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Labor Supply Shock and Firm Innovation: Evidence from EU Enlargement

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Abstract

This study examines the effects of the 2004 European Union enlargement on firm productivity and innovation in Finland. Using linked employer–employee and firm-level data, the analysis exploits increased access to workers from the ten new EU member states (EU10). To address the endogenous geographic distribution of immigrants, I construct an instrumental variable based on historically predetermined migration patterns. The results show that increased EU10 employment raises firm labor productivity, the probability of having a granted patent, and STEM employment, while effects on other innovation outcomes are more limited. The responses also differ across sectors. In manufacturing, EU10 employment increases process innovation but reduces STEM employment, whereas in services it increases labor productivity and the probability of having granted patents. Overall, the findings suggest that immigration-induced labor-supply changes can improve firm performance and affect selected dimensions of innovation, with the effects varying across sectors and innovation margins.

Tiivistelmä

EU:n laajentumisen ja työn tarjontasokin vaikutukset yritysten innovaatiotoimintaan

Tässä tutkimuksessa tarkastellaan vuoden 2004 Euroopan unionin laajentumisen vaikutuksia yritysten tuottavuuteen ja innovaatiotoimintaan Suomessa. Tutkimuksessa hyödynnetään yhdistettyjä työntekijä–työnantaja- ja yritystason aineistoja sekä EU:n kymmenestä uudesta jäsenmaasta (EU10) tulevan työvoiman saatavuuden lisääntymistä. Tilastollisessa analyysissa käytetään historiatietoja maahanmuuttajien alueellisesta keskittymisestä syy-seuraussuhteen identifioimiseksi. Tulosten mukaan EU10-maista tulevan työvoiman kasvu vaikuttaa myönteisesti tuottavuuteen sekä STEM-työntekijöiden määrään ja lisäksi kasvattaa patentoinnin todennäköisyyttä yrityksissä. Vaikutukset muihin innovaatiomittareihin ovat vähäisempiä. Vaikutukset eroavat myös toimialoittain. Teollisuudessa EU10-työvoiman kasvu kasvattaa prosessi-innovaatioiden todennäköisyyttä mutta vähentää STEM-työntekijöiden määrää. Palvelualoilla se puolestaan parantaa tuottavuutta ja kasvattaa patentoinnin todennäköisyyttä. Tulokset osoittavat, että maahanmuutosta aiheutuva työvoiman tarjonnan kasvu voi parantaa yritysten suorituskykyä ja vaikuttaa joihinkin innovaatiotoiminnan osa-alueisiin, mutta vaikutukset vaihtelevat toimialojen ja innovaatiomittareiden välillä.

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Keywords: EU enlargement, Firms, Immigration, Innovation, Instrumental variables, Productivity

Asiasanat: EU:n laajeneminen, Yritystason analyysi, Maahanmuutto, Innovaatiot, Tuottavuus, Instrumenttimuuttujamenetelmä

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1. Introduction

International migration has become an increasingly important source of labor supply in European economies. Most recently, Russia's war against Ukraine has generated a large inflow of displaced Ukrainians into European countries and renewed interest in the economic consequences of migration-induced labor-supply shocks for receiving economies (Caliendo et al., 2023; Postepska and Voloshyna, 2025). While much of the policy debate has focused on the employment and wages of native workers, immigration may also influence firms' production decisions, productivity, and incentives to innovate (e.g., Mitaritonna et al., 2017; Gray et al., 2020; Beerli et al., 2021). Understanding these firm-level responses is important for assessing the broader economic consequences of immigration.

The 2004 enlargement of the European Union provides a useful historical setting for examining these effects. The accession of ten new member states substantially increased opportunities for labor mobility from Central and Eastern Europe to Western and Nordic European countries. Although the institutional circumstances differ from more recent migration episodes, both illustrate how substantial changes in cross-border labor mobility can alter the labor supply available to firms. Finland initially imposed transitional restrictions on workers from eight of the new member states (excluding Malta and Cyprus), but these restrictions were removed in 2006 (European Commission, 2006). Immigration from the EU10 countries subsequently increased markedly. At the same time, the geographic distribution of immigrants was uneven across Finland, generating regional differences in exposure to the increase in EU10 labor supply (Statistics Finland, 2026).

Immigration can affect firms through several channels. Immigrant workers may expand the range of skills, complement or reallocate native workers, contribute to knowledge recombination through diversity, or affect market-size available to firms.[1] These mechanisms may increase productivity and encourage innovation. Conversely, an increase in labor supply may reduce incentives to adopt labor-saving technologies or alter firms' incentives to invest in innovation if immigrant labor substitutes for capital or other innovation inputs (e.g., Gray et al., 2020). The effect of immigration on firm innovation is therefore theoretically ambiguous and may depend on the nature of the labor supply shock, firms' initial characteristics and workforce, and their production technologies (Cohen and Levinthal, 1990; Kerr et al., 2015; Gray et al., 2020; Beerli et al., 2021).

Much of the literature linking immigration to innovation has focused on highly skilled migrants, who may contribute directly to knowledge creation through their scientific, technical, or entrepreneurial skills. Studies have documented positive relationships between skilled immigration and patenting, technological development, and firm innovation (e.g., Hunt and Gauthier-Loiselle, 2010; Kerr and Lincoln, 2010; Burchardi et al., 2020; Mayda et al., 2022). Other studies, however, examine broader immigration shocks without restricting attention to only highly skilled workers, and the evidence from European firms is more mixed (e.g., Ozgen et al., 2013; Bratti and Conti, 2018; Beerli et al., 2021).

