assumed that one's birthplace indicates in some meaningful way one's manner of approaching the world". This is an assumption that has never been convincingly tested, and none of the literature on this has empirically demonstrated either the relationship between birthplace and a different way of thinking, or between within-group differences in ways of thinking and innovation. An equally probable mechanism might be that "rather than some inbuilt culture-specific characteristics, foreign-born individuals enjoy international social connections to which natives lack access" (Kemeny, 2014: 33). Indeed, other contributions have also shown that a more diverse workforce can help the firm to exploit and make use of external knowledge and extract it from more diverse source bases (Østergaard *et al*, 2011).

This paper continues this line of reasoning by examining international networks as a potential mechanism in the relationship between immigration and innovation. We examine whether firms that employ foreign workers tend to engage to a greater extent with international partners in their innovation processes, and whether this is, in turn, associated with higher probability of innovation in these firms. Addressing this question might provide one building block in empirically establishing the mechanisms that can account for the observed relationship between immigration and innovation.

The paper builds on firm-level survey data of approximately 500 Norwegian firms, including indicators of the innovative process, and whether or not the firm employs foreign workers and of which educational level. We use a set of regression models to examine the relationship between employing foreign workers and various indicators of the innovation development process, controlling for R&D investments, education levels, firm size and industry. The paper is structured into four sections: The first section presents the theoretical framework and hypotheses. Second, we introduce the empirical framework, and thirdly, the data, descriptive statistics and models. The final section presents the results of the regression analyses of the relationship between foreign workers and collaboration in innovation, leading up to the concluding remarks.

Establishing a mechanism for the relationship between foreign workers and innovation

This paper aims to fill a gap in the literature by empirically demonstrating a mechanism by which immigration and the resulting presence of foreign workers might affect innovation at the firm level. While the dominant interpretation is the literature is that the presence of foreign workers promotes a diversity of perspectives and ideas, this paper focuses on a different mechanism, which has hitherto received relatively little attention in the literature: The idea that foreign workers have international connections and/or a set of intercultural and language skills that help them make such connections, and that these connections may in turn promote the firm's potential for innovation. In order to explain why we expect these mechanisms to hold, this section reviews the literature and existing empirical evidence on the relationships between each set of the variables: Firstly, between immigration and innovation; secondly, between immigration and international networks; and thirdly, between international networks and innovation.

Why would foreign workers affect innovation?

There is by now a considerable literature examining the relationship between immigration and innovation both at the firm and the regional level. For the most part, these studies find a positive association between the two phenomena. At the firm level, Østergaard et al. (2011) find that Danish firms with a greater diversity of national backgrounds among their employees are significantly more likely to introduce new product innovations. Similar conclusions are reached by Özgen et al. (2011) for the Netherlands, Niebuhr and Peters (2012) for Germany, and Nathan and Lee (2013) for the United Kingdom. At the regional level, Hunt and Gauthier-Loiselle (2010) find that US states with more foreign workers tend to patent more, and Suedekum et al. (2014) find a positive association with GDP per capita for German regions.

What is particular about foreign workers? In this context, it is not their status as foreigners as such that makes a difference. However, "surface-level" diversity in country background is hypothesised in this literature as being indicative of deeper-level differences, such as "cognitive processes/schemas, differential knowledge base, different sets of experiences, and different views of the world" (Shore *et al*, 2009: 118). It could therefore be expected that foreign workers might bring in different perspectives from natives, as they would have a different background and possibly outlook on how to solve problems. When individuals with

different knowledge and backgrounds interact, they stimulate and help each other to stretch their knowledge for the purpose of bridging and connecting diverse knowledge (Nooteboom *et al*, 2007). This is a purpose not only useful, but vital for innovation: bridging and connecting new knowledge in order to create something new.

