Skilled Immigration and Firm-level Upgrading as Exports Boosters in a Developing Country*

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August 24, 2025

Abstract

We examine firm-level upgrading in Colombian manufacturing firms as a result of a high-skilled labor supply shock triggered by the Venezuelan exodus. Using a unique and confidential dataset from 2013 to 2019 and a shift-share instrumental variables approach, we find that the increased supply of skilled workers primarily drove high-skill hires, especially in R&D divisions. This skill-upgrading process boosted investments in R&D activities. Improved access to higher-quality inputs led to better production and organizational processes, product enhancements, and an increased likelihood of obtaining quality certifications, which serve as a straightforward objective measure of firm-level upgrading. Collectively, these changes were crucial for firms to increase their exports at both the extensive and intensive margins. This effect was driven by a rise in differentiated product exports, allowing firms to enter new and more sophisticated markets, particularly in high- and upper-middle-income countries.

JEL Classification: D22, D24, F22, F14, F16, J61, L16, O14, O31.
Keywords: Firm-level Upgrading, Innovation Behavior, Trade, Development, Migration.

*We would like to thank Facundo Albornoz, Irene Brambilla, Andrés César, Nancy Chau, and Ezra Oberfield for many useful discussions. We also appreciate the comments and suggestions of David Atkin, David Burgherr, Leonardo Gasparini, Vaios Triantafyllou as well as participants at the 2024 Migration and Organizations Conference (The Wharton School, University of Pennsylvania), the 2nd Junior Workshop on the Economics of Migration (LISER), the 37th Annual Conference of the European Society for Population Economics (Erasmus School of Economics, Erasmus University Rotterdam), the 2024 EALE Conference (Norwegian School of Economics), the 2024 RES PhD Conference 2024 (University of Portsmouth), LACEA, the 2nd Research Conference on Forced Displacement, the 19th Economics Graduate Students' Conference (Washington University in St. Louis), the 2024 CEMIR Junior Economist Workshop on Migration Research, the Labor Work in Progress Seminar and the Alumni Workshop (Cornell University).
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1 Introduction

Productivity varies starkly across countries. Since 2010, developing economies have achieved labor productivity levels that are less than one-fifth of those observed in advanced economies. In particular, low-income countries have demonstrated productivity levels as low as 2% of those of their high-income counterparts (Hall and Jones, 1999; Bloom and Van Reenen, 2007; Bloom et al., 2010; Kindberg-Hanlon and Okou, 2020). Closing this gap is essential for economic development, and firm-level upgrading plays a critical role. By accumulating knowledge, improving quality, adopting technology, and innovating products, firms can enhance their productivity levels, accelerate growth, access higher-income and higher-standards markets, and drive structural transformation (Hausmann et al., 2007; Atkin et al., 2017). However, such upgrading hinges on the availability of skilled labor, as advanced production methods and products are inherently skill-intensive (Goldin and Katz, 1998; Verhoogen, 2023).

Massive migration events provide an opportunity to bridge this gap by supplying firms with the high-quality skills and expertise needed for upgrading (Beerli et al., 2021; Bahar et al., 2022). High-skilled migrant inflows enrich labor markets, enabling firms to match with better workers. This, in turn, facilitates investment in innovative production processes and technology adoption. These changes not only boost productivity but also enhance firm product portfolios, allowing them to compete in higher-income export markets—a critical step for developing countries pursuing structural transformation (Hausmann et al., 2007). Despite its relevance, empirical evidence on how high-skilled labor, and particularly migration, drives firm-level upgrading and promotes improved export performance in developing countries remains scarce. This is true particularly regarding the extent of these upgrades and the internal mechanisms within firms that enable them.

In this paper, we explore the impact of the Venezuelan exodus on firm-level upgrading and trade dynamics within Colombian manufacturing firms. Since 2014, Venezuela has faced a severe political, social, and macroeconomic crisis, resulting in the third-largest global displacement of citizens, totaling around 6.1 million. Simultaneously, Colombia emerged as the third most significant destination for displaced immigrants, providing refuge to about 2.9 million Venezuelan migrants (UNHCR, 2024). A unique aspect of this migration wave is that displaced Venezuelans, on average, have similar skills to the local Colombian workforce (Lebow, 2024). In the manufacturing sector, however, Venezuelan migration led to a relatively larger supply shock of high-skilled labor. Our estimates indicate that the share of high-skilled Venezuelans in this sector increased by over 5 percentage points (p.p.), while the shares of medium- and low-skilled workers rose by 3.6 and 2.6 p.p., respectively. Given this context and Colombia's labor market vulnerability due to its developing status, the implications and mechanisms of this situation may differ from those observed in earlier studies focusing on the impacts of migration in developed host countries (such as Mitaritonna et al., 2017; Ottaviano et al., 2018; Beerli et al., 2021).

We estimate the impact of this high-skilled labor supply shock on the Colombian manufacturing sector by leveraging variation in migrant settlements across Colombian local labor mar-

kets from 2013 to 2019 and tracking their evolution over time. Acknowledging the non-random distribution of refugees, we employ a shift-share instrumental variable approach based on the distance to Venezuelan states for each local labor market. This instrument is designed to account for the forced nature of the influx, as Venezuelan migrants were notably concentrated in places near the Colombian side of the border with Venezuela.[1]

We perform our analysis using a novel, rich, representative, and confidential dataset. This dataset merges customs data, the Annual Manufacturing Census (EAM, by its acronym in Spanish), and the Technological Development and Innovation Survey (EDIT, by its acronym in Spanish), all of them provided by Colombia's National Institute of Statistics (DANE). Hence, it enables a detailed analysis of firm-level upgrading measures, the skill composition of the workforce (both overall and within R&D divisions), as well as overall wages. It also provides key variables related to firms' export performance, such as total value, product variety, and destination markets. We further match these datasets at the local labor market level with the Colombian Household Survey (GEIH, for its acronym in Spanish). This survey provides data on migration status, allowing us to calculate the share of Venezuelan migrants relative to the local labor force and assess its impact on firm performance.

There have been many approaches in the economic literature to measure firm-level upgrading, such as residual-based measures of TFP or those obtained from demand information combined with data on output prices and market shares (Hallak and Schott, 2011; Khandelwal et al., 2013). However, according to Verhoogen (2023), utilizing directly observable information on firm-level upgrading, such as technology use (including management practices) or quality certifications, constitutes a better approach. This is because they can provide more credible information on the scope of the upgrading and its enhancements in the performance and productivity of firms. They do not require any strong assumptions either about the functional forms of firms' demand and production functions or about the relationship between quality and markups on observable prices (examples of papers using these measures are Verhoogen, 2008; Crozet et al., 2012; Atkin et al., 2017; Macchiavello and Morjaria, 2021, among others).

In this paper, we use direct measures of upgrading as we are able to identify technological development decisions implemented by firms, namely the adoption of new production processes, organizational, and marketing techniques, which are rarely available for analysis in developing countries. We also use self-reported information on the quality of the goods offered by firms to analyze whether or not a firm-level upgrading process took place as a consequence of the migration shock. Finally, similarly to Verhoogen (2008) and Kugler and Verhoogen (2012), we use quality certifications (ISO standards, such as ISO-9001, Quality management systems, and ISO-14040, Environmental management - Life cycle assessment) to measure the production process and product upgrading of firms. This allows us to assess the impact on the quality of products offered to the market, as well as the organizational and managerial practices of firms.

Our primary findings reveal that the greater availability of skilled workers due to the

[1] This instrumental variable is a well-established tool and has been previously utilized in various studies examining episodes of forced migration (see, for instance, Del Carpio and Wagner, 2015; Morales, 2018; Caruso et al., 2019).

Venezuelan exodus induced firm-level upgrading in the Colombian manufacturing sector. First, we find that this skilled labor supply shock led to a skill-upgrading effect in the manufacturing sector. Firms began hiring more high-skilled workers overall, who are expected to enhance performance through improved plant, business, and managerial practices. Importantly, firms increased their hiring of high-skilled workers in R&D divisions, bringing valuable knowledge for advancing technology adoption, as well as process and product improvements. Our estimates indicate that a one p.p. increase in the share of migrants relative to the local labor force translated into an increase of 3.1% in the total number of high-skilled workers (more than secondary education) hired in R&D departments. Additionally, we observe a positive impact in R&D investments (investments aimed at introducing novel or significantly enhanced goods, services, and/or processes), a positive technological-upgrading effect consistent with the complementarity between greater hiring of skilled R&D workers and investment in those areas.

Furthermore, we find that firms upgraded not only in terms of inputs, such as labor and R&D investments, but also through enhanced technology adoption. They implemented improved production processes and organizational methods. A one p.p. increase in the share of Venezuelan migrants relative to the local labor force raised the probability of process innovation by 1.9 p.p. and the adoption of new organizational methods by 0.6 p.p. We interpret these changes as efforts to optimize the use of higher-quality inputs. These advancements, often referred to as *recipes* in the literature, are expected to enhance firm performance, operational efficiency, and product quality by coordinating efforts within firms to improve outputs (Boehm and Oberfield, 2020; Verhoogen, 2023). Our findings indicate that this comprehensive upgrading—encompassing both input quality and refinements in production and organizational processes—enabled firms to produce higher-quality goods and increased their chances of obtaining quality certifications. Specifically, a one p.p. increase in the local share of Venezuelans resulted in a 0.7% rise in the number of significantly enhanced products and a 1.1 p.p. increase in the likelihood of firms achieving a quality certification. These certifications are essential for firms competing in higher-standards markets, which require strict compliance of quality standards in both production processes and final goods offered to consumers (Kugler and Verhoogen, 2012; Hallak and Sivadasan, 2013).

Subsequently, we go one step further and study how these firm-level upgrading effects impacted the export performance of firms in the Colombian manufacturing sector. Our estimates reveal five noteworthy results: (i) The Venezuelan exodus boosted exports for Colombian manufacturing firms, evident not only in the increase of the probability of firms engaging in international trade (extensive margin) but also in the increased amount of exports (intensive margin); (ii) The trade-creation effect was notably driven by exports directed towards high- and upper-middle-income destinations; (iii) Beyond increasing the total value of exports and the likelihood of participating in global markets, the Venezuelan exodus also helped diversify the product variety exported by Colombian firms in the manufacturing sector; (iv) The effect on trade was also attributed to firms successfully entering new markets, particularly within high- and upper-middle-income destinations; (v) The predominant trade-creation effect was driven by differentiated goods (Rauch, 1999), which suggests that firms were able to enter the

global markets with more complex products, rather than homogeneous ones.

We rationalize the impact of the Venezuelan exodus on Colombia's firm upgrading and trade using three families of theoretical models/hypotheses. First, a search model with labor market frictions helps explain how an increase in the supply of skilled labor may have driven the hiring of more qualified workers, particularly in R&D divisions. Second, drawing from a Melitz-Heckscher–Ohlin framework akin to Bustos (2011) and Harrigan and Reshef (2015), we explain the translation of the increase in productivity into an improvement in the export performance of firms. Finally the firm-level upgrading literature and the quality-complementarity hypothesis from Verhoogen (2008) and Kugler and Verhoogen (2012) help explain how Colombian firms' increased exports of skill-intensive, complex goods were particularly concentrated in high-income markets with more demanding quality standards (Brambilla et al., 2012; Brambilla and Porto, 2016).

Regarding the labor market effects, drawing from a search model with frictions similar to Beerli et al. (2021), we argue that the influx of skilled Venezuelan workers reduced labor market tightness, enabling firms to expand the hiring of high-skilled workers, particularly in divisions responsible for technological advancements. Our findings support the hypothesis that the greater availability of skilled workers boosts employment without negatively affecting wages, as firms experience productivity gains and increased returns to scale through the recruitment of highly skilled workers and investments in technology. This upgrade in the hiring possibilities of the firms in terms of skills, increased their productivity, especially in R&D divisions responsible for developing and improving products and production processes.

On the firm upgrading and trade side, we first argue that the increased hiring of skilled labor enabled firms to adopt new techniques, methods, and processes. These operational improvements enhanced firms' productivity and the quality of the goods they offered to their customers. This phenomenon can be incorporated into a traditional Melitz trade model as an upward location-shift in the distribution of firms' productivity. The increased hiring of skilled workers, along with investments in R&D, would enhance the productivity of firms in the Colombian manufacturing sector, allowing them to overcome the costs of entering international markets and improve their export performance (Melitz, 2003; Matsuyama, 2007).

In this framework, we argue that the firms benefiting most from this labor shock were those with higher levels of productivity, making them prime candidates for international market entry and export growth. Our results are consistent with this Melitz-type heterogeneous effect: firms that were more productive prior to the exodus, benefited more from it in terms of the international trade outcomes outlined above. Finally, consistent with the Heckscher–Ohlin model, we show that the increased availability of skilled labor expanded trade opportunities for firms that were more intensive in its use, particularly in R&D divisions, prior to the exodus.

Building on the quality complementarity hypothesis—which suggests that input quality and firm productivity work together to enhance output quality—we show that improvements in firms' labor force quality and R&D investments enabled better coordination efforts within companies, such as introducing new or improved production processes and organizational methods, ultimately boosting the quality of their goods (Boehm and Oberfield, 2020; Ver-

hoogen, 2023). This, in turn, allowed them to expand exports to high-income markets, which have higher quality standards and demand these more complex products (Verhoogen, 2008; Kugler and Verhoogen, 2012; Brambilla et al., 2012; Brambilla and Porto, 2016).

Our research contributes to three main strands of economic literature. First, we build on studies of firm-level upgrading, which examine the capacity of firms to enhance productivity and narrow the gap with the global technological frontier—a crucial determinant of economic development (Verhoogen, 2023). This body of work highlights the importance of hiring workers with specific skills as a key driver of this upgrading process (Lewis, 2011; Hornbeck and Naidu, 2014). By expanding the skill set available to firms, high-skilled workers can lead improvements in production and organizational processes, enabling firms to secure quality certifications and implement more complex and advanced practices.

However, as Verhoogen (2023) notes, much of the existing literature falls short in understanding and measuring the degree of firm-level upgrading and the mechanisms behind it. Our study leverages rich data to "open the black box" of firm-level upgrading by examining the interactions between high-quality inputs demanded by firms, advanced techniques used to combine those inputs, and the resulting high-quality outputs. Specifically, we measure how an increase in skill availability within the economy led to greater hiring of skilled workers in R&D, and how this, in turn, influenced the adoption of improved production and organizational techniques. These changes positively impacted the ability of firms to secure quality certifications—an objective measure of output and process quality. The novelty of our paper is identifying migration in developing countries as a key driver of firm-level upgrading and a crucial catalyst in the efforts of firms to catch up with their counterparts in developed economies in terms of productivity.

Secondly, our paper adds to the literature on migration-induced trade creation. Traditional research has focused on the positive effect of migration on trade via network channels, where migrants reduce the costs of doing business in export markets (Gould, 1994; Head and Ries, 1998; Peri and Requena-Silvente, 2010; Hiller, 2013). However, more recent studies have explored the impacts of migration on the skills and knowledge within host economies, demonstrating how these factors can enhance firm performance and positively influence export dynamics (Bahar and Rapoport, 2018; Orefice et al., 2021; Bahar et al., 2022; Ariu, 2022).

This paper advances this second line of inquiry. We show that a migration-induced increase in skilled labor not only facilitated skill- and technological-upgrading within firms, boosting their export potential, but also drove a comprehensive firm-level upgrading process. This process went beyond improving input quality because it involved implementing more advanced techniques for combining these inputs, ultimately resulting in higher-quality products, better aligned with the demands of high-income markets. In summary, our work is the first to directly analyze and quantify the firm upgrading mechanisms taking place within firms that link improvements in labor inputs, investment in R&D, enhancements in terms of production and organizational techniques, and exports to higher-standards destinations.

Furtheremore, firm-level upgrading is often linked to export growth, especially in high-income markets (Verhoogen, 2008; Bastos and Silva, 2010; Martin, 2012; Artopoulos et al., 2013;

Brambilla and Porto, 2016; Macis and Schivardi, 2016; Görg et al., 2017). Products exported to these markets are typically differentiated and of higher relative quality.[2] Most studies in this literature suggest that firm-level upgrading is driven by trade with high-income destinations and markets with high-quality standards (Verhoogen, 2008; Brambilla et al., 2012; Brambilla and Porto, 2016). However, for the first time, we demonstrate that this causal relationship can also work in the opposite direction. Specifically, the increased availability of skilled labor in the economy due to a migration shock led firms to demand more skilled workers and invest in R&D, thereby improving production processes, organizational practices, and output quality. This upgrading boosted exports in the Colombian manufacturing sector, enabling firms to access high-standard markets, including those in high-income countries, with more differentiated goods.

Thirdly, our study contributes to the literature on migration and structural transformation, with a focus on its role in promoting economic development (Imbs and Wacziarg, 2003; Hausmann et al., 2007; Hidalgo et al., 2007). In cases like the one analyzed in this paper, migration significantly increases the supply of skills and human capital in the host economy. By enhancing the skill composition of the workforce, migration can shift the product mix offered to the market, increasing complexity and facilitating entry into higher-standards markets. This shift can ultimately benefit the economic performance of the host countries (Hummels and Klenow, 2005; Hausmann et al., 2007; Hallak and Schott, 2011; Koren and Tenreyro, 2013).

To our knowledge, the most closely related studies to ours are those by Bahar et al. (2022) and Imbert et al. (2022). Bahar et al. (2022) examines the impact of Yugoslavian returnees on export performance and firm productivity in their country of origin. Our analysis differs in several key ways. First, while they consider a process of knowledge diffusion through migrants returning from a developed country to their home countries, we focus on the effect of expanding the skill set available to firms in the host economy. Second, we study a migration episode between two developing countries with similar cultural, social, and economic contexts, as well as comparable educational levels. This highlights the relevance of skill-upgrading not only when immigrants bring specific skills or knowledge absent in the host economy but also when there is merely an increase in the availability of skills overall.

Third, we extend their analysis by examining not just firms' total exports, but also the destinations, product diversification, and product complexity. This allows us to link firm-level upgrading effects from Venezuelan migration to enhanced export performance, particularly towards high-income markets with stricter quality standards. Finally, while Bahar et al. (2022) use TFP and labor productivity as proxies for upgrading, we focus on directly observable variables related to technology adoption, the implementation of new methods, and quality certifications, which provide more direct measures of firm-level upgrading (Verhoogen, 2023).