The study most closely related to the present analysis is Gray et al. (2020), who exploit the 2004 EU enlargement to examine how a substantial increase in immigration affected innovation among UK firms. They characterize the resulting immigration shock as predominantly

[1] For a discussion of potential channels between immigration and innovation, see for example, Maczulskij (2026) and Ozgen et al. (2013).

involving less-skilled labor and find that immigration increased process innovation but reduced product innovation, with stronger responses among firms initially more intensive in less-skilled labor. The present study takes a more neutral approach to the skill composition of EU10 immigration and asks how firms respond to increased access to workers from the new EU member states. More generally, as emphasized by Glennon (2024), positive relationships between immigration and innovation at the regional level need not imply that individual firms become more innovative when their exposure to immigrant labor increases. Firm-level evidence is therefore important for identifying the mechanisms through which immigration affects innovation.

This paper examines the effects of the 2004 EU enlargement on productivity and innovation among Finnish manufacturing and selected private-sector service firms. I combine linked employer–employee records with firm-level administrative and survey data that provide information on firms' financial performance, workforce composition, R&D activities, and innovation outcomes. Innovation outputs are measured by patent applications and grants and by process and product innovation, while innovation inputs include internal R&D expenditure and STEM employment. This broad set of outcomes makes it possible to examine whether immigration affects the resources firms devote to innovation as well as realized innovative activity.

The empirical analysis exploits differences in firms' exposure to the increase in EU10 immigration following enlargement. A key identification challenge is that immigrants do not locate randomly across regions. Local labor-market conditions may simultaneously attract immigrants and affect firms' productivity and innovation, generating an endogenous relationship between immigrant employment and firm outcomes. To address this concern, I develop an instrumental-variable strategy inspired by Burchardi et al. (2019) and Terry et al. (2026). The instrument combines historically predetermined settlement patterns with subsequent immigration shocks and uses geographic and continental leave-outs to isolate supply-driven variation in EU10 immigration that is unrelated to contemporaneous regional labor-demand conditions.

The results indicate that increased exposure to EU10 workers has positive effects on firm productivity and selected dimensions of innovation. The IV estimates show that a 1 percentage-point increase in the EU10 worker share raises labor productivity by approximately 0.4%, increases the probability of having a granted patent by 2.2 percentage points, and increases STEM employment by approximately 9%. In contrast, I find no statistically significant effects on process or product innovation, patent applications, or internal R&D expenditure. The effects also differ substantially across sectors. In manufacturing, greater EU10 employment increases process innovation but reduces STEM employment, whereas the positive effects on productivity and granted patents are concentrated among service-sector firms. These findings suggest that immigration-induced labor supply changes affect firms along several margins and that the nature of these adjustments differs across industries.

The paper contributes to the literature in three ways. First, it provides firm-level evidence on the consequences of increased labor mobility following a major episode of European economic integration. This complements a literature that has often examined immigration and innovation at more aggregate levels or focused on highly skilled immigration. Second, by considering innovation inputs alongside several innovation outputs, the analysis provides evidence on how firms adjust both the resources devoted to innovation and realized innovative activity. Third, Finland provides a useful setting in which to examine these effects because immigration was relatively limited before EU enlargement. The substantial subsequent increase in EU10 immigration therefore represents a meaningful change in firms' potential access to immigrant labor.

The remainder of the paper is organized as follows. Section 2 discusses the related literature and institutional background. Section 3 describes the data and sample construction. Section 4 presents the empirical strategy, and Section 5 reports the results. Section 6 concludes.

2. Conceptual Framework

2.1. Previous Literature

A growing literature examines the relationship between immigration and innovation. Much of the earlier evidence is based on regional or industry-level variation and generally points to a positive relationship between immigration and innovative activity (see Capoani et al., 2024, for a review). Skilled migration has been associated with greater innovation across European manufacturing industries (Fassio et al., 2019), while studies from the United States document positive effects of foreign students and immigrants on patenting (Gnanaraj et al., 2008; Hunt and Gauthier-Loiselle, 2010; Terry et al., 2026). These findings indicate that immigration can contribute to innovation by expanding the stock of human capital and knowledge available in the receiving economy.

More closely related to the present study is the growing literature using firm-level data to examine how immigration is related to firms' innovation activity. The evidence from these studies is mixed. Bratti and Conti (2018) examine Italian firms and find no statistically significant relationship between immigration and product, process, or organizational innovation. Using Dutch employer–employee data, Ozgen et al. (2013) find that firms employing a larger share of immigrants tend to be less innovative, although greater diversity within the immigrant workforce is associated with higher product innovation.[2] By contrast, other studies provide evidence of positive innovation effects. Mayda et al. (2022) find that immigration increases firms' product innovation and patenting activity in France, particularly when immigrant workers are highly educated. Similarly, Stuen et al. (2012) show that foreign graduate students contribute positively to patenting in U.S. universities, while, Bitzer et al. (2021) find a positive association between immigration and patent applications in Danish manufacturing. Overall, the firm-level evidence suggests that the effects of immigration on innovation are heterogeneous and may depend on the skill composition of immigrants, firm characteristics, and the type of innovation considered.

Several mechanisms may account for these heterogeneous effects. Immigrants can directly augment firms' human capital and alleviate skill shortages, while complementarities between immigrant and native workers can improve the allocation of skills within firms. A more diverse workforce may also broaden the range of knowledge, ideas, and perspectives available to firms and thereby facilitate knowledge recombination and innovation. At the same time, these benefits need not arise uniformly across firms. Their realization may depend on firms' existing knowledge base and absorptive capacity (Cohen and Levinthal, 1990), as well as on their ability to integrate heterogeneous workers. Immigration may therefore generate larger innovation effects in firms that are already better positioned to exploit additional skills and knowledge.

