Foreign Workers, Product Quality and Trade: Evidence from a Natural Experiment*

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Abstract

This paper shows that international labor mobility attenuates information frictions and leads to higher quality products, more trade and to a more efficient organization of global value chains. Exploiting the variation in the time and intensity at which Swiss postal codes were hit by the labor supply shock due to the implementation of the "Swiss-EU Agreement on the Free Movement of Persons", I find that the increased availability of high-skilled European workers led to an upgrade in the quality of inputs coming from their origin countries. Better intermediates improved the quality of output, making Swiss products more appealing for international markets and boosting exports. Therefore, foreign workers improved the upstream structure of Swiss global value chains by opening the host market to higher quality inputs. In turn, this increased the quality of the exported products and made them more intensively used downstream.

Keywords: Information Frictions, Labor Mobility, Innovation, Trade, GVCs.
JEL Classification: F14, F16, F22.

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1 Introduction

Information frictions make the quest of appropriate intermediate inputs and potential clients costly, thus hindering the formation of efficient global value chains. This problem is particularly binding because production increasingly involves a complex international network of many customers and suppliers.[1] Foreign workers can represent an antidote by providing up to date information about technology, taste, institutions, and economic environment on their origin countries. For this reason, many business and tech leaders are standing against the recent threat of building walls and closing borders.[2] Yet, there is surprisingly little causal evidence on how cross-country labor mobility affects trade and the international organization of production.

This paper uses the staggered opening of the Swiss labor market to European workers led by the 'Swiss-EU Agreement on the Free Movement of Persons" (AFMP) to show that international labor mobility is a crucial determinant of product quality, trade growth, and the organization of global value chains. Following the agreement, a large number of high-skilled European workers arrived in Switzerland and lowered upstream information frictions by bringing novel knowledge about suppliers and improving the quality of intermediates imported from their origin countries. The use of better inputs improved the quality of exported products and fostered growth especially towards extra-EU destinations. Quality upgrading represents the main determinant of export expansion while lower downstream information frictions did not play a major role because export growth was not directed towards foreign workers' origin countries. Therefore, labor mobility can be an innovation source and its positive effects on quality are similar to an input trade liberalization and can help better reaching distant markets. At the same time, foreign workers' knowledge can play a crucial role for trade growth and the international organization of production, also in settings where information frictions are already quite low, i.e., among developed countries.

The AFMP was signed in 1999 and it was implemented in Switzerland in 2004 for the postal codes in the border region, and in 2007 for those in the central region. The agreement was particularly successful in attracting foreign workers in Switzerland. The yearly inflows of European workers increased from 0.4 to almost 35 thousand, rising their importance in total inflows from 2% to almost 60%. These were composed

[1]For instance, Wall-Mart has more than 2,800 suppliers and 275 million clients from all over the world, and Apple, employs more than 200 suppliers in 43 countries and sells its products worldwide.

[2]For example, Bill Gates and Mark Zuckerberg together with many top ranked managers from the most important US companies funded a political organization, FWD.us, to lobby for a reform of the US immigration system.

mostly by cross-border high-skilled workers coming from border countries and directed to high-tech industries. Because cross-border workers have a limited propensity to spend long times to get to work, their share increased substantially only in postal codes within fifteen minutes from the border. Instead, postal codes between fifteen and thirty minutes were only mildly affected and those beyond thirty minutes remained practically untouched. Exports experienced a similar pattern: they grew more in postal codes closer to the border. This growth was especially strong for high-tech products and for extra-EU destinations, and it is mostly explained by an increase in the average exports per destination and product while the extensive margins (i.e., number of products and destinations) played only a marginal role.

To provide causal evidence on the effects of the agreement, I exploit variation in both the timing and the intensity at which postal codes were affected by the labor supply shock. I implement a difference-in-difference analysis comparing exports of a certain product to a particular destination between exposed and unaffected postal codes before and after the implementation of the agreement. I find that highly treated postal codes (i.e., those within fifteen minutes from the border) increased exports 5.5% more than unaffected ones (i.e., those beyond thirty minutes from the border) but I do not observe any differential effect for postal codes only mildly affected (i.e., between fifteen and thirty minutes from the border).[3] Export growth was mostly concentrated on extra-EU destinations. Therefore, it is unlikely that foreign workers lowered downstream information frictions by providing export-relevant information about their origin countries. Instead, by decomposing exports into quantities and prices I find that an increase in the former is not followed by a decrease of the latter. This is suggestive that the quality of Swiss products produced in border localities increased. To dig deeper into this finding, I construct a measure of perceived quality based on the methodology developed in Khandelwal et al. (2013) and I find evidence that the appeal of Swiss products produced in affected localities increased following the AFMP. Therefore, quality upgrading is the

[3]This setting is particularly appealing because compositional differences in terms of products and destinations across treated and control localities do not play any role. This comes at the expense of not being able to identify a causal effect on the extensive margins, however, the descriptive analysis shows that they did not play any role in the export growth of affected postal codes. At the same time, unobserved demand or supply shocks affect symmetrically both the treated and control groups, trends are parallel before the implementation of the AFMP and there is no evidence of plan relocation across treated and control localities due to the agreement. These results hold when controlling for heterogeneous responses to the same shock within treated and control regions by using industry-region trends; discarding from the estimation products which are involved in the implementation of other concurrent agreements; restricting the analysis to the border region (as in Beerli et al., 2018); the years before the great trade collapse; using alternative clustering for standard errors; controlling for product-destination shocks; and when checking the quality of the variation exploited by using a placebo test.

driving force behind export growth.

How could foreign workers improve the quality of exports? The most direct way is by bringing new ideas, technologies, and skills from their home country. However, I find that export growth was not concentrated on the products for which neighboring countries have a comparative advantage, thus suggesting that foreign workers did not bring origin-specific technology to improve existing products. A second way to improve the quality of exported products is the use of better intermediate inputs. Indeed, I observe that localities which experienced an increase in the quality of exports also improved the quality of inputs (measured as unit prices) coming from the origin country of foreign workers that are used in the production of exported products. To assess whether better inputs affected the quality of exported products, I use the same difference-in-difference strategy to compare the role of input prices for export prices and quality. I find that only the increase in prices of foreign workers' origin country inputs is positively and significantly related to export price and quality growth. Instead, the prices of inputs coming from other origin countries are not.

This suggests that foreign workers used their knowledge on the network of suppliers in their origin country to decrease upstream information frictions and help sourcing better intermediate inputs. This fostered an increase in the quality of exported products and led to more exports, especially to non-EU destinations. Thus, the shock led to asymmetric effects on information frictions, which did not decrease significantly downstream. Importantly, I do not claim that this is the only mechanisms that could explain both import and export growth. Labor constrained firms, local spillovers and complementarity between high-skilled labor and high-quality intermediate products can represent other concurring channels to explain trade growth. However, upstream information frictions decreased *specifically* with respect to foreign workers' origin countries and only inputs imported from these countries were responsible for the increase in export quality. It is therefore hard to argue that my empirical results can be rationalized by mechanisms that do not involve country-specific information frictions.

