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Immigration and Innovation in Finnish Manufacturing Firms

Terhi Maczulskij
ETLA Economic Research, Finland
terhi.maczulskij@etla.fi

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Abstract

This study examines the relationship between immigration and firmlevel innovation in the Finnish manufacturing sector. The analysis leverages unique matched data, including employees' immigration status, firm-level patenting, process and product innovation activities, and innovation inputs spanning the 2000–2018 period. To address the potential endogeneity of a firm's immigrant employment, an instrumental variables approach is employed using the historical geographic distribution of immigrants in the region where the firm is located. The results reveal that an increase in immigrant employment positively influences process and product innovation, and skilled foreign knowledge boosts the number of patent applications. Additionally, immigration leads to reduced external R&D expenditures, indicating that immigrant workers may substitute outsourced innovation inputs. The study also finds no evidence that immigration adversely affects native workers' employment in Finnish firms. By contrast, it may benefit natives with complementary skills.

Tiivistelmä

Ulkomaiset työntekijät ja innovaatiot Suomen teollisuuden yrityksissä

Tässä tutkimuksessa tarkastellaan maahanmuuton ja innovaatiotoiminnan välisiä yhteyksiä Suomen teollisuudessa. Analyysissä hyödynnetään korkeatasoisia aineistoja, kuten työntekijöiden maahanmuuttotaustaa, patenttitoimintaa, prosessi- ja tuoteinnovaatioita sekä innovaatiopanoksia vuosilta 2000–2018. Tilastollisessa analyysissa käytetään historiatietoja maahanmuuttajien alueellisesta keskittymisestä syy-seuraussuhteiden identifioimiseksi. Tulosten mukaan maahanmuuttajataustaisen työvoiman kasvu vaikuttaa myönteisesti prosessi- ja tuoteinnovaatioihin, ja lisäksi osaava ulkomainen työvoima lisää patenttihakemusten määrää yrityksissä. Lisäksi maahanmuutto johtaa ulkoisten t&k-menojen vähenemiseen, mikä viittaa siihen, että maahanmuuttajatyöntekijät voivat korvata ulkoisesti ostettuja innovaatiopanoksia. Tutkimuksessa ei myöskään löydy todisteita siitä, että maahanmuutto vaikuttaisi kielteisesti kotimaisten työntekijöiden työllisyyteen suomalaisissa yrityksissä. Sitä vastoin se voi hyödyttää syntyperäisen väestön työllisyyttä.

Ph.D. **Terhi Maczulskij** is a Chief Research Scientist at ETLA Economic Research, a Research Director at the Yrjö Jahnsson Foundation and a Research Fellow at IZA.

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Asiasanat: Yritystason analyysi, Maahanmuutto, Innovaatiot

JEL: D22, F22, O30

1 Introduction

Innovation is a key driver of economic growth and firm performance. Understanding the factors that influence innovation at the firm level is crucial for policymakers and business leaders. One potential source of innovation that has received increasing attention is immigration, with skilled immigrants often viewed as potential catalysts for innovation, such as patenting and productivity growth (Capoani, Chabert, and Izzo 2024, for a survey). However, most studies have primarily focused on US examples and often rely on aggregate data. As Glennon (2024) also points out, positive immigrant-innovation relationships at the regional level does not necessarily imply that hiring immigrants - skilled or otherwise - would directly enhance a firm's innovativeness.

In the European context, the relationship between immigration and firm-level innovation remains an open empirical question, with mixed findings in the existing literature. Some studies suggest that immigration leads to lower innovation (Ozgen, Nijkamp, and Poot 2013), others report positive effects (Beerli et al. 2021; Bitzer, Gören, and Kruse-Becker 2021; Mayda, Orefice, and Santoni 2022), while some find statistically insignificant or mixed evidence (Bratti and Conti 2018; Gray, Montresor, and Wright 2020).

This study examines the relationship between immigration and firm-level innovation in the Finnish manufacturing sector. Finland provides a compelling case study due to its relatively low share of foreign-born population compared to many other European countries (Edo 2019; Peri 2016). The proportion of foreign-born residents increased from just 0.5% in 1990 to less than 7% by 2023 (Statistics Finland 2024). Despite this modest growth, Finland faces significant challenges, including ethnicity-based recruitment discrimination (Ahmad 2020) and difficulties in retaining skilled foreign workers (Kauhanen et al. 2024). As a snapshot, over 80% of all Finnish establishments do not employ any immigrant employees (Kauhanen et al. 2024).

Understanding how immigrant workers influence firm innovation could help shape policies aimed at leveraging immigration for economic growth.

The analysis combines detailed data on employees' immigration status with firm-level measures of innovation outputs and inputs. Specifically, the study explores how changes in the share of immigrant workers within firms are associated with patenting activity, process and product innovations, R&D expenditures, and employment. The dataset covers Finnish manufacturing firms from 2000-2018. To address potential endogeneity in firms' immigrant employment, an instrumental variables approach is employed, exploiting variation in the historical geographic distribution of immigrants across regions. The findings generally indicate that immigration enhances innovation activity in Finnish firms.

This study contributes to the growing literature in three meaningful ways. First, it provides novel evidence on the immigration-innovation nexus in the context of a highly developed and diversified economy that ranks among the most advanced in the world, yet still has one of the lowest foreign-born populations. Second, while previous European studies mostly focus on either patenting (Bitzer, Gören, and Kruse-Becker 2021; Mayda, Orefice, and Santoni 2022) or the implementation of process and product innovations (Bratti and Conti 2018; Gray, Montresor, and Wright 2020; Ozgen, Nijkamp, and Poot 2013), this study examines a broader spectrum of innovation outputs. Third, it also explores how immigration impacts firms' innovation inputs, an aspect not widely explored in prior research.

Studying the effect of immigration on innovation separately for innovation outputs (e.g., patenting and implementing new processes or products) and innovation inputs (e.g., R&D or hiring STEM workers) is important because these aspects of innovation represent distinct stages and mechanisms in the innovation process. Immigrants may contribute to inputs by, for example, joining R&D teams or bringing diverse skills that enhance collaboration

and idea generation without immediately translating to increased outputs. Conversely, immigrants might directly influence outputs through unique expertise or insights, even if they do not significantly increase R&D expenditure or other measurable inputs. By examining these dimensions separately, researchers can uncover nuanced relationships and identify targeted strategies to maximize the contributions of immigration to innovation. The results suggest that immigration mostly affects innovation outputs, specifically increasing both process and product innovation, and expanding on previous work that has found mixed effects (Bratti and Conti 2018; Gray, Montresor, and Wright 2020; Ozgen, Nijkamp, and Poot 2013). Additionally, more skilled immigrants are associated with increased patent applications within firms. However, firms' reliance on outsourced R&D decreases with a higher proportion of immigrant workforce.