Firms and managers place increasing emphasis on the need to recruit and take advantage of foreign workers. They are increasingly trying to make their internal employee skill structure match the external reality of globalized markets. Many find that foreign workers bring a valuable new perspective, not only due to knowledge of different cultures, religions and traditions, but also in terms of how to solve processes in-house. In the words of Apple's former Vice-President of Human Resources Kevin Sullivan: "When you are surrounded by sameness, you only get variations of the same". This is particularly important in innovative processes, in which different outlooks are needed in order to create something new.

To what extent do foreign workers contribute with a different view? This is a relationship that has remained mainly in the theoretical realm and has been the subject of little direct empirical scrutiny. Previous contributions on the effects of foreign workers on economic outcomes have mostly examined this association directly, leaving the establishment of the causal mechanisms mainly to theoretical speculation. Empirical studies of the relationship have mostly focused on wages and employment, for instance how foreign workers affect the unemployment rate of natives. Studies of the relationship with innovation outcomes directly are a relatively recent phenomenon, but contributions by Niebuhr (2010), Özgen et al. (2011) and Nathan and Lee (2013), among others, have helped to fill in this gap.

Related research is concerned with migration of human capital, but the existing literature on migration and its link to innovation gives limited guidance on what we could expect. Human migration may have an impact on economic growth through different channels. For instance, immigrants from other countries may have skills that are scarce in that place and thus enhance productivity and innovation (substituting or complementing the existing skill platform); hence the impact depends on the characteristics of those migrating (Kangasniemi *et al*, 2009). Foreign workers could create competitive advantage through the new skills, new solutions, different perspectives and outlooks that they bring with them. Cultural diversity in human capital is considered an important asset which could serve as a source of "sustained competitive advantage because it creates value that is both difficult to imitate and rare" (Richard, 2000:165).

However, the impact of foreign workers may not be the same regardless of their educational level. There are two different reasons for this: Firstly, foreign workers that are high-educated may have more to contribute in innovation processes. The role of workers as the primary vehicle for knowledge spillovers and innovation is often linked to a more educated workforce "as innovation is a relatively more skill-intensive activity than imitation" (Vandenbussche *et al*, 2006). Benhabib and Spiegel (1994) support this view by emphasizing that a more educated workforce would innovate at a faster rate. There have also been many studies emphasizing

and identifying human capital as a crucial feature of economic growth (Faggian and McCann, 2009). This again reflects increased focus on employees and the heterogeneity of employees, which further underlines the potential importance of human capital and its link to innovation. Secondly, high-educated workers typically have positions of more responsibility, in which they are more able to participate in innovative processes, whereas low-educated workers may conduct more manual labour, which may be more or less detached from innovation processes. Previous studies (Axtell *et al*, 2000) suggests that when employees engage in a wide variety of tasks combined with high levels of control, ownership of work-related tasks and self-efficiency will have an impact on innovation. We would expect that high-educated foreign workers could relate more to a wide variety of tasks and higher level of control, than low-educated foreign workers would.

However, the impact of foreign workers should not be viewed through rose-tinted spectacles. Too much internal heterogeneity also has potential costs, for instance in terms of language barriers, conflicts, internal clashes and distrust. These issues could harm collaboration within the firm and consequently lead to less innovation (Basset-Jones, 2005; Parrotta *et al*, 2012a). In some cases, foreign and domestic workers self-organize into two different groups within the firm, with little bridging across the groups. This could impede their opportunities for contributing in the various processes leading up to an innovation. Foreign workers might also experience discrimination and non-transferability of their skills, as well as a lack of recognition of their qualifications, which "can be barriers to free exchange of ideas and the accumulation of new knowledge" (Ozgen *et al*, 2013: 1) and may increase conflict levels (O`Reilly *et al*, 1998; Jehn *et al*, 1999). Some conflict might be good for innovation, but too much conflict is almost certainly harmful. If the risk of conflict and internal distrust represent a cost of foreign workers, while the potential for new ideas represent a benefit that is mostly associated with high-educated workers, we could expect more educated foreign workers to be particularly closely related to innovation, while less educated workers represent more of a cost.