My paper contributes to the literature analyzing how information frictions hamper trade. These works study how communication technologies, such as telegraph (Steinwender, 2018; Juhasz and Steinwender, 2018), mobile phones (Jensen, 2007; Allen, 2014), web hosts (Freund and Weinhold, 2004), internet bradband access (Leuven et al., 2018), and, telephone call rates (Portes and Rey, 2005; Fink et al., 2005) foster trade by lowering the burden of communication. To my knowledge, this is the first paper showing that also foreign workers can affect information frictions and lead to higher

quality products, more trade, and more efficient global value chains. Other contributions analyze more generally the role of workers' experience for export performance and firm productivity (Balsvik, 2011; Mion and Opromolla, 2014; Parrotta et al., 2014; Mion et al., 2016; Parrotta et al., 2016). My paper quantifies the role of foreign workers' knowledge and identifies the mechanism by which they foster trade. Consistent with Martin and Mayneris (2015), quality upgrading mattered for trade growth especially to distant destinations. Finally, together with Egger et al. (2019), my paper brings a new perspective to the literature analyzing the determinants of global value chains (e.g. Antràs et al., 2012; Antràs and Chor, 2013; Alfaro et al., 2019) by demonstrating that labor mobility is crucial for the structure and quality of global value chains.

Most contributions analyzing the link between migration and trade (e.g. Head and Ries, 1998; Rauch, 1999, 2001; Rauch and Trindade, 2002; Felbermayr and Toubal, 2012) fail to convincingly assess a causal relation due to endogeneity issues and poor data quality (Felbermayr et al., 2015). Only few recent papers use natural experiments to assess causality (Parsons and Vézina, 2018; Bahar et al., 2019; Olney and Pozzoli, 2018). These works focus on the effects of developing country low-skilled immigrants on trade. My paper provides new insights to this literature by analyzing the case in which a developed country receives a large number of high skilled workers from other developed countries. This difference is important because information frictions for trade between developed countries are lower than for trade between developed and developing countries and because there is no evidence available for high-skilled flows.

More in general, this paper contributes to the literature pointing at the positive effects of foreign workers for the economy. These papers focus on FDI activity (Burchardi et al., 2018), productivity (Kerr and Lincoln, 2010; Hornung, 2014; Ghosh et al., 2014; Ruffner and Siegenthaler, 2016; Mayda et al., 2018; Mitaritonna et al., 2018) and innovation (Gray et al., 2017). My analysis provides another dimension in which foreign workers are beneficial to the economy. Moreover, it qualifies the results of Ruffner and Siegenthaler (2016) in so that part of the increase in sales and productivity that they observe is due to exports and input quality growth.

The rest of the paper is organized as follows. Section 2 describes the Swiss-EU agreement. Section 3, presents the data and provides descriptive statistics. Based on these facts, section 4 outlines the empirical strategy and discusses the results. Section 5 analyzes the possible mechanisms. Finally, section 6 concludes.

2 The Swiss-EU Agreement on the Free Movement of Persons

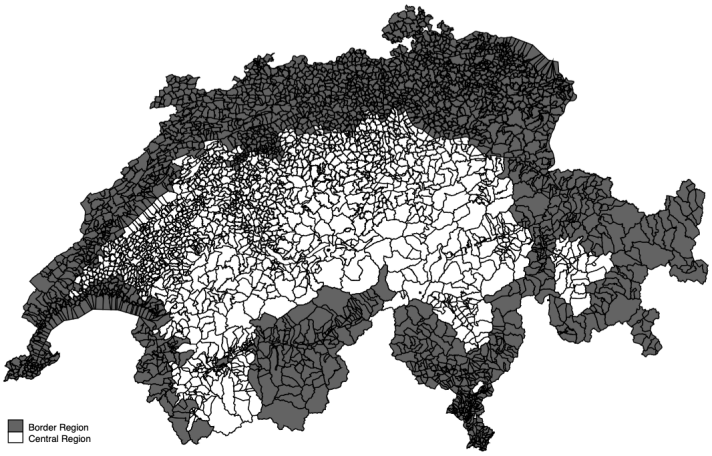
Switzerland and the EU signed a bilateral agreement on the free movement of persons in Luxembourg in June 1999. The objective of AFMP was to gradually introduce free access of each others' labor markets and it included provisions on free movement of economically active and inactive persons and the cross-border provision of services by natural persons and legal entities. The AFMP was part of a package of bilateral agreements on different issues that comprised air transport, international trade, mutual recognition of conformity assessment, government procurement and scientific and technological cooperation.[4] Details of the agreement were first released in 1998, it was signed and approved by the Swiss parliament in 1999 and it was ratified in May 2000 by a Swiss referendum approval and the parliamentary vote of each EU member states. Finally, it was gradually put into force from 2002.

To understand the changes implied by the agreement, it is useful to describe the situation of the labor market before its implementation. Switzerland distinguishes two main types of foreign workers: Resident Immigrants (RI) and cross-border workers (CBW). The first group includes foreign workers that live and work in Switzerland. Before the agreement, they were subject to national quotas set by the Swiss federal government and they could be employed by Swiss firms only if the priority requirement was satisfied, i.e. if no equally qualified Swiss worker could be found. The second group of workers includes instead EU citizens working in Switzerland but residing in one of the border EU countries. Before the agreement, these workers were also subject to the priority requirement. Moreover, they had to return to their residence every day after work and they could not work in the central regions of Switzerland. The definition of border and central regions was stipulated between Switzerland and its neighboring countries well before the AFMP: Italy in 1928, France in 1946, Germany in 1970 and Austria in 1973. This remained stable over time and, importantly, it does not overlap with any language, cultural or political border (Ruffner and Siegenthaler, 2016). Figure 1 provides a visual illustration of this repartition.

The implementation of the agreement was gradual and affected the two categories of foreign workers and Swiss localities differently. Table 1 provides a representation of the different steps that I describe in the following. Since 2002 resident immigrants enjoyed higher quotas, the duration of the residency permits was prolonged, family reunions

[4] I will discuss the role of these other agreements as potential confounding factors in Section 4

Figure 1: Border and Central Postal Codes of Switzerland



were facilitated and the admission process was simplified. Then, from 2007 onwards the liberalization for this category of workers was fully implemented with the abolition of admission process and of quotas. From that moment foreign workers were fully comparable to Swiss workers. For CBW the liberalization varied not only over time but also across regions. The impediment to work in the central region remained fully effective and it was lifted only in 2007. The border regions instead obtained facilitated access to CBW before and more gradually. From 1999 to 2002 cantonal offices gained more flexibility in handing CBW applications (Beerli and Peri, 2017). From 2002 to 2004 some restrictions were lifted. First, quotas increased. Second, the foreign residence requirement became more flexible and CBW were supposed to commute back to their residence weekly instead of daily. Third, the duration of the working permit was not anymore that of the working contract but it lasted for 5 years. From 2004 onwards also the priority requirement was lifted and CBW could be freely hired. The elimination of this last impediment substantially improved the process of hiring a CBW because it canceled the uncertainty related to the possibility of hiring the chosen worker and the delay between filing the file and receiving an answer.[5]

Table 1: Implementation of the Swiss-EU Agreement on the Free Movement of Persons

	Region	Before AFMP	2002-2003	2004-2007	After 2007
Resident immigrants (RI)	BR & CR	Subject to national quotas	Higher quotas	Higher Quotas	Free
	BR & CR	National priority requirement	National priority requirement	National priority requirement	Free
Cross-border workers (CBW)	BR	Subject to national quotas	Higher quotas	Free	Free
	BR	National priority requirement	National priority requirement	Free	Free
	BR	Daily return to foreign domicile	Weekly return to foreign domicile	Free	Free
	CR	No Access	No Access	No Access	Free

[5]For the countries which joined the EU in 2004, workers from Cyprus and Malta were granted the same rights as those of EU15 since the beginning. For all the other countries it became effective only in 2011.