[2] Workforce diversity may foster innovation by combining workers with different knowledge, experiences, networks, and problem-solving approaches, thereby facilitating knowledge recombination (Nathan and Lee, 2013; Parrotta et al., 2014). However, diversity may also increase coordination and communication costs, and its effects can vary across firms and types of innovation (Ozgen et al., 2013).

Another strand of the literature exploits policy reforms and other exogenous changes in access to foreign labor to identify firm responses to immigration.[3] Studies have used changes in skilled-worker visa policies in the United States (e.g., Kerr and Lincoln, 2010; Ghosh et al., 2016; Ashraf and Ray, 2017; Doran et al., 2022), the removal of restrictions on cross-border workers in Switzerland (Beerli et al., 2021), and the 2004 eastern enlargement of the European Union (Gray et al., 2020). These studies are particularly relevant because they separate immigration-induced labor supply changes from firms' endogenous decisions to recruit foreign workers.

Gray et al. (2020) provide the closest comparison to the present study. They exploit the 2004 EU enlargement to examine how UK firms adjusted their innovation activity following increased access to Eastern European workers. In contrast to much of the literature emphasizing highly skilled immigration, Gray et al. (2020) characterize the enlargement as generating an increased supply of less-skilled labor. They find that the labor-supply shock increased process innovation but reduced product innovation, with an overall positive effect on innovation activity. Beerli et al. (2021), in turn, find that improved access to foreign workers following the removal of immigration restrictions in Switzerland increased firms' innovation activity and R&D employment. More generally, this literature shows that immigration shocks can affect not only the composition of firms' workforces but also their broader production and innovation decisions.

[3] Empirical studies address the endogeneity of immigration using various identification strategies, including shift-share instruments based on historical settlement patterns (e.g., Bratti and Conti, 2018; Mayda et al., 2022; Ozgen et al., 2013), policy-induced variation from immigration reforms (e.g., Kerr and Lincoln, 2010; Ashraf and Ray, 2017; Ghosh et al., 2016; Doran et al., 2022), and quasi-experimental variation from exogenous labor-supply shocks (e.g., Beerli et al., 2022; Gray et al., 2020).

The present study contributes to this literature by examining the effects of the 2004 EU enlargement on Finnish manufacturing and service firms. Rather than focusing on a particular skill group, the analysis considers firms' exposure to EU10 workers more broadly and examines responses across several dimensions of firm performance and innovation. The linked data allow innovation inputs and outputs to be considered separately, alongside firm productivity. The Finnish setting also complements the existing evidence from the United Kingdom and other larger European economies, given the relatively low level of immigration prior to EU enlargement.

2.2. Institutional Background

Finland has traditionally had relatively low levels of immigration compared with many other European countries. In 2023, foreign-born individuals aged 15–74 accounted for approximately 10% of the population in Finland, compared with 25% in Sweden and 21% in Norway, while the corresponding share across the EU was 14.5% (Eurostat, 2026). Nevertheless, immigration to Finland has increased steadily over the past three decades.

Figure 1 illustrates this development by showing the share of individuals with a foreign background in the Finnish population between 1990 and 2025. The figure follows Statistics Finland's classification of foreign background, which is also used to identify immigrants in the empirical analysis. The share increased from less than 1% in 1990 to approximately 10% in 2025, with particularly rapid growth in recent years. Historically, immigration to Finland has been dominated by individuals originating from nearby countries, particularly Estonia, Sweden, and Russia (Peri, 2016), although the composition of immigration has become increasingly diverse over time (Maczulskij, 2026).

An important institutional change during this period was the enlargement of the European Union in May 2004, when ten new member states joined the EU: Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia, Cyprus, and Malta. These countries are hereafter referred to as the EU10. The enlargement substantially increased opportunities for labor mobility between the new and existing EU member states. Finland initially imposed a two-year transitional restriction on the free movement of workers from the EU8 countries, excluding Cyprus and Malta, but these restrictions were removed in May 2006. As Figure 1 shows, the share of immigrants originating from the EU10 countries increased markedly following the enlargement.

[Add Figure 1 here]

Immigrants are also unevenly distributed geographically within Finland. Across the country's 19 NUTS 3 regions, the immigrant population is particularly concentrated in Åland and Uusimaa, which includes the Helsinki metropolitan area. In 2023, immigrants accounted for 12.2% of the population in Åland and 11.5% in Uusimaa, compared with only 3.1% in Central Ostrobothnia (Statistics Finland, 2024). This geographic variation in immigrant settlement is important for the empirical analysis, which exploits differences in firms' exposure to immigration across Finnish regions.

3. Data Construction and Variable Definitions

3.1. Data

The empirical analysis combines several administrative datasets maintained by Statistics Finland. The main firm-level source is the Financial Statement Panel, which contains information on firms' balance sheets and income statements from 1987. The data cover all enterprises with at least 20 employees, while information on smaller firms is obtained from administrative sources, including business taxation records. The panel provides information on employment, industry, value added, sales, and financial characteristics. Firm identifiers are used to link these records with information on firms' geographical location from the Business Register.

Information on employees is obtained from the FOLK population registers. These longitudinal administrative records contain detailed information on individuals' demographic characteristics, nativity, employment, earnings, and education from 1987 onwards. Employees can be linked to their employers through unique identifiers, allowing the demographic and educational composition of each firm's workforce to be constructed.