Why would foreign workers affect international networking?

While the mechanisms discussed above are certainly plausible as an explanation for the relationship between immigration and innovation, they remain fraught with controversy. Ultimately, it is hard to demonstrate empirically that foreign workers really have different cognitive schemes and perspectives in ways that would matter for innovation. Arguably, different educational backgrounds or employment histories might be at least as important in shaping work-related perspectives as country of origin. A perhaps less controversial assumption, which has nonetheless received very scant attention in the literature so far, is that foreign workers might help the firm to establish international connections and networks. The could be the result either of their own personal or professional networks, which almost by definition span multiple countries, or because they provide a set of skills that are useful in connecting to and collaborating with international

partners, whether in terms of foreign language command, knowledge of foreign cultures or experience from working in a different cultural environment.

Ultimately, the relationship between foreign workers and the collaboration of innovation is an empirical question. However, to the best of our knowledge, little to no research has been done on this relationship. There has been carried out some research linked to foreign workers and networks, but the conclusions stemming from this research have been inconclusive. Theoretically it has been argued that having foreign workers in your company could increase the diversity of partners and networks of the firm and could provide the firm with better access to new market segments, but empirically we know too little about these mechanisms.

Nonetheless, several studies have pointed to the role of employee diversity in broadening the search scope of the firm (Østergaard and Timmermans, 2011; Østergaard *et al*, 2012; Parrotta *et* al, 2012a; Parrotta *et al*, 2012b). Do firms with foreign workers collaborate differently than those firms that do not employ foreign workers? The underlying factor to foreign workers contributing to collaboration in the firm is that firms employing foreign workers could enjoy more diverse sources of knowledge that in turn allows the firm to create new combinations of knowledge and resources as well as new ways of collaborating though more diverse sources of networks. That is why we ask whether the presence of foreign workers might help firms develop new networks as having a culturally diverse firm might increase the firms' knowledge search scope and widen the use of different information sources.

Firstly, foreign workers bring with them their own personal and professional networks, which might be very different from the networks of domestic workers in terms of geographical scale and scope. To the extent that these networks are relevant to the firm, they may enable the firm to make new connections and reach new partners, thus expanding the networks of the firm. Secondly, foreign workers also possess cultural and linguistic skills that may enable firms to collaborate with partners also outside the individual network of the employee. Certainly, all foreign workers will have knowledge and understanding of the language and culture of their country of origin, which might be valuable to the firm in creating effective partnerships there. By definition, foreign workers also have experience from working in a different cultural context, which provide a level of understanding of intercultural issues that could prove helpful in connecting with partners also from different cultural contexts. This could in turn, create a competitive edge (Cox, 1994) for the firm. As "firms reach out to a broader customer base; they need employees who understand particular customer preferences and requirements" (Richard, 2000:165) and we are increasingly seeing that firms compete in a globalized market.

Through the rise of a digital era, the world is brought to us, making it easier to communicate with a large number of people and create more diverse networks than ever before. This could be an argument that foreign workers do not matter that much for network building, because the firms could reach broadly out anyway.