3 Data Description and Stylized Facts

In this section I describe the data used for the analysis and I outline three main stylized facts that will guide the empirical strategy.

3.1 Data description

The data used in this paper come from the Swiss Federal Customs Administration (EDEC) and covers the period 1996-2010. Both exports and imports are available at the postal code level, with indication of the type of product at Harmonized System 8-digit level, the destination or origin country, the quantities, the value in CHF and the year.[6] I restrict the analysis to flows worth at least one thousand Swiss Francs and having non-zero quantities to avoid the estimates to be sensitive to small numbers. Moreover, I aggregate the HS classification at 6-digit level to alleviate the computational burden. Table A-1 in the appendix presents some descriptive statistics. The data comprise 16.3 million import flows and 6.8 million export flows. Imports flows are more frequent, with higher quantities but smaller values than export ones.

To understand if and how foreign workers' flows changed in Switzerland following the agreement with the EU, I use the Swiss Wage Structure Survey (SESS) provided by the Swiss Federal Statistical Office (FSO). These data are composed by a cross-sectional survey conducted every two years on a representative sample of workers since 1994. The survey does not contain information on the country of birth of workers. However, it contains information of the work permit and it allows to distinguish across Swiss and foreign workers. Moreover, it contains information on the education of the worker and on the workplace at the MS region level.[7] I focus on workers aged between 18 and 65 years employed in the private sector. Using this dataset, I can analyze how the presence of foreign workers in Switzerland varied over time and across regions. To complement this data with indication of the nationality, I use the information provided by Secretariat d'Etat (2017).

[6] Data at the firm-level are available only from 2006 onwards. Therefore, they do not cover the period of the Swiss-EU agreement that I analyze in this paper. For more details, see Egger and Lassmann (2015) and Egger et al. (2019).

[7] MS is the acronym for "spatial mobility areas". These represent 106 local labor markets defined by the Swiss Federal Statistical Office (FSO).

3.2 Stylized facts

I present in this subsection three stylized facts that characterize the changes in foreign workers and trade patterns after the implementation of the Swiss-EU agreement.

- ***Stylized fact 1:*** *the agreement was highly effective in attracting EU workers*

Following the AFMP, the net yearly inflow of foreign workers into Switzerland increased 2.3 times, from an average of 26.4 thousands per year in the period 1991-2001 to 60.5 thousand per year in the period 2002-2010 (Table 2). This growth is totally imputable to EU workers, which increased from about 0.4 to 34.9 thousands per year, while the number of foreign workers coming from outside the EU slightly decreased from 26.0 thousand to 25.6 thousand per year.[8] These numbers highlight the fact that the importance of EU workers in yearly inflows increased enormously, from 2% in 1991-2001 to 58% in the period 2002-2010. Table 2 shows that most of the incoming EU flows arrived from Germany and the other border countries. However, there is also a large number of foreign workers that arrived from Portugal, UK and Poland. While the increase in absolute numbers can be influenced also from a period of florid economic growth in Switzerland after few years of relative poor performance, the change in composition can be reasonably due to the facilitated immigration policy for EU citizens brought by the AFMP. Importantly, there are not significant changes in the patterns of Swiss emigration. More specifically, the stock of Swiss emigrants (Table A-2 in Appendix A) and net emigration flows (Table 2.6 in Secretariat d'Etat, 2017) increased steadily but only mildly. Moreover, their location choices did not significantly change after the implementation of the AFMP (Table A-2 in Appendix A). Therefore, the AFMP had asymmetric effects by increasing the number and share of EU workers in Switzerland but not fostering Swiss emigration into the EU.

The skill level of incoming flows is another key element of the AFMP. Using the SESS data I can analyze the educational composition of foreign and Swiss workers over time in Figure 2. Their composition shifted quite dramatically in favor of highly educated workers: their share among foreign workers almost doubled, growing from 12.4% in 1996 to 24.2% in 2010. To provide a benchmark, I plot in Figure 2 also the share of tertiary educated among Swiss workers. Interestingly, the former converged over time to the latter, reaching the same composition in 2012. This means that tertiary

[8]Further distinguishing across EU15 and the ten states which joined the EU in 2004, I find that EU15 countries increased from -0.4 thousand per year to 31.8 and the new member states from 0.9 to 3.1. Therefore, the contribution of new EU member countries is quite limited.

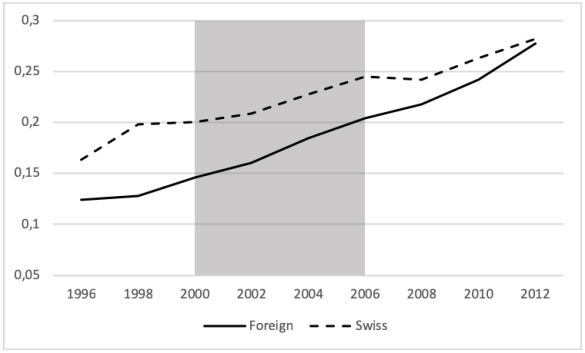
Table 2: Average Net Immigration Flows in Switzerland

	1991-2001	2002-2010
Total	26.4	60.5
Outside EU27	26.0	25.6
EU27	0.4	34.9
Germany	3.7	17.3
Portugal	1.1	6.5
France	1.5	4.0
UK	0.6	1.6
Poland	0.2	1.1
Austria	0.3	0.9
Italy	-4.2	0.8
Other EU27	-0.3	2.6

Note: Source: Secretariat d'Etat (2017), values are in thousands.

educated were dominating incoming flows and this led the stock composition of foreign and Swiss workers to become the same following the AFMP. Therefore, the agreement was particularly successful in attracting especially tertiary educated workers. This makes this setting quite unique and differs from other natural experiments in which the exogenous increase of foreign workers was characterized by an inflow of low skilled coming from developing countries (e.g. Bahar et al., 2019; Barsbai et al., 2017; Gray et al., 2017; Olney and Pozzoli, 2018; Parsons and Vézina, 2018).