The paper also considers heterogeneous effects of skilled versus overall immigration and examines impacts on a range of firm outcomes beyond innovation, including productivity, growth, and native employment. These findings suggest that, alongside innovation growth, immigration improves overall firm-level performance by increasing productivity, expanding firm size, and boosting native employment, potentially due to complementary skills.

The remainder of the paper is structured as follows. Section 2 discusses the conceptual framework and related literature. Section 3 describes the data and empirical methodology. Section 4 presents the results, supplemented by various robustness tests. Section 5 discusses the results by contextualizing the findings within a broader framework, while section 6 concludes the paper.

2 Conceptual Framework

2.1 Related Literature

Numerous studies have used aggregated data, such as industry- or region-level data, to study the association between immigration and innovation activity (Capoani, Chabert, and Izzo 2024, for a review). For example, Fassio, Montobbio, and Venturini (2019) find a positive relationship between skilled migration and innovation in 16 manufacturing industries located in France, UK and Germany. Foreign graduate students also positively contribute to US innovation, as measured by the number of patent applications and patent grants (Gnanaraj, Maskus, and Mattoo 2008) or patents per capita (Hunt and Gauthier-Loiselle 2010). Recently, using data on the ancestry composition of US counties, Burchardi et al. (2020) show that immigration has a positive causal impact on innovation, as measured by the patenting of local firms.

Given the specific focus of this study on detailed administrative data pertaining to individual firms, I review the most recent literature particularly relevant to the research context. Several studies have constructed instruments for local changes in the supply of immigrants using a shift-share approach originally proposed by Altonji and Card (1991) and Card (2001). This method relies on the pre-existing local concentration of immigrants by country of origin, interacted with national, country-specific immigrant trends over time, to produce plausibly exogenous variation in local immigration. These studies include, among others, Bratti and Conti (2018), Gray, Montresor, and Wright (2020), Mayda, Orefice, and Santoni (2022), and Ozgen, Nijkamp, and Poot (2013).[1]

Bratti and Conti (2018) examine the relationship between the province-level share of immigrants and self-reported measures of innovation activity

[1]See also Brunello, Lodigiani, and Rocco (2020), Ottaviano, Peri, and Wright (2018), and Mitaritonna, Orefice, and Peri (2017), focusing on other firm-level outcomes, including productivity and trade.

in Italian firms. Their identification strategy relies on immigrant enclaves, and the findings do not indicate a statistically significant relationship between immigration and innovation activity, measured by the introduction of product, process, or organizational innovations. Ozgen, Nijkamp, and Poot (2013) use firm-level employee information on immigration status, and the potential endogeneity issue similarly is accounted for using past local distribution of immigrants of the municipality in which the firm is located. The results suggest that Dutch firms employing relatively more migrants are less innovative, although this effect is more profound among first- than second-generation immigrants. However, companies employing a more diverse foreign workforce are more innovative, especially in terms of product innovations.

Gray, Montresor, and Wright (2020) study the impact of the immigration shock generated by the 2004 expansion of the EU to eastern European countries on innovation activity in the UK. They find that the increased supply of low-skilled labor in TTWAs led to higher process innovation but reduced product innovation, with an overall positive effect on innovation activity. Mayda, Orefice, and Santoni (2022) apply a modified version of the shift-share instrument by analyzing the effect of skilled immigration on patenting activity in French firms. Their analysis shows novel evidence that skilled migrants increase the number of patents through the effect of task specialization. In particular, skilled migrants specialize in research-oriented tasks, while skilled natives shift to more language-specific managerial tasks within firms. Furthermore, Parrotta, Pozzoli, and Pytlikova (2014) analyze the effect of labor diversity on the patent activity of firms. They likewise instrument their diversity variable with indexes of initial workforce diversity that are computed at the regional level. Their results show that ethnic diversity leads to more patenting.

A few papers have focused on skilled immigrants and the effect of H-1B

visa processing on firm-level outcomes in the US. Ashraf and Ray (2017) rely on a quasi-random assignment and study the relation between 2004 immigration policy shock, which created constraints on hiring skilled immigrant workers, and innovation activity. Their results show that firms dependent on skilled immigrants reduced R&D investments and innovation, as measured by patents and citations. Ghosh, Mayda, and Ortega (2016) use a similar study design and find heterogeneity in the effects of relaxing the cap on H-1B visas on firm-level outcomes. They find that increase in skilled immigrants would increase labor productivity and sales among large firms with intensive R&D. W. R. Kerr and W. F. Lincoln (2010) similarly find that higher H-1B admissions increase especially Indian and Chinese patenting in firms that are particularly dependent on the program. In contrast, there is a null effect of H-1B lotteries on firm patenting (Doran, Gelber, and Isen 2022).

Studies employing different econometric approaches to address endogeneity issues include Beerli et al. (2021). Their findings show that free access to Swiss labor markets by European workers affected firms near border, with the reform increasing the size (measured by sales and the number of employees), productivity, and patenting of incumbent firms. Skilled immigrant workers also enhance innovation activity in Science & Engineering (S&E) in the US (Stuen, Mobarak, and Maskus 2012). Their analysis is based on instrumental variables regression approach where macroeconomic crises and policy shocks in source countries affect students differently to enter graduate programmes abroad. Bitzer, Gören, and Kruse-Becker (2021) analyze the association between foreign knowledge, productivity and innovation in Danish manufacturing firms. They rely on a model that includes several firm- and employee-level control variables and fixed effects to address potential endogeneity, such as self-selection of more skilled immigrants into more productive firms. Their findings suggest that immigrant employment is positively associated with total-factor productivity and a higher probability of

new firm-level patent applications.

2.2 Immigration in Finland

The number of international migrants has nearly doubled in developing countries since 1990. In Europe, the share of migrants increased from approximately 7% in 1990 to 11% in 2015 (Edo 2019). By 2023, 14.5% of European individuals aged 15-74 were foreign-born (Eurostat 2024). However, there is considerable variation in the distribution of migrants across countries. Luxembourg had the highest share of foreign-born residents (56%), followed by Switzerland (35%), and Latvia and Cyprus (28% each). In contrast, the share of foreign-born individuals aged 15-74 in Finland was comparatively low, at just 10%, significantly lower than neighboring Nordic countries such as Sweden (25%) and Norway (21%).