[2] Using firm-level trade transaction data, Bastos and Silva (2010), Manova and Zhang (2012), Martin (2012), and Görg et al. (2017) find a positive correlation between export prices and GDP per capita of the destination (in Portugal, China, France, and Hungary, respectively). This supports the hypothesis in Verhoogen (2008) that firms offer higher-quality varieties to consumers willing to pay for premium quality.

In contrast, Imbert et al. (2022) finds that low-skilled rural-urban migration in China resulted in a downgrading effect for manufacturing firms, shifting production to labor-intensive techniques, lowering productivity, and changing the output mix toward low-skill products and reduced patenting. Our paper goes beyond these findings by focusing on skilled migration and its effects on firm-level upgrading at a granular level. Unlike Imbert et al. (2022), we estimate the labor composition of firms by skill level, particularly within R&D divisions, which we argue is the main driver of firm upgrading in the Colombian manufacturing sector following Venezuelan migration. We also link this firm upgrading to their export performance, a crucial determinant of structural transformation and macroeconomic growth in developing countries.

Finally, we make two incremental contributions. On the one hand, we add to the body of literature that explores the impact of migration on firm-level outcomes: while numerous studies in developed countries have explored this realm in the context of economic migration, our focus extends to *forced* migration in a developing country, which is a relatively understudied setting in the economic literature (Kerr et al., 2015; Mitaritonna et al., 2017; Ottaviano et al., 2018; Altındağ et al., 2020; Beerli et al., 2021).

On the other hand, regarding the Venezuelan exodus, several recent papers have explored how this migratory episode impacted the labor market, not only in Colombia but also in other Latin American countries like Ecuador (Olivieri et al., 2022) and Peru (Morales and Pierola, 2020). In the Colombian context, most of the economic literature on this subject has consistently identified a negative impact on wages, particularly for low-skilled and informal workers. Additionally, these studies have observed adverse effects on native employment (see, for instance, Caruso et al., 2019; Lombardo et al., 2021; Peñaloza-Pacheco, 2022; Lebow, 2024). We contribute to this strand by analyzing the effect on the demand side of the labor market and how it affected firm performance in the manufacturing sector.

The remainder of the paper is organized as follows. Section 2 describes the Venezuelan exodus in Colombia. Section 3 presents the data used to perform our analysis. Then, Section 4 shows some descriptive statistics of Venezuelan migration, manufacturing firms, and exports. Section 5 provides a theoretical framework to interpret the results found in the paper. Section 6 presents the empirical strategy proposed in this paper to estimate the causal effect of the Venezuelan exodus on firms' outcomes. Section 7, shows our estimates on the impact of the Venezuelan exodus on firm-level upgrading in the Colombian manufacturing sector. Section 8 analyzes how the firm-level upgrading caused by the migration labor supply shock had a trade-creation effect on firms. In Section 9, we show additional results in terms of firms' wages, but also using local labor market level information to reassure the results presented in the paper. In Section 10 we conduct robustness checks and address potential threats and concerns regarding the internal validity of our identification strategy. Finally, Section 11 concludes.

2 The Venezuelan exodus in Colombia

Venezuela has grappled with an unprecedented economic crisis over the past decade, driven by a decline in government revenues, unsustainable public debt, and macroeconomic imbalances. The onset of this economic chaos dates back to 2013 when Nicolás Maduro took office as the president of Venezuela. The country faced formidable challenges in sustaining public spending and economic activity, primarily due to a sharp drop in international oil prices, a significant contributor to fiscal and external revenues (Caruso et al., 2019; Rozo and Vargas, 2021; UNHCR, 2024).

The economic turmoil, coupled with unsustainable public debt and macroeconomic imbalances, triggered a staggering 62.2% decline in GDP from 2013 to 2019, as estimated by ECLAC (2019). This downturn exacerbated existing challenges, including food shortages, insecurity, and numerous human rights violations, fostering an atmosphere of chaos, uncertainty, and social unrest (United Nations, 2019). The dire circumstances forced an exodus of 6.1 million Venezuelans, seeking a new beginning predominantly in various Latin American nations. Geographic proximity made Colombia the primary destination, receiving over 2.9 million immigrants between 2016 and 2023 (UNHCR, 2024).

Despite the substantial efforts exerted by the Colombian government to integrate Venezuelan migrants into the national economy, the challenges faced by Venezuelans still persist in both the labor market and daily life (Bahar et al., 2021). Starting in 2017, the Colombian government implemented various waves of work permits to facilitate the participation of Venezuelan migrants in the formal labor sector and enable access to essential public services like education and health. Nevertheless, Venezuelans continue to face challenging labor conditions marked by high levels of informality, low wages, and limited job opportunities within the market (Delgado-Prieto, 2023). In the upcoming sections, we will explore the distinctive characteristics of Venezuelan migrants in comparison to Colombian individuals. This examination aims to shed light on the scope and circumstances of immigrants' integration into the Colombian economy.

3 Data

We use data from various sources and perform our analysis at the firm level. The units are treated at the local labor market level, which groups municipalities (Colombian administrative

units), focusing on the period from 2013 to 2019.[3]

3.1 Data on Venezuelan Migrants

Data on immigrant stocks at the municipality level come from the Colombian household survey carried out by the National Statistical Institute (DANE): the Great Integrated Household Survey (GEIH, for its acronym in Spanish).[4] We consider all individuals who were born in Venezuela as Venezuelan migrants. As we analyze the effects on firm performance, we only take into account working-age individuals (18-64 years old). We use GEIH's weights to calculate representative shares of Venezuelan immigrants at the local labor market level.

3.2 Firms and Exports Data

For our empirical analysis, we use a unique and confidential panel dataset of firms in the manufacturing sector which merges information from three different sources. First, we use the Colombian Annual Manufacturing Survey (EAM, for its acronym in Spanish), a representative panel of manufacturing firms in the country with 10 or more employees, or firms with fewer employees but with revenues above a certain threshold annually updated.[5] The EAM provides information on employment, wage bill, sales, sector identifiers, and unique identifiers for both the firm and the constituent plants that make up the firm. We keep a balanced panel of firms for the period analyzed. Our sample consists of 3,017 manufacturing firms in 79 local labor markets.

The second source of information in our database is the Technological Development and Innovation Survey (EDIT, for its acronym in Spanish), which collects data on innovation, technology, and the quality of productive processes for the same universe of manufacturing firms covered by the EAM. This survey allows us to examine the skill composition of the labor force in each firm, particularly within R&D divisions, as well as firms' investments in R&D activities. Additionally, it includes questions on the implementation of new or significantly improved

[3] Municipalities in Colombia are similar to counties in the US. Colombia has 1,123 municipalities. In our sample, we are working with 106 municipalities for which there is information on manufacturing firms grouped in 79 local labor markets that represent about 65% of the Colombian population. For the case of the municipalities belonging to the Metropolitan Area of the main cities Bogotá, Barranquilla, Medellin, and Cali, we grouped them as part of the main city in our data (which we define as local labor market), according to the official definition of DANE. The Metropolitan Area of Bogotá is comprised of Soacha, Mosquera, Funza, Madrid, Chía, Cajicá, Cota, La Calera, Tenjo, Tubio, Sibaté, Zipaquirá, and Facatativá. The Metropolitan Area of Barranquilla is comprised of Puerto Colombia, Soledad, Malambo, and Galapa. The Metropolitan Area of Medellín is comprised of Barbosa, Bello, Copacabana, La Estrella, Girardota, Itagüi, Envigado, Caldas, and Sabaneta. Finally, the Metropolitan Area of Cali is comprised of Palmira, Yumbo, Jamundí, and Candelaria.

[4] The household survey consists of monthly repeated cross-sections that characterize both individual socio-demographics and labor outcomes. Although the migration module of DANE's household survey has been available since 2012, the question about immigrants' country of origin was included in April 2013.

[5] For example, DANE set US$ 164 million (approximately) in annual revenue as the inclusion threshold in 2016.

production, organizational, and marketing processes, as well as the improvement or creation of new products. It also captures whether firms obtained quality certifications such as ISO 9000 and ISO 14000, along with subjective measures of the impact of these technological adoptions and the barriers firms face in implementing them.[6] By leveraging EDIT, we can merge each firm in the EAM with its corresponding observations in EDIT. Since EDIT data is only available at the firm level rather than the plant level, for multi-plant firms, we retain the plant with the largest number of employees over the analysis period.[7]

Finally, to estimate firm exporting performance we use data on their export values and destinations. We rely on detailed Colombian customs data also published by DANE. This data records the total value of Colombian exports by firm, year, destination country, and 10-digit NANDINA (Common Tariff Nomenclature of the Andean Community) product classification from 2013 to 2019. Using this data, we merge our yearly panel of firms from the EAM and EDIT databases with their corresponding export values (in FOB US dollars), as well as the number of different products exported and different destinations firms traded with each year. We ignore exports to Venezuela in our sample (so our results are not driven by network effects of the immigrants with their home country), and exports to Free Trade Zones.

4 Descriptive Statistics

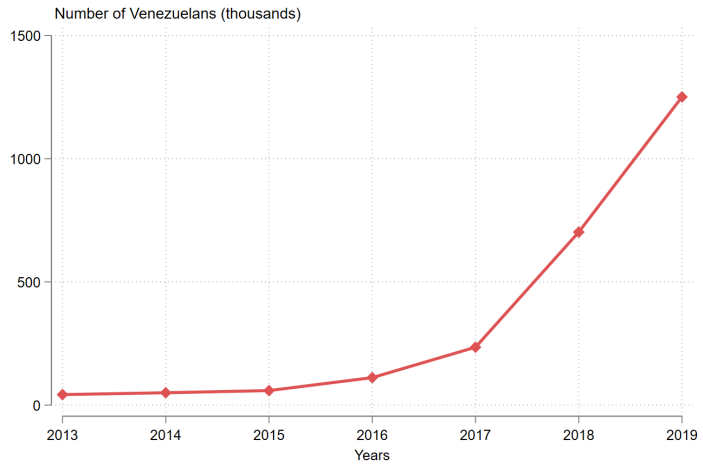
4.1 Venezuelan refugees in Colombia

As can be seen in Figure 1, the number of Venezuelans living in Colombia increased continuously over the 2013-2019 period. Notably, the influx of Venezuelan immigrants into Colombia intensified starting in 2016. This surge can be attributed to the reopening of the border between the two countries following a year-long closure due to a political crisis between the governments of Colombia and Venezuela (Peñaloza-Pacheco, 2022).

[6] The questions regarding the implementation of new or significantly improved techniques or goods, the attainment of quality certifications, and the subjective measures of the impact of these technological adoptions, including barriers faced during implementation, are asked retrospectively every two years. For example, firms are asked if they implemented a new production process during the 2013-2014 period. Consequently, for these two years, by construction the variable will have the same value. In our sample, we consider only the observations from one year for each of the corresponding periods. Results that include all years are quite similar and can be provided upon request.

[7] We exclude from our sample firms that meet any of the following criteria: (i) those with zero sales and (ii) those reporting fewer than 10 employees. Also, to avoid the influence of outliers, we follow Kugler and Verhoogen (2012) and exclude firms whose capital, employment, intermediate inputs, energy consumption, or wage bill differ by more than a factor of 5 from the median value across the entire period of analysis.

Figure 1: Venezuelans in Colombia. 2013-2019



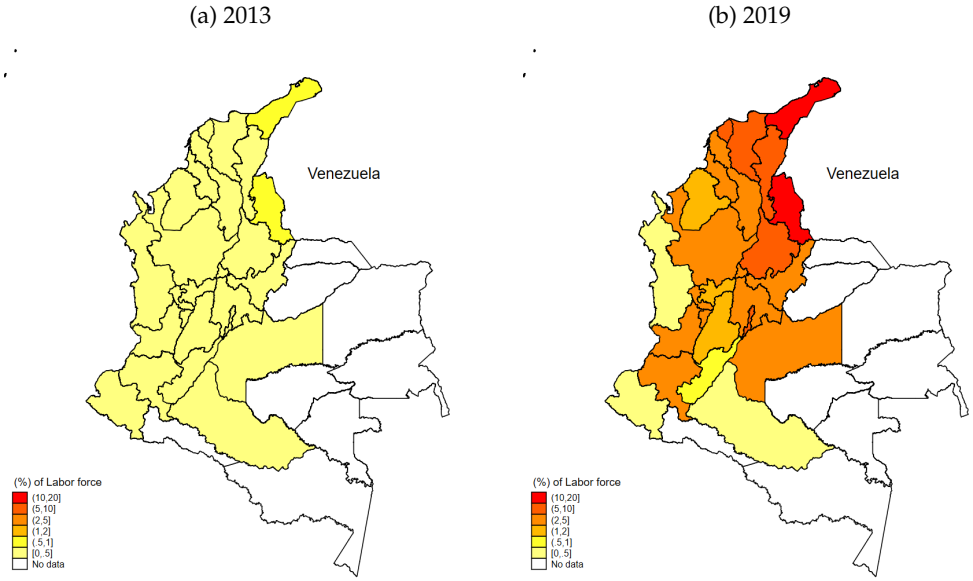
Source. Own elaboration based on GEIH data from DANE.

As presented in Figure 2, the distribution of the massive influx of Venezuelan refugees has been heterogeneous across Colombian departments.[8] First, it is evident that the proportion of working-age Venezuelans in comparison to the local labor force has risen in nearly all Colombian departments. Nevertheless, this relative surge in labor supply has been particularly pronounced in the bordering departments situated near Venezuela (e.g., La Guajira and Norte de Santander).

Based on our calculations, border departments experienced a substantial increase of approximately 10-15 percentage points (p.p.) in the share of the Venezuelan labor force relative to the local labor force. This represents a notable labor supply shock, with the potential to exert a significant impact on various economic outcomes within the regions receiving Venezuelan refugees. To study the influence of this labor supply shock from Venezuelan immigrants on Colombian firms in the manufacturing sector, we leverage the variability in refugee distribution across local labor markets over time.

[8] The departments in Colombia are equivalent to the States in the U.S. and consist of grouped municipalities. Figure 2 illustrates the migration by department instead of municipality, providing a clearer visualization of the geographical distribution of Venezuelan migration in Colombia.

Figure 2: Venezuelan Immigration by Department (% Native Labor Force)



Notes: We define Venezuelan immigrants as individuals born in Venezuela. The number of immigrants was normalized by the working-age population of each department in 2012. Departments with no data in the figures primarily consist of regions in the Amazon characterized by low population density and small cities where data is unavailable. According to the latest available census in Colombia (2018), the population in these departments accounts for less than 3% of the total population in Colombia. Survey weights are applied to calculate the shares by department.
Source. Own elaboration based on GEIH data from DANE.

A crucial factor to consider when analyzing this substantial influx of refugees relates to the attributes of this labor supply shock, particularly in comparison to the local labor force. As demonstrated by existing literature, we anticipate a self-selection process among immigrants opting to flee their home country. Consequently, despite historical similarities in socio-demographic characteristics between Colombians and Venezuelans, it is expected that the labor supply shock and the working conditions of Venezuelan employees in the Colombian labor market may significantly differ from those experienced by their Colombian counterparts.

Table A.1 presents descriptive statistics of individual socio-demographic and labor market variables, drawing comparisons between Venezuelan migrants and native populations. Among the working-age population, Venezuelans are notably younger than Colombians. Turning to labor market characteristics, Table A.1 further highlights that working-age Venezuelans have a higher likelihood of unemployment, work more hours per week, earn lower average wages, and have a reduced likelihood of securing formal employment. These descriptives underscore a well-documented aspect discussed in recent economic literature: the challenges faced by Venezuelan refugees in attaining satisfactory living conditions and their struggles in integrating into the formal labor market under the same conditions as native workers, despite the various measures implemented by the Colombian Government to facilitate the integration of Venezuelan immigrants into Colombia's formal labor market (Bahar et al., 2021; Lebow,

2024).[9]

Remarkably, according to Table A.1, Venezuelan immigrants exhibit higher qualifications in terms of years of education. Figure 3 delves into this fact particularly in the manufacturing sector by illustrating the proportion of Venezuelan workers employed in that sector, broken down by education levels, in comparison to their Colombian counterparts of the same educational attainment. In 2019, the highest proportion belonged to high-skilled workers, followed by medium-skilled ones. The data shows that, relative to the pre-exodus share, the increase in the share of Venezuelans compared to Colombians was 5.1 and 3.6 p.p. for high- and medium-skilled workers respectively, and 2.6 p.p. for low-skilled workers. This suggests that the majority of the impact of the labor supply shock in the manufacturing sector was concentrated among individuals with higher educational levels.

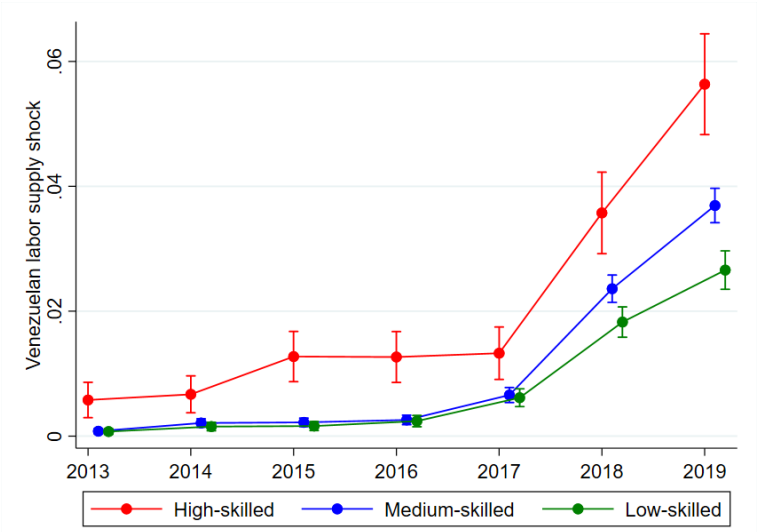
This analysis prompts a natural concern regarding the similarities in the quality of education between Colombia and Venezuela. Establishing the comparability of the Venezuelan workforce to the native labor force, particularly in terms of education, is crucial. Lebow (2024) addresses this concern by demonstrating that the educational systems in the two countries are comparable and similar. In the 2009 Program for International Student Assessment (PISA), both nations ranked closely across all categories,[10] with Venezuela slightly outperforming Colombia.[11] Additionally, Lebow (2024) highlights that in the U.S. labor market Venezuelan and Colombian immigrants with secondary and post-secondary education exhibit comparable education wage premia (a proxy for education quality and the value the market gives to the education of workers). If anything, the post-secondary education wage premium appears to be slightly higher for Venezuelans, and this is not attributed to selection pattern disparities between the two migrant groups.