Figure 2: Share of Tertiary Educated Workers in Switzerland



The distribution of foreign workers in the different industries represents another interesting feature of the period considered that can be analyzed using the SESS data. More or less 70% of foreign workers are in service industries while 30% are in manufacturing. They represent about 30% of the workforce in the former and more than 35% in the latter. During the period considered, the share of foreign workers increased on average of about three percentage points in both sectors, meaning that Swiss firms

relied more and more on them in order to produce. Looking within these two macro categories, I observe that the share of foreign workers increased especially in Vehicles, Pharmaceutical and Car industries for the manufacturing sector and in R&D, Management Consultancy and Technical Services industries for the services sector. These are all sectors which are high-tech and most of the increase is explained by a higher number and share of foreign high-skilled workers. Other more traditional sectors such as textile, furniture, construction instead experienced a decrease in the number and importance of foreign workers.

Table 3: Share of Foreign Workers by Industry

Industry	**1996**	**2010**	**Difference**
Manufacturing	0.35	0.38	0.03
- *Vehicles*	*0.25*	*0.49*	*0.24*
- *Pharmaceutical*	*0.40*	*0.55*	*0.15*
- *Cars*	*0.36*	*0.50*	*0.14*
Services	0.28	0.31	0.03
- *R&D*	*0.29*	*0.47*	*0.18*
- *Management Consult.*	*0.22*	*0.40*	*0.17*
- *Technical Services*	*0.14*	*0.24*	*0.11*

- ***Stylized fact 2:*** *change in the presence of foreign workers was inversely proportional to border distance.*

Another peculiar feature the AFMP agreement is that its impact varied depending on the distance from the border (Beerli and Peri, 2017; Ruffner and Siegenthaler, 2016). Table 2 shows for the border region (BR) and the central region (CR), the share of cross border workers for the years 1996 (i.e. before the agreement) and 2010 (i.e. after the agreement) depending on the travel distance (in minutes) to the closest border crossing.[9] It is evident that the share of CBW increased more heavily in BR, while the central region remained practically unaffected. Moreover, the magnitude of the increase crucially depends on the distance from the border. Localities in BR within fifteen minutes from the border crossing experienced an increase of five percentage points. Those between fifteen and thirty minutes and those beyond thirty minutes increased

[9]Figure A-1 in Appendix A provides a visual representation of the time distance from the border for all the postal codes in Switzerland.

their share of CBW of one percentage point. For the central region the increase is of about one percentage point for those within fifteen and thirty minutes from the border and zero for the localities beyond thirty minutes. This pattern simply reflects the fact that cross-border workers have limited propensity to travel to get to their job location. Looking at the overall share of foreign workers on the right side of Table 1, results indicate that most of the increase in the share of foreign workers in the border region is actually due to cross-border workers. Therefore, most of the supply shock is accounted by this category of workers. In the central region instead the magnitude of the increase in the share of foreign workers was smaller than for the border region and mostly due to resident immigrants. Importantly, the increase of resident immigrants does not seem to be correlated with the distance from the border. These patterns highlight that the agreement impacted localities depending on the distance from the border and that the increase in the supply of foreign workers was due mostly to cross-border workers. These are important features that I will exploit in the empirical strategy.

Table 4: Presence of Foreign Workers by Border Time Distance

		Cross-Border		All	
	Border Time	1996	2010	1996	2010
Border Region	≤15 min	19%	24%	46%	50%
	>15≤30 min	5%	6%	32%	33%
	>30 min	1%	2%	26%	28%
Central Region	≤15 min	-	-	-	-
	>15≤30 min	0%	1%	23%	26%
	>30 min	0%	0%	20%	22%

- ***Stylized fact 3:*** *export growth was inversely proportional to the time distance from the border.*

To provide evidence on how trade reacted to the implementation of AFMP, I compare the evolution of exports before and after the implementation of the agreement depending on border travel time. More specifically, I test whether the 1996-2010 export growth for each postal code is stronger for those within fifteen minutes and those between fifteen and thirty minutes from the border (i.e. those affected by the inflow of CBW workers), with respect to localities beyond thirty minutes from the border (i.e. those not affected by the inflow of CBW workers). This is done by regressing the 1996-2010 change in log exports of locality i, Δ Log Exp_i on dummies identifying

Table 5: Exports Growth by Time Distance from the Border

	(1) Δ Log Exp$_i$	(2) Δ Log #Dest$_i$	(3) Δ Log #Prod$_i$	(4) Δ Log Dens$_i$	(5) Δ Log Int$_i$
D1$_i$	0.1899^b	-0.0493	-0.0384	-0.0193	0.2776^a
	(0.096)	(0.041)	(0.037)	(0.050)	(0.067)
D2$_i$	0.1252	-0.0163	0.0310	0.0477	0.1106^c
	(0.091)	(0.039)	(0.036)	(0.048)	(0.064)
Observations	2,793	2,793	2,793	2,793	2,793
R-squared	0.0016	0.0005	0.0009	0.0005	0.0062

Note: Robust standard errors in parentheses. ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

localities within fifteen minutes from the border, D1$_i$, and localities between fifteen and thirty minutes from the border, D2$_i$. Looking at column 1 of Table 5, it is clear that only localities within fifteen minutes from the border observed a stronger export growth with respect to the region beyond thirty minutes from the border. This simple positive correlation is actually encouraging because it says that localities mostly affected by the increased availability of foreign workers were also those experiencing the fastest export growth.

To understand better the features of the increase in total exports just observed, I decompose the change in exports of locality i into the change in the number of destinations, Δ Log #Dest$_i$, number of products, Δ Log #Prod$_i$, density Δ Log Dens$_i$ and average exports per product and destination effectively served, Δ Log Int$_i$.[10] Results in columns 2-5 of Table 5 indicate that the only factor explaining the differential export growth is actually the intensive margin. This means that export growth during 1996-2010 is not due to an increase the number of destinations or an increase in the number of products, but rather by an increase in the average export per destination and product.

These results provide descriptive evidence that localities affected by the inflow of foreign workers also experienced a differential increase in exports, mostly led by the intensive margin, i.e. their average exports per country/product. Therefore, this is the key margin in the differential reaction to the AFMP. It is important to highlight that these results do not provide a causal link between the inflow of foreign workers and the export increase because of differences between treated and control localities in the composition of export flows in terms of types of products and destinations. However,

[10]The density is defined as the log number of products-destinations effectively observed by locality i divided by the total number of possible destinations served by i: $LogDens_{it} = \frac{LogObs_{it}}{Log\#Dest_{it} * Log\#Prod_{it}}$ and the intensive margin is defined as the total exports of locality i divided by the number of log number of products-destinations effectively observed by locality i: Log Int$_{it}$=$\frac{LogExp_{it}}{LogObs_{it}}$

Table 6: 1996-2010 Export Growth by Product and Border Distance

HS Code	Product Name	≤15mins	<15≤30mins	>30mins
1	Animal Products	132%	184%	20%
2	Vegetable Products	31%	102%	2,206%
3	Animal and Vegetable Fats and Oils	436%	9,806%	-63%
4	Beverages and Tobacco	304%	219%	53%
5	Mineral Products	60%	-24%	1,011%
6	Chemical Products	101%	317%	214%
7	Plastic and Rubber Products	26%	69%	71%
8	Leather Products	359%	11%	46%
9	Wood and Cork Products	3%	2%	66%
10	Paper Products	16%	12%	24%
11	Textiles	-5%	10%	-33%
12	Apparel	214%	518%	-71%
13	Stone, Ceramic, Glass Products	48%	56%	43%
14	Jewelry	183%	627%	157%
15	Base Metals	44%	53%	60%
16	Machinery	37%	37%	33%
17	Vehicles	49%	28%	20%
18	Optical and Precision Instruments	207%	299%	72%
19	Arms and Ammunitions	23%	171%	739%
20	Miscellaneous Manufacturing	43%	-20%	-27%
21	Art Products	3%	-45%	127%

they clearly point at a differential response of aggregate export values and the average exports per product and destination that offer guidance for the assessment of a causal link.