Figure 1 illustrates the share of foreign-born individuals in the total Finnish population between 1990 and 2023 (Statistics Finland 2024). In 1990, only 0.5% of the Finnish population was foreign-born. However, immigration has steadily increased over the decades, reaching 6.7% by 2023. The share of foreign-born employees follows the trends in total population. The immigration rate to Finland is also relatively low. In 1990, immigrants entering Finland represented just 0.1% of the total population, rising to 1.2% by 2023. The largest groups of immigrants in Finland have traditionally been Estonian, Swedish or Russian (Peri 2016). In recent years, however, there have been significant inflows of immigrants from Ukraine and Iraq (Statistics Finland 2024).

Foreign-born individuals in Finland are also unevenly distributed across different local areas, defined at the NUTS 3-level, which includes 19 regions. In 2023, the share of foreign-born individuals was highest in Åland (12.2%) and the capital city region Uusimaa (11.5%). In contrast, the lowest prevalence of foreign-born individuals was in Central Ostrobothnia (3.1%).

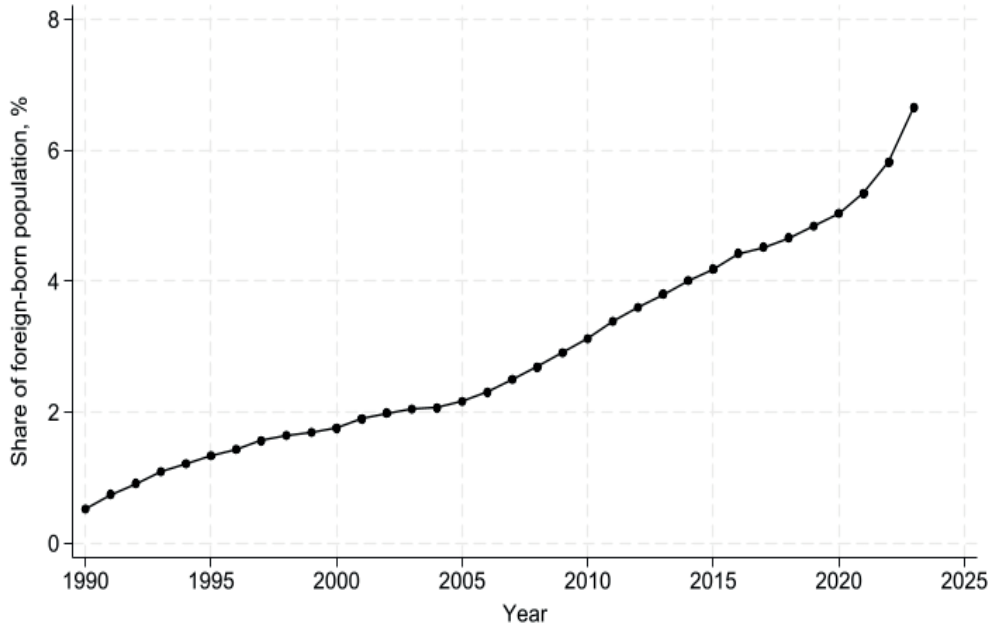

Figure 1: The share of boreign-born in Finland, 1990-2023 (Source: Statistics Finland)

3 Data Construction, Definitions and Methodology

3.1 Data sources

Several administrative datasets from Statistics Finland are utilized to examine the impact of immigrant employees on firms' innovation activity. The FOLK modules provide comprehensive background information on the entire population, including nationality, wages, employment, and other individual characteristics from 1987 to 2018. Employees are matched to their respective firms using unique identification codes.

The analysis is based on the Financial Statement panel, which provides firm-level data on income statements and balance sheets spanning 1987 to 2019. Enterprises with at least 20 employees are directly included, while data for smaller enterprises is obtained from administrative sources such as business taxation registers. This panel contains variables such as the number of personnel, industry code, value added, sales, and various financial

metrics. Using firm identification codes, the Financial Statement panel is linked to other administrative datasets, adding further firm-level characteristics. Specifically, firm-level information on location and age are sources from the Business Register and export data from Finnish customs. Firm-level employee characteristics, including the average age of employees, their education years, and the share of female workers, are drawn from the FIRM enterprise-specific personnel characteristics data. These additional datasets are available from 1999 onwards. Individual-level FOLK registers were also utilized to gather data on occupation of individual employees according to the ISCO-08 classification (International Standard Classification of Occupations). At the firm level, this enables identification of the share of a firm's workforce in STEM (Science, Technology, Engineering, and Mathematics) occupations. Consequently, a matched dataset is constructed, combining employee-level information with firm-level characteristics to provide comprehensive background data for each firm.

The patent data come from the Finnish Patent and Registration Office (PRH). The data include information on patents granted to companies for the 1995-2013 period, and patent applications from 1985 to 2013. Firm-level R&D surveys, available from 1989 onwards, were also included. These statistics are compiled from data provided by businesses, educational institutions, major university hospitals, polytechnics, and government organizations. The surveys are primarily designed to target companies likely to engage in R&D activities. Each year, the survey encompasses all firms that previously reported R&D work, large corporations (over 100 employees), companies that received government R&D funding or applied for R&D tax incentives, and a random selection of mid-sized businesses (10-100 employees). The annual sample size is roughly 4,000 companies, with response rates ranging from 75% to 78%. Survey questions comprehensively examine R&D activities and expenses at the firm level. Additionally, data on firms' innovation activities

from the Innovation Survey, conducted biennially from 2000 to 2018 and covering approximately 2,500 firms per year, were incorporated.

3.2 Immigrant status

The FOLK basic data is used to determine immigration status, with a person's origin serving as a key variable. This variable is based on the country of birth of both the individual and their parents. A person's origin is classified into four groups: (1) Finnish background, born in Finland; (2) Finnish background, born abroad; (3) foreign background, born in Finland; and (4) foreign background, born abroad. Immigrants are defined as individuals born abroad with a foreign background to distinguish them from those with Finnish ties through either parentage or birthplace.

3.3 Innovation outputs and inputs

The analysis distinguishes between innovation outputs and innovation inputs. Innovation output refers to the actual results or outcomes of the innovation process, while innovation inputs represent the resources utilized to create and foster innovation. Innovation output is measured first by the number of patent applications and granted patents in a given year. Additionally, it is assessed using two binary indicators, which are based on yes/no responses regarding whether firms were engaged in: a) process innovation activities, or b) product innovation during the past two years. Since the innovation survey is conducted biennially, the resulting sample size is reduced compared to the administrative register datasets on patents.[2] Process and product innovations are studies separately, because Gray, Montresor, and Wright (2020) find adverse effects of different innovation types as s response to (low skilled) immigration.