The linked firm data are complemented with several sources of information on innovation activity. Patent information is obtained from the Finnish Patent and Registration Office (PRH) and covers patent applications from 1985 to 2013 and patents granted during 1995–2013. Information on R&D activity and expenditure comes from Statistics Finland's R&D survey, available from 1989 onwards. The survey primarily covers firms that conduct or are likely to conduct R&D and includes approximately 4,000 firms annually, with response rates of around 75–78%. Finally, the analysis uses the Community Innovation Survey (CIS), conducted every second year from 2000 onwards, to obtain information on firms' broader innovation activities. Each CIS wave covers approximately 2,500 firms. The empirical analysis begins in 2000, while the end year varies across outcomes according to the availability of the underlying data, as summarized in Table 1.

3.2. Immigrant Status

Immigrant status is constructed using the individual-level origin variable available in the FOLK registers. Statistics Finland's classification of origin takes into account both an individual's country of birth and the countries of birth of their parents, distinguishing between individuals with Finnish and foreign backgrounds who were born either in Finland or abroad. In the empirical analysis, immigrants are defined as individuals with a foreign background who were born abroad. This definition excludes foreign-born individuals classified as having a Finnish background and individuals with a foreign background who were born in Finland. EU10 workers are defined as immigrants whose country of origin is one of the ten countries that joined the EU in 2004.

3.3. Outcome Variables

The analysis examines the effects of the 2004 EU enlargement on firms' productivity and innovation-related outcomes. Labor productivity is measured as value added per employee (full-time equivalents). For innovation, I distinguish between outputs that capture realized innovative activity and inputs that measure the resources firms devote to generating innovation. Innovation outputs are first measured using two indicator variables: (1) whether a firm filed at least one patent application in a given year and (2) whether a firm had at least one patent granted in a given year. [4] As alternative measures of innovation output, I consider firms' process and

[4] Although patenting is less prevalent in services than in manufacturing, some of the service industries included in the analysis, such as communications, technical and business services, and environmental services, may engage in

product innovation. Based on the Community Innovation Survey, two indicator variables identify whether a firm introduced (3) a process innovation or (4) a product or service innovation during the preceding two years. Because the survey is conducted biennially, missing innovation data for intervening years were imputed using values from the subsequent year. Process and product innovation are considered separately, as previous research suggests that immigration may affect different forms of innovation differently (Gray et al., 2020; Ozgen et al., 2013). Innovation inputs capture the resources firms devote to innovative activity. The first measure is (5) internal R&D expenditure. The second captures innovation-related human capital through (6) the number of STEM workers. STEM workers are defined as employees holding a Master's degree or an equivalent qualification in science, technology, engineering, or mathematics.

3.4. Sample Construction and Descriptive Statistics

The analysis focuses on firms operating in manufacturing and selected private-sector service industries for which the innovation measures considered in the study are particularly relevant. Industries are classified according to the Standard Industrial Classification (SIC 2002). In addition to manufacturing (SIC codes 15–37), the sample includes transport, storage and communications; financial intermediation; real estate, renting and business activities; and selected community and environmental services (SIC codes 60–74 and 90–93). Public-sector activities and sectors such as wholesale trade, hotels, and restaurants are excluded because their

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patentable technological innovation. Firms are classified according to their principal industry and may therefore undertake patenting activity even when their main activity is the provision of services.

innovation processes and institutional settings differ substantially from those of the industries considered in the analysis.

The estimation sample is further restricted to firms with at least 20 employees and excludes firms undergoing restructuring, identified using administrative worker-flow data.[5] This restriction reduces potential measurement problems arising from mergers and acquisitions, which may mechanically alter both workforce composition and other firm characteristics. As Kerr et al. (2015) point out, such events may distort measured relationships depending on the workforce composition and innovativeness of the acquired or merged firm relative to the base firm.

Table 1 summarizes the sample coverage and descriptive statistics for the productivity and innovation outcomes. The estimation period varies across outcomes because of differences in the coverage of the underlying data sources. Labor productivity, observed over 2000–2023, provides the largest sample, with 78,478 firm-year observations and average value added per employee of approximately EUR 66,000. The number of STEM workers is available for 2000–2018, yielding 65,349 firm-year observations, with firms employing an average of 6.6 STEM workers.

Patent outcomes are observed over 2000–2013 and cover 51,128 firm-year observations. Patenting is relatively uncommon: 4.5% of firm-year observations involve at least one patent application and 3.1% at least one granted patent. The CIS-based measures of process and product innovation cover 2000–2022 and provide 21,020 firm-year observations.

[5] Mergers and acquisitions are identified using administrative worker-flow data. A firm is classified as undergoing restructuring if at least 50% of its employees move to the same target firm between years t and t+1.

Approximately 46% of these observations report process innovation and 47% product or service innovation during the preceding two years. Internal R&D expenditure is available over 2000–2020 for 24,368 firm-year observations, with average expenditure of approximately EUR 2.2 million.

EU10 workers account for a relatively small share of firm employment across the estimation samples. The average EU10 worker share ranges from 0.32% in the R&D sample to 0.45% in the patent and STEM-worker samples. For comparison, the average share of all immigrant employees is substantially higher, at approximately 3.4% across the different samples (not reported in the table).