Looking at the growth of exports for the different product categories in Table 6, it is evident that localities closer to the border experienced higher export growth than the localities farther away in most of the product categories. This is especially true for more high-tech products such as Machinery, Vehicles, Optical and Precision Instruments, Jewelry and Chemicals but also for more traditional products such as Animal, Food, Leather, Textile, Apparel and Stone, Ceramic and Glass products. This means that sectors in which there was a higher inflow of foreign workers also experienced higher export growth. Of course, this can be due to demand and in the next section I will develop an empirical strategy to understand whether this link can be considered as causal. Instead, localities further away from the border (i.e. less affected by the inflow of foreign workers) experienced a stronger growth of only more traditional products such as Vegetables, Mineral, Plastic and Rubber, Wood and Cork, Paper, Base Metals and Arms and Ammunitions.

By distinguishing export growth by destination country and time distance from the border, I find that exports to countries outside the EU15 area grew more than border and EU15 countries (Table 7). Moreover, localities closer to the border experienced a more sustained growth than localities farther away in all the destination markets. Therefore, localities closer to the border performed better following the implementa-

tion of the AFMP in terms of export growth. However, it does not look like there is a significant relation between the origin country of the foreign worker and the export growth. Since Gould (1994), most of the literature states that migration fosters trade towards their origin country. Therefore, it is quite surprising to see that exports of localities affected by the AFMP did not especially grow towards EU destinations. Section 5 will dig deeper into this issue by analyzing the mechanisms at play.

Table 7: 1996-2010 Export Growth by Country and Border Distance

Country Group	**≤15mins**	**<15≤30mins**	**>30mins**
Border Countries (Italy, France, Germany and Austria)	62%	74%	49%
EU15 (Excluding Border Countries)	94%	95%	76%
EU25(Excluding EU15 Countries)	165%	213%	161%
OECD (Excluding EU25 Countries)	122%	87%	79%
Non-OECD Countries	150%	155%	107%

In conclusion, this section shows that the AFMP was really successful in increasing the availability of foreign workers into Switzerland, by attracting a great number of cross-border tertiary educated EU workers. This increase was heterogeneous depending on the time distance from the border and benefited mostly localities within fifteen minutes from the border and to a lesser extent localities between fifteen and thirty minutes from the border. However, it left those beyond thirty minutes practically unaffected. At the same time, exports grew more especially for the regions mostly affected by the increase in foreign workers and this growth is explained solely by an increase in the average exports per product and destination, while the extensive margins (i.e. the number of products and destinations) do not play any role. For the affected regions this growth was especially strong for high-tech products and especially to destinations outside the EU15 area. These results offer precious guidance for the empirical strategy that I outline in the next section.

4 Empirical Strategy and Results

Guided by the stylized facts presented in the previous section, I outline in the present one the empirical strategy to establish causality and I present the results.

4.1 Empirical strategy

In the absence of detailed data on foreign workers at the postal code level, I cannot directly relate changes in their presence to export growth. However, I can use the

exceptional features of the agreement highlighted in the previous section to provide evidence about its impact on trade. In particular, I use the time variation in the implementation of the agreement across regions and the difference in the intensity at which the agreement affected postal codes within each region depending on the time distance from the border. This means that I compare the exports of the same product to the same destination before and after the reform, across localities (i.e. postal codes) within fifteen minutes from the border crossing (highly treated), localities between fifteen and thirty minutes (lowly treated) and localities beyond thirty minutes (control). This is implemented by using a simple difference-in-difference model:

$$log\, Exp_{ipct} = \alpha_0 + \alpha_1 R_{it} + \alpha_2 R_{it} * D1_i + \alpha_3 R_{it} * D2_i + \lambda_{ipc} + \sigma_t + \epsilon_{ipct} \qquad (1)$$

where $log\, Exp_{ipct}$ represents log exports of postal-code i of product p to country c at time t; R_{it} captures the timing difference across central and border regions in the implementation of the agreement and takes value one for localities in border regions after 2004 and after 2007 for the localities in central regions. $D1_i$ identifies localities within fifteen minutes from the border and $D2_i$ localities between fifteen and thirty minutes from the border. λ_{ipc} and σ_t represent respectively locality-product-country and year dummies.

A similar approach has been implemented by Beerli and Peri (2017), Bigotta (2015) and Ruffner and Siegenthaler (2016) to understand respectively the effect of the same agreement on the labor market outcomes and on the size and productivity of firms. A key element of these works that further supports the credibility of my strategy is that labor markets and firms do not differ significantly across treated and control localities before the implementation of the agreement. Finally, I have a great number of observations and for 99% of the products I have at least one locality in both the treated and control group that produces it. Similarly, the share of destinations for which I observe positive exports in both treated and control region is close to unity. Therefore, my results do not depend on specific products or destinations. By comparing the exports of the same product to the same destination in the same year across treated and control localities, the estimates have the advantage of not depending on the composition of exports in terms of destinations or products. The limitation is that I cannot identify the effect on entry and exit patterns. However, Section 3 highlighted that the extensive margins did not play any role in the adjustment, so, I am confident I am not ignoring a key element of the AFMP trade consequences.

4.2 Results

Results in column 1 of Table 8 show that postal codes within fifteen minutes from the border increased their exports of product p in country c 7% more than localities further away than thirty minutes from the border. The same differential effect for localities located between fifteen and thirty minutes from the border is smaller, about 2% and only mildly significant. Therefore, there is evidence of a positive differential effect on exports for localities closer the border due to the implementation of the Swiss-EU agreement. Summing the coefficient of R_{it} with that of the interaction with the time to border dummies, e.g. R_{it}*$D1_i$ or R_{it}*$D2_i$, it is possible to assess the aggregate effect of the agreement. For the region within fifteen minutes, this accounts to about 5.5%, meaning that the reform significantly increased the exports of localities closest to the border. Instead, it is not significantly different from zero for the localities between fifteen and thirty minutes from the border. Therefore, the Swiss-EU agreement caused divergence in export growth only between highly treated and control localities by increasing relatively more the exports of the regions highly affected by the increasing availability of foreign workers.