[9] For instance, the Colombian Government implemented the "Special Permit of Permanence" which was a renewable two-year visa that granted the legal right to work and access to basic public services to undocumented Venezuelan migrants in Colombia.

[10] For the case of reading literacy, the mean score (standard deviation) for Colombia is 413 (3.7) and for Venezuela is 422 (5.3); in Math literacy, the mean scores are 381 (3.2) and 397 (4.3), respectively, and for Science literacy 402 (3.6) and 422 (4.9), respectively.

[11] In his analysis, Lebow (2024) exclusively focuses on the State of Miranda in Venezuela, as it is the only state for which information is available. However, Walker (2011) highlights that students in federal public schools did not participate in the exam in the State of Miranda. The State of Miranda represented 10% of the Venezuelan population in 2011.

Figure 3: Share of Venezuelans working in the Colombian manufacturing sector by skills, 2013-2019



Notes. Each line shows the share of Venezuelan workers in the manufacturing sector within each education group, relative to the total number of Colombian workers in the same group. Low-skilled refers to those with primary education, medium-skilled to those with secondary education, and high-skilled to those with post-secondary education. Source. Own elaboration based on GEIH data from DANE.

Moreover, the comparability between Colombian and Venezuelan education systems is reinforced by the validation process of degrees earned by Venezuelan immigrants in Colombia. The Ministry of Education (MEN), the highest education authority in Colombia, validates almost all degrees earned by Venezuelan immigrants in their country of origin. Over the 2015-2019 period, out of 12,800 validation requests for post-secondary degrees from Venezuelan immigrants, 88% were granted, as reported by MEN. Collectively, these findings strongly suggest that the quality of education in the two countries is highly similar.

Based on this analysis, we propose the Venezuelan migration as a skilled labor supply shock in the Colombian manufacturing sector. It is plausible to consider that Venezuelan workers may play a crucial role in the manufacturing labor market, offering the skilled labor that this sector requires. As a result of this shock, Colombian firms would be enabled to undergo a firm-level upgrading process that enhances their ability to trade in international markets.

4.2 Characteristics of Manufacturing Firms and their Exports

Table 1 provides summary statistics derived from our balanced panel of firms, distinguishing between exporting (those that exported at least once in the 2013-2019 period) and non-exporting firms, as well as between high- and low-productivity firms.[12] On average, the firms

[12] We defined as high- (low-) productive firms those whose average output per worker in 2013 relative to the same figure for the corresponding 3-digit industry was above (below) the median.

in our sample employ around 150 individuals. As expected, exporting firms tend to have a larger workforce, employing an average of 230 individuals.

In terms of the skill composition of firms, exporting firms tend to have significantly larger numbers of high-skilled workers compared to the overall sample. For instance, for the case of exporters, the share of high-skilled workers relative to the total workforce is about 37%, whereas for non-exporters this figure is 25%. The same pattern is present when considering high- and low-productive firms.

Similarly, when considering the number of employees in the R&D divisions of the firms under analysis, we can observe that exporters rely significantly on high-skilled workers in this division. These workers seem to be a crucial component in the implementation of new technologies and production processes due to their qualifications and abilities. This pattern reflects the fact that firms engaged in global exports often require high-skilled labor to ensure the quality of their production processes, which goes in line with the evidence shown in the economic literature (Brambilla et al., 2012). Additionally, it can be seen that high-productive firms are also more likely to hire high-skilled workers in their R&D divisions.

The average annual wage across all firms in our sample is US$13,021.[13] However, exporters and high-productivity firms pay a higher average yearly salary, with an average of US$15,459 and US$16,349, respectively. Furthermore, when assessing firm size in terms of annual sales, we can observe that exporting and high-productive firms in our sample are larger on average, with annual sales of US$2.2 million and US$2.5 million, respectively, compared to the average firm size of US$1.3 million, and invest more in technological development (2.4% and 2.2% of annual sales, respectively) relative to non-exporting firms (0.9% of annual sales) and low-productive firms (1.3% of annual sales). Finally, exporter firms are 2.5 times more likely to have quality certifications and nearly twice as likely to have adopted innovations in their techniques or methods compared to non-exporters. This difference is anticipated since firms must meet specific demand standards to access international markets. This further requires them to elevate the quality of their products and their production processes. The same pattern is observed when comparing high- and low-productivity firms.

[13] The average wage is calculated by dividing the total wage bill by the total employment, excluding owners, partners, and relatives who do not receive a fixed remuneration.

Table 1: Descriptive Statistics of Colombian Manufacturing Firms - 2013-2019

		Exporting Status		Productivity	
	All firms	**Yes**	**No**	**High**	**Low**
Number of workers	149.84	230.28	63.49	230.63	68.10
High-skilled workers	51.26	84.53	15.55	85.87	16.68
Medium-skilled workers	84.41	128.62	36.94	127.50	41.35
Low-skilled workers	14.17	17.13	11.00	17.27	11.08
High-skilled workers in R&D	2.19	3.64	0.63	3.65	0.73
Medium-skilled workers in R&D	1.03	1.59	0.43	1.48	0.58
Low-skilled workers in R&D	0.06	0.09	0.02	0.07	0.05
Average annual wage in USD	13,021	15,459	10,404	16,349	9,696
Annual sales in 1,000 USD	1,347	2,160	473	2,502	193
Innovation in USD in 1,000 USD	28.66	51.96	4.06	55.26	2.48
Has a quality certification	0.14	0.20	0.08	0.20	0.09
Adopted a new technology/technique	0.23	0.29	0.16	0.29	0.16
Observations	3,017	1,562	1,455	1,508	1,509

Notes. Each cell contains the mean of the referred variable over the years 2013-2019 either for exporters, non-exporters, high-, low-productivity firms, and all firms. Firms were considered as exporters if they exported at least once in the 2013-2019 period. High-productive firms are those whose average output per worker in 2013 was above the median for the corresponding 3-digit industry, while low-productive firms are those with average output below the median. Monetary values were calculated in US current dollars unless otherwise specified. Source: Own elaboration based on data from DANE.

Table 2 presents the export values of manufacturing products from Colombian firms in our sample for each year between 2013 and 2019, measured in millions of current dollars. The exports are categorized by the income level of the destinations following the World Bank classification. As can be seen, the majority of Colombian exports are directed toward high- and upper-middle-income destinations, which represented 47% and 50% of total exported value, respectively in 2013.

An evident trend emerges from the data: after a peak in 2013, total exports experienced a decline until 2016.[14] However, exports rebounded in 2017 and by 2019 had returned to levels close to those of 2013.

[14] The decline in manufacturing exports post-2014 can be attributed to general equilibrium effects resulting from the decrease in international commodity prices, primarily oil, and a slowdown in economic activity within the European Union (MinCIT, 2019).

Table 2: Colombian exports by year and destination 2013-2019 (million USD)

	Total exports	High-Income	Upper-middle	Lower/Low
2013	6,449.8	3,025.7	3,237.8	185.3
2014	6,433.8	3,392.9	2,830.5	210.5
2015	6,019.1	3,299.0	2,508.0	212.1
2016	5,952.6	3,388.3	2,314.6	249.7
2017	6,113.1	3,324.0	2,499.1	290.0
2018	6,273.7	3,198.9	2,803.8	271.0
2019	6,458.7	3,301.9	2,879.0	278.8

Notes. Each cell contains the total value of Colombia's exports in millions of dollars of the firms in our sample. The first column shows the total value exported and the following columns show the total amount for each group of destination countries. Source: Own elaboration based on customs data from DANE.

Furthermore, in Table 3, we present descriptive statistics regarding the proportion of firms that engaged in exports to different destination country groups in 2019, employing the same classification introduced in Table 2. Additionally, we show statistics related to the total export value in millions of US dollars for these establishments in 2019, along with the number of products they exported.

According to our data, it appears that, on average, approximately 39% of the manufacturing firms in our sample were involved in exporting their products. Furthermore, roughly 28% of these firms exported to at least one high-income country, 32% exported to an upper-middle-income country and, finally, 14% to a lower-middle/low-income country, according to the World Bank classification.

In Panels B and C of Table 3, we can observe that there exists a substantial dispersion in both export values and the number of products exported by the firms in our dataset. Conditioning on firms that exported in 2019, firms exported an average of 10 products. However, the top 5% of firms exported approximately 39 different products, as indicated by the product codes they reported. Surprisingly, the diversification of these exports seems to be less pronounced for products traded with high-income countries when compared to those exported to upper-middle-income countries.

Table 3: Exports of Colombian Firms by Destination Group: Total Exports, Exported Value Distribution, and Exported Quantity Distribution

	Total exports	High-Income	Upper-middle	Lower/Low
Panel A. Share of firms exporting in 2019				
Mean	0.39	0.28	0.32	0.14
Panel B. Exports Value of exporting firms (millions USD - 2019)				
Mean	5.55	2.84	2.47	0.24
p25	0.05	0.00	0.01	0.00
p50	0.27	0.04	0.12	0.00
p75	1.52	0.36	0.76	0.03
p95	26.9	7.12	11.3	0.87
Panel C. Number of products exported of exporting firms (2019)				
Mean	9.99	5.08	7.35	2.10
p25	2.00	0.00	1.00	0.00
p50	4.00	2.00	3.00	0.00
p75	10.0	5.00	7.00	1.00
p95	39.0	21.0	30.0	10.0

Notes. Panel A indicates the share of firms exporting in our sample and the fraction of firms exporting to at least one country of the destination groups. Panel B presents descriptive statistics for the total exported value in 2019, broken down by percentiles of the total exported value. Panel C shows the number of exported products in 2019, measured by the variety of 10-digit product codes, categorized by percentiles of product quantity. Source: Own elaboration based on customs data from DANE.

5 Theoretical Framework

The analysis presented in this paper can be examined through two main theoretical frameworks. The first is based on a search model with frictions, which explains how a positive supply shock of skilled labor can lead to an increase in the hiring of skilled workers, particularly those responsible for technological decisions within firms. The second framework draws from the firm-level upgrading literature summarized by Verhoogen (2023), incorporating a Melitz-Heckscher–Ohlin model, similar to those of Harrigan and Reshef (2015) and Bustos (2011), as well as the quality-complementarity hypothesis articulated by Verhoogen (2008) and Kugler and Verhoogen (2012).

These approaches help rationalize how the positive influx of skilled workers hired by firms in the manufacturing sector contributes to a firm-level upgrading process, thereby increasing exports of complex goods—especially those that are intensive in skilled labor and oriented

toward high-income destinations with higher quality requirements.

5.1 Labor Market Dynamics

Similar to the analysis by Beerli et al. (2021), our study can be interpreted within the framework of imperfect competition in the labor market, utilizing a search framework with frictions (Chassamboulli and Palivos, 2014; Chassamboulli and Peri, 2020).

In this framework, firms post vacancies and workers search for jobs. The Venezuelan exodus is expected to reduce labor market tightness by increasing the availability of high-skilled workers in the economy searching for employment, thereby positively impacting the employment of skilled workers. We will show that our findings support this hypothesis. The Venezuelan exodus decreased the tightness of the skilled workers market by increasing their availability. Consequently, firms expanded their hiring, particularly in divisions where tightness is expected to be higher, such as those responsible for R&D decisions.

Additionally, within this framework we will also show that, similar to Beerli et al. (2021), when there are increasing returns to scale due to productivity gains driven by the hiring of high-skilled workers and the investments in R&D, a greater supply of skilled workers can increase the hiring of this type of workforce without negatively impacting wages.

5.2 Firm-Level Upgrading and Trade

Regarding the interaction between the high-skilled labor supply shock and firm-level upgrading, our analysis is mainly based on Verhoogen (2023). Firm production decisions depend on two main variables: physical inputs (such as machines and labor) and their capabilities for a specific product-technique. Within this framework, firm-level upgrading is categorized into four dimensions: learning, quality upgrading, technology adoption, and product innovation. *Learning* refers to the variety of products or techniques firms are familiar with; *quality* pertains to the standards of the products offered; *technology adoption* involves the implementation of new techniques or, as Boehm and Oberfield (2020) describe, *recipes*—different ways of combining inputs to produce goods; and finally, *product innovation* refers to an increase in firms' product diversification.

Under this approach, firm-level upgrading can be driven by output-side factors (such as exports, local demand, reputation, and competition), input-side factors (such as imported or domestic inputs, labor supply, among others), or know-how. Thus, an increased availability of domestic inputs—in this case, a high-skilled labor force shock—particularly when skill-intensive product-techniques are involved, would lead to greater technology adoption. Furthermore, with skill-capital complementarity, this would encourage higher levels of investment in R&D capital. Together, these factors would help firms upgrade by enhancing their operations, improving the quality of goods offered to the market, and boosting productivity.

Moreover, the firm-level upgrading process can significantly impact firms' trade performance. We interpret our findings within the Melitz-Heckscher–Ohlin framework, as used by

Bustos (2011) and Harrigan and Reshef (2015), alongside the quality-complementarity hypothesis proposed by Verhoogen (2008) and Kugler and Verhoogen (2012). At the extensive margin of exports, and following Melitz (2003), firms must meet certain productivity thresholds to profitably engage in international trade. Firms that do not meet this export cutoff will continue to produce for the domestic market, as long as doing so remains profitable. Therefore, the decision to produce—and, more importantly, to export—primarily hinges on firm productivity levels, given the fixed costs associated with both production and exporting.

Following Melitz (2003), firm productivity can be understood in two ways: either as the ability to produce the same variety of goods as other firms at a lower marginal cost, or as the ability to produce higher-quality goods at the same cost. In this context, we argue that the increased availability of high-skilled workers played a pivotal role in the trade-creation effect observed in our main results. Specifically, the recruitment of skilled workers, combined with investments in R&D, enabled firms to undergo an upgrading process that enhanced their productivity and helped them overcome barriers to entering global markets (Melitz, 2003; Matsuyama, 2007). These productivity gains, driven by the newly hired skilled labor force, are reflected in improvements in production and organizational processes, as well as in product quality. Under this scenario, the firms most likely to benefit from these gains—and thus experience the strongest trade-creation effects—are those near the productivity export cutoff, i.e., are the most productive firms. We will provide evidence to support this claim.

The trade dynamics we analyze in this paper can also be understood through the lens of the quality-complementarity hypothesis proposed by Verhoogen (2008) and Kugler and Verhoogen (2012). This perspective, building on Melitz (2003) and incorporating endogenous input and output quality decisions, suggests that firms aiming to engage in international trade must invest in high-quality inputs, particularly when exporting to high-income markets. High-income consumers, who are willing to pay premium prices for superior quality, impose stricter quality standards, requiring firms to upgrade both the quality of their inputs and the skills of their labor force to meet these demands (Brambilla and Porto, 2016). In our analysis, high-quality inputs are reflected in the technology embedded in firm investments. When combined with the advanced skills of newly hired workers, particularly in R&D roles, these factors positively affect production processes, enhancing the quality of the firms' final output. We will present evidence that following the high-skilled labor supply shock, firms increased their hiring of skilled workers, particularly in R&D, and made complementary investments in R&D, enabling them to expand exports to high-income markets.

Finally, within the Heckscher–Ohlin framework, we expect that the increased availability of a specific input—high-skilled labor—would enhance trade opportunities for firms that are more intensive in using that input. This suggests that our estimated effects will be primarily driven by firms that rely heavily on high-skilled labor, particularly in divisions responsible for technology decisions, implementing new production methods, and improving the quality of goods offered in the market. We will present evidence consistent with this expectation.

6 Empirical Strategy

To study the effect of Venezuelan exodus on Colombian firm outcomes, we estimate the following equation:

$$Y_{ijmrt} = \alpha + \beta S_{mrt} + \theta_i + \delta_{rt} + \omega_j t + [\Gamma_{mr} \times \gamma_t] + \epsilon_{ijmrt} \quad (1)$$

Where Y_{ijmrt} is the outcome variable for firm i belonging to the 4-digits-CIIU industry j, in local labor market m, region r, and year t. Firm outcomes studied in this paper include employment by qualification level (overall and in R&D divisions), the probability and amount of investment in R&D, and the implementation of new or improved processes, techniques, and products. We also examine the attainment of quality certifications, the impact of adopting new or improved products or techniques, and the barriers firms face during their implementation. Finally, we consider the probability of exporting, the amount exported in US dollars, the number of different exported products and destinations, the amount exported by product type (differentiated or homogeneous), and average wages.

Our main variable of interest is S_{mrt} which represents the share of Venezuelan migrants living in local labor market m, located in region r relative to the working-age population of the same local labor market-region in 2012 (before the exodus). θ_i and δ_{rt} are firm and region-year fixed effects, respectively.[15] These sets of fixed effects allow us to control for constant differences between firms over time and differential time-varying shocks across regions that affect firms in the same region equally, respectively. Finally, $\omega_j t$ is an industry-specific linear trend that controls for any monotonic trend in our outcome variables for each industry in the sample.

Furthermore, we include a set of pre-shock local labor market characteristics interacted with year fixed effects, which are captured by the term $[\Gamma_{mr} \times \gamma_t]$. The pre-determined local labor market characteristics are per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. This set of control variables, interacted with year fixed effects, allows us to nonparametrically control for changes in our dependent variables over time that might be correlated with any shocks that differentially affect the local labor market according to their past characteristics, such as those related to the income level in the past or their exposure to violence or drug-related historical characteristics. Additionally, we also control by the total amount of exports in USD (in logs) between each firm and Venezuela in 2012 (before the exodus) interacted with year dummies, to control for any impact that the collapse of the

[15] Each region is a group of municipalities defined by DANE. The Central region comprises the municipalities in the departments of Antioquia, Caldas, Cundinamarca, Risaralda, Tolima and the city of Bogotá; the Atlántica region comprises the municipalities of Atlántico, Bolívar, Córdoba, and Magdalena; the Oriental region comprises the municipalities in the departments of Norte de Santander, Boyacá, Meta and Santander; finally, the Pacífica region comprises municipalities Cauca, Nariño and Valle del Cauca.