[Add Table1 here]

4. Model Specification

The effects of the 2004 EU enlargement on firm productivity and innovation are first estimated using the following specification:

$$y_{it} = \beta\left[Post_t \times EU10_{i,2004}\right] + \alpha_i + \mu_s + \gamma_t + \theta_r + \delta'(x_{it_0} \times \gamma_t) + \varepsilon_{it} \qquad (1)$$

where y_{it} denotes a productivity or innovation outcome for firm i in year t. $EU10_{i,2004}$ is the share of EU10 workers in firm i in year 2004, capturing the firm's exposure to EU enlargement. $Post_t$ is an indicator for the post-enlargement period, equaling to 1 for post-2004 period and 0 for the 2000-2004 period (see also Gray et al., 2020). The parameter α_i captures firm fixed effects, μ_s denotes industry fixed effects at the 2-digit SIC level, γ_t represents calendar-year fixed effects, and θ_r denotes region fixed effects based on the LAU-1 classification (70 local administrative regions). Following Aghion et al. (2024), the specification also includes a vector of initial firm characteristics measured at t_0 (firm size, sales, and patent stock) interacted with year fixed effects. The coefficient β captures differential post-enlargement changes in firm outcomes associated with the labor supply shock induced by the 2004 EU enlargement. Standard errors are clustered at the region level.

Although the 2004 EU enlargement generated an exogenous change in the potential supply of EU10 labor to Finnish firms, firms' actual exposure to EU10 workers may be endogenous. In particular, EU10 immigrants may locate in regions experiencing favorable labor-demand or innovation shocks, while firms that employ immigrant workers may differ systematically from other firms. Moreover, the eastern enlargement differentially exposed firms across regions and industries (Kuosmanen and Meriläinen, 2025).[6] A related concern, emphasized by Terry et al. (2026), is that immigrants from particular origin countries may possess skills that are especially well suited to industries concentrated in specific regions. To address these concerns, I construct a modified version of an instrumental variable based on the two-step approach of Burchardi et al. (2019) and Terry et al. (2026). The strategy exploits historically predetermined migration patterns to isolate supply-driven variation in firms' exposure to EU10 immigration.

[6] Other potential sources of endogeneity include measurement error, although this concern is limited by the use of administrative data. Potential bias arising from corporate mergers and acquisitions (Kerr et al., 2015) is addressed by excluding firms undergoing restructuring identified from worker-flow data.

In the first step, I predict the pre-existing immigrant stock in 2003 from EU10 origin county o in local region r using migration patterns observed from the baseline year 1995.[7] The approach combines leave-out measures of origin-specific migration ("push") and regional attractiveness ("pull"):

$$A_{o,r,2003} = \delta_{o,l(r)} + \delta_r + X'_{o,r}\varphi + a_{l(r)}\left[I_{o,-l(r),1995}\frac{I_{non-Europe,r,1995}}{I_{non-Europe,1995}}\right] + \varepsilon_{o,r,2003} \qquad (2)$$

The push component, $I_{o,-l(r),1995}$, measures migrants arriving from origin o to Finland outside the NUTS3 region *l(r)* containing local region r. The pull component, $\frac{I_{non-Europe,r,1995}}{I_{non-Europe,1995}}$, captures local region r's share of immigrants arriving from outside Europe. The 70 LAU-1 local regions are nested within 19 NUTS3 regions, which are used to construct geographic leave-outs. The specification further includes origin country×NUTS3-region fixed effects, $\delta_{o,l(r)}$,, local-region fixed effects, δ_r, and time-invariant regional characteristics, $X'_{o,r}$, including geographic distance and differences in altitude. Equation (2) yields the predicted pre-existing immigrant stock from origin o in region r in 2003, $\hat{A}_{o,r,2003}$, based on the orthogonalized push-pull component.

[7] Rather than using a long historical series of migration flows to construct the pre-existing settlement pattern, I use immigrant settlement in 1995 as the historical baseline for three reasons. First, earlier immigration to Finland was too limited to provide a sufficiently informative distribution across regions. Second, several Eastern European EU10 countries became independent only in the early 1990s, complicating the construction of consistent country-specific migration histories for earlier decades, when migrants from these areas were often recorded under broader geographical entities such as the Soviet Union. Third, Finland experienced a severe recession in the early 1990s, during which the unemployment rate rose to approximately 16%. The economy began to recover in 1993–1994, improving employment opportunities for both native and immigrant workers. I therefore use 1995 as the first post-recession year providing a sufficiently informative and consistently measured historical settlement pattern.

In the second step, the predicted pre-existing immigrant stock is interacted with the 2004 leave-out immigration flow from each EU10 origin region:

$$I_{o,r,2004} = \delta_{o,l(r)} + \delta_r + X'_{o,r}\theta + \rho\left[\hat{A}_{o,r,2003} \times \tilde{I}_{o,-l(r),2004}\right] + \mu_{o,r,2004} \tag{3}$$

where $\tilde{I}_{o,-l(r),2004} = I_{o,-l(r),2004}\left(\frac{I_{non-Europe,r,2004}}{I_{non-Europe,2004}}\right)$. The resulting origin-specific predicted immigration shocks are then aggregated across the EU10 countries to obtain predicted immigration shock for local region r following the enlargement, $\hat{I}_{r,2004}$. In the firm-level IV regression, the predicted regional immigration shock interacted with $Post_t$ is used as an instrumental variable in the IV regressions for $Post_t \times EU10_{i,2004}$.