Table 8: The Effect of the AFMP on Exports

	(1) Log Exp_{ipct}	(2) Log Exp_{ipct}	(3) Log Exp_{ipct}
R_{it}	-0.0185^b		
	(0.009)		
R_{it}*$D1_i$	0.0733^a	0.0798^a	0.1098^a
	(0.016)	(0.016)	(0.022)
R_{it}*$D2_i$	0.0181^c	0.0212^b	0.0430^a
	(0.010)	(0.010)	(0.015)
A_t*$D1_i$			0.0419^b
			(0.018)
A_t*$D2_i$			0.0304^b
			(0.013)
Obs.	5,136,193	3,909,665	3,909,665
R^2	0.7589	0.7588	0.7588

Note: column 1 reports results for the complete sample and columns 2 and 3 for the sample that excludes the central region and the years before 2007. All regressions include locality-product-destination and time fixed effects. Standard errors clustered at the postal code-year level in parentheses

This empirical specification provides lower bound estimates since it does not take into account possible anticipatory effects between 1999 and 2004. It embeds in the control group the central region which includes mostly postal codes beyond thirty minutes

from the border and it considers the years of the great trade collapse. To account for these factors, I follow Beerli et al. (2018) and restrain the analysis to the border region, on the years before 2007 and I account for potential anticipatory effects by interacting a dummy that identifies the years between 1999 and 2004, A_t, with the time to border dummies.[11] The results in column 2 of Table 8 show that when restraining the analysis to the border region and the years before 2007 the results remain the same. This further confirms that the positive effect of foreign workers on trade is actually due to the cross-border rather than resident immigrants because they enjoyed free access to the Swiss labor market only after 2007. Moreover, results do not depend on time-varying differences across border and central region and on possible heterogenous effects across postal codes due to the great trade collapse. Finally, column 3 of Table 8 indicates that there are positive differential effects also during the transitional phase that are particularly strong especially for the region closer to the border. As expected, by controlling for the anticipatory effects, the positive differential effect of the AFMP increases substantially.

4.3 Robustness Checks

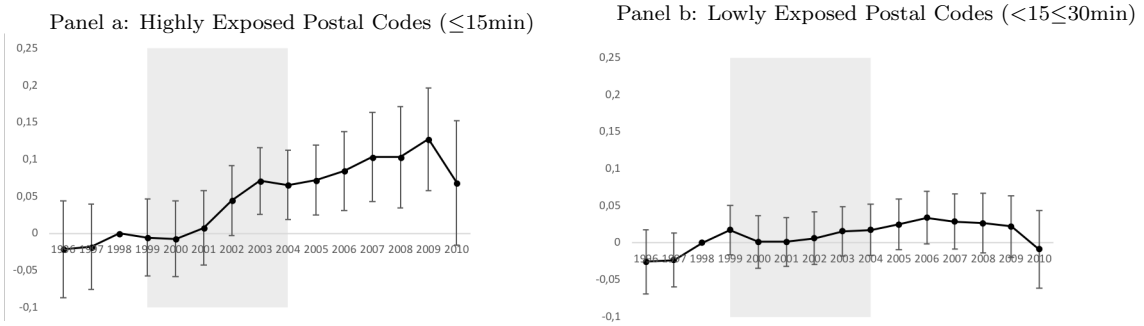
In this subsection I test the robustness of the previous results to a series of potential threats.

4.3.1 Parallel Trends

My results can be considered as causal only if the trends between treated and control localities are parallel before the implementation of the AFMP. One way to supply supporting evidence on this issue is to use an event study approach. The idea is to test whether the export growth of treated and control localities differed before, during and after the implementation of the agreement. This is possible by regressing the log exports of locality i of product p in country c in year y on locality-product-country and year fixed effects and the interaction between year dummies and dummies that identify localities within fifteen minutes from the border $D1_i$ and localities between fifteen and thirty minutes from the border, $D2_i$. I normalize results with respect to 1998, which is the last year before the notice of the agreement. Tables A-3 and A-4 in the appendix present the results. Panel a of Figure 3 provides their visual representation for the localities within fifteen minutes from the border and Panel b for the postal

[11] Please note that both R_{it} and A_t are absorbed by the time fixed effects in this specification.

Figure 3: Yearly Effect of the AFMP on Exports



codes between fifteen and thirty minutes from the border. For both, it is clear that export growth did not differ across treated and control localities in the period before the agreement. Therefore, trends in export values are not significantly different across treated and control localities in the period before the implementation of the agreement. Then, starting from 2002, export growth significantly increased but only for highly treated localities (Panel a), leading to higher exports also in the years after the full implementation.

4.3.2 Concurrent Agreements

A potential threat to identification is represented by the concurrent implementation of other agreements together with the AFMP. These included provisions on air transport, international trade, mutual recognition of conformity assessment, government procurement and scientific and technological cooperation. Most of them could not play a role for international trade, at least in the short term.[12] Instead, the mutual recognition of conformity assessment and the international trade agreements could have had an effect on trade also in the short term because they specifically affected products produced in Switzerland. Since I am comparing export growth of the same product to the same destination across treated and control postal codes, their effects should be symmetric and they should not affect my results. However, if there is any geographical variation related to their effects that is correlated with the time distance from the border, my estimates could be biased. To linger this doubt, I removed from the estimation sample

[12]The agreement on government procurement decreased the requirements for a tender to be of international dimension and it enlarged its scope to Swiss communes. The scientific and technological cooperation agreement allowed Swiss universities and research centers to be part of ERC research networks. The air transport agreement extended to Swiss airline companies the same rights of EU carriers.

Table 9: Robustness Checks

	(1) Log Exp_{ipct}	(2) Log Exp_{ipct}	(3) Log Exp_{ipct}	(4) Log Exp_{ipct}	(5) Log Exp_{ipct}	(6) Log Exp_{ipct}	(7) Log Exp_{ipct}
R_{it}	-0.0047	-0.0236^b	-0.0197^b	-0.0157	-0.0157	-0.0157	0.0040
	(0.014)	(0.009)	(0.009)	(0.012)	(0.010)	(0.011)	(0.003)
R_{it}*$D1_i$	0.0793^a	0.0565^a	0.0524^a	0.0729^b	0.0729^a	0.0729^c	0.0018
	(0.023)	(0.013)	(0.012)	(0.037)	(0.020)	(0.040)	(0.002)
R_{it}*$D2_i$	0.0087	0.0342^a	0.0316^a	0.0199	0.0199	0.0199	-0.0015
	(0.014)	(0.010)	(0.010)	(0.018)	(0.013)	(0.013)	(0.002)
Obs.	2,623,422	4,488,926	4,488,926	5,136,193	5,136,193	5,136,193	5,136,193
R^2	0.7672	0.7950	0.7956	0.7589	0.7589	0.7589	0.7589

Note: Column 1 reports the results for the sample of products not related to other agreements. Column 2 includes destination-product-year dummies. Column 3 includes also labor mart area-product trends. Column 7 performs a placebo test in which postal codes are randomly assigned to time distance bins. All regressions include locality-product-destination and time fixed effects. Standard errors clustered at the postal code-year level in parentheses in columns 1-3, at the postal code level in column 4, at the regional-time level in column 5 and at the regional level in column 6. ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

all the products included in these agreements.[13] Column 1 of Table 9 shows that all the results remain practically unchanged. Therefore, the estimated effect of the AFMP on trade does not depend on the concurrent implementation of other agreements with the EU.