Venezuelan economy could have had on the performance of firms.[16] Therefore, the identification in our empirical approach comes from variation between the local labor market shares of Venezuelan immigrants relative to the pre-shock local labor force over time and the local labor market average firms' outcomes. Standard errors are clustered at the local labor market level to account for potential serial correlation within local labor markets over time.

6.1 Instrumental Variable Approach

Time-varying components that we cannot account for might affect both the geographic location pattern of the Venezuelan migrants and firm behavior. Refugees, for instance, might choose to move to areas where local businesses are more prosperous, which would lead us to overestimate the effects of refugees on firms' outcomes. Thus, to account for the possibility that the allocation of Venezuelan immigrants was not random, we use an instrumental variable approach to instrument the share of Venezuelan immigrants in each Colombian local labor market.

We employ a well-known enclave instrument that has been used in several papers analyzing episodes of forced migration (see, for instance, Del Carpio and Wagner, 2015; Morales, 2018; Caruso et al., 2019). This instrument exploits the fact that given the forced nature of the migration, the location of Venezuelan migrants was spatially concentrated in local labor markets near Venezuela. Thus, the travel distance from the Venezuelan state from which the displaced are fleeing to each potential Colombian destination local labor market is a key determinant of the refugee location decisions. Formally, our instrumental variable (IV) is defined as follows:

$$IV_{mrt} = V_t \left[\frac{1}{K} \sum_{K} \frac{1}{D_{mrk}} \right] \tag{2}$$

Where V_t is the stock of Venezuelan immigrants living in Colombia in year t and provides our IV time variation. This component is orthogonal to the differences in the share of Venezuelans across Colombian local labor markets. The discrete jump in the inflow of Venezuelans between 2015 and 2019 (Figure 1) was due to events occurring in Venezuela: the macroeconomic, social, and political crisis.

K is is the number of different Venezuelan states (23) and D_{mrk} is the driving-distance in kilometers between Colombian local labor market m in the region r and Venezuelan state k. This ratio provides our instrument with variability at the local labor market level. The hyperbolic functional form of the distance weights local labor markets in Colombia closer to states in Venezuela with a much higher importance than those farther away.

The intuition behind the instrument is that those Colombian local labor markets located near Venezuelan states are expected to face higher immigration than those local labor markets located far away from Venezuelan states (conditional on controls in equation 1).

[16] We present all our results with the full set of pre-determined local labor market characteristics included in the vector Γ_{mr} of equation 1. However, results remain very similar if we exclude these controls. Results of those estimates are available upon request.

The key threat to the validity of any distance-based instrument is that local labor markets closer to Venezuelan states may systematically differ from those farther away. As discussed above, we can deal with this concern by controlling for pre-shock local labor market characteristics interacted with year dummies and specific regional trends. The identifying assumption of the instrument, once local labor markets characteristics and fixed effects are included, is that the location of Venezuelan immigrants depends on the travel distance from various states of Venezuela. Moreover, we address Goldsmith-Pinkham et al. (2020)'s concerns about Bartik-type instruments in Section 10 and demonstrate the internal validity of our IV.

Table A.2 in Appendix A shows the first-stage correlation between the instrument and the share of Venezuelan immigrants, which appears to be strong, supporting the relevance condition of the instrumental variable approach proposed in this paper. The instrument is significant at the one percent level in every specification we estimated, and the F-statistic is well above the standard levels.

7 Firm-Level Upgrading Effects

According to Verhoogen (2023), there are three main drivers of firm-level upgrading: output-side drivers, input-side drivers, and know-how/firm capabilities. In this section we will show that the skilled labor supply shock caused by Venezuelan migrants in the Colombian manufacturing sector, led to firm-level skill-upgrading. The increased availability of qualified labor enabled firms to invest more in research and development (R&D) and to enhance both their range of products and the techniques or technologies used to produce them (product-techniques portfolio). First, in Subsection 7.1, we show that the increased supply of high-skilled workers in the manufacturing sector of Colombia effectively resulted in a significant rise in the hiring of skilled workers, mainly within divisions responsible for R&D decisions. Additionally, we show that this increase in skilled labor led to greater R&D investments. These investments in developing countries are often aimed at adopting new technologies or enhancing the quality of existing ones within firms.

In Subsection 7.2, we show that the increased availability of high-skilled labor facilitated the adoption of new techniques and processes, which Verhoogen (2023) defines as technological adoption. This process is driven by the complementarity between these two critical inputs (skills and technology), enabling firms to better combine inputs and improve the quality of goods offered to the market.

Thus, we further present evidence that firm-level upgrading led to improvements not only in the quality of firms' methods but also in the goods they offered to the market, as indicated by a higher likelihood of obtaining quality certifications. Finally, we show that firms were more likely to self-report significant improvements in their performance due to this upgrading process, while also facing fewer obstacles when implementing changes to enhance their operational processes.

7.1 The Skill and R&D Upgrading of Firms

To examine skill upgrading in Colombian manufacturing firms, we use data on the number of workers in each company, categorized by education level. With this data, we can divide the number of workers into three categories: those with primary education (Low-skilled workers), secondary education (Medium-skilled workers), and post-secondary education (High-skilled workers). This breakdown will allow us to analyze the changes in the skill composition of the labor force within manufacturing firms more precisely. The findings from this initial analysis are presented in Panel A of Table 4, which illustrates the impact on the total number of employees hired (in logs) by manufacturing firms, categorized by skill level.

Furthermore, and more importantly, we take advantage of the granularity of the EDIT data and study the impact on the skill composition within divisions that are in charge of technological and innovative tasks (henceforth, R&D divisions). We argue that these departments are crucial for implementing new production processes, adapting or creating better products, and upgrading overall firm performance. This improvement will be reflected in the firm's ability to sell products to markets with more sophisticated demands, such as high-income countries.

To conduct this analysis, we examine the impact of the Venezuelan exodus on the total number of employees by skill level within R&D divisions (Panel B of Table 4). Additionally, we estimate the impact on the ratio of employees at each skill level in R&D divisions relative to the total number of employees in the firms (Panel C of Table 4). This latter measure captures the intensity of R&D employment within a firm and reveals how it was affected by the Venezuelan exodus.

Several results in terms of skill upgrading emerge from our estimates. Importantly, the influx of Venezuelans in Colombia positively impacted the skill composition of workers within manufacturing firms by increasing high-skilled employment.

First, our analysis suggests that a one p.p. increase in the share of Venezuelan migrants in each local labor market led to an approximate 1% increase, on average, in the employment of high-skilled workers. For medium- and low-skilled workers, we find no statistically significant effects. We interpret this change in the composition of workers at the higher end of the skill distribution as an effect that could have helped firms acquire the abilities needed to improve their production processes and the types of goods they are able to produce and export.

Secondly, and speaking more to this interpretation, our estimates suggest that the number of high- and medium-skilled workers in the R&D divisions increased as a consequence of the Venezuelan exodus. Our estimates indicate that a one p.p. increase in the share of migrants translated into an increase of 3.1% and 1.9% in the total number of high- and medium-skilled workers, respectively. For the case of low-skilled workers we find no-significant impact. In fact, this skill-upgrading within the R&D divisions shifted the within-firm employment structure. We estimate that firms increased the proportion of high- and medium-skilled workers in those divisions relative to the total employment as a consequence of the skilled labor supply shock caused by the Venezuelan exodus.

The estimates in Table 4 support the skill-upgrading argument posited in this paper. Firms

were able to enhance skills overall, particularly in R&D divisions, which likely had a positive impact on their production processes and performance. This skill enhancement provided the crucial abilities needed to improve business practices and participate in the international market (Artopoulos et al., 2013), trading with high-income economies.

Table 4: Effect of immigration on skill-upgrading

	High-skilled	Medium-skilled	Low-skilled
Panel A: Total No Employees			
Share of immigrants	0.010*	0.011	0.007
	(0.006)	(0.009)	(0.013)
Panel B: R&D Division No Employees			
Share of immigrants	0.031***	0.019***	0.004
	(0.007)	(0.007)	(0.003)
Panel C: R&D Division Share Employees			
Share of immigrants	0.002***	0.001**	0.001
	(0.000)	(0.001)	(0.000)
F-Statistic	65.39	65.39	65.39
Number of firms	3,017	3,017	3,017
Observations	21,119	21,119	21,119
Firm FE	Yes	Yes	Yes
Region FE × Time FE	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes
Past controls × Time FE	Yes	Yes	Yes

Notes: The outcome variables are the number of employees by education level (in logs). High-skilled workers are those with any post-secondary education. Medium-skilled workers are those with secondary education. Low-skilled workers are those with less than secondary education. Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

Finally, we examine how the influx of migrants in Colombia influenced firms' R&D investment decisions. If the skill-upgrading channel proposed in this paper is valid, we would expect firms to increase their R&D investments due to the greater supply of skilled workers and the complementarity between these skilled workers and other necessary production inputs. The evidence in Table 5 supports this R&D upgrading effect.[17]

We present an analysis of the estimated impact of the Venezuelan exodus on overall investments in R&D. All these investments, captured by the EDIT in our database, are explicitly identified as those aimed at introducing novel or significantly enhanced goods, services,

[17] The R&D decisions discussed in this paper, given the focus on a developing country like Colombia, differ from those in developed nations, such as patents. According to Verhoogen (2023), R&D in developing countries is more about catching up with the technological frontier rather than pushing it forward.

and/or processes. First, in Table 5, we present the extensive margin where the dependent variable is a dummy indicating whether the firm made any R&D investments. Our estimates reveal a positive and statistically significant coefficient for overall innovation, suggesting that a one p.p. increase in the share of migrants raised the probability of R&D investment by 1.2 p.p. Examining the intensive margin in the same table, we also find a statistically significant effect: a one p.p. increase in the share of migrants led to a 14.2% increase in R&D investment by firms. These results highlight the crucial role of skilled labor in fostering innovation and technological progress within firms. Such advancements enhance their competitiveness and export efficiency, supporting the firm-level upgrading hypothesis emphasized in this paper.

Table 5: Effect of immigration on technological development investment

	Extensive Margin	Intensive Margin
Share of immigrants	0.012***	0.142**
	(0.005)	(0.057)
F-Statistic	65.39	65.39
Number of firms	3,017	3,017
Observations	21,119	21,119
Firm FE	Yes	Yes
Region FE × Time FE	Yes	Yes
Industry Linear Trend	Yes	Yes
Past controls × Time FE	Yes	Yes

Notes: The outcome variable for the Extensive Margin column is a dummy indicating whether firms invested a positive amount in technological development (investments aimed at introducing novel or significantly enhanced goods, services, and/or processes). For the Intensive Margin column it is the amount invested by the firm in technological development (in logs). Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

7.2 Technology Adoption and Quality Upgrading

Thus far, we have put forth evidence indicating increases in hiring of skilled workers and investments in R&D. These findings align with the concept of skill and R&D upgrading within the production processes of firms, potentially enhancing the complexity and differentiation of their goods. The economic literature emphasizes the relevance of adopting new production processes and enhancing business practices as pivotal factors for entering the global market, especially for firms in developing countries (Brambilla and Porto, 2016; Verhoogen, 2008, 2023). A key challenge for exporters in developing nations is the need to improve production techniques to gain greater control over the manufacturing process (Artopoulos et al., 2013). By addressing these issues, plants can reduce defects in goods and ultimately enhance product quality.

In this subsection, we examine how the increase in the quality of both the labor force and

R&D investments by firms in Colombia, driven by the influx of high-skilled labor from the Venezuelan exodus, led to the adoption of new technologies, including innovative processes and methods. Essentially, the skilled labor supply shock experienced by Colombian manufacturing firms could have expanded the stock of knowledge available in the economy and within firms, thereby enhancing the techniques and business practices used to produce goods with higher quality standards.

We analyze four sets of variables to investigate how the Venezuelan exodus affected firms' capacity to adopt new or improved techniques and processes, and how these changes translated into quality upgrades in their output.[18] These techniques may include management practices, organizational methods, or operational *recipes* that coordinate efforts within firms to improve outputs (Boehm and Oberfield, 2020; Verhoogen, 2023).

Table 6 presents the first set of variables analyzing the impact of the Venezuelan exodus on technology adoption. The dependent variable in the second column is a binary indicator for the probability of implementing new or significantly improved processes, production methods, distribution methods, delivery methods, or logistics systems (labeled "Processes"). The third column features a binary variable indicating the adoption of new organizational methods related to internal functioning, knowledge management systems, workplace organization, or management of external relations (referred to as "Organizational"). Finally, the last column shows a binary variable capturing the adoption of new marketing techniques, such as changes in product packaging or design, aimed at expanding or maintaining market presence (labeled "Marketing").

Our results suggest that the Venezuelan exodus had a positive impact on the implementation of new or significantly enhanced production processes, with an increase of 1.9 p.p. in the probability of introducing a process innovation given a one p.p. increase in the share of Venezuelans relative to the local labor force. Additionally, there was an increase of 0.6 p.p. in the probability of adopting new or better organizational methods caused by a rise of one p.p. in the share of Venezuelan migrants. This evidence suggests that the increased supply of skilled workers fostered technology adoption within firms: the tasks performed by high-skilled new hires significantly improved overall performance and techniques in key areas such as production processes and methods, workplace organization, and the management of the company's external relationships.

[18] For details on the phrasing of the questions in this section, please refer to Appendix D.

Table 6: Effect of immigration on the improvement of production methods

	Processes	Organizational	Marketing
Share of Immigrants	0.019***	0.006*	0.003
	(0.004)	(0.003)	(0.003)
F-Statistic	59.12	59.12	59.12
Number of firms	3,017	3,017	3,017
Observations	12,068	12,068	12,068
Firm FE	Yes	Yes	Yes
Region FE × Time FE	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes
Past controls × Time FE	Yes	Yes	Yes

Notes: The outcome variables are binary indicators indicating whether firms introduced or significantly improved a production process/method, internal organization of the firm or marketing/product design (thoroughly defined in the text and Appendix D). Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

The second set of questions on quality upgrading explores whether companies made substantial improvements to their existing products or introduced entirely new ones. The quality upgrades in firms' goods and processes can be measured in two ways using our data. On the one hand, we can define objective measures of quality upgrading as the likelihood of obtaining a quality certification for either products or processes. This variable is shown in the second column of Table 7. This type of variable has been extensively used in the economic literature as an observable and credible measure of firm-level upgrading (Verhoogen, 2008; Hallak and Sivadasan, 2013; Verhoogen, 2023).[19]

On the other hand, we use self-reported information from firms as a subjective measure of quality upgrading for the products they offer, as shown in columns 3-6 of Table 7. These variables provide valuable insights into the perceptions of firms on the quality and type of output they are producing, allowing us to estimate the extent of quality upgrading in the goods offered to the market. The third and fourth columns display the total number of enhanced or new products (in logs), while the last two columns show the probability of improving or introducing new products.

Our estimates suggest that firms were able to significantly improve their products both at the extensive and intensive margins, considering both objective and subjective measures of quality upgrading. First, we find that one p.p. increase in the share of migrants led to a 1.1 p.p. increase in the likelihood of firms obtaining a quality certification. Secondly, we find that a one p.p. increase in the share of migrants due to the Venezuelan exodus increased the number of significantly enhanced products by 0.7% and the probability of improving the quality of

[19] These quality certifications for processes and products refer to ISO standards, such as ISO-9001 (Quality management systems) and ISO-14040 (Environmental management — Life cycle assessment).

goods produced by firms by 0.7 p.p. Regarding the creation of new products, although the coefficients are not statistically significant, they are similar in magnitude to those for improved goods and suggest a noisily estimated positive effect on new product creation. Our estimates indicate that a 1 p.p. increase in the share of Venezuelan migrants relative to the local labor force positively affected the number of newly created products by 0.7% (with a p-value of 0.12) and the probability of creating new products by 0.5 p.p. (with a p-value of 0.15).

Table 7: Effect of immigration on objective and self-reported quality indicators

	Certifications	Number of products (in logs)		Probability (dummy variable)	
		Improved	New	Improved	New
Share of Immigrants	0.011**	0.007**	0.007	0.007**	0.005
	(0.005)	(0.003)	(0.004)	(0.003)	(0.004)
F-Statistic	59.12	59.12	59.12	59.12	59.12
Number of firms	3,017	3,017	3,017	3,017	3,017
Observations	12,068	12,068	12,068	12,068	12,068
Firm FE	Yes	Yes	Yes	Yes	Yes
Region FE × Time FE	Yes	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes	Yes
Past controls × Time FE	Yes	Yes	Yes	Yes	Yes

Notes: The outcome variables in columns 2, 5, and 6 are binary indicators reflecting whether firms obtained a quality certification, significantly improved an existing product or introduced a new product. Columns 3 and 4 represent the total number (in logs) of significantly improved or new products. Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

Furthermore, the EDIT enables an analysis of the impact of technology adoption on firms performance indicators. Hence, with this third set of variables we examine whether the implementation of new or improved processes, organizational methods, marketing, or products helped firms achieve specific outcomes. These include improving the quality or variety of goods offered to consumers, accessing new markets, retaining existing ones, increasing productivity, or reducing costs. These outcomes are analyzed in Table 8, using binary variables that indicate whether (i) firms implemented any of the mentioned technology adoptions *and* (ii) experienced improvements in any of these dimensions. Our results suggest that the high-skilled labor supply shock caused by the Venezuelan exodus, along with the skill- and R&D-upgrading and technology adoption within firms, positively impacted their ability to achieve these goals. Specifically, firms improved product quality and variety, retained market presence, boosted productivity, reduced costs, and entered new markets (this latter coefficient noisily estimated with a p-value of 0.12).