However, similarity breeds connection (McPherson *et al*, 2001: 415), following the principle behind homophily that birds of a feather flock together. People prefer to have and engage in relationships with other people that are similar to us. We might therefore expect firms with a greater internal diversity of employees to be able to reach out to a broader set of external partners, as each of the employees seek out partners that are similar to them. This also extends to the geographical scale, where firms with only domestic workers might be expected to seek out similar – domestic – partners, while firms with foreign workers would be more likely to have international partners. Following McPherson *et al* (2001: 415), "homophily limits people`s social worlds in a way that has powerful implications for the information they receive, the attitudes they form, and the interactions they experience". Firms with limited internal diversity might therefore also be expected to rely on a narrow set of information sources. This is also supported by previous research showing that the most central element to homophily is geographical space. We tend to communicate with people close to us, geographically (McPherson *et al*, 2001), and that it is often a matter of effort (Zipf, 1949), because it takes far more energy to communicate with someone far away than someone who is geographically close (McPherson *et al*, 2001). One could argue that this is not the case for foreign workers who might be able to compensate for geographical distance with a greater sense of social and institutional proximity to international partners. If they perceive their personal network as close in a social sense, this might make up for the geographical distance, and similarly, increase social and institutional distance to local partners might reduce collaboration at the local scale. Thus, in a social sense, international partners may seem closer than regional ones. There are many challenges linked to finding a successful partner in relation to enhancing innovation. One important element is mutual understanding, which in turn is linked to familiarity and trust, which could facilitate successful collaboration. However, too much familiarity may hamper innovation, and the challenge is rather to find partners "at sufficient cognitive distance to tell something new, but not so distant as to preclude mutual understanding" (Nooteboom *et al*, 2007:1017). So there could be a negative effect not only with working with similar people, but also with finding partners that are too analogous to us. We could experience an issue of self-selection processes, where foreign workers tend to go to firms that are more internationally oriented and that is the reason why they collaborate with international partners, more than because they employ foreign workers.

It could also be that firms with foreign workers are more internationally focused, especially in firms with high-educated foreign workers, and hence collaborate more with international partners than firms that do not have the presence of foreign workers. Hence, a diverse workforce can facilitate connections with new partners and hence the acquisition of new knowledge. This is one way that collaboration could prove to be fruitful, if the firms engage with partners that have resources and knowledge that complement their own and is relevant to the innovation being sought (Nieto and Santamaria, 2007). More diversity might lead to more cooperation, as foreign workers bring with them new perspectives, resources and potential and existing networks.

On this basis, we might formulate the following hypotheses:

H1: Firms which employ foreign workers tend to cooperate with a wider range of partners, in particular at the international scale.
H2: The relationship between foreign workers and cooperation is stronger for more educated foreign workers.

Why would international networking affect innovation?

The final piece of the puzzle is to establish whether and why international networks that foreign workers help to facilitate would be associated with innovation. In the relational geography literature, innovation, knowledge and learning are understood as the result of interactive processes where actors with different knowledge and competences meet and exchange information with the aim of solving something, whether technical, organizational, commercial or intellectual (Bathelt *et al*, 2004). In this landscape, firms with access to a broader set of sources and connections are in a good position to tap into knowledge and information of various origins and exploit these in their innovation processes. Consequently, Laursen and Salter (2006) find that firms with a broader search scope tend to be more innovative. These findings are supported also from other disciplinary perspectives. For instance, in sociology, Granovetter (1973) finds that an abundance of weak ties is associated with positive economic outcomes, and Burt (1992) argues that agents occupying structural holes in a network are in a good position for exploiting knowledge from a range of perspectives.

Collaboration and potential new networks and innovation development practices should enhance innovation due to the increased amount and variety of knowledge available to be shared, as well as the possible compatibilities of knowledge in an alliance (Nieto and Santamaria, 2007). There has been an increased focus on the role that networking plays in innovative processes, and this underpins a recognition that innovations are perhaps less the outcome of an individual firm`s isolated efforts (Nieto and Santamaria, 2007). Previous research (Amara and Landry, 2005), also show that firms that introduce more radical innovations are more likely to use a wider range of information sources.

While much of the research in this area has focused on networks within regions or clusters, there is an increasing recognition that international networks may be at least as important for innovation in the contemporary economy. The literature on global innovation networks emphasises connections at the international scale as crucial in boosting the innovativeness of regions or firms, especially in lagging regions (Zander 1999; Ernst and Kim, 2002; Kafouros et al. 2012; Chaminade and Plechero, 2014).

In recent years, an abundance of studies from various geographical contexts have concluded that firms with a greater variety or density of international contacts tend to be more likely to introduce new products or processes. This includes studies from Norway (Fitjar and Rodríguez-Pose, 2011), Sweden (Moodysson,

2008), Denmark (Lorentzen, 2008), Austria (Trippl et al. 2009), Canada (Doloreux and Dionne, 2008), India (Lorenzen and Mudambi, 2013) and China (Leung, 2013), among others.