The identifying assumption is that, conditional on the included fixed effects and controls, the historical push–pull interactions used to construct predicted EU10 immigration shocks are unrelated to subsequent region-specific shocks to firm productivity and innovation. The geographic leave-out prevents migration to the firm's own broader region from determining the push component, while the continental leave-out constructs regional attractiveness using immigrants from origins outside Europe. These restrictions are intended to reduce the possibility that the instrument captures persistent origin-specific or regional labor-demand conditions rather than supply-driven immigration following EU enlargement.

5. Econometric Results

5.1. Main Results

Panel A of Table 2 reports the OLS estimates for the relationship between exposure to the 2004 EU enlargement and firms' labor productivity and innovation outcomes. Patenting and process and product innovation are measured using indicator variables, whereas continuous outcomes are transformed using the logarithm of the variable plus one to retain observations with zero values. The estimates indicate that a higher post-enlargement EU10 worker share is positively associated with patenting activity but negatively associated with labor productivity and product or service innovation. Specifically, a 1 percentage-point (pp) increase in the EU10 worker share is associated with a 0.16 pp increase in the probability of filing a patent application and a 0.11 pp increase in the probability of having a granted patent. Relative to the respective sample means, these effects correspond to increases of approximately 3.6% and 3.5%. In contrast, a 1 pp increase in the EU10 worker share is associated with approximately 0.03% lower labor productivity and a 2.7 pp lower probability of product or service innovation, the latter corresponding to approximately 5.7% of the sample mean.

No statistically significant relationships are found for process innovation, internal R&D expenditure, or STEM employment. Overall, the OLS estimates therefore provide mixed evidence on the relationship between EU10 employment and firm performance. Moreover, these associations need not reflect causal effects, as the geographic distribution of EU10 immigrants and firms' exposure to immigrant labor may respond to local economic conditions. Panel B addresses this concern using the instrumental-variable strategy described above.

Panel B reports the corresponding IV estimates. The first-stage relationship is strong across all outcome-specific samples: the Kleibergen–Paap Wald F-statistics range from 33.9 to 98.8, providing little indication of a weak-instrument problem. The IV estimates differ substantially from their OLS counterparts. Most notably, the negative OLS association with labor productivity reverses sign: a 1 pp increase in the EU10 worker share increases labor productivity by approximately 0.4%.[8] The IV estimates also indicate positive effects on granted patents and STEM employment. A 1 pp increase in the EU10 worker share raises the probability of having a granted patent by 2.15 pp and increases the number of STEM workers by approximately 9.2%. Relative to the respective sample means, these estimates imply a 69% increase in the probability of having a granted patent and approximately 0.6 additional STEM workers per firm. By contrast, the estimates for process and product innovation, patent applications, and internal R&D expenditure are not statistically significant.

The contrast between the OLS and IV estimates suggests that endogenous immigrant location and firm–worker matching may influence the associations observed in the OLS specifications. Once the analysis exploits supply-driven variation in EU10 immigration, the negative associations with productivity and product innovation are no longer observed. The preferred IV estimates instead provide evidence of positive effects on labor productivity, granted patents, and innovation-related human capital, as measured by STEM employment.

[Add Table 2 here]

[8] The positive productivity effect is also observed when total factor productivity (TFP), estimated as the residual from a firm-level production function, is used as an alternative outcome. A 1 pp increase in the EU10 worker share increases TFP by approximately 5.5% (results available upon request).

5.2. Heterogeneity Analyses

Table 3 reports the preferred IV estimates separately for manufacturing (Panel A) and service-sector firms (Panel B). The results reveal substantial heterogeneity across the two sectors. In manufacturing, EU10 employment has no statistically significant effect on labor productivity, whereas the probability of process innovation increases. A 1 pp increase in the EU10 worker share raises the probability of process innovation by approximately 40 pp. Relative to the sample mean of 0.485, this corresponds to an increase of about 83%. In contrast, the number of STEM workers decreases by approximately 26%, corresponding to about 1.9 fewer STEM workers per firm when evaluated at the sample mean. Although these effects are economically large, they should be interpreted in light of the relatively low average EU10 worker share of around 0.4%. A 1 pp increase therefore represents a substantial change in firms' exposure to EU10 workers. The estimated effects on product innovation, patenting activity, and internal R&D expenditure are not statistically significant.

The results for service-sector firms differ markedly. A 1 pp increase in the EU10 worker share is associated with approximately 0.4% higher labor productivity and a 0.6 pp increase in the probability of having a granted patent. Evaluated against the relatively low mean probability of a granted patent among service-sector firms (1.0%), the latter effect is economically sizeable. The estimated effects on process and product innovation, patent applications, internal R&D expenditure, and STEM employment are not statistically significant. The first stage remains sufficiently strong in both sectoral samples, with Kleibergen–Paap Wald F-statistics ranging from 14.5 to 26.3 in manufacturing and from 22.6 to 53.7 in services.

Overall, the sector-specific estimates suggest that the pooled effects mask considerable heterogeneity. The positive productivity effect observed in the full sample appears to originate primarily from service-sector firms, whereas the positive effect on process innovation is concentrated in manufacturing. The results for innovation-related human capital are less uniform: while the pooled estimates indicate an increase in STEM employment, the manufacturing estimates suggest a reduction, and the corresponding effect for services is positive but remains statistically insignificant at conventional level of significance.

[Add Table 3 here]

6. Discussion and Conclusions

This study examines how increased access to immigrant labor following the 2004 EU enlargement affected firm productivity and innovation in Finland. The enlargement provides a useful setting for studying this question because immigration from the new EU member states was relatively limited before enlargement but increased thereafter. To address the endogenous location choices of immigrants, the analysis combines the enlargement with historically predetermined migration patterns to construct an instrument for firms' exposure to EU10 workers.