Table 8: Effect of immigration on firms' performance indicators through the adoption of new/better production methods/products

	Quality	Variety	Keep Markets	New Markets	Productivity	Costs
Share of Immigrants	0.012**	0.007**	0.013***	0.007	0.008*	0.007*
	(0.005)	(0.004)	(0.005)	(0.004)	(0.004)	(0.004)
F-statistic	59.12	59.12	59.12	59.12	59.12	59.12
Number of observations	3,017	3,017	3,017	3,017	3,017	3,017
Observations	12,068	12,068	12,068	12,068	12,068	12,068
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE × Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes	Yes	Yes
Past controls × Time FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The outcome variables are binary indicators indicating whether firms (i) introduced or significantly improved a product and/or a process (as described in the text) *and* (ii) achieved one of the goals described in the columns. Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

Lastly, the fourth set of questions in Table 9 examines the probability that firms face obstacles to adopt new or improved products or processes, as detailed in Tables 6 and 7. Specifically, the dependent variables in each column of Table 9 are binary, taking a value of 1 if firms reported obstacles related to a lack of internal resources (second column), a shortage of qualified workers (third column), a difficulty meeting technical regulations (fourth column), or a low availability of inspection, testing, calibration, certification, and verification services (fifth column).

In all cases, the effect is negative and statistically significant at conventional levels. These results suggest that firms more strongly exposed to the skilled labor supply shock in the manufacturing sector, caused by the Venezuelan exodus, were less likely to face these types of obstacles. Consequently, they had better opportunities to improve their operations and the products they offer to the market.

This aligns with the mechanisms highlighted in this paper: given a greater availability of skilled workers, firms faced fewer constraints due to shortages of internal resources, particularly skilled labor, which would have otherwise hindered operational and product improvements. Additionally, having more skilled workers available allowed firms to upgrade and better meet quality standards and technical regulations, consistent with the increased likelihood of obtaining quality certifications, as shown in Table 7. Finally, the increased availability of skilled labor contributed to a rise in quality accreditation services, aligning with both the enhanced capacity of the workforce and the growing demand for accredited certifications and testing to meet quality standards.

Table 9: Effect of immigration on the probability of facing obstacles to adopt new and better production methods or products

	Own resources	Skills	Regulations	Accreditation services
Share of Immigrants	-0.009**	-0.010**	-0.016***	-0.014**
	(0.004)	(0.005)	(0.005)	(0.007)
F-statistic	59.12	59.12	59.12	59.12
Number of observations	3,017	3,017	3,017	3,017
Observations	12,068	12,068	12,068	12,068
Firm FE	Yes	Yes	Yes	Yes
Region FE × Time FE	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes
Past controls × Time FE	Yes	Yes	Yes	Yes

Notes: The outcome variables are binary indicators that specify whether firms encountered any of the described obstacles when attempting to introduce or significantly improve a product or method. Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

8 The Effect of Migration on Exports through Firm-Level Upgrading

In this section, we show how the firm-level upgrading effects identified in the previous section positively impacted the integration of firms into export markets. We demonstrate that this was achieved not only through the export of more complex and differentiated products but also by increasing their participation in high-income destinations. We view these final effects of the Venezuelan exodus on trade as crucial consequences of firm-level upgrading in a developing country, as they imply better opportunities for economic development in emerging economies like Colombia.

8.1 The Effect on the Extensive and Intensive Margin of Exports

We begin our analysis by examining the impact of the Venezuelan exodus on the likelihood of a Colombian manufacturing firm engaging in export activities. Table 10 presents our estimates of equation 1 for all firms in our sample. All coefficients should be interpreted as the effect of a one p.p. increase in the share of Venezuelans relative to the (pre-shock) local labor force on the probability of exporting. Our estimates reveal that a one p.p. increase in the proportion of Venezuelan migrants had a positive effect on the export probability of manufacturing firms, leading to a 0.6 p.p. increase.

Moreover, when examining variation in the effects across export destinations, we find that the positive impact is largely concentrated in high-income countries. Our estimations indicate that a one p.p. increase in the proportion of migrants led to a 0.5 p.p. increase in the likelihood of exporting to high-income countries. To put this in perspective, according to our own estimates in 2013, the probability of manufacturing firms exporting to high-income countries in 2013 was 32%. Therefore, a simple back-of-envelope calculation indicates that this increase is equivalent to a 1.6% rise over the baseline probability of exporting manufacturing goods to high-income countries.

Table 10: Effect of immigration on the probability of exporting - Total and by income level of destinations

	Total	High	Upper-middle	Lower/Low
Share of Immigrants	0.006**	0.005**	0.004*	0.003
	(0.003)	(0.003)	(0.002)	(0.002)
F-Statistic	65.39	65.39	65.39	65.39
Number of firms	3,017	3,017	3,017	3,017
Observations	21,119	21,119	21,119	21,119
Firm FE	Yes	Yes	Yes	Yes
Region FE $\times$ Time FE	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes
Past controls $\times$ Time FE	Yes	Yes	Yes	Yes

Notes: The outcome variables are a binary indicator that denotes whether the firm exported to each destination. Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

After examining the extensive margin impact of the Venezuelan exodus on the export performance of manufacturing firms in Colombia, the logical next step is to investigate whether there is an intensive margin effect. To do so, we use the total value of exports by each firm in each year (in logs) in FOB US dollars as our dependent variable.

Before delving into our results, it is crucial to highlight certain caveats. In order to address attrition issues in our sample and to avoid working with an unbalanced panel of firms, we include those firms that did not engage in any exports, assigning a value of zero to the dependent variable. Consequently, our analysis is not exclusively contingent upon exporting firms but considers all firms in our dataset. In light of this, the intensive margin effect we estimate in this part of the study comprises two distinct components: firms that have consistently been exporters but now export a different value due to the migration exodus (pure intensive margin), and firms that were previously non-exporters but have now begun exporting with a positive value.

Table 11 presents our estimates of the impact of the Venezuelan exodus on the total value of exports. Our results yield two main conclusions. Firstly, the Venezuelan exodus had a posi-

tive and statistically significant effect on the total amount exported by manufacturing firms in Colombia. As indicated in the second column of Table 11, a one p.p. increase in the share of immigrants had a positive impact on the total value of firms' exports, resulting in an average increase of 7.1%. Secondly, this positive effect of the exodus appears to be particularly concentrated in exports to high- and upper-middle-income destinations. Our estimations reveal that for both of these destination categories, the positive impact stood at 7.3% and 4.4%, respectively. Finally, we estimate a non-significant impact on exports to low/lower-middle-income countries.

Table 11: Effect of immigration on exports (in logs) - Total and by income level of destinations

	Total	High	Upper-middle	Lower/Low
Share of Immigrants	0.071**	0.073***	0.044*	0.026
	(0.027)	(0.027)	(0.023)	(0.021)
F-Statistic	65.39	65.39	65.39	65.39
Number of firms	3,017	3,017	3,017	3,017
Observations	21,119	21,119	21,119	21,119
Firm FE	Yes	Yes	Yes	Yes
Region FE × Time FE	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes
Past controls × Time FE	Yes	Yes	Yes	Yes

Notes: The outcome variable is the total amount exported in US dollars (in logs). Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

8.2 The Effect on the Diversification of Exports and the Creation of New Markets

Another key finding that indicates a trade-creation effect of immigration on firms is the diversification of their exports, measured by the number of distinct products they export. Our analysis considers the count of different products based on their 10-digit NANDINA product classification for each firm and year to examine this outcome.

The results presented in Table 12 suggest that, on average, the impact of Venezuelan immigration on the diversity of products exported by manufacturing firms was positive and statistically significant, particularly concerning exports to high-income and upper-middle-income countries. Our estimates indicate that a one p.p. increase in the share of Venezuelan immigrants had a positive effect on the number of different products exported overall, to high-income countries, and to upper-middle-income countries of 1.1%, 0.8%, and 0.7%, respectively. This suggests that the firm-level upgrading caused by the Venezuelan exodus contributed to the diversification of Colombia's manufacturing exports to high- and upper-middle-income

countries. Essentially, Colombian manufacturing firms were more adept at exporting different types of products to these countries with higher quality requirements as a consequence of the skilled labor supply shock produced by the Venezuelan exodus.

Table 12: Effect of immigration on number of products exported (in logs) - Total and by income level of destinations

	Total	High	Upper-middle	Lower/Low
Share of Immigrants	0.011**	0.008**	0.007***	0.001
	(0.004)	(0.004)	(0.002)	(0.002)
F-Statistic	65.39	65.39	65.39	65.39
Number of firms	3,017	3,017	3,017	3,017
Observations	21,119	21,119	21,119	21,119
Firm FE	Yes	Yes	Yes	Yes
Region FE $\times$ Time FE	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes
Past controls $\times$ Time FE	Yes	Yes	Yes	Yes

Notes: The outcome variable is the number of different products exported (in logs) categorized according to the 10-digit NANDINA product classification. Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

Moreover, when examining the total number of countries to which firms exported (in logs), as presented in Table 13, we find that firms not only expanded the variety of goods they exported but also began establishing new markets and increased the number of countries they exported to as a consequence of the firm-level upgrading. Our estimates indicate that the number of country destinations to which firms exported increased by 1% with a one p.p. rise in the share of Venezuelan migrants relative to the pre-shock local labor force. Furthermore, this effect was primarily driven by the creation of new markets in high-income and upper-middle-income countries.

Table 13: Effect of immigration on number of destinations (in logs) - Total and by income level of destinations

	Total	High	Upper-middle	Lower/Low
Share of Immigrants	0.010***	0.007***	0.005***	0.002
	(0.003)	(0.003)	(0.002)	(0.002)
F-Statistic	65.39	65.39	65.39	65.39
Number of firms	3,017	3,017	3,017	3,017
Observations	21,119	21,119	21,119	21,119
Firm FE	Yes	Yes	Yes	Yes
Region FE × Time FE	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes
Past controls × Time FE	Yes	Yes	Yes	Yes

Notes: The outcome variable is the number of different country destinations for each firm (in logs). Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

8.3 The Effect on the Complexity and Differentiation of Exports

Our core hypothesis in this study posits that the augmented supply of skilled workers in the Colombian economy had a positive effect on firm-level upgrading that spurred advancements in the production processes and technological development of manufacturing firms. Consequently, this increased the quality and complexity of the goods they produce and export globally.

Entering global markets with differentiated products necessitates specific knowledge, business practices, and input qualities. For example, firms employing skilled workers or adopting improved production processes are expected to be better positioned to increase exports of differentiated products (Artopoulos et al., 2013; Bernini et al., 2018). Therefore, the increased availability of skilled workforce could have positively affected manufacturing firms in this direction. The findings in Table 14, which outlines the impact on the total export value and the number of different products exported, classified by product type (differentiated or homogeneous), align with these observations.

We partition our estimates into exports of differentiated and homogeneous goods, following the methodology introduced by Rauch (1999). In his seminal work, Rauch (1999) classifies internationally traded commodities into three distinct categories: traded goods in organized exchanges, reference-priced goods, and the remaining goods. Consistent with this approach, we classify reference-priced goods and traded goods in organized markets as homogeneous

goods while categorizing the remaining goods as differentiated goods.[20]

Based on our estimates outlined in Table 14, it becomes evident that the previously identified positive effect on exports was primarily concentrated in differentiated goods rather than homogeneous ones. Our analysis shows that our estimates in terms of the export value of products in USD (in logs) is only statistically significant for differentiated goods and that the coefficient for this category is 1.66 times the coefficient of homogeneous goods. Similarly, when considering the number of products (in logs) as a dependent variable, our results show that the effect on differentiated goods is 2.25 times the estimated effect for homogeneous products. Our findings suggest that Colombian manufacturing firms increased their likelihood of exporting and the total value of exports worldwide due to the Venezuelan exodus. This positive effect was largely explained by the export of differentiated and more complex goods.

Table 14: Effect of immigration on exports by type of products (in logs)

	Differentiated		Homogeneous	
	Exports USD	No. Products	Exports USD	No. Products
Share of immigrants	0.048**	0.009**	0.029	0.004**
	(0.023)	(0.004)	(0.021)	(0.002)
F-Statistic	65.39	65.39	65.39	65.39
Number of firms	3,017	3,017	3,017	3,017
Observations	21,119	21,119	21,119	21,119
Firm FE	Yes	Yes	Yes	Yes
Region FE × Time FE	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes
Past controls × Time FE	Yes	Yes	Yes	Yes

Notes. The outcome variable is the total amount exported in US dollars (in logs) by a firm each year for each type of product. Products were defined as differentiated or homogeneous following Rauch (1999)'s definition. Goods defined as reference-priced goods or goods traded in organized markets were considered as homogeneous. The remaining goods were classified as differentiated goods. Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

The evidence presented in this paper strongly suggests that the arrival of Venezuelan immigrants catalyzed firm-level upgrading and induced a trade-creation effect in the Colombian manufacturing sector. Descriptive statistics presented above (Section 4.1) indicate that Venezuelan workers are disproportionately represented among high-skilled workers in the Colombian manufacturing sector (as shown in Figure 3). This influx of skilled labor enabled firms to upgrade their inputs, particularly by hiring high-skilled workers for R&D divisions

[20] For instance, according to Rauch (1999)'s classification the category 8510 "Footwear" is defined as differentiated product, whereas the category 4110 "Animal oils and fats" belongs to goods traded on an organized exchange, and category 0340 "Fish, fresh (live or dead), chilled or frozen" is defined as reference-priced goods.

and increasing R&D investments.

This upgrading of input quality enabled firms to adopt improved production techniques and organizational methods, allowing them to make better use of available resources. As a result, firms improved the quality of their goods and met international quality standards, reflected in a higher likelihood of receiving quality certifications. This firm-level upgrading translated into a competitive advantage, boosting exports, especially to high- and upper-middle-income countries and of differentiated products. The heterogeneity in export destinations aligns with prior evidence on how firm-level upgrading can enable companies to meet the sophisticated demands of developed markets (Verhoogen, 2008; Bastos and Silva, 2010; Brambilla et al., 2012; Brambilla and Porto, 2016).

8.4 The Effect on Exports by Firms' Productivity and Skill-Intensity

As highlighted in the theoretical section, we interpret our trade-creation findings through the lens of a Melitz-type model (Melitz, 2003), integrated with a Heckscher-Ohlin framework. In this context, more productive firms benefit the most from productivity gains associated with hiring high-skilled workers from the Venezuelan exodus.

Our theoretical framework further predicts that firms experiencing the greatest export impacts are those with a comparative advantage in the skill composition of their workforce, especially those intensive in R&D high-skilled workers, who could capitalize more on the increased supply of skilled labor.

To test these hypotheses, we estimate heterogeneous effects by comparing high- vs. low-productivity firms and high- vs. low-skill-intensity firms. Firm productivity is measured as average output per worker, while skill intensity is defined as the share of high-skilled workers in R&D divisions relative to total employees. We categorize firms as high- or low-productivity (or skill-intensity) based on whether their average productivity (or skill-intensity) in 2013—prior to the exodus— relative to their respective 3-digit industry was above or below the median. We then estimate equation 1 separately for both groups. Our results of this exercise are shown in Tables B.1-B.6 of Appendix B.

As shown in Tables B.1-B.3, the effects on exports identified earlier were primarily driven by high-productivity firms, with stronger impacts on exports to high-income destinations and differentiated goods. This observation aligns with the theoretical framework presented by Melitz (2003). The productivity improvements resulting from the skill-upgrading process in Colombia's manufacturing sector enable firms to overcome the fixed costs associated with exporting, allowing them to enter international markets. This was especially true for firms with productivity levels close to the threshold at which they are indifferent between exporting and selling solely in the domestic market.

Additionally, our estimates in Tables B.4-B.6 indicate that high-skill intensive firms—those significantly intensive in hiring high-skilled workers in R&D divisions—benefited the most from the increased availability of skilled workers in the economy. This finding aligns with the predictions of the Heckscher-Ohlin model, which posits that an increase in the abundance of a

specific input—such as a high-skilled labor force—will particularly benefit firms that are more intensive in the utilization of that input. In our context, firms that rely heavily on high-skilled workers for R&D decisions are likely to experience greater advantages. This model suggests that such firms can leverage the increased availability of high-skilled labor to enhance their technological investments, improve productivity, and ultimately gain a competitive edge in the market.

9 Additional Results: Wages and Local Labor Market-Level Outcomes

9.1 Impact on Firm Wages

As an additional result, we studied whether or not the Venezuelan exodus negatively affected the wages paid by the firms in our sample. Table A.3 presents our estimates regarding the impact of a one p.p. increase in the share of Venezuelan immigrants relative to the pre-exodus local labor force on firm wages.

Our estimates suggest a non-statistically significant effect on the average wage paid by manufacturing firms due to the exodus. These wage estimates align with findings from the economic literature on the labor market effects of the Venezuelan exodus in Colombia. Studies such as those by Caruso et al. (2019) and Peñaloza-Pacheco (2022) indicate a negative impact on wages resulting from the Venezuelan exodus. However, this effect is primarily concentrated among informal and low-skilled workers, while for high-skilled and formal workers, the effect is not statistically distinguishable from zero.

According to DANE, although the level of informality in the Colombian labor market is above 50%, among individuals working in firms with 10 or more employees, those levels are below 10%. Given that the EAM surveys firms in the manufacturing sector with 10 or more employees, it is expected that most of the workers in our sample are formal, which explains the absence of any negative effect on wages. This finding is consistent with the existing economic literature.

This result rules out the possibility that the main effect found in this paper in terms of trade-creation is merely a cost-reduction shock. Instead, we show that the effects are mostly driven by the firm-level upgrading impact of the migration episode.

Similarly to Beerli et al. (2021), the absence of a negative impact on wages can be rationalized through potential productivity effects and increasing returns to scale resulting from the hiring of high-skilled workers following the onset of the exodus. These increasing returns to scale may be attributed to positive productivity effects stemming from knowledge spillovers or the diffusion of better ideas facilitated by the hiring of new skilled workers, particularly in the R&D divisions of firms (Hunt and Gauthier-Loiselle, 2010; Bahar et al., 2022). Our results support this idea. We find that the increase in the overall hiring of high-skilled workers, and particularly the skill-upgrading in R&D divisions, enabled firms to enhance their operations.

This improvement was manifested in the enhancement of production and organizational processes as well as in a significant improvement in the quality of products offered in the market, which ultimately positively impacted the ability of firms to obtain quality certifications.

9.2 Impact on Local Labor Market-Level Outcomes

One limitation of our dataset is that we cannot distinguish between Venezuelan migrants and Colombian workers within firms. As a result, we cannot directly test whether the skill-upgrading effect observed was driven by the replacement of Colombian workers with Venezuelan migrants or whether the hiring of highly qualified Venezuelans occurred without displacing Colombian workers.