These ideas have been conceptualised in a broader sense by literature emphasising the need for global pipelines, a concept coined by Bathelt et al. (2004) to denote purpose-built knowledge flows between clusters. These global pipelines are necessary to ensure the continuous renewal of knowledge and ideas within the cluster and avoid the risks of lock-in. Morrison et al. (2013) have later demonstrated using a simulation model the need for pipelines to import new knowledge into a network. In a similar sense, Rodríguez-Pose and Fitjar (2013) talk of archipelago economies in which distant regions are connected by pipelines to bypass traditional hinterlands and interact directly with each other.

Data and case description

This paper builds on firm-level data from a survey of 533 Norwegian firms, gathered in 2013. The survey was conducted in two stages: First, through a telephone interview, in which 2002 firms participated. These firms were sampled from a larger population of all firms with more than ten employees registered in the Norwegian Register of Business Enterprises according to quotas for five different regions: Oslo (500 firms), Stavanger (350), Bergen (300), Trondheim (250), and the rest of Norway (600). During the telephone interview, respondents were invited to fill in a follow-up web questionnaire containing further questions, which 533 managers did. The dependent variables on innovation, collaboration, and the organization of innovation processes are all drawn from the telephone interviews, as are several of the control variables, while the data on foreign workers are based on the web questionnaire. Consequently, we limit the study to the firms that participated in both stages of the survey for the models concerned with foreign workers. The survey was developed by the authors to fit the needs of this research, although it draws on indicators from the Community Innovation Survey (CIS) and the Oslo Manual, in particular for the dependent variables. The data has been combined with firm-level registry data on firm size and NACE-classification.

The study is conducted in the context of Norway, which has a growing number of foreign workers. In 2014, immigrants and Norwegians born of immigrants added up to 14.9 per cent of the total population. No research has previously addressed the impact of foreign workers on innovation or the collaborative pattern of innovation in Norwegian firms, although there has been some work on firm perceptions of the need for foreign workers' skills. For instance, Seip (2007) found that a majority of firms sought foreign expertise due to problems finding the competence they need in Norway (Seip, 2007). That finding underpins the importance of bringing in foreign workers because of their skills and competence. This paper goes beyond firm perceptions in examining the relationship between employing foreign workers and the innovation behaviour of the firm. Even though it is highly necessary to obtain a better understanding of the relationship between foreign workers and collaboration paths of innovation in firms and regions, we know little about these mechanisms for firms in regions in Norway.

Variables and model

In order to examine the relationship between having foreign workers in the firm and international networking, we examine whether firms have or have not cooperated with any of seven different types of partners located abroad during the last three years, including other firms in the conglomerate, suppliers, customers, competitors, consultants, universities, and research institutes. Based on this, we construct an index counting the number of different types of partners used at the international scale. We further examine the relationship between this variable and the presence of foreign workers, using a poisson regression model, specified as follows:

$$\log(E(\text{Partners}_i)) = \alpha + \beta_1 \text{ Foreign workers}_i + \beta_2 \text{ Controls}_i + \varepsilon \quad (1)$$

The main independent variable of interest is *Foreign workers*, which measures the presence of foreign workers in the firm, as well as the highest level of education among these workers. The variable is specified as a categorical variable with four possible values: (1) The firm has no foreign workers; (2) The firm has foreign workers, but no university educated foreign workers (*low-educated foreign workers*); (3) The firm has foreign workers, and some of the foreign workers have university education (*medium-educated foreign workers*); (4) The firm has foreign workers, and some of the foreign workers have postgraduate university education (*high-educated foreign workers*). In the models, we include dummy variables for categories 2-4, comparing with the baseline of having no foreign workers.