4.3.3 Heterogeneous Demand and Supply Shocks

Demand and supply shocks can potentially represent potential unobserved factors in my setting. If these shocks affect symmetrically treated and control localities, my estimates are safe. If instead the shock is specific to the treated or control postal codes, my estimates are biased. For example, if the demand decreases coincidentally with the AFMP especially for producers located in the control postal codes, my difference-in-difference specification would show a positive effect of the AFMP which is instead driven by the location-specific demand drop. Technological or more in general supply-side shocks can have similar consequences on my estimates. To control for general demand shocks, I added to the main specification destination-product-year fixed effects (column 2 of Table 9). To further account for the possible heterogenous impact of demand and supply shocks I performed two main exercises. In the first, I regress population changes at the municipality level between 1990 and 2010 on dummies identifying the distance bins from the border, $D1_i$ and $D2_i$.[14] This exercise will be able to assess

[13]The complete list is available in Table A-5 in the Appendix.

[14]Unfortunately, yearly information at the postal code level becomes available only in 2010. That is why I cannot run the same difference in difference exercise as in the rest of the paper, I need to aggregate the analysis at the municipal level and I rely on the long difference between 1990 and 2010.

whether municipalities within fifteen minutes from the border or between fifteen and thirty minutes from the border experienced differential changes in population growth with respect to municipalities beyond thirty minutes from the border. The idea is that if the rise in exports is due to an increase in demand for products produced close to the border, we should observe both an increase in the number of foreign and native workers. Results in Table 10 show instead that there is not a significant differential increase in the population across municipalities depending on the distance from the border. Moreover, by distinguishing between Swiss and foreigners the results are very much in line with the descriptive statics of section 3. The number of foreigners increased differentially more only for the region closer to the border. Moreover, the increase in the number of Swiss between 1990 and 2010 did not grow at different paces depending on the distance from the border. In the second exercise, I added to the main specification industry-labor market area trends. Column 3 of Table 9 shows that my estimates decrease slightly in the magnitude but remain highly significant. Therefore, both exercises cast away the possibility that my results could be driven by heterogeneous demand or supply shocks that depend on the distance from the border.

Table 10: 1990-2010 Population Dynamics

	Δ Total	Δ Swiss	Δ Foreigners
$D1_i$	0.014	0.004	0.017^b
	(0.016)	(0.013)	(0.008)
$D2_i$	-0.015	-0.010	-0.005
	(0.011)	(0.009)	(0.005)
Observations	1,731	1,731	1,731
R-squared	0.002	0.001	0.006

Note: Robust standard errors in parentheses. ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

4.3.4 Alternative Clustering

In the main specification I use standard errors clustered at the same level as the variable of interest (i.e. postal code-year level). However, it could be that errors are correlated within the same postal code or region. To control for this potential bias, I clustered standard errors at the postal code level (column 4 of Table 9), at the regional-time level (column 5 of Table 9) and at the regional level (column 6 of Table 9). In all cases, I observe a positive differential effect of the AFMP for the region within fifteen minutes from the border, meaning that the significance of the results do not depend on the

correlation of errors within the same postal code or region.

4.3.5 Placebo

To dissipate doubts about the fact that it is not random noise that is driving the results, in column 7 of Table 9 I randomly assign postal codes to the three time to border distance bins. Results indicate that our identification does not come from random noise present in the data but really from the variation provided by the AFMP.

4.3.6 Firm Relocation

The potential relocation of economic activity across treated and control localities represents a further threat for my estimates. This would violate the stable unit treatment value assumption (SUTVA) and lead to biased estimates. This is possible if firms left the control localities to relocate in the treated ones in order to enjoy earlier the facilitated access to foreign workers. This potential issue should not be important in my setting for two reasons. First, if the relocation of a firm is associated with a new product exported or a new destination for exports, this is out of my estimations because I am focusing the analysis on the time variation in the exports of the same product to the same destination. Second, firms' relocation is a very costly investment that takes time and the incentives to incur in such a risky strategy would not be justified by the short time difference in the implementation of the AFMP across border and central regions.

In order to provide a formal test that firms did not relocate across treated and control postal codes, I exploit the information on plants' location contained in the Industrial Census for the years 1991, 1995, 1998, 2001, 2005, 2008. With these data, I can count for each postal code and year the number of plants that relocate from other postal codes. Column 1 of Table 11 shows that plant relocation did not differ between treated and control postal codes following the implementation of the AFMP. The data allow me to disentangle the total number of relocations between those happening within the treated and control postal codes (column 2) and those across them (column 3). For the postal codes within fifteen minutes from the border, the implementation of the AFMP increased plant relocations within the treated and control postal codes but it decreased relocation across them. For the postal codes between fifteen and thirty minutes from the border, I do not observe any statistically significant change. Therefore, there is no evidence of a SUTVA assumption violation.

Table 11: The effect of the EU-Swiss Agreement on Plant Relocation

	(1) log # plants	(2) log # plants same region	(3) log # plants different region
R_{it}	-0.0055	-0.0242	0.0682^a
	(0.023)	(0.023)	(0.014)
R_{it}*$D1_i$	-0.0112	0.0427^c	-0.1243^a
	(0.027)	(0.026)	(0.018)
R_{it}*$D2_i$	0.0169	0.0314	0.0091
	(0.024)	(0.023)	(0.019)
Observations	19,582	19,582	19,582
R-squared	0.7377	0.7336	0.6181

Note: All regressions include postal code and year fixed effects. Standard errors clustered at the postal code level in parentheses. ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

5 Understanding the Mechanisms

In this section I explore the possible mechanisms behind the increase in exports for the localities within fifteen minutes from the border observed in the previous section.

5.1 How Could Foreign Workers Increase Exports?

Language, taste, culture and institutions represent crucial elements to be able to reach foreign consumers. Foreign workers can help firms in the host country by bringing trade-specific knowledge about their origin country that would be otherwise costly to get (e.g. Parsons and Vézina, 2018; Felbermayr and Toubal, 2012; Rauch and Trindade, 2002; Rauch, 2001; Gould, 1994). In my contest, this would mean that that the increase in exports highlighted in the previous section should be directed especially to the foreign workers' origin countries. Given that the AFMP was characterized by a shift towards more foreign workers coming to Switzerland from border and EU countries, most of the increase in exports should be actually directed to these countries.