However, we can use Colombian household survey data to study the impact of migration on employment at the local labor market level, focusing on both natives and migrants in the manufacturing sector, overall and by skill level. We calculate employment rates for both Colombian and Venezuelan workers in each local labor market and estimate the impact of Venezuelan migration on these outcomes. The results are presented in Table A.4 of Appendix A. Panel A shows the effect on total employment, overall and by nationality; Panel B shows the aggregate effect on employment rates by skill level; Panels C and D disaggregate this information for Colombians and Venezuelans, respectively. Finally, Panel E estimates the impact on average hourly wages (in logs) in the manufacturing sector by skill level. All employment rate regressions are normalized by the corresponding 2013 employment rate.

Several key results emerge from this analysis. First, as shown in Panel A, there is an increase in the employment rate of Venezuelans in the manufacturing sector, which aligns with the trends shown in Figure 3. Our estimates suggest that a 1 p.p. increase in the share of Venezuelans increases their employment rate by 4.4 times relative to its 2013 value. Moreover, we find no evidence that Venezuelan employment growth in the manufacturing sector negatively affected the employment opportunities of Colombian workers.

In terms of skills, Panels C and D show that while the employment rate for high-skilled Venezuelans increased nearly nine-fold with a 1 p.p. increase in the migrant share, the increase was six-fold for medium-skilled and three-fold for low-skilled workers. This supports the argument that the Venezuelan migration, particularly in the manufacturing sector, represented a high-skilled supply shock, with the participation of highly qualified Venezuelans growing more than proportionally compared to medium- and low-skilled workers. For Colombians, we do not observe any significant negative impact on employment across skill levels.

Lastly, when examining hourly wages by skill level in Panel E, we find no statistically significant effects. These results, consistent with the firm-level findings in Table A.3, provide strong evidence that the trade-creation effect observed in this paper was driven by firm-level upgrading of manufacturing firms. This enhanced their productivity, product quality, and overall performance, rather than being solely a cost shock from the influx of Venezuelan migrants.

10 Robustness checks and threats to the identification strategy

In this section, we conduct robustness checks on our empirical approach and address potential internal validity issues associated with our identification strategy. Firstly, we examine aspects of the implemented instrumental variable approach and perform additional analyses to bolster our confidence in the exogeneity of our instrumental variable. Finally, we explore a potential challenge to our identification strategy, considering changes that occurred during the analysis period that might have influenced the export performance of Colombian firms.

10.1 Parallel-trends test for IV internal validity

The study by Goldsmith-Pinkham et al. (2020) decomposes the Bartik-type 2SLS estimator into its "shift" part and "share" part. This decomposition reveals that the estimator can be understood as a weighted sum of individually just-identified instruments, each represented by a local share. In settings like ours, where the approach relies on differential exposure to a common shock, the identification hinges on the exogeneity of these shares.[21] In more concrete terms, in scenarios like the one examined in this paper, characterized by a pre-shock period, the empirical strategy is akin to a difference-in-differences setting. Consequently, assessing whether the shares of differential exposure to the common shock lead to variations in our outcomes is crucial for establishing credibility in our strategy.

Our IV serves as a shift-share instrument, where the "share" part is constructed through the average inverse of each pairwise distance between Colombian local labor markets and Venezuelan states. These distance shares capture the varying exposure to the national Venezuelan exodus that began in 2016.

However, it is crucial to address the possibility that the effects identified due to the massive forced immigration of Venezuelans could be partially driven by pre-existing trends at the local labor market level before their arrival. Therefore, we need to investigate potential endogenous pre-exodus mechanisms that are correlated with both distances and our main outcome variables to establish that the exposure to the national arrival of displaced persons has identifying power. Following the suggestion of Goldsmith-Pinkham et al. (2020), we conduct tests for parallel trends to alleviate concerns that our results are influenced by pre-existing differential trends in our outcomes across local labor markets with varying distances to Venezuela's states and, consequently, different exposure to the arrival of displaced citizens from that country.

To test for parallel trends, we generate plots illustrating the reduced-form coefficients of the average distance shares on our outcomes of interest for three years preceding the opening

[21] Although, according to Goldsmith-Pinkham et al. (2020), the consistency of the estimator depends on the shares, Borusyak et al. (2018) emphasize that under some assumptions, the consistency of the estimator might also come from the shocks.

of the Colombia-Venezuela border.[22] Subsequently, we conduct regressions of our outcomes for each year against the average of the distance shares $\left(\text{i.e., } \frac{1}{K}\sum_K \frac{1}{D_{mrk}}\right)$ interacted with year fixed effects, following the specification outlined in equation 1.[23]

Figures C.1-C.4 in Appendix C depict the results, revealing no statistically significant parallel trends in our outcome variables before the opening of borders between Colombia and Venezuela explained by the "share" component of our instrumental variable. The findings support our identification assumption that pre-exodus shares do not predict outcomes through mechanisms other than the post-2016 immigration shock.

Finally, it is crucial to briefly address the exogeneity of the common shock affecting all our treated units (local labor markets), denoted as V_t in equation 2, representing the stock of Venezuelan immigrants living in Colombia in each year t. We argue that this component is orthogonal to the differences in the share of Venezuelans across Colombian local labor markets. The discrete surge in the inflow of Venezuelans between 2016 and 2019 (Figure 1) was primarily driven by push factors, i.e. events occurring in Venezuela, such as the macroeconomic, social, and political crisis. This influx was not instigated by any shock in Colombia that could be endogenous to the performance of manufacturing firms and potentially bias our estimates.

10.2 Potential Threats to the Identification Strategy: Free Trade Agreements

A potential threat to our identification strategy is the possibility that our estimated effects may not be solely attributed to the Venezuelan exodus and its positive impact on firm-level upgrading, but could also be influenced by the free trade agreements signed by the Colombian government in the 2010s with various groups of countries. According to MinCIT (2019), between 2012 and 2016, Colombia entered into free trade agreements with the United States and Venezuela in 2012, the European Union in 2013, and, finally, with Costa Rica, the Pacific Alliance, and South Korea in 2016. These free trade agreements could have potentially contributed to the positive effects observed in the export performance and firm-level upgrading of Colombian firms, serving as a potential confounding factor for our estimates.

To address this potential issue, we introduce the total value of exports before our analysis period (in 2012) between each firm in our sample and each of these country groups individually, interacting with year dummy variables as a control variable in our estimates. This inclusion allows us to account for any influence stemming from the free trade agreements and better isolate the impact of the Venezuelan exodus on our outcomes of interest.

These interactions serve to control for potential divergent trends and time-varying shocks that may vary across firms based on their prior level of trade exposure with each of these

[22] It is worth noting that, following the insights from Goldsmith-Pinkham et al. (2020), the Bartik-type instruments are derived as a sum of shares weighted by Rotemberg weights. They recommend calculating these weights initially to identify the specific exposure design that receives a larger weight in the overall Bartik-2SLS estimate and, consequently, which share effects are worth testing. In our design, these weights are explicit as we are considering only one type of migrant inflow (Venezuelan migration).

[23] Due to the data structure underlying the estimates in Tables 6, 7, 8, and 9, we cannot show parallel trends for these results, as there is only one pre-exodus period.

groups of countries. The results, presented in Tables C.1-C.11 of Appendix C, demonstrate that our estimates remain robust even with the inclusion of these additional controls. This robustness provides further evidence supporting the idea that the positive effects on firm-level upgrading and the export performance of manufacturing firms, as previously identified, can be attributed to the Venezuelan exodus.

11 Concluding remarks

Enabling firms in developing countries to catch up with the global technological frontier, boost their productivity, and help them compete in high-income markets is a priority for policymakers aiming to drive development and structural change. In this paper, we show evidence that skilled labor supply shocks induced by migration episodes can create the ideal conditions for firm-level upgrading, enhancing firm competitiveness in international markets. Thus, we propose migration as an alternative to traditional industrial policy tools.

We specifically examine how the significant influx of skilled labor into Colombia's manufacturing sector, driven by the Venezuelan exodus, impacted firm performance, the capacity to upgrade production processes, and the ability to expand into international markets. Our analysis leverages the variation in the location and timing of Venezuelan migrant settlements across Colombian local labor markets. To address potential endogeneity, we employ a shift-share instrumental variable strategy, using distances between Colombian local labor markets and Venezuelan states, which reflects the forced nature of the migration.

Our findings show that the skilled labor supply shock generated by the Venezuelan exodus led to firm-level upgrading in Colombian manufacturing firms. This shock enhanced firms' ability to hire skilled labor, particularly in R&D divisions, and increased investments in R&D, improving production methods and organizational practices. These improvements ultimately led to higher quality in products and processes, as evidenced by the increased ability of firms to obtain quality certifications. We also find that this firm-level upgrading translated into better export performance, characterized by a diversification effect. Firms exported a greater variety of products and entered new international markets, particularly in high- and upper-middle-income countries. The primary driver was an increase in the total exports of differentiated goods.

Our analysis underscores the role of skilled migration not merely as a labor supply phenomenon but as a driver of structural change through its impact on firm-level upgrading and exports. This perspective adds to the broader literature on migration and development by highlighting the interplay between high-skilled labor inflows and firm-level upgrading, contributing to debates on the economic integration of migrants and the global competitiveness of emerging economies.

References

Altındağ, O., Bakış, O., and Rozo, S. V. (2020). Blessing or Burden? Impacts of Refugees on Businesses and the Informal Economy. *Journal of Development Economics*, 146:102490.

Ariu, A. (2022). Foreign Workers, Product Quality, and Trade: Evidence from a Natural Experiment. *Journal of International Economics*, 139:103686.

Artopoulos, A., Friel, D., and Hallak, J. C. (2013). Export Emergence of Differentiated Goods from Developing Countries: Export Pioneers and Business Practices in Argentina. *Journal of Development Economics*, 105:19–35.

Atkin, D., Khandelwal, A. K., and Osman, A. (2017). Exporting and Firm Performance: Evidence from a Randomized Experiment. *The Quarterly Journal of Economics*, 132(2):551–615.

Bahar, D., Hauptmann, A., Özgüzel, C., and Rapoport, H. (2022). Migration and Knowledge Diffusion: The Effect of Returning Refugees on Export Performance in the Former Yugoslavia. *Review of Economics and Statistics*, pages 1–50.

Bahar, D., Ibáñez, A. M., and Rozo, S. V. (2021). Give me your Tired and your Poor: Impact of a Large-scale Amnesty Program for Undocumented Refugees. *Journal of Development Economics*, 151:102652.

Bahar, D. and Rapoport, H. (2018). Migration, Knowledge Diffusion and the Comparative Advantage of Nations. *The Economic Journal*, 128(612):F273–F305.

Bastos, P. and Silva, J. (2010). The Quality of a Firm's Exports: Where you Export to Matters. *Journal of International Economics*, 82(2):99–111.

Beerli, A., Ruffner, J., Siegenthaler, M., and Peri, G. (2021). The Abolition of Immigration Restrictions and the Performance of Firms and Workers: Evidence from Switzerland. *American Economic Review*, 111(3):976–1012.

Bernini, F., González, J., Hallak, J. C., and Vicondoa, A. (2018). The Micro-D Classification: A New Approach to Identifying Differentiated Eexports. *Economia*, 18(2):59–85.

Bloom, N., Mahajan, A., McKenzie, D., and Roberts, J. (2010). Why do Firms in Developing Countries have Low Productivity? *American Economic Review*, 100(2):619–623.

Bloom, N. and Van Reenen, J. (2007). Measuring and Explaining Management Practices Across Firms and Countries. *The Quarterly Journal of Economics*, 122(4):1351–1408.

Boehm, J. and Oberfield, E. (2020). Misallocation in the Market for Inputs: Enforcement and the Organization of Production. *The Quarterly Journal of Economics*, 135(4):2007–2058.

Borusyak, K., Hull, P., and Jaravel, X. (2018). Quasi-Experimental Shift-Share Research Designs. Working Paper 24997, National Bureau of Economic Research.

Brambilla, I., Lederman, D., and Porto, G. (2012). Exports, Export Destinations, and Skills. *American Economic Review*, 102(7):3406–38.

Brambilla, I. and Porto, G. G. (2016). High-Income Export Destinations, Quality and Wages. *Journal of International Economics*, 98:21–35.

Bustos, P. (2011). Trade Liberalization, Exports, and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinian Firms. *American economic review*, 101(1):304–40.

Caruso, G., Canon, C. G., and Mueller, V. (2019). Spillover Effects of the Venezuelan Crisis: Migration Impacts in Colombia. *Oxford Economic Papers*.

Chassamboulli, A. and Palivos, T. (2014). A Search-Equilibrium Approach to the Effects of Immigration on Labor Market Outcomes. *International Economic Review*, 55(1):111–129.

Chassamboulli, A. and Peri, G. (2020). The Economic Effect of Immigration Policies: Analyzing and Simulating the US Case. *Journal of Economic Dynamics and Control*, 114:103898.

Crozet, M., Head, K., and Mayer, T. (2012). Quality Sorting and Trade: Firm-level Evidence for French Wine. *The Review of Economic Studies*, 79(2):609–644.

Del Carpio, X. V. and Wagner, M. (2015). The Impact of Syrian Refugees on the Turkish Labor Market. *World Bank Policy Research Paper, No. 7402*.

Delgado-Prieto, L. (2023). Immigration and Worker Responses Across Firms: Evidence from Administrative Records in Colombia. *Unpublished Manuscript*.

ECLAC (2019). *Balance Preliminar de las Economías de América Latina y el Caribe 2018*. ECLAC, UN.

Goldin, C. and Katz, L. F. (1998). The Origins of Technology-Skill Complementarity. *The Quarterly journal of economics*, 113(3):693–732.

Goldsmith-Pinkham, P., Sorkin, I., and Swift, H. (2020). Bartik Instruments: What, When, Why, and How. *American Economic Review*, 110(8):2586–2624.

Görg, H., Halpern, L., and Muraközy, B. (2017). Why do Within-firm–product Export Prices Differ Across Markets? Evidence from Hungary. *The World Economy*, 40(6):1233–1246.

Gould, D. M. (1994). Immigrant Links to the Home Country: Empirical Implications for US Bilateral Trade Flows. *The Review of Economics and Statistics*, pages 302–316.

Hall, R. E. and Jones, C. I. (1999). Why Do Some Countries Produce So Much More Output Per Worker than Others? *The Quarterly Journal of Economics*, 114(1):83–116.

Hallak, J. C. and Schott, P. K. (2011). Estimating Cross-country Differences In Product Quality. *The Quarterly Journal of Economics*, 126(1):417–474.

Hallak, J. C. and Sivadasan, J. (2013). Product and Process Productivity: Implications for Quality Choice and Conditional Exporter Premia. *Journal of International Economics*, 91(1):53–67.

Harrigan, J. and Reshef, A. (2015). Skill-biased Heterogeneous Firms, Trade Liberalization and the Skill Premium. *Canadian Journal of Economics/Revue Canadienne d'Économique*, 48(3):1024–1066.

Hausmann, R., Hwang, J., and Rodrik, D. (2007). What You Export Matters. *Journal of Economic Growth*, 12:1–25.

Head, K. and Ries, J. (1998). Immigration and Trade Creation: Econometric Evidence from Canada. *Canadian Journal of Economics*, pages 47–62.

Hidalgo, C. A., Klinger, B., Barabási, A.-L., and Hausmann, R. (2007). The Product Space Conditions the Development of Nations. *Science*, 317(5837):482–487.

Hiller, S. (2013). Does Immigrant Employment Matter for Export Sales? Evidence from Denmark. *Review of World Economics*, 149(2):369–394.

Hornbeck, R. and Naidu, S. (2014). When the Levee Breaks: Black Migration and Economic Development in the American South. *American Economic Review*, 104(3):963–990.

Hummels, D. and Klenow, P. J. (2005). The Variety and Quality of a Nation's Exports. *American Economic Review*, 95(3):704–723.

Hunt, J. and Gauthier-Loiselle, M. (2010). How Much Does Immigration Boost Innovation? *American Economic Journal: Macroeconomics*, 2(2):31–56.

Imbert, C., Seror, M., Zhang, Y., and Zylberberg, Y. (2022). Migrants and Firms: Evidence from China. *American Economic Review*, 112(6):1885–1914.

Imbs, J. and Wacziarg, R. (2003). Stages of Diversification. *American Economic Review*, 93(1):63–86.

Kerr, S. P., Kerr, W. R., and Lincoln, W. F. (2015). Skilled Immigration and the Employment Structures of US Firms. *Journal of Labor Economics*, 33(S1):S147–S186.

Khandelwal, A. K., Schott, P. K., and Wei, S.-J. (2013). Trade liberalization and Embedded Institutional Reform: Evidence from Chinese Exporters. *American Economic Review*, 103(6):2169–2195.

Kindberg-Hanlon, G. and Okou, C. (2020). Productivity convergence: Is anyone catching up? *Policy Research Working Paper*.

Koren, M. and Tenreyro, S. (2013). Technological Diversification. *American Economic Review*, 103(1):378–414.

Kugler, M. and Verhoogen, E. (2012). Prices, Plant size, and Product Quality. *The Review of Economic Studies*, 79(1):307–339.

Lebow, J. (2024). Immigration and Occupational Downgrading in Colombia. *Journal of Development Economics*, 166:103164.

Lewis, E. (2011). Immigration, Skill Mix, and Capital Skill Complementarity. *The Quarterly Journal of Economics*, 126(2):1029–1069.

Lombardo, C., Martinez-Correa, J., Peñaloza-Pacheco, L., and Gasparini, L. (2021). The Distributional Effect of a Massive Exodus in Latin America and the Role of Downgrading and Regularization. Working Paper 290, CEDLAS-FCE-Universidad Nacional de La Plata, La Plata, Argentina.

Macchiavello, R. and Morjaria, A. (2021). Competition and Relational Contracts in the Rwanda Coffee Chain. *The Quarterly Journal of Economics*, 136(2):1089–1143.

Macis, M. and Schivardi, F. (2016). Exports and Wages: Rent Sharing, Workforce Composition, or Returns to Skills? *Journal of Labor Economics*, 34(4):945–978.

Manova, K. and Zhang, Z. (2012). Export Prices Across Firms and Destinations. *The Quarterly Journal of Economics*, 127(1):379–436.