In order to isolate the effect of foreign workers on international networking and avoid spurious associations, we employ two further robustness checks: Firstly, the model itself controls for several confounding variables, including firm size (measured by the natural log of the number of employees), the overall educational level in the firm (log percentage share of employees with university-level education), research & development intensity (measured by log of R&D expenditure), the sector of the firm (applying ten different dummy variables for different industries) and the location of the firm in different regions of Norway (including dummy variables for the four largest city regions - Oslo, Bergen, Stavanger and Trondheim). Most of the variables are log transformed since their distributions are highly skewed.

Secondly, to control for any remaining unobserved heterogeneity that may cause firms with foreign workers to network more in general, we run the model also for counts of different types of regional and national partners as outcomes. If foreign workers are indeed associated with larger international networks, we would expect to find an effect only for this dependent variable and not for regional and national partners as dependent variables.

We also run a second model examining the relationship between international networks and innovation. In this model, the count of different types of international partners serves as the main independent variable of interest, while the dependent variables are four measures of innovation, derived from Community

Innovation Survey indicators for product innovation, new-to-market product innovation, process innovation and new-to-industry process innovation. We control for the same variables as in Model (1) above, as well as for counts of different types of partners used at the regional and national scales. In this analysis, we exploit the full sample of 2002 firms participating in the telephone interviews, as all the indicators are derived from this part of the survey. The model is specified as follows:

$$\text{logit}(\Pr(\text{Innovation}_i=1)) = \alpha + \beta_1 \text{ International partners}_i + \beta_2 \text{ Controls}_i + \varepsilon \qquad (2)$$

Descriptive statistics

Table 1 shows descriptive statistics on the sample of firms in terms of company size, sectors and geographical distributions, as well as for the outcome variables product and process innovation, as well as new-to-market product and process innovation, and for the main independent variable *Foreign workers*. More firms report new product innovation (59 per cent) than what is the case for process innovations (46 per cent). The same is true for new-to-market innovations, with 32 per cent of firms reporting new-to-market product innovation, while 16 per cent report new-to-market process innovation. Table 2 further depicts the correlation matrix of all the variables included in the analysis. The correlation matrix show that the presence of high- and medium-educated foreign workers in the firm has a positive, but weak, association with all four innovation outcomes. With the exception of product innovation, the correlation is strongest for highly educated workers. The presence of less educated foreign workers in general tends to have a negligible effect on all four innovation outcomes, in two cases with a negative sign.

Table 1: Descriptive statistics on firms in the sample

City regions	N	% of sample	No. of employees	N	% of sample
Oslo	127	23.8	10-19	242	45.4
Bergen	74	13.9	20-49	203	38.1
Stavanger	115	21.6	50-99	46	8.6
Trondheim	60	11.2	100-999	37	6.9
Rest of Norway	157	29.5	1000 or more	5	0.9

Sector	N	% of sample	Innovation	N	% of sample
Mining	16	3.0	**Product innovation**	319	60
Manufacturing	119	22.3	New-to-market innovation	172	32
El., gas and water supplies	16	3.0			
Construction	59	11.1			
Wholesale and retail trade	98	18.4	**Process innovation**	250	47
Transport and storage	29	5.4	New-to-industry innovation	85	16
Hotels and restaurants	29	5.4			
Information and communications	28	5.3			
Financial and insurance services	32	6.0			
Other services	107	20.1			

Foreign workers	N	% of sample
All firms with foreign workers	291	54.6
High-educated foreign workers	79	14.8
Medium-educated foreign workers	87	16.3
Low-educated foreign workers	125	23.5

---------- Table 2 about here ----------

Results

Table 3 shows the results of the estimation of model (1), examining the relationship between foreign workers and the use of international partners, in order to test H1 and H2. The analysis shows, in line with expectations, that firms with foreign workers cooperate with a wider range of international partners. However, this is only true for foreign workers of a certain educational level. Firms with high-educated foreign workers cooperate with a significantly higher number of international partners, whereas for firms

with medium- or low-educated workers there are no significant differences in the levels of international cooperation, and even a negative sign. This might be an indication that high-educated foreign workers are more involved in their firms' partner search and collaboration procedures, and are thus able to influence the collaboration patterns of the firm, whereas medium- and low-educated foreign workers tend to hold positions of less responsibility in which they are not able to utilize their cultural and language skills to increase the search scope of the firm. For regional and national partners as outcomes, none of the variables related to foreign workers have any significant effect, and the coefficients are very low, suggesting that the presence of foreign workers is not related to the firm's general collaboration pattern, but is specific to collaboration with international partners.