[2]Missing innovation data for intervening years were also imputed using values from the subsequent year in robustness test, and the results remained robust to the main findings.

R&D expenditure has been frequently used as a proxy for innovation activity in few studies. However, R&D spending is considered as an input to innovation rather than an output, and potential challenges arise when it is used as a direct measure of innovation (Lerner and Seru 2022). Nevertheless, to complement the analysis, it is important to understand whether immigration influences innovation activity directly or through it resources. In this paper, these resources are measured by both external and internal R&D expenditures (in euros), with data obtained from the R&D survey. Other key innovation inputs include human capital, which encompasses the skills, knowledge, and expertise of employees or researchers working on innovative projects. To capture this, the number of STEM workers is used, as these individuals are often directly involved in R&D and innovation activities. Accordingly, firms with higher numbers of STEM workers are more likely to pursue technological advancements, product development, and process improvements. STEM workers are labeled as those in ISCO 2-digit occupations classified under 21, 25, 31 and 35 (Meoli, Piva, and Righi 2024). Another variable representing human capital is the number of R&D workers, which is also derived from the R&D survey.

3.4 Sample construction and description of the firm samples

Table 1 summarizes the outcome variables and their definitions, along with the sample coverage for private sector firms operating in manufacturing. Firms in this sector are classified according to the Standard Industrial Classification (SIC 2002), the SIC codes 15-37 presenting the manufacturing sector. The number of immigrant employees and other firm characteristics could be biased if mergers and acquisitions are included in the sample. Such inclusions may distort the results, depending on the workforce composition and innovativeness of the joining firm compared to the base firm (S. Kerr P., W. Kerr, and W. Lincoln 2015). To address this issue, administrative

data on worker flows are used to identify mergers and acquisitions. Worker transitions are tracked where an employee changes firms between t and $t+1$, with mergers or acquisitions defined as cases where 50% or more of the employees from the initial employer move to a target firm within a year. For the estimation, only firms with at least 10 employees are included, excluding those involved in firm restructuring based on worker flow data, and omitting workers with zero annual earnings during the observation year.

The FOLK registers cover all private-sector employees and their employing firms, providing a large number of observations at both the worker and firm levels. The Financial Statement data include virtually all Finnish enterprises, as do the other administrative datasets. After excluding missing data on firm background characteristics, we have nearly 72 thousand firm-year observations in the manufacturing sector. The full estimation period spans from 2000 to 2018. However, occupation variable is available for 2000 and 2004-2018, yielding 59,168 firm-year observations (6,825 firms). The number of STEM workers is, on average, 14 employees in manufacturing firms. Patent data from 2000 to 2013 constitute a census of patent applications and granted patens registered by the Finnish Patent and Registration Office. Firms absent from this dataset are not engaged in patent activity. The patent data includes 53,332 firm-year observations, the average number of annual patent applications and granted patents being between 0.1 and 0.2. However, patent innovations tend to accumulate to a marginal sample of firms. Only 3-5% of manufacturing firms had a non-zero number of patent applications (on average, 4.4 applications) or granted patents (on average, 3.9 granted patents).

The R&D survey includes 21,501 firm-year observations. While the average internal R&D expenses were approximately 2.3 million euros, external R&D expenses were more modest, averaging 140,000 euros. Outsourced R&D activities thus constitute only 6% of total R&D expenses. Firms most

likely engaged in R&D activities employed on average 16 R&D personnel. Finally, the Innovation survey is the smallest sample, consisting of fewer than 9,000 firm-year observations. Among these firms, approximately half of the manufacturing firms reported engaging in process or product innovation in the past two years. The share of immigrant workers in a firm is approximately 3% across the samples.

3.5 Estimation specification

The relationship between immigrant workers and firm's innovation activity is examined by estimating the following linear probability model:

$$y_{it} = \delta \text{Share\_immig}_{it} + \beta' x_{it} + \gamma_t + \alpha_i + \theta_r + \epsilon_{it} \quad (1)$$

Here, y_{it} represents either innovation input or output for firm i in year t. The parameter α_i captures firm fixed effects, included to capture the unobserved time-invariant firm-specific factors affecting the firm's outcomes. Accordingly, γ_t represents calendar year, and θ_r represents region fixed effects (using the NUTS 3-level classification with 19 categories). x_{it} is a vector of time-varying firm characteristics, including the share of female employees, the average years of education and age of employees, exporter status, firm age, firm size (with three categories: 10-49 employees, 50-249 employees, and at least 250 employees), and industry classification (measured using a 2-digit SIC code). Despite the inclusion of firm fixed effects, industry is explicitly incorporated in the model because firms may switch industries within the same sector, reflecting changes in production strategies or survival tactics (N. Kuosmanen and T. Kuosmanen 2023). Similarly, some firms may change their location.[3] The key parameter of interest is δ, which captures how innovation activity changes with a one-percentage-point change in the

[3]Based on the data, 3,580 firms within the sample switched the 2-digit industry, and 1,334 firms changed the location at the NUTS 3-level during the study period.

Table 1: Description of the innovation variables

Variable	Definition	Source	Firm-year (firm) observations	Mean of innovation	Immigrant share, %
Process innovation	An indicator variable that gets a value of 1 if a firm has engaged in any process innovation in the past two years	Innovation survey conducted biennially, 2000-2018	8,838 (2,551)	0.47	3.08
Product innovation	An indicator variable that gets a value of 1 if a firm has engaged in any product innovation in the past two years	Innovation survey conducted biennially, 2000-2018	8,838 (2,551)	0.48	3.08
Patent applications	Number of patent applications in a given year	PRH data, years 2000-2013	53,332 (6,808)	0.17	2.92
Granted patents	Number of granted patents in a given year	PRH data, years 2000-2013	53,332 (6,808)	0.10	2.92
Internal R&D expenses	Internal R&D expenses (€)	R&D survey, years 2000-2018	21,501 (3,571)	2.29 million	3.00
External R&D expenses	External R&D expenses (€)	R&D survey, years 2000-2018	21,501 (3,571)	0.14 million	3.00
Number of R&D personnel	Number of workers doing R&D-related tasks at least 10% of the working time	R&D survey, years 2000-2018	21,501 (3,571)	16.33	3.00
Number of STEM workers	Number of workers holding 2-digit level ISCO occupation 21, 25, 31, or 35	FOLK registers, years 2000 and 2004-2018	59,168 (6,825)	14.10	3.80

share of immigrant workers in a firm. When model (1) is estimated by OLS (ordinary least squares), error terms ϵ_{it} are clustered at the firm level.