Martin, J. (2012). Markups, Quality, and Transport Costs. *European Economic Review*, 56(4):777–791.

Matsuyama, K. (2007). Beyond Icebergs: Towards a Theory of Biased Globalization. *The Review of Economic Studies*, 74(1):237–253.

Melitz, M. J. (2003). The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica*, 71(6):1695–1725.

MinCIT (2019). Informe sobre los Acuerdos Comerciales Vigentes de Colombia. Available at: http://www.tlc.gov.co/temas-de-interes/informe-sobre-el-desarrollo-avance-y-consolidacion/documentos/ley-1868-informe-2019.aspx (Last accessed: May 28, 2021). *Ministry of Commerce, Industry and Tourism - Colombia*.

Mitaritonna, C., Orefice, G., and Peri, G. (2017). Immigrants and Firms' Outcomes: Evidence from France. *European Economic Review*, 96:62–82.

Morales, F. and Pierola, M. D. (2020). Venezuelan Migration in Peru: Short-Term Adjustments in the Labor Market. Technical report, IDB Working Paper Series.

Morales, J. S. (2018). The Impact of Internal Displacement on Destination Communities: Evidence from the Colombian Conflict. *Journal of Development Economics*, 131:132–150.

Olivieri, S., Ortega, F., Rivadeneira, A., and Carranza, E. (2022). The Labour Market Effects of Venezuelan Migration in Ecuador. *The Journal of Development Studies*, 58(4):713–729.

Orefice, G., Rapoport, H., and Santoni, G. (2021). How Do Immigrants Promote Exports? Working papers, CEPII.

Ottaviano, G. I. P., Peri, G., and Wright, G. C. (2018). Immigration, Trade and Productivity in Services: Evidence from UK Firms. *Journal of International Economics*, 112:88–108.

Peri, G. and Requena-Silvente, F. (2010). The Trade Creation Effect of Immigrants: Evidence from the Remarkable Case of Spain. *Canadian Journal of Economics/Revue Canadienne d'Économique*, 43(4):1433–1459.

Peñaloza-Pacheco, L. (2022). Living with the Neighbors: The Effect of Venezuelan Forced Migration on the Labor Market in Colombia. *Journal for Labour Market Research*, 56(1):14.

Rauch, J. E. (1999). Networks versus Markets in International Trade. *Journal of International Economics*, 48(1):7–35.

Rozo, S. V. and Vargas, J. F. (2021). Brothers or Invaders? How Crisis-driven Migrants Shape Voting Behavior. *Journal of Development Economics*, 150:102636.

UNHCR (2024). Global Trends: Forced Displacement in 2023. *Technical Report, The UN Refugee Agency*.

United Nations, H. R. (2019). Human Rights in the Bolivarian Republic of Venezuela. Report of the United Nations High Commissioner for Human Rights. Technical report, United Nations, Office of the High Comissioner.

Verhoogen, E. (2023). Firm-level Upgrading in Developing Countries. *Journal of Economic Literature*, 61(4):1410–1464.

Verhoogen, E. A. (2008). Trade, Quality Upgrading, and Wage Inequality in the Mexican Manufacturing Sector. *The Quarterly Journal of Economics*, 123(2):489–530.

Walker, M. (2011). Pisa 2009 Plus Results: Performance of 15 year olds in Reading, Mathematics and Science for Additional Participants. Technical report, Acer Press Melbourne.

A Additional Tables

Table A.1: Characteristics of Venezuelan and Colombian workers (2019)

	Venezuelan	Colombian	Difference	P-Value	Observations
Male	0.49	0.49	0.00	0.706	508035
Age	30.03	36.49	-6.46	0.000	508035
Years of education	10.33	9.61	0.72	0.001	507999
Unemployment	0.15	0.11	0.04	0.000	360542
Employment	0.68	0.65	0.03	0.012	508035
Hourly wages (logs)	8.04	8.38	-0.34	0.000	293563
Hours worked	49.82	44.58	5.23	0.000	316279
Formality	0.10	0.41	-0.31	0.000	312935
Income per capita (logs)	12.53	12.97	-0.45	0.000	508035
Poverty rate	0.37	0.20	0.17	0.000	508035

Notes. P-values are for the difference between Venezuelan and Colombian averages with clustered standard errors at the departmental level. Source. Own elaboration based on GEIH data from DANE.

Table A.2: First stages estimates

	(1)	(2)	(3)
Instrument	0.225***	0.234***	0.234***
	(0.038)	(0.029)	(0.029)
F-Statistic	34.44	65.39	65.59
Number of firms	3,017	3,017	3,017
Observations	21,119	21,119	21,119
Firm FE	Yes	Yes	Yes
Region FE $\times$ Time FE	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes
Past controls $\times$ Time FE	No	Yes	Yes
FTA Controls $\times$ Year FE	No	No	Yes

Notes. Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. Standard errors clustered at the local labor market level in parentheses. Kleibergen-Paap rk Wald F-statistics are shown. ***, **, * denote significance at the 1, 5, and 10 percent significance level. Source: Own elaboration based on data from DANE.

Table A.3: Effect of immigration on firms' average wages

	Wages
Share of immigrants	0.003
	(0.003)
F-Statistic	65.39
Number of Firms	3,017
Observations	21,119
Firm FE	Yes
Region FE $\times$ Time FE	Yes
Industry Linear Trend	Yes
Past controls $\times$ Time FE	Yes

Notes: The outcome variable is the average wage for each firm (in logs). Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

Table A.4: Effect of immigration on employment and wages - Local Labor Market level

	Panel A: Total Employment		
	Aggregate	Colombians	Venezuelans
Share of Immigrants	0.012	0.002	4.418***
	(0.034)	(0.033)	(0.706)
	Panel B: Employment by Skill Level		
	High-Skill	Medium-Skill	Low-Skill
Share of Immigrants	-0.005	0.004	0.023
	(0.082)	(0.038)	(0.032)
	Panel C: Employment of Venezuelans by Skill Level		
	High-Skill	Medium-Skill	Low-Skill
Share of Immigrants	8.762***	5.852***	3.287***
	(2.881)	(1.614)	(0.589)
	Panel D: Employment of Colombians by Skill Level		
	High-Skill	Medium-Skill	Low-Skill
Share of Immigrants	-0.005	0.004	0.023
	(0.082)	(0.038)	(0.032)
	Panel E: Wages by Skill Level		
	High-Skill	Medium-Skill	Low-Skill
Share of Immigrants	-0.058	-0.071	0.056
	(0.128)	(0.067)	(0.048)
F-Statistic	12.54	12.54	12.54
Observations	553	553	553
Local Labor Market FE	Yes	Yes	Yes
Region FE $\times$ Year FE	Yes	Yes	Yes
Past controls $\times$ Year FE	Yes	Yes	Yes

Notes: The outcome variables for Panel A-D are the rate of employment of each group relative to the corresponding figure for 2013. The outcome variable for Panel E is the average hourly wage (in logs). Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

B Heterogeneous Effects

Table B.1: Effect of immigration by firms' productivity

	Probability of Exporting			
	Total	High	Upper-middle	Low
High Productivity	0.009*	0.011**	0.007*	0.001
	(0.005)	(0.005)	(0.004)	(0.002)
Low Productivity	0.002	0.002	0.000	0.004*
	(0.002)	(0.003)	(0.002)	(0.002)
	Exports (in logs)			
	Total	High	Upper-middle	Low
High Productivity	0.128**	0.152***	0.090*	0.010
	(0.054)	(0.055)	(0.045)	(0.024)
Low Productivity	0.022	0.022	0.002	0.043*
	(0.025)	(0.029)	(0.019)	(0.024)
Firm FE	Yes	Yes	Yes	Yes
Region FE $\times$ Time FE	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes
Past controls $\times$ Time FE	Yes	Yes	Yes	Yes

Notes: The outcome variables are a binary indicator that denotes whether the firm exported to each destination (Probability of Exporting), and the total amount exported in US dollars (in logs). Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

Table B.2: Effect of immigration on number of products and destinations by firms' productivity

	Number of Products			
	Total	High	Upper-middle	Low
High Productivity	0.021***	0.017**	0.010**	-0.003
	(0.008)	(0.007)	(0.004)	(0.002)
Low Productivity	0.006	0.005	0.004	0.005*
	(0.004)	(0.003)	(0.003)	(0.003)
	Number of Destinations			
	Total	High	Upper-middle	Low
High Productivity	0.016***	0.015***	0.008**	-0.000
	(0.005)	(0.005)	(0.004)	(0.002)
Low Productivity	0.005*	0.003	0.003	0.004**
	(0.003)	(0.003)	(0.002)	(0.002)
Firm FE	Yes	Yes	Yes	Yes
Region FE $\times$ Time FE	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes
Past controls $\times$ Time FE	Yes	Yes	Yes	Yes

Notes: The outcome variables are the number of different products exported (in logs) categorized according to the 10-digit NANDINA product classification, and the number of different country destinations for each firm (in logs). Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

Table B.3: Effect of immigration on exports by type of products and firms' productivity

	Differentiated		Homogeneous	
	Exports USD	No. Products	Exports USD	No. Products
High Productivity	0.083*	0.015**	0.078	0.011*
	(0.044)	(0.007)	(0.047)	(0.005)
Low Productivity	0.013	0.004	0.010	0.002
	(0.024)	(0.004)	(0.020)	(0.002)
Firm FE	Yes	Yes	Yes	Yes
Region FE × Time FE	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes
Past controls × Time FE	Yes	Yes	Yes	Yes

Notes. The outcome variables are the total amount in US dollars and the total number of different products exported (both in logs) by a firm each year for each type of product. Products were defined as differentiated or homogeneous following Rauch (1999)'s definition. Goods defined as reference-priced goods or goods traded in organized markets were considered as homogeneous. The remaining goods were classified as differentiated goods. Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

Table B.4: Effect of immigration by firms' skill intensity

	Probability of Exporting			
	Total	High	Upper-middle	Low
High Skill-intensity	0.012***	0.006**	0.009***	0.006**
	(0.003)	(0.003)	(0.002)	(0.003)
Low Skill-intensity	-0.001	0.004	-0.003	-0.004*
	(0.004)	(0.006)	(0.003)	(0.002)
	Exports (in logs)			
	Total	High	Upper-middle	Low
High Skill-intensity	0.146***	0.100***	0.110***	0.071**
	(0.032)	(0.030)	(0.026)	(0.031)
Low Skill-intensity	-0.019	0.044	-0.035	-0.045**
	(0.046)	(0.068)	(0.038)	(0.021)
Firm FE	Yes	Yes	Yes	Yes
Region FE $\times$ Time FE	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes
Past controls $\times$ Time FE	Yes	Yes	Yes	Yes

Notes: The outcome variables are a binary indicator that denotes whether the firm exported to each destination (Probability of Exporting), and the total amount exported in US dollars (in logs). Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

Table B.5: Effect of immigration on number of products and destinations by firms' skill intensity

	Number of Products			
	Total	High	Upper-middle	Low
High Skill-intensity	0.020***	0.016***	0.011***	0.006*
	(0.005)	(0.005)	(0.004)	(0.003)
Low Skill-intensity	0.000	-0.003	0.002	-0.006*
	(0.007)	(0.007)	(0.005)	(0.003)
	Number of Destinations			
	Total	High	Upper-middle	Low
High Skill-intensity	0.019***	0.013***	0.012***	0.006**
	(0.003)	(0.003)	(0.002)	(0.002)
Low Skill-intensity	-0.003	0.001	-0.002	-0.004
	(0.005)	(0.007)	(0.003)	(0.002)
Firm FE	Yes	Yes	Yes	Yes
Region FE $\times$ Time FE	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes
Past controls $\times$ Time FE	Yes	Yes	Yes	Yes

Notes: The outcome variables are the number of different products exported (in logs) categorized according to the 10-digit NANDINA product classification, and the number of different country destinations for each firm (in logs). Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

Table B.6: Effect of immigration on exports by type of products and firms' skill intensity

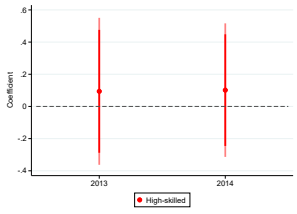
	Differentiated		Homogeneous	
	Exports USD	No. Products	Exports USD	No. Products
High Skill-intensity	0.096***	0.015***	0.065**	0.007**
	(0.028)	(0.005)	(0.026)	(0.003)
Low Skill-intensity	-0.001	0.001	-0.013	0.000
	(0.028)	(0.006)	(0.040)	(0.004)
Firm FE	Yes	Yes	Yes	Yes
Region FE $\times$ Time FE	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes
Past controls $\times$ Time FE	Yes	Yes	Yes	Yes

Notes. The outcome variables are the total amount in US dollars and the total number of different products exported (both in logs) by a firm each year for each type of product. Products were defined as differentiated or homogeneous following Rauch (1999)'s definition. Goods defined as reference-priced goods or goods traded in organized markets were considered as homogeneous. The remaining goods were classified as differentiated goods. Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

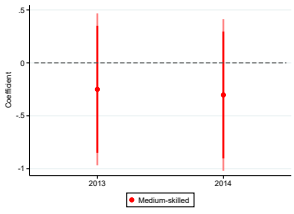
C IV Internal Validity, Identification Threats, Robustness Checks

Figure C.1: IV internal validity test (pre-trends) - Skill-upgrading and R&D investments

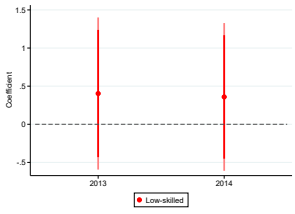
(a) High-skilled



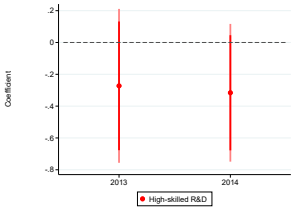
(b) Medium-skilled



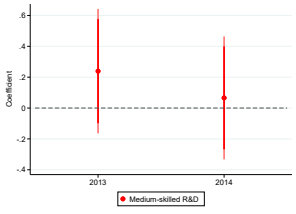
(c) Low-skilled



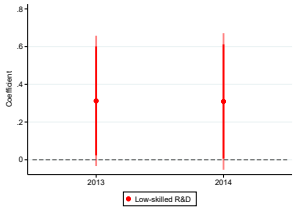
(d) High-skilled R&D



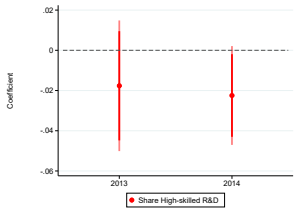
(e) Medium-skilled R&D



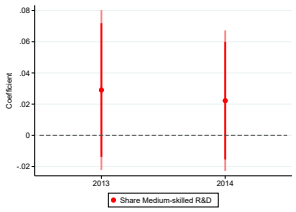
(f) Low-skilled R&D



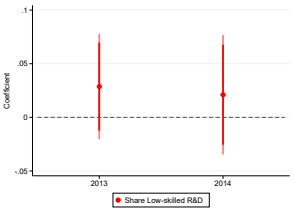
(g) Share High-skilled R&D



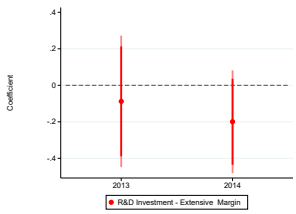
(h) Share Medium-skilled R&D



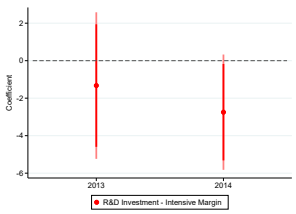
(i) Share Low-skilled R&D



(j) R&D Investment - Extensive Margin



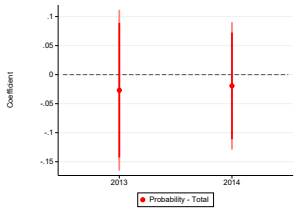
(k) R&D Investment - Intensive Margin



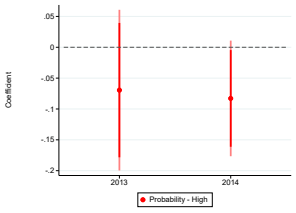
Notes. Titles above each graph show the outcome of each regression. Each dot represents the coefficient of the interaction between the average distance shares $\left(\text{i.e., } \frac{1}{K}\sum_K \frac{1}{D_{mrk}}\right)$ and year dummies. Regressions control for Industry Linear Trends at the 4-digit CIIU level and region fixed effects interacted with year dummies. Standard errors are clustered at the local labor market level. Source: Own elaboration based on data from DANE.

Figure C.2: IV internal validity test (pre-trends) - Trade-creation effect

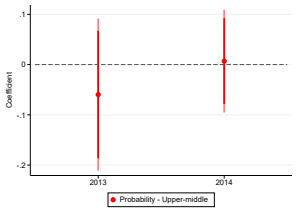
(a) Exporting dummy (all)



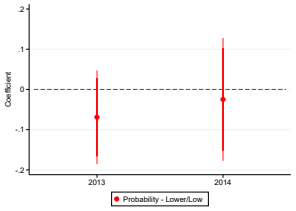
(b) Exporting dummy (High-income)



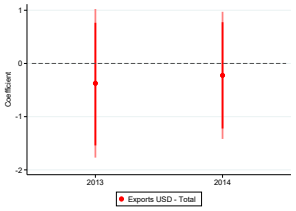
(c) Exporting dummy (Upper-middle)



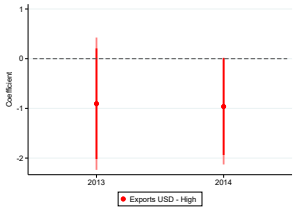
(d) Exporting dummy (Lower/Low)



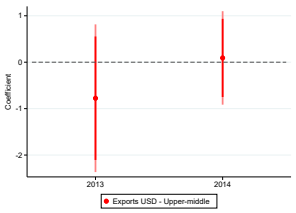
(e) Exports in USD (all)



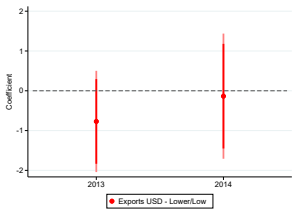
(f) Exports in USD (High-income)



(g) Exports in USD (Upper-middle)



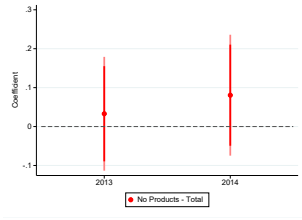
(h) Exports in USD (Lower/Low)



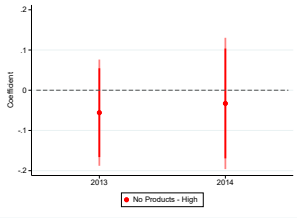
Notes. Titles above each graph show the outcome of each regression. Each dot represents the coefficient of the interaction between the average distance shares $\left(\text{i.e., } \frac{1}{K}\sum_K \frac{1}{D_{mrk}}\right)$ and year dummies. Regressions control for Industry Linear Trends at the 4-digit CIIU level and region fixed effects interacted with year dummies. Standard errors are clustered at the local labor market level. Source: Own elaboration based on data from DANE.