---------- Table 3 about here ----------

Table 4 shows the results of the estimation of model (2) examining the relationship between international networking and innovation. For product innovation, we find a significant positive effect of interacting with international partners. This holds both for product innovation in general and, even more, for new-to-market product innovation. Regional and national collaboration have no significant effects on product or new-to-market product innovation. The effect of international partners is robust controlling for the industry and region of the firm, as well as for its R&D expenditure, size, human capital stock and foreign ownership.

For process innovation, the results are quite different. In this case, international collaboration has no significant effect either on process or on new-to-industry process innovation, although the sign stays on the positive side. However, national collaboration has a significant positive effect for both variables related to process innovation, and regional collaboration also has a positive effect on general product innovation.

---------- Table 4 about here ----------

Conclusion

The results of the regression analyses show that firms with foreign workers have broader networks and engage in a wider set of international relationships. This contributes to broadening their search scope and where they get input and new ideas. Our hypothesis (H1) was in line with this previous research, linked to the idea that birds of a feather flock together. Firms with foreign workers enjoy a more diversified set of partners. We tested this relation distinguishing between different levels of education of the foreign workers (H2). In this case, we find a positive relationship between high-educated foreign workers and collaboration with international partners. This complements previous contributions showing that diversity leads to collaboration, as foreign workers help firms connect with a more geographically diversified set of partners.

But does it matter? Yes, it does. Firms that collaborate with international partners are more likely to introduce product innovation in general and new-to-market product innovation in particular, as shown in the regression analysis of model (2). This suggests that the presence of high-educated foreign workers might be

related to innovation output through the relationship of international collaboration with both of these variables. Firms with foreign workers thus appear to be able to introduce new product innovations to a greater extent at least partly because they have a broad network internationally so that they get valuable input, information and feedback from their global network or advantages of entry to new market segments.

The main contribution of this paper is hence in demonstrating one of the mechanisms by which foreign workers can influence innovation at the level of the firm. This is a necessary step in going beyond establishing an empirical association between foreign workers and innovation, which has been done by numerous recent contributions, and towards unbundling the various mechanisms that make up a potential causal chain accounting for this relationship. However, this study represents only one of the hypothesised mechanisms. Further research is required in order to demonstrate whether foreign workers can also affect innovation through producing a diversity of perspectives and ideas within the firm. Secondly, the present contribution is limited to the level of the firm, and further research is also needed to examine whether similar mechanisms hold also at lower or higher scales, such as work groups, regions or nations. Nonetheless, the present study represents a necessary start in probing more deeply a relationship that has been heavily theorised, but only quite crudely examined with empirical data.

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Table 2: Correlation matrix of the variables used in the estimation models