As should be noted, the parameter δ should be treated only as descriptive evidence. One concern involves measurement error. Classical measurement error due to inaccurate reporting is likely minimal in this study since all right-hand-side variables are sourced from administrative registers. However, some outcome variables are self-reported, but robustness tests using administrative proxies for innovation activities are provided. Accordingly, potential bias resulting from corporate mergers and acquisitions, as pointed out in S. Kerr P., W. Kerr, and W. Lincoln (2015), is taken into account by excluding those firms involved in firm restructuring based on worker flow data. A second concern is that the decision to hire immigrants may be influenced by other factors affecting the firm. For instance, the result could be upward biased if a firm has received an Innovation voucher and simultaneously hires skilled immigrants to pursue innovation activities. These issues may generate a correlation between the residual ϵ_{it} and the explanatory variable $Share\_immig_{it}$. To address these endogeneity concerns, an IV strategy is employed.

To identify the effect of immigrants, a plausibly exogenous source of variation in the local supply of immigrants is used as an instrumental variable estimator, following the approach by Altonji and Card (1991). This method has been widely used in various immigration-related empirical studies (Bratti and Conti 2018; Gray, Montresor, and Wright 2020; Ozgen, Nijkamp, and Poot 2013). The identification strategy relies on the concept of immigrant enclaves, based on the tendency of new immigrants to settle in areas where their compatriots have already established themselves. Accordingly, I construct an expected share of immigrants in a region to serve as an instrument for the share of a firm's immigrant workforce that operate in that region. Detailed data on immigrants' nationality is available for the entire migrant

population annually. However, due to Finland's relatively modest immigration rate compared to other Western/European countries (Edo 2019; Peri 2016), I group immigrants into seven broader geographic categories. These categories, defined by Statistics Finland immigration statistics, include Russia, Asia, Europe, North America, South America, Africa, and Oceania.

The instrument is constructed as follows. First, I calculate $IMMI_{rt}$, the imputed number of immigrants in region r (measured at the NUTS 3-level) for year t (t = 2000-2018):

$$IMMI_{rt} = \sum_{o} \left(\frac{IMMI_{ort_0}}{IMMI_{ot_0}} \times IMMI_{ot} \right) \tag{2}$$

In equation (2), $IMMI_{ot}$ represents the national stock of immigrants from originating region o in year t. These immigrants are allocated to Finnish regions r based on the initial distribution of immigrants from the same originating region o across regions in the base year t_0, which is 1995 in this analysis. The predicted stocks of immigrants from each originating region are then aggregated at the regional level to calculate the total predicted stock of immigrants in region r for year t.

The predicted share of immigrants in each region is subsequently calculated as:

$$IMMIshare_{rt} = \frac{IMMI_{rt}}{IMMI_{rt} + Native_{rt_0}} \tag{3}$$

Here, the denominator combines the imputed stock of immigrants with the native population of the region as of the base year 1995. The native population is fixed at 1995 levels to avoid spurious effects that could arise from endogenous changes in native population growth within a region during the 2000-2018 period. This predicted share serves as the instrumental variable, helping to address potential endogeneity in the observed immigrant workforce share at the firm level.

3.6 Test of validity of instrument

It is possible that unobserved region-specific factors or shocks may have influenced the initial immigrant inflow to certain regions and subsequently affected firm-level innovation activity. If this is the case, the exclusion restriction would be violated, and the instrument variable might be spuriously correlated with firm-level outcomes during the 2000-2018 period. To address this concern, I examine how pre-2000 firm-level innovation variables correlate with the instrumental variable. Since the initial year of immigrant stock is measured in 1995, innovation variables are drawn from before 1995, where data are available. Table 2 presents the correlation coefficients derived from the separate regressions. The results show no significant correlations between the firms' initial innovation input or output measures and the instrumental variable in the region where the firm is located. While these findings provide evidence that the instrumental variable is not correlated with the pre-"instrument" trends, they do not completely rule out the possibility of other omitted variables violating the exclusion restriction. Accordinglye, the firm location decision could be driven by the local concentration of immigrant population, although present research highlight the importance of other local characteristics, such as proximity to customers, suppliers and physical infrastructure (Parrotta, Pozzoli, and Pytlikova 2014, for a discussion). As a robustness test, the main analyses were also re-run for a sample of firms that were established before 1995, that is, before the initial immigrant stock were measured. The results remained robust to the main findings reported in this paper.[4]

[4]The results are available from the author upon request.

Table 2: Correlations between the imputed local share of immigrants (instrumental variable) and the pre-2000 firm-level innovation inputs and outputs

	Local imputed share of immigrants (1)	**Firm-year cbservations** (2)	**Pre-innovation data** (3)
Process innovation	-0.025	14,142	1991 or 1996
	(0.0166)		
Product innovation	0.000	14,142	1991 or 1996
	(0.0163)		
ln(Patent applications)	0.018	1,246	1990
	(0.0268)		
ln(Granted patents)	-0.040	1,044	1995
	(0.0498)		
ln(Internal R&D)	0.000	4,893	1989
	(0.0026)		
ln(External R&D)	0.002	4,893	1989
	(0.0037)		
ln(STEM workers)	0.003	33,541	1990
	(0.0052)		
ln(R&D workers)	0.005	4,893	1989
	(0.0128)		

Notes: Each row reports the OLS coefficient from a separate regression, where the outcome variable is the imputed local share of immigrants in 2000-2018 (instrumental variable) and the explanatory variable is a pre-2000 firm-level innovation input or output variable. Each model includes year and region indicators, and the standard errors are clustered at the firm level and reported in parentheses.

4 Econometric Results

4.1 Main results

Table 3 reports the OLS correlation coefficients between immigration and various firm-level outcomes related to productivity, as well as innovation outputs and inputs, across manufacturing firms. The models include the full set of explanatory variables described in model (1). The primary variable of interest is the share of immigrant employees in a firm (Column 1). Given that a majority of firms (approximately 60%) do not employ any immigrants, an indicator variable for firms with zero immigrant employees is also used as an alternative measure of the composition of immigrant employment (Column 2).[5] The findings reveal that presence of immigrants in a firm is significantly and positively associated with labor productivity and the number of STEM and R&D employees. Specifically, a one-percentage-point increase in the share of immigrants in a firm corresponds to a 0.2% increase in labor productivity and 0.5% increase in STEM workers. Conversely, firms with no foreign labor exhibit 1.7% lower productivity and 5-15% fewer research or STEM workers compared to otherwise similar firms with a foreign workforce. However, no consistent relationship between immigration and innovation outputs is observed, which stands in contrast to previous research often demonstrating links between immigration, patenting, and process and product innovations. These results highlight the need for a more robust identification strategy that leverages local, supply-driven inflow of immigrants.