The results indicate that increased EU10 employment improved firm productivity, while its effects on innovation were more selective. In the preferred IV estimates, a higher EU10 worker share increases labor productivity, the probability of having a granted patent, and the number of STEM workers. The positive productivity effect in the pooled sample is broadly consistent with previous evidence documenting productivity gains from immigration (Beerli et al., 2021;

Bitzer et al., 2021; Gu et al., 2020; Mitaritonna et al., 2017; Ottaviano et al., 2018). Similarly, the positive effect on granted patents is consistent with previous evidence linking immigration to greater patenting activity (Ashraf and Ray, 2017; Beerli et al., 2021; Bitzer et al., 2021; Mayda et al., 2022; Stuen et al., 2012), as well as with recent evidence from Finnish firms showing that overall immigration increases patenting and R&D employment (Maczulskij, 2026). Importantly, however, the effects are not uniform across innovation measures: no statistically significant effects are found for patent applications, process or product innovation, or internal R&D expenditure. The findings therefore suggest that greater access to immigrant labor affects particular margins of firm performance and innovative activity rather than generating a broad-based increase in innovation.

The sector-specific estimates reveal further heterogeneity. In manufacturing, increased EU10 employment raises the probability of process innovation but reduces STEM employment, while no statistically significant effect on productivity is observed. The positive effect on process innovation is particularly interesting in light of Gray et al. (2020), who find that the labor-supply shock generated by the 2004 EU enlargement increased process innovation among UK firms. The absence of a productivity effect in manufacturing is also consistent with Brunello et al. (2020), who find no effect on total factor productivity among Italian manufacturing firms following an increase in the local supply of less-skilled immigrants. In services, by contrast, EU10 employment increases labor productivity and the probability of having a granted patent, while the remaining innovation outcomes are largely unaffected. These sector-specific estimates suggest that firms may respond differently to immigration-induced labor-supply changes depending on the nature of production and innovation across industries.

More broadly, the findings complement a literature that has often emphasized highly skilled immigration as a source of knowledge and innovation. The 2004 enlargement generated a broader labor-supply shock that was not targeted specifically toward highly skilled workers. Nevertheless, the results indicate positive effects on productivity and selected innovation outcomes. The positive effect on STEM employment in the pooled sample is also consistent with evidence that immigration can increase firms' demand for skilled labor. Kerr et al. (2015) find that skilled young immigrants increase the employment of skilled native workers within firms, while Maczulskij (2026) documents an increase in R&D employment in response to immigration among Finnish manufacturing firms. One possible mechanism is complementarity between immigrant and native workers through greater task specialization and a more efficient allocation of skills within firms (Peri and Sparber, 2009, 2011). Although the present analysis does not distinguish between native and immigrant STEM employment, the increase in STEM workers suggests that greater access to EU10 labor may be accompanied by adjustments in firms' demand for innovation-related human capital.

The Finnish setting provides evidence from an economy in which both overall immigration and EU10 employment were relatively limited during the period studied. This is relevant because much of the existing evidence comes from countries with substantially larger immigrant populations. At the same time, the low initial EU10 worker share should be kept in mind when interpreting the magnitude of the estimates: a one-percentage-point increase represents a substantial change relative to firms' average exposure to EU10 workers. The results therefore speak most directly to the effects of relatively large changes in exposure from a low initial level.

Overall, the findings show that the labor-supply changes associated with European integration can affect firms beyond their immediate workforce composition. Increased access to EU10 workers improved productivity and affected selected dimensions of innovation, but these responses varied across innovation measures and between manufacturing and services. The results therefore highlight that the economic effects of immigration need not operate uniformly across firms or innovation margins and underscore the importance of accounting for sectoral differences when assessing how immigration-induced labor-supply changes affect firm performance and innovative activity.

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Figures and Tables

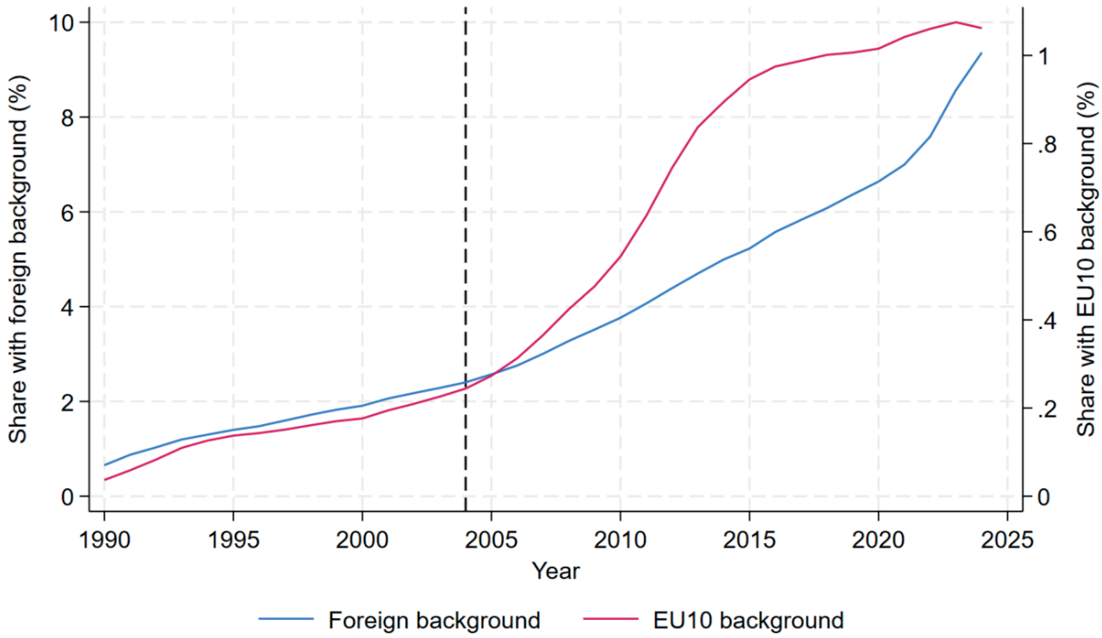

Figure 1: The share of immigrants and EU10 immigrants from total population between 1990 and 2025. *Source*: Statistics Finland's Immigration statistics. Immigrants are defined as people with foreign background.