	Product innovation	New-to-market product innovation	Process innovation	New-to-industry process innovation	High-educated foreign workers	Medium-educated foreign workers	Low-educated foreign workers	Log of education	Regional partner	National partner	Foreign partner	Log of R & D	Log no. of employees	Foreign ownership share
Product innovation	1.0000													
New-to-market product innovation	0.5654	1.0000												
Process innovation	0.2560	0.2921	1.0000											
New-to-industry process innovation	0.1581	0.2474	0.4634	1.0000										
High-educated foreign workers	0.0831	0.1187	0.1370	0.1067	1.0000									
Medium-educated foreign workers	0.1200	0.1009	0.0374	0.0318	-0.0107	1.0000								
Low-educated foreign workers	-0.0586	-0.0100	0.0471	0.0086	-0.1630	-0.0551	1.0000							
Log of education	0.1917	0.1597	0.0920	0.1066	0.3148	0.1039	-0.2499	1.0000						
Regional partner	-0.0506	-0.0323	0.0664	0.0615	0.0964	0.0655	-0.0032	0.0886	1.0000					
National partner	0.0113	0.0498	0.1658	0.1367	0.1195	0.0453	-0.0150	0.2183	0.3158	1.0000				
Foreign partner	0.1893	0.2387	0.1458	0.1319	0.3169	0.0237	-0.1051	0.2392	0.1074	0.4048	1.0000			
Log of R & D	0.2988	0.3420	0.2240	0.1632	0.2651	0.0523	-0.0865	0.3146	0.1309	0.1856	0.2951	1.0000		
Log no. of employees	0.0382	0.1108	0.1359	0.1057	0.0895	0.1065	0.1047	0.0497	0.1496	0.1861	0.2096	-0.0008	1.0000	
Foreign ownership share	0.1074	0.1073	0.0516	0.0655	0.2053	0.0147	-0.0796	0.1615	-0.0770	0.1096	0.3899	-0.0004	0.1633	1.0000

Table 3: Poisson regression model of collaboration with partners

VARIABLES	Regional partner	National partner	International partner
High-educated foreign workers	0.0557 (0.0855)	-0.0229 (0.108)	0.264** (0.114)
Medium-educated foreign workers	0.0465 (0.0754)	0.0118 (0.0997)	-0.0395 (0.123)
Low-educated foreign workers	0.000171 (0.0714)	0.121 (0.0961)	-0.118 (0.128)
Log of education	0.0294 (0.0264)	0.171*** (0.0388)	0.133*** (0.0495)
Log of R & D	0.0799*** (0.0303)	0.141*** (0.0393)	0.297*** (0.0468)
Log no. of employees	0.100*** (0.0311)	0.145*** (0.0389)	0.137*** (0.0441)
Foreign ownership share	-0.00120 (0.000897)	0.00182* (0.00106)	0.00768*** (0.00112)
Sector	Controlled	Controlled	Controlled
Region	Controlled	Controlled	Controlled
Constant	0.350** (0.152)	-1.038*** (0.215)	-1.335*** (0.261)
Observations	496	496	496
Pseudo R^2	0.02	0.05	0.19

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Baseline: No foreign workers

Table 4: Logit regression model of innovation

VARIABLES	Product innovation	New-to-market product innovation	Process innovation	New-to-industry process innovation
International partners	0.135**	0.157***	0.0584	0.0985
	(0.0587)	(0.0549)	(0.0515)	(0.0599)
Regional partners	-0.0384	-0.00957	0.0812***	0.0360
	(0.0329)	(0.0365)	(0.0308)	(0.0415)
National partners	0.0666	0.0586	0.170***	0.119**
	(0.0423)	(0.0441)	(0.0392)	(0.0496)
Log of education	0.115***	0.154***	0.0330	0.0662
	(0.0431)	(0.0516)	(0.0419)	(0.0601)
Log of R &D	0.780***	0.663***	0.328***	0.276***
	(0.0683)	(0.0675)	(0.0586)	(0.0745)
Log no.of employees	0.143**	0.159**	0.229***	0.119
	(0.0661)	(0.0687)	(0.0626)	(0.0773)
Foreign ownership share	0.00369**	0.00383**	0.000440	0.00183
	(0.00183)	(0.00178)	(0.00170)	(0.00211)
Sector	Controlled	Controlled	Controlled	Controlled
Region	Controlled	Controlled	Controlled	Controlled
Constant	-1.372***	-2.589***	-2.086***	-2.969***
	(0.300)	(0.334)	(0.291)	(0.383)
Observations	1,852	1,852	1,852	1,852
Pseudo R^2	0.16	0.17	0.07	0.05

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1