Table 4 presents the preferred IV estimates, where the share of immigrant workforce in a firm is instrumented using a predicted share of immigrants in a region, derived from immigrant enclaves. The estimation models incorporate a comprehensive set of explanatory variables and fixed effects, with standard

[5] If smaller manufacturing firms, those with fewer than 10 employees, are also included in the sample, the proportion of companies that do not employ any foreign workers increases even further, reaching 80%.

Table 3: OLS estimates between immigration and firm's outcomes

Variable	(1)	(2)
ln(LP)	0.002***	-0.017***
	(0.0005)	(0.0061)
Process innovation	0.001	-0.018
	(0.0022)	(0.0190)
Product innovation	-0.003*	0.006
	(0.0019)	(0.0191)
ln(Patent applications)	0.000	-0.003
	(0.0002)	(0.0028)
ln(Granted patents)	0.000	0.000
	(0.0001)	(0.0021)
ln(Internal R&D)	-0.003	-0.227*
	(0.0139)	(0.1212)
ln(External R&D)	0.016	-0.077
	(0.0115)	(0.1043)
ln(STEM workers)	0.005***	-0.147***
	(0.0008)	(0.0095)
ln(R&D workers)	0.002	-0.054***
	(0.0022)	(0.0195)
Explanatory variable	Immigrant share in the firm	Indicator for zero immigrants in the firm

Notes: Each row reports the OLS coefficient from a separate regression, where the outcome variable is either labor productivity, innovation output or innovation input. Each model includes a full set of control variables and region, firm and year fixed effects described in model (1). Standard errors are clustered at firm-level and reported in parentheses. *** $p < 0.001$, * $p < 0.100$.

errors clustered at regional level - the level of variation of the instrument. The results differ from those of the OLS estimates. Increased immigration within a firm is positively associated with higher levels of process and product innovation in manufacturing firms. Specifically, a one-percentage-point increase in the employment share of immigrants corresponds to a 2.4 and 2.9 percentage-point increase in innovation activity. These percentage-point changes translate into a 5-6% higher probability of implementing new process or product innovations, evaluated at the mean. Regarding innovation inputs, immigration is negatively associated with external R&D expenditure, suggesting that foreign workers may substitute for outsourced R&D. However, no statistically significant effects are observed on the number of patent applications, granted patents, innovation inputs related to research or STEM workers, or internal R&D expenses. The final row reports the Kleibergen-Paap F-statistics, which assess the power of the instrument. The F-statistics consistently exceed 10, indicating that the instrument is robust and not weak. Therefore, the imputed local share of immigrants may thus be a strong predictor of immigrant employment within firms.

4.2 Robustness analyses

4.2.1 Alternative immigration measure

As a robustness test, an alternative measure of immigration is considered. Some recent studies (Bratti and Conti 2018; Gray, Montresor, and Wright 2020) have utilized region-level data on immigrant employment instead of firm-level data. In line with this approach, the IV estimation models are adjusted to use the NUTS 3-level share of immigrants in the total annual regional population to evaluate the impact of immigration on firm-level innovation. The results are presented in Table 5. Although the point estimates are slightly lower, the findings remain consistent with the main results based on employee-level immigration data. Specifically, a one-percentage-

Table 4: IV results: Share of immigrants and innovation outputs and inputs

	Process innovation	**Product innovation**	**ln(Patent applications)**	**ln(Granted patents)**	**ln(Internal R&D)**	**ln(External R&D)**	**ln(STEM workers)**	**ln(R&D workers)**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Share immigrant workers	0.024**	0.029**	0.006	-0.001	-0.067	-0.908***	0.002	-0.011
	(0.0093)	(0.0103)	(0.0051)	(0.0034)	(0.0965)	(0.1952)	(0.0115)	(0.0168)
Workforce characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	8,838	8,838	53,332	53,332	21,501	21,501	59,168	21,501
Number of firms	2,551	2,551	6,808	6,808	3,571	3,571	6,825	3,571
Kleibergen-Paap Wald test	10.391	10.391	10.204	10.204	26.299	26.299	14.055	26.299

Notes: The share of immigrant employees is instrumented by a predicted immigrant population share in a region. Innovation outputs: Columns 1-4. Innovation inputs: Columns 5-8. Each model includes a full set of control variables described in model (1). Standard errors are clustered at region-level and reported in parentheses. *** $p < 0.001$, ** $p < 0.050$.

point increase in the local immigrant population share is associated with a 1.4 percentage-point increase in the likelihood of a firm implementing new process innovations (equivalent to a 3% increase, evaluated at the mean) and a 1.7 percentage-point increase in the likelihood of a firm implementing new product innovations (equivalent to a 3.5% increase, evaluated at the mean). These estimates are statistically significant at least at the 5% level. Additionally, an increase in the local share of the immigrant population is linked to reduced external R&D expenses, consistent with the substitution effect observed in the main analysis. However, no significant relationships are detected between immigration and patenting activity or other innovation inputs. The Kleibergen-Paap F-statistics remain well above 10, confirming the strength of the instrument. Notably, the F-statistics are considerably higher when using regional-level immigration data compared to firm-level data.

4.2.2 Skilled immigrants

Previous studies have primarily focused on skilled immigrants as drivers of innovation, whereas this paper examines the impact of all immigrant employees within a firm. To explore whether innovation activity is more influenced by skilled immigrants, IV models are re-estimated using data on workers' skill levels. While education level, such as tertiary education, is commonly used to define skilled employees, Finnish register data only report migrants' education level and field if the education was obtained in Finland. Relying on such data would introduce measurement error in defining the share of a skilled workforce within firms. Instead, this analysis uses the ISCO-08 occupational classification to categorize workers into skilled groups. Skilled workers are defined as those employed in high-paying managerial, professional and technical roles (ISCO 1-digit levels 1-3).

The preferred instrumental variable results are presented in Table 6.