Figure C.3: IV internal validity test (pre-trends) - Trade-creation effect

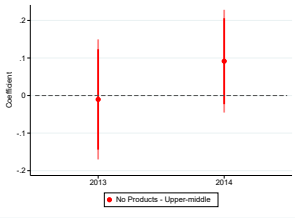
(a) Number of products (all)



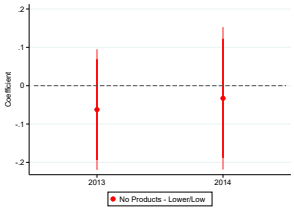
(b) Number of products (High-income)



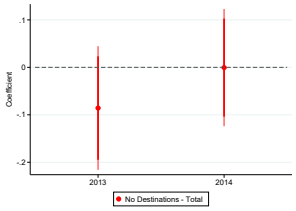
(c) Number of products (Upper-middle)



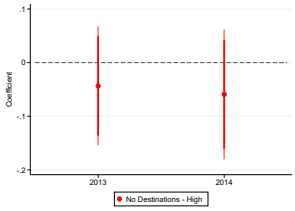
(d) Number of products (Lower/Low)



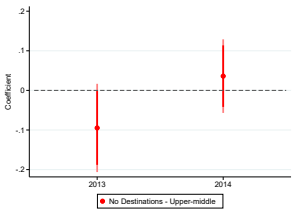
(e) Number of destinations (all)



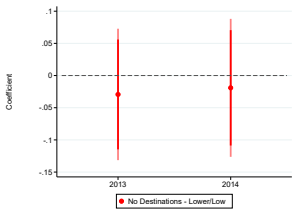
(f) Number of destinations (High-income)



(g) Number of destinations (Upper-middle)



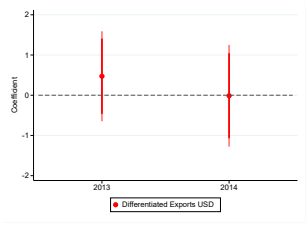
(h) Number of destinations (Lower/Low)



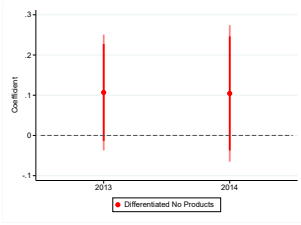
Notes. Titles above each graph show the outcome of each regression. Each dot represents the coefficient of the interaction between the average distance shares $\left(\text{i.e., } \frac{1}{K}\sum_K \frac{1}{D_{mrk}}\right)$ and year dummies. Regressions control for Industry Linear Trends at the 4-digit CIIU level and region fixed effects interacted with year dummies. Standard errors are clustered at the local labor market level. Source: Own elaboration based on data from DANE.

Figure C.4: IV internal validity test (pre-trends) - Trade-creation effect

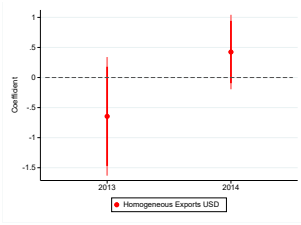
(a) Differentiated exports



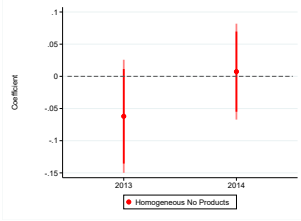
(b) Number of differentiated products



(c) Homogeneous exports



(d) Number of homogeneous products



Notes. Titles above each graph show the outcome of each regression. Each dot represents the coefficient of the interaction between the average distance shares $\left(\text{i.e., } \frac{1}{K}\sum_K \frac{1}{D_{mrk}}\right)$ and year dummies. Regressions control for Industry Linear Trends at the 4-digit CIIU level and region fixed effects interacted with year dummies. Standard errors are clustered at the local labor market level. Source: Own elaboration based on data from DANE.

Table C.1: Effect of immigration on skill-upgrading (Robustness)

	High-skilled	Medium-skilled	Low-skilled
Panel A: Total No Employees			
Share of immigrants	0.010	0.011	0.006
	(0.006)	(0.009)	(0.013)
Panel B: R&D Division No Employees			
Share of immigrants	0.031***	0.019***	0.004
	(0.007)	(0.006)	(0.003)
Panel C: R&D Division Share Employees			
Share of immigrants	0.002***	0.001**	0.001
	(0.000)	(0.001)	(0.000)
F-Statistic	65.59	65.59	65.59
Number of firms	3,017	3,017	3,017
Observations	21,119	21,119	21,119
Firm FE	Yes	Yes	Yes
Region FE $\times$ Time FE	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes
Past controls $\times$ Time FE	Yes	Yes	Yes
FTA Controls $\times$ Year FE	Yes	Yes	Yes

Notes: The outcome variables are the number of employees by education level (in logs). High-skilled workers are those with any post-secondary education. Medium-skilled workers are those with secondary education. Low-skilled workers are those with less than secondary education. Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. FTA controls include the amount exported by each firm in 2012 (in logs) to South Korea, the U.S., Costa Rica, the European Union, Chile, Mexico, and Peru. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

Table C.2: Effect of immigration on technological development investment - Extensive and intensive margin (Robustness)

	Extensive Margin	Intensive Margin
Share of immigrants	0.012***	0.141**
	(0.005)	(0.057)
F-Statistic	65.59	65.59
Number of firms	3,017	3,017
Observations	21,119	21,119
Firm FE	Yes	Yes
Region FE $\times$ Time FE	Yes	Yes
Industry Linear Trend	Yes	Yes
Past controls $\times$ Time FE	Yes	Yes
FTA Controls $\times$ Year FE	Yes	Yes

Notes: The outcome variables are binary indicators indicating whether firms invested a positive amount in technological development (investments aimed at introducing novel or significantly enhanced goods, services, and/or processes). Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. FTA controls include the amount exported by each firm in 2012 (in logs) to South Korea, the U.S., Costa Rica, the European Union, Chile, Mexico, and Peru. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

Table C.3: Effect of immigration on the improvement of processes (Robustness)

	Production	Organizational	Marketing
Share of Immigrants	0.019***	0.006*	0.004
	(0.004)	(0.003)	(0.003)
F-Statistic	59.40	59.40	59.40
Number of firms	3,017	3,017	3,017
Observations	12,068	12,068	12,068
Firm FE	Yes	Yes	Yes
Region FE $\times$ Time FE	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes
Past controls $\times$ Time FE	Yes	Yes	Yes
FTA Controls $\times$ Year FE	Yes	Yes	Yes

Notes: The outcome variables are binary indicators indicating whether firms introduced or significantly improved a product and/or a method. Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. FTA controls include the amount exported by each firm in 2012 (in logs) to South Korea, the U.S., Costa Rica, the European Union, Chile, Mexico, and Peru. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

Table C.4: Effect of immigration on the adoption of new and better products (Robustness)

	Certifications	Number of products (in logs)		Probability (dummy variable)	
		Improved	New	Improved	New
Share of Immigrants	0.011**	0.007**	0.007	0.007**	0.005
	(0.005)	(0.003)	(0.004)	(0.003)	(0.004)
F-Statistic	59.40	59.40	59.40	59.40	59.40
Number of firms	3,017	3,017	3,017	3,017	3,017
Observations	12,068	12,068	12,068	12,068	12,068
Firm FE	Yes	Yes	Yes	Yes	Yes
Region FE × Time FE	Yes	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes	Yes
Past controls × Time FE	Yes	Yes	Yes	Yes	Yes
FTA Controls × Year FE	Yes	Yes	Yes	Yes	Yes

Notes: The outcome variables are binary indicators indicating whether firms introduced or significantly improved a product and/or a method. Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. FTA controls include the amount exported by each firm in 2012 (in logs) to South Korea, the U.S., Costa Rica, the European Union, Chile, Mexico, and Peru. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

Table C.5: Effect of immigration on the adoption of new/better processes/products and improving firms' outcomes (Robustness)

	Quality	Variety	Keep Markets	New Markets	Productivity	Costs
Share of Immigrants	0.012**	0.008**	0.013***	0.007	0.008*	0.008*
	(0.005)	(0.004)	(0.005)	(0.004)	(0.004)	(0.004)
F-statistic	59.40	59.40	59.40	59.40	59.40	59.40
Number of observations	3,017	3,017	3,017	3,017	3,017	3,017
Observations	12,068	12,068	12,068	12,068	12,068	12,068
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE × Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes	Yes	Yes
Past controls × Time FE	Yes	Yes	Yes	Yes	Yes	Yes
FTA Controls × Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The outcome variables are binary indicators indicating whether firms introduced or significantly improved a product and/or a method. Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. FTA controls include the amount exported by each firm in 2012 (in logs) to South Korea, the U.S., Costa Rica, the European Union, Chile, Mexico, and Peru. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

Table C.6: Effect of immigration on the probability of facing obstacles to adopt new and better products or processes (Robustness)

	Own resources	Skills	Regulations	Qualified services
Share of Immigrants	-0.008**	-0.010**	-0.016***	-0.014**
	(0.004)	(0.005)	(0.005)	(0.007)
F-statistic	59.40	59.40	59.40	59.40
Number of observations	3,017	3,017	3,017	3,017
Observations	12,068	12,068	12,068	12,068
Firm FE	Yes	Yes	Yes	Yes
Region FE $\times$ Time FE	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes
Past controls $\times$ Time FE	Yes	Yes	Yes	Yes
FTA Controls $\times$ Year FE	Yes	Yes	Yes	Yes

Notes: The outcome variables are binary indicators indicating whether firms introduced or significantly improved a product and/or a method. Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. FTA controls include the amount exported by each firm in 2012 (in logs) to South Korea, the U.S., Costa Rica, the European Union, Chile, Mexico, and Peru. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

Table C.7: Effect of immigration on the probability of exporting - Total and by income level of destinations (Robustness)

	Total	High	Upper-middle	Lower/Low
Share of Immigrants	0.006**	0.005**	0.004*	0.002
	(0.003)	(0.003)	(0.002)	(0.002)
F-statistic	65.59	65.59	65.59	65.59
Number of firms	3,017	3,017	3,017	3,017
Observations	21,119	21,119	21,119	21,119
Firm FE	Yes	Yes	Yes	Yes
Region FE × Time FE	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes
Past controls × Time FE	Yes	Yes	Yes	Yes
FTA Controls × Year FE	Yes	Yes	Yes	Yes

Notes: The outcome variable is a binary indicator that denotes whether the firm exported to each destination. Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. FTA controls include the amount exported by each firm in 2012 (in logs) to South Korea, the U.S., Costa Rica, the European Union, Chile, Mexico, and Peru. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

Table C.8: Effect of immigration on exports - Total and by income level of destinations (Robustness)

	Total	High	Upper-middle	Lower/Low
Share of Immigrants	0.071**	0.070**	0.043*	0.024
	(0.029)	(0.027)	(0.023)	(0.020)
F-statistic	65.59	65.59	65.59	65.59
Number of firms	3,017	3,017	3,017	3,017
Observations	21,119	21,119	21,119	21,119
Firm FE	Yes	Yes	Yes	Yes
Region FE × Time FE	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes
Past controls × Time FE	Yes	Yes	Yes	Yes
FTA Controls × Year FE	Yes	Yes	Yes	Yes

Notes: The outcome variable is the total amount exported in US dollars (in logs). Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. FTA controls include the amount exported by each firm in 2012 (in logs) to South Korea, the U.S., Costa Rica, the European Union, Chile, Mexico, and Peru. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

Table C.9: Effect of immigration on number of products exported - Total and by income level of destinations (Robustness)

	Total	High	Upper-middle	Lower/Low
Share of Immigrants	0.011**	0.008*	0.007**	0.001
	(0.005)	(0.004)	(0.003)	(0.002)
F-statistic	65.59	65.59	65.59	65.59
Number of firms	3,017	3,017	3,017	3,017
Observations	21,119	21,119	21,119	21,119
Firm FE	Yes	Yes	Yes	Yes
Region FE × Time FE	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes
Past controls × Time FE	Yes	Yes	Yes	Yes
FTA Controls × Year FE	Yes	Yes	Yes	Yes

Notes: The outcome variable is the number of different products exported (in logs) categorized according to the 10-digit NANDINA product classification. Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. FTA controls include the amount exported by each firm in 2012 (in logs) to South Korea, the U.S., Costa Rica, the European Union, Chile, Mexico, and Peru. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

Table C.10: Effect of immigration on number of destinations - Total and by income level of destinations (Robustness)

	Total	High	Upper-middle	Lower/Low
Share of Immigrants	0.009***	0.007***	0.005**	0.002
	(0.003)	(0.003)	(0.002)	(0.001)
F-statistic	65.59	65.59	65.59	65.59
Number of firms	3,017	3,017	3,017	3,017
Observations	21,119	21,119	21,119	21,119
Firm FE	Yes	Yes	Yes	Yes
Region FE × Time FE	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes
Past controls × Time FE	Yes	Yes	Yes	Yes
FTA Controls × Year FE	Yes	Yes	Yes	Yes

Notes: The outcome variable is the number of different country destinations for each firm (in logs). Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. FTA controls include the amount exported by each firm in 2012 (in logs) to South Korea, the U.S., Costa Rica, the European Union, Chile, Mexico, and Peru. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

Table C.11: Effect of immigration on exports by type of products - Total and by income level of destinations (Robustness)

	Differentiated		Homogeneous	
	Exports USD	No. Products	Exports USD	No. Products
Share of immigrants	0.049*	0.009*	0.026	0.004*
	(0.025)	(0.005)	(0.021)	(0.002)
F-Statistic	65.59	65.59	65.59	65.59
Number of firms	3,017	3,017	3,017	3,017
Observations	21,119	21,119	21,119	21,119
Firm FE	Yes	Yes	Yes	Yes
Region FE × Time FE	Yes	Yes	Yes	Yes
Industry Linear Trend	Yes	Yes	Yes	Yes
Past controls × Time FE	Yes	Yes	Yes	Yes
FTA Controls × Year FE	Yes	Yes	Yes	Yes

Notes. The outcome variable is the total amount exported in US dollars (in logs) by a firm each year for each type of product. Products were defined as differentiated or homogeneous following Rauch (1999)'s definition. Goods defined as reference-priced goods or goods traded in organized markets were considered as homogeneous. Industry linear trends are specified at the 4-digit CIIU level. Past controls include the following local labor market-level variables: per capita GDP (in logs), homicide rate, the total number of cultivated hectares of coca crops (in logs), share of population in the subsidized health system, and the Gini coefficient. FTA controls include the amount exported by each firm in 2012 (in logs) to South Korea, the U.S., Costa Rica, the European Union, Chile, Mexico, and Peru. Standard errors, clustered at the local labor market level, are reported in parentheses. Kleibergen-Paap rk Wald F-statistics are provided. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels, respectively. Source: Own elaboration based on data from DANE.

D Variables Details: Technology Adoption and Quality Upgrading Outcomes

Variables related to the improvement of processes - Table 6:

Please indicate whether your company introduced any of the following innovations during the period XXXX-YYYY. If your answer is affirmative, specify the number.

Processes: Introduction of new or significantly improved processes, production methods, distribution methods, delivery methods, or logistics systems in the company (Dummy variable).

Organizational: Introduction of new organizational methods implemented in the internal functioning of the company, in the knowledge management system, in the organization of the workplace, or in the management of the company's external relations (including suppliers, partners, and other stakeholders) (Dummy variable).

Marketing: Introduction of new marketing techniques in your company (channels for promotion and sales, or significant changes in product packaging or design) aimed at expanding or maintaining your market. (Excludes changes affecting product functionalities, as this would correspond to a significantly improved good or service) (Dummy variable).

Variables related to the improvement or introduction of products - Table 7:

Please indicate whether your company introduced any of the following innovations during the period XXXX-YYYY. If your answer is affirmative, specify the number.

Certifications: During the period XXXX–YYYY, did your company obtain process/product quality certifications? If your answer is affirmative, please specify how many. (Dummy variable if the firm answered 'yes' to any type of quality certification).

New Product: A product whose fundamental characteristics (technical specifications, components and materials, embedded software, or intended uses) are new compared to previous products produced by the company. (Dummy variable and Number of Products in logs)

Improved Product: A product whose performance has been significantly improved or refined. This may occur through the use of better-performing components or materials or by changes in one of the technical subsystems that make up a complex product. (Dummy variable and Number of Products in logs)

Variables related to firms' outcomes affected by the adoption of new/better processes/products - Table 8:

Please indicate the degree of importance of the impact that the introduction of new or significantly improved goods or services, and/or the implementation of new or significantly improved processes, organizational methods, or new marketing techniques had on the following aspects of your company during the period XXXX - YYYY:

Quality: Improvement in the quality of goods or services.

Variety: Expansion of the range of goods or services.

Keep Markets: Maintenance of your company's geographic market share.

New Markets: Entry into a new geographic market.

Productivity: Increase in productivity.

Costs: Reduction in labor costs.

Variables related to the probability of facing obstacles to adopt new and better products or processes - Table 9:

Please indicate the degree of importance of the following obstacles to the introduction of new or significantly improved goods or services, and/or the implementation of new or significantly improved processes, organizational methods, or new marketing techniques in your company during the period XXXX-YYYY:

Own Resources: Lack of own resources.

Skills: Lack of qualified personnel.

Regulations: Difficulty in complying with regulations and technical standards.

Qualified Services: Low availability of inspection, testing, calibration, certification, and verification services.