Table 1: Description of the Productivity and Innovation Variables

Variable	Definition	Source	Number of firm-year observations (firms)	Mean value of the variable	Share of EU10 immigrants
Labor productivity	Value added per full-time equivalent employee	Financial Statement panel from 2000-2023	78,478 (6,649)	0.066 million	0.44%
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	Community Innovation Survey conducted biennially from 2000 to 2022	21,020 (3,415)	0.456	0.35%
Product innovation	An indicator variable that gets a value of 1 if a firm has engaged in any product- and service innovation in the past two years	Community Innovation Survey conducted biennially from 2000 to 2022	21,020 (3,415)	0.471	0.35%
Has patent applications	An indicator variable that gets a value of 1 if a firm has submitted any patent applications in a given year	PRH data, years 2000-2013	51,128 (5,894)	0.045	0.45%
Has granted patents	An indicator variable that gets a value of 1 if a firm has any granted patents in a given year	PRH data, years 2000-2013	51,128 (5,894)	0.031	0.45%
Internal R&D expenses	Internal R&D expenses in euros	R&D survey, years 2000-2020	24,368 (3,450)	2.20 million	0.32%
Number of STEM workers	Number of workers holding a Master's or equivalent degree in science, technology, engineering, or mathematics.	FOLK registers, years 2000-2018	65,349 (6,315)	6.58	0.45%

Note: Author's own calculations based on data from Statistics Finland.

Table 2: OLS and IV results: EU10 immigrant-share on firm-level productivity and innovation outcomes

	ln(LP)	Process innovation	Product innovation	Has patent applications	Has granted patents	ln(Internal R&D)	Ln(STEM workers)
Panel A: OLS regressions	(1)	(2)	(3)	(4)	(5)	(6)	(7)
EU10 worker-share x Post	-0.0003**	-0.0181	-0.0269**	0.0016**	0.0011**	-0.0001	-0.0036
	(0.0001)	(0.0115)	(0.0106)	(0.0007)	(0.0005)	(0.0676)	(0.0041)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Panel B: IV regressions							
EU10 worker-share x Post	0.0036**	0.0940	0.0163	-0.0002	0.0215**	-0.0821	0.0917**
	(0.0017)	(0.0613)	(0.0759)	(0.0109)	(0.0090)	(0.7134)	(0.0424)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	78,478	21,020	21,020	51,128	51,128	24,368	65,349
Outcome mean	0.066 million	0.456	0.471	0.045	0.031	2.20 million	6.58
Kleibergen-Paap Wald test	70.302	98.810	98.810	66.874	66.874	33.917	68.549

Notes: Innovation output measures are indicator variables, and productivity, R&D expenditure and the number of STEM workers follow a functional form log(1+y_{it}). Other control variables include initial firm size (number of employees), initial sales volume, and patenting stock interacted with year indicators. Standard errors are clustered at region-level. Predicted regional immigrant shock is used as an instrumental variable. ** $p < 0.050$.

Table 3: IV results: EU10 immigrant-share on firm-level productivity and innovation outcomes by industry

	ln(LP)	Process innovation	Product innovation	Has patent applications	Has granted patents	ln(Internal R&D)	Ln(STEM workers)
Panel A: Manufacturing	(1)	(2)	(3)	(4)	(5)	(6)	(7)
EU10 worker-share x Post	-0.0029	0.4024**	-0.0205	-0.0335	0.0323	0.6241	-0.2981***
	(0.0039)	(0.1615)	(0.1739)	(0.0299)	(0.0303)	(1.2320)	(0.0989)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	39,574	14,107	14,107	26,727	26,727	16,361	33,369
Outcome mean	0.067 million	0.485	0.505	0.071	0.049	2.69 million	7.21
Kleibergen-Paap Wald test	22.294	26.330	26.330	21.812	21.812	14.475	21.224
Panel B: Services							
EU10 worker-share x Post	0.0041**	0.0539	0.1617	-0.0136	0.0060**	-1.6633	0.1294
	(0.0020)	(0.0866)	(0.1113)	(0.0088)	(0.0026)	(1.0767)	(0.0844)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	38,816	6,860	6,860	24,319	24,319	7,938	31,898
Outcome mean	0.066 million	0.395	0.399	0.016	0.010	0.98 million	5.89
Kleibergen-Paap Wald test	53.650	23.411	23.411	47.556	47.556	22.595	51.602

Notes: Innovation output measures are indicator variables, and productivity, R&D expenditure and the number of STEM workers follow a functional form $\log(1+y_{it})$. Other control variables include initial firm size (number of employees), initial sales volume, and patenting stock interacted with year indicators. Standard errors are clustered at region-level. Predicted regional immigrant shock is used as an instrumental variable. *** $p < 0.010$; ** $p < 0.050$.

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