Table 5: IV results: Region-level share of immigrants and innovation outputs and inputs

	Process innovation	**Product innovation**	**ln(Patent applications)**	**ln(Granted patents)**	**ln(Internal R&D)**	**ln(External R&D)**	**ln(STEM workers)**	**ln(R&D workers)**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Local share of immigrants	0.014**	0.017**	0.003	0.000	-0.040	-0.539***	0.001	-0.007
	(0.0065)	(0.0079)	(0.0020)	(0.0015)	(0.0589)	(0.0497)	(0.0072)	(0.0097)
Workforce characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	8,838	8,838	53,332	53,332	21,501	21,501	59,168	21,501
Number of firms	2,551	2,551	6,808	6,808	3,571	3,571	6,825	3,571
Kleibergen-Paap Wald test	561.148	561.148	460.052	460.052	881.946	881.946	618.478	881.946

Notes: The local share of immigrant population is instrumented by a predicted immigrant population share in a region. Innovation outputs: Columns 1-4. Innovation inputs: Columns 5-8. Each model includes a full set of control variables described in model (1). Standard errors are clustered at region-level and reported in parentheses. *** $p < 0.001$, ** $p < 0.050$.

Due to the unavailability of occupational data for 2001-2003, the sample sizes are smaller than in previous analyses. Two notable findings emerge that differ from earlier results. First, skilled immigration no longer shows a statistically significant positive effect on firms implementing new process innovations. Although the point estimate is larger than in the main findings (Column 1 of Table 4), it misses statistical significance ($\delta = 0.044$, $p = 0.0514$). However, the coefficient for product innovation remains positive and is marginally significant at the 10% level. Second, skilled immigration positively influences the number of patent applications within firms. Specifically, a one-percentage-point increase in the share of skilled immigrant workers corresponds to a 3.5% increase in patent applications. Finally, consistent with the main findings, skilled immigration reduces the need for outsourced R&D services, again suggesting a substitution effect.

4.2.3 Alternative innovation measures

Two alternative measures of innovation activity are further conducted to assess the sensitivity of the results. Administrative data on external R&D expenses and revenues from patents and licenses are incorporated from the Longitudinal Database on Plants in Finnish Manufacturing. These data are available for manufacturing firms, though some information is missing, for the period 2000-2018. Firm revenues from patents and licenses are used as a proxy for innovation output. The preferred IV estimation results are reported in Table A1 of the Appendix. The findings indicate that immigration is negatively associated with external R&D expenses, consistent with similar outcomes obtained from a smaller sample of self-reported survey data. However, the coefficient for the relationship between immigration and the revenues from patenting and licenses is statistically significant at the 10% level, indicating a negative association between immigrant employment and the proxy for patenting.

Table 6: IV results: Share of skilled immigrants and innovation outputs and inputs

	Process innovation	**Product innovation**	**ln(Patent applications)**	**ln(Granted patents)**	**ln(Internal R&D)**	**ln(External R&D)**	**ln(STEM workers)**	**ln(R&D workers)**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Share of skilled immigrant workers	0.044	0.069*	0.035*	-0.002	-0.297	-3.682***	0.012	-0.042
	(0.0514)	(0.0424)	(0.0193)	(0.0117)	(0.3375)	(0.6824)	(0.0738)	(0.0548)
Workforce characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	7,514	7,514	40,797	40,797	17,318	17,318	59,168	17,318
Number of firms	2,262	2,262	5,938	5,938	3,037	3,037	6,825	3,037
Kleibergen-Paap Wald test	26.792	26.792	16.464	16.464	51.918	51.618	40.099	51.618

Notes: The share of skilled immigrant employees is instrumented by a predicted immigrant population share in a region. Innovation outputs: Columns 1-4. Innovation inputs: Columns 5-8. Each model includes a full set of control variables described in model (1). Standard errors are clustered at region-level and reported in parentheses. *** $p < 0.001$, * $p < 0.100$.

4.3 Alternative firm-level outcomes

This section considers how other firm-level outcomes respond to immigration growth within firms. First, labor productivity and total-factor productivity (hereafter TFP) are analyzed as outcome variables, as previous research consistently highlights a positive relationship between immigration and productivity growth (Beerli et al. 2021; Bitzer, Gören, and Kruse-Becker 2021; Mitaritonna, Orefice, and Peri 2017; Ottaviano, Peri, and Wright 2018). Labor productivity is measured by a firm's value added per employee, while TFP is a multifactor productivity measure estimated as the residual from a firm-level production function regression.[6] The results, presented in Column 1-2 of Table 7, indicate that a one-percentage-point increase in the share of immigrant workers raises labor productivity by 1.4%. The effect of immigrant employment on TFP is also positive and statistically significant at the 10% level.

Next, the focus shifts to firm expansion, measured by the sales and employment variables. The results, reported in Columns 3-4 of Table 7, reveal that immigrant employment drives firm growth, with approximately a 3% increase in both sales and employee numbers in response to a one-percentage-point rise in immigrant employment. Additional findings suggest that higher growth in immigrant employment is associated with lower employee departure rates. These estimates support the idea that firms on a positive growth trajectory are better able to recruit new employees and retain existing ones (S. Kerr P., W. Kerr, and W. Lincoln 2015). Finally, the analysis examines

[6]Specifically, we use a firm-level fixed effects model, represented by the following equation:

$$\exp(\varepsilon_{it}) = \frac{GO_{it}}{\exp(\alpha + \mu_i)(L_{it}^{\beta})(K_{it}^{\gamma})(M_{it}^{\delta})}$$

. In this equation, GO_{it} represents gross output (sales) of firm i in year t, while L_{it}, K_{it}, and M_{it}, represent the labor, capital, and intermediate inputs, respectively. The specific parameters include α, β, γ, δ as coefficients. μ_i accounts for firm-specific fixed effects, and ϵ_{it} captures the error term. The residuals reflect firm-level TFPs, measuring the efficiency with which firms transform their inputs into output.

the impact of immigrant employment on native workers within firms to determine whether immigrants replace or complement native employment. The results, reported in Column 5, show that native employment increases (by 1.4%) with a rise in immigrant employment, the coefficient being statistically significant at the 10% level.

5 Discussion

This paper provides novel evidence on the relationship between immigrant employment and innovation in Finnish manufacturing firms. The results suggest that foreign labor has the potential to drive innovation, with an increased share of immigrant employment positively affecting both process and product innovation. These findings contrast with Bratti and Conti (2018), who report a statistically insignificant relationship between immigration and the introduction of process or product innovations in Italian firms. Similarly, Ozgen, Nijkamp, and Poot (2013) find that Dutch firms with higher levels of immigrant employment are less innovative, although a more diverse foreign workforce is positively correlated with product innovation. In contrast, Gray, Montresor, and Wright (2020) show that low-skilled immigrant labor enhances process innovation but hinders product innovation. The novel contribution of this paper is the identification of a positive effect of immigration and both process and product innovation, which expands upon the existing literature.

Further analysis reveals that while total immigrant workforce stock does not correlate with increased patent activity in Finnish manufacturing firms, a higher concentration of skilled immigrants in managerial, professional and technical roles significantly boosts the number of patent applications. This finding aligns with the work of Ashraf and Ray (2017), Beerli et al. (2021), Bitzer, Gören, and Kruse-Becker (2021), Mayda, Orefice, and Santoni (2022),

Table 7: IV results: Share of immigrants and other firm-level performance

	ln(LP)	**TFP**	**ln(Sales)**	**ln(Employment)**	**ln(Native employment)**
	(1)	(2)	(3)	(4)	(5)
Share immigrant workers	0.014***	0.006**	0.029**	0.026***	0.014*
	(0.0049)	(0.0030)	(0.0142)	(0.0080)	(0.0080)
Workforce characteristics	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes
Region effects	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Number of obs.	71,915	71,352	71,915	71,915	71,915
Number of firms	7,688	7,626	7,688	7,688	7,688
Kleibergen-Paap Wald test	14.885	14.686	14.885	14.885	14.885

Notes: The share of immigrant employees is instrumented by a predicted immigrant population share in a region. Innovation outputs: Columns 1-4. Innovation inputs: Columns 5-8. Each model includes a full set of control variables described in model (1). Standard errors are clustered at region-level and reported in parentheses. *** $p < 0.001$, * $p < 0.100$.

and Stuen, Mobarak, and Maskus (2012), who have similarly found that skilled migrants contribute positively to patenting activity in firms. A second novel insight of this study is that immigrant employment may reduce reliance on outsourced innovation inputs, as indicated by the lower external R&D expenses observed with higher immigrant employment. This suggests that immigrant workers could play a role in internalizing and substituting innovation activities typically conducted outside the firm. In contrast, Gray, Montresor, and Wright (2020) finds that innovation inputs, as reflected in total R&D, increased alongside innovation outputs due to increased local immigration supply.

In addition to innovation, immigration appears to enhance productivity. This finding is consistent with previous firm-level studies, which highlight a positive association between foreign workforce and productivity (Beerli et al. 2021; Bitzer, Gören, and Kruse-Becker 2021; Mitaritonna, Orefice, and Peri 2017; Ottaviano, Peri, and Wright 2018). Gu, Hou, and Picot (2020) also find a positive relationship between the share of immigrants in a firm and its productivity, with the effects being more pronounced for less-skilled immigrants in the long term. However, an interesting outlier is Brunello, Lodigiani, and Rocco (2020), who report no effect on total factor productivity in Italian manufacturing firms following an increase in the local supply of low-skilled immigrants.

Lastly, the study shows that immigrant employment is linked to firm expansion, as measured by increased sales and employment. A one-percentage-point increase in the share of immigrant workers results in a 3% rise in both sales and total employment within Finnish firms. This is consistent with Beerli et al. (2021), who report similar effects of immigrant employment on firm growth. Furthermore, the results suggest that foreign employment does not crowd out native workers but rather complements their roles. This finding echoes Mitaritonna, Orefice, and Peri (2017), who note that immigrant

employment boosts native employment in less productive firms but leads to a reallocation of workers in more productive ones. In contrast, S. Kerr P., W. Kerr, and W. Lincoln (2015) find that skilled young immigrants increase the demand for skilled native workers within firms, while older natives experience less job growth. However, in Finnish manufacturing firms, higher immigrant employment did not increase the need for innovation inputs, such as skilled STEM or research workers.

6 Conclusion

As economic growth depends on innovation, it is crucial to identify the channels through which immigration impacts innovation. The case study from Finland is particularly interesting, as the average share of foreigners in Finland is considerably lower compared to other European countries (Edo 2019; Peri 2016). This paper analyzed the effect of immigrant workers on firms' innovation activity in the Finnish manufacturing sector, contributing to the growing literature on immigration and firm-level outcomes. We utilized rich datasets to examine how changes in the share of immigrant workers within firms relate to various firm-level measures, including innovation outputs and inputs. The research shows that immigration generally has a positive effect on firm performance, productivity, and innovation. Immigration leads to increased process and product innovation, but skilled migrants also enhance firm's patenting activity. Furthermore, we find evidence that immigration leads to reduced external R&D expenditures, suggesting that immigrant workers may substitute for outsourced innovation inputs. The study also finds that immigration does not negatively impact native workers' employment in Finnish firms. On the contrary, it can benefit natives with complementary skills.

The findings of this paper have important implications for immigra-

tion policy and firm strategies aimed at fostering innovation-lead economic growth. The results suggest that immigration primarily influences innovation outputs rather than inputs. Consequently, policies should prioritize intellectual property protection, facilitate collaboration between immigrant workers and local innovators, and incentivize firms to transform ideas into marketable products. To promote economic growth, it is therefore essential to increase Finland's attractiveness to foreign labor. However, two significant caveats must be considered. First, ethnicity-based recruitment discrimination remains prevalent in Finnish labor markets (Ahmad 2020). Second, although the number of immigrant workers arriving in Finland has increased over the past decades, a significant portion—approximately 50%—of skilled foreign workers leave Finland within a few years (Kauhanen et al. 2024). For the Finnish economy to fully benefit from immigrant labor, more work is needed to address ethnicity-based recruitment discrimination, encourage firms to hire immigrants, improve Finland's appeal to foreign workers, and develop strategies to improve or adapt workplace cultures to support successful integration of immigrants.

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A Appendix

Table A1: IV results: Immigration and alternative innovation outcomes

	ln(External R&D) (1)	**ln(Revenue from patents)** (2)
Share immigrant workers	-0.295***	-0.049*
	(0.0838)	(0.0255)
Workforce characteristics	Yes	Yes
Time effects	Yes	Yes
Region effects	Yes	Yes
Firm FE	Yes	Yes
Number of obs.	52,526	40,384
Number of firms	6,941	6,089
Kleibergen-Paap Wald test	17.048	13.132

Notes: The share of immigrant workers is instrumented by a predicted immigrant population share in a region. External R&D expenses and revenues from patents and licenses are sourced from the administrative Longitudinal Database on Plants in Finnish Manufacturing. Each model includes a full set of control variables described in model (1). Standard errors are clustered at region-level and reported in parentheses. *** $p < 0.001$, * $p < 0.100$.

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Tel. +358-9-609 900
www.etla.fi
firstname.lastname@etla.fi

Arkadiankatu 23 B
FIN-00100 Helsinki