To test for this mechanism, I interact R_{it}*$D1_i$ and R_{it}*$D2_i$ with a dummy that identifies particular sets of destination countries: $Border_c$ for the border countries (France, Italy, Germany and Austria), $EU15_c$ for EU15 countries and $EU25_c$ for EU25 countries. Table 12 shows that all these interactions are actually negative. This means that exports grew less towards destinations from which foreign workers came than for other destinations. In other words, the differential increase in exports of border localities did not direct more towards the countries from which the foreign workers are from. Therefore, it is unlikely that a decrease in downstream information frictions played

Table 12: The effect of the EU-Swiss Agreement on the Free Movement of Persons on Exports by Destination Country

		(1)		(2)		(3)
Dep. Var.		Log Exp_{ipct}		Log Exp_{ipct}		Log Exp_{ipct}
R_{it}		0.0130		0.0539^{a}		0.0454^{a}
		(0.010)		(0.011)		(0.011)
R_{it}*$D1_i$		0.0866^{a}		0.0913^{a}		0.1033^{a}
		(0.021)		(0.023)		(0.024)
R_{it}*$D2_i$		0.0101		0.0233^{c}		0.0206
		(0.012)		(0.014)		(0.015)
R_{it}*$D1_i$	*$Border_c$	-0.0364^{b}	*$EU15_c$	-0.0376^{b}	*$EU25_c$	-0.0540^{a}
		(0.016)		(0.017)		(0.017)
R_{it}*$D1_i$	*$Border_c$	0.0223^{c}	*$EU15_c$	-0.0063	*$EU25_c$	-0.0022
		(0.011)		(0.013)		(0.013)
Observations		5,136,193		5,136,193		5,136,193
R-squared		0.7590		0.7591		0.7591
R_{it}+R_{it}*$D1_i$+R_{it}*$D1_i$	*$Border_c$	0.0632^{a}	*$EU15_c$	0.0947^{a}	*$EU25_c$	0.1031^{a}
R_{it}+R_{it}*$D2_i$+R_{it}*$D2_i$	*$Border_c$	0.0454^{a}	*$EU15_c$	0.0638^{a}	*$EU25_c$	0.1086^{a}

Note: All regressions include locality-product-destination, year fixed effects and the interaction of $D1_i$ with $Border_c$ or $EU15_c$ or $EU25_c$ dummy. Standard errors clustered at the postal code-year level in parentheses. ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

a substantial role in the differential increase in exports of the localities within fifteen minutes from the border. This is not surprising given that most of the foreign workers came from the main trade partners of Switzerland. These have been historical destinations for Swiss products and the extent to which information frictions can still play a substantial role is quite limited. One important element that must be highlighted is that this does not mean that exports towards border or EU destinations decreased. The sums of the interactions suggest that the AFMP had an overall positive effect also for border and EU countries, but smaller than for non-EU ones. Moreover, it does not mean that this channel does not work in general, but rather that is less important for trade between developed countries than in a developed-developing country context (e.g. Olney and Pozzoli, 2018; Parsons and Vézina, 2018; Bahar et al., 2019).

Another key element of the agreement can help identify the mechanism at play. The AFMP led to a sharp increase in the stock of foreign skilled workers in Switzerland. It is therefore possible that high-skilled workers might have helped firms in developing better products and made them more appealing for international markets. If this is the case, the positive effect in export values observed in Table 8 should be driven by both quantities and prices. By decomposing the increase in exports values into quantities and prices (columns 2 and 3 of Table 13), I observe that both are positive and significant. Increasing prices despite observing increasing quantities provides evidence that the appeal of the same product increased. This means that the labor supply shock increased the quality of Swiss products and shifted positively their foreign demand. To provide further evidence of the quality improvement, it is possible to build a measure

Table 13: Decomposition of the Effect of the AFMP on Exports

	(1) Log Exp_{ipct}	(2) Log Q_{ipct}	(3) Log P_{ipct}	(4) $\hat{\eta}_{ipct}$	(5) Log Exp_{ipct}
R_{it}	-0.0185^b	-0.0198^b	0.0013	-0.0038	-0.0207^c
	(0.009)	(0.010)	(0.004)	(0.006)	(0.012)
R_{it}*$D1_i$	0.0733^a	0.0631^a	0.0102^c	0.0276^a	0.129^a
	(0.016)	(0.016)	(0.006)	(0.008)	(0.018)
R_{it}*$D2_i$	0.0181^c	0.0262^b	-0.0081^c	0.0006	0.0195
	(0.010)	(0.011)	(0.005)	(0.006)	(0.014)
R_{it}*$D1_i$*CA_p^{Bord}					-0.0949^a
					(0.016)
R_{it}*$D2_i$*CA_p^{Bord}					0.0002
					(0.013)
Obs.	5,136,193	5,136,193	5,136,193	4,303,419	5,136,193
R^2	0.7589	0.8564	0.9187	0.6408	0.759
R_{it}+R_{it}*$D1_i$	0.0548^a	0.0433^a	0.0115^b	0.0238^a	
R_{it}+R_{it}*$D2_i$	-0.0004	0.0064	-0.0068	-0.0032	

Note: All regressions include locality-product-destination and time fixed effects. Standard errors clustered at the postal code-year level in parentheses. ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

of perceived quality following Khandelwal et al. (2013). Supposing CES preferences and a for a given value of σ,[15] the residual from the OLS estimation of the following demand equation (divided by $\sigma - 1$) measures how much more localities sell conditional on prices and demand.

$$log\, q_{ipcy} + \sigma\, logp_{ipcy} = \delta_{pcy} + \xi_{ipcy}$$

The estimated perceived quality $\hat{\eta}_{ipcy} = \frac{\hat{\xi}_{ipcy}}{\sigma - 1}$ can be used as dependent variable to understand if the AFMP had a differential positive effect on the perceived quality of goods produced in the localities within fifteen minutes from the border. Column 4 of Table 13 shows that Swiss products produced in these localities increased their appealing after the implementation of the Swiss-EU agreement. Therefore, quality upgrading is the main mechanisms by which foreign workers made exports to grow. This means that they can be seen as an innovation source and the effect that they exert on exports is very similar to that of an input trade liberalization (e.g. Topalova and Khandelwal, 2011; Amiti and Khandelwal, 2013).

[15] I use the estimates of σ from Broda et al. (2006)

5.2 How Could Foreign Workers Improve Swiss Products?

The most intuitive way in which foreign workers could actually improve the quality of Swiss products is by bringing a set of technical skills that improved their characteristics. However, testing whether the innovation was effectively performed by the new foreign workers and if the upgraded product was responsible for the differential response in exports is an impossible task due to the lack of firm-level information on trade and detailed information on the person that actually did the innovation. Moreover, Ruffner and Siegenthaler (2016) show that localities highly exposed to the labor supply shock did not experience any product innovation and the likelihood of improving existing products increased only for the subset of firms which experienced difficulties in hiring qualified R&D personnel. Therefore, this channel is rather unlikely to represent the main cause for the quality improvement. To provide further evidence, I check whether the increase in exports is driven by products for which border countries have a comparative advantage by interacting R_{it}*$D1_i$ and R_{it}*$D2_i$ with a dummy identifying such products, CA_p^{Bord}, constructed following the Balassa (1965) methodology. Column 5 of Table 13 shows that the differential effect is actually negative for the products for which border countries have a comparative advantage. This means that most of the export growth is due to products for which border countries do not have a comparative advantage. So, the extent to which foreign workers brought origin specific technologies to improve exported products is rather low.

Another way in which foreign workers could upgrade the quality of Swiss products is by decreasing upstream information friction. More specifically, they could have used their knowledge about their origin country suppliers to improve quality of the intermediates used in production. Using data on imports, I can test if the quality of intermediates increased due to the AFMP by looking at their price and quantities.[16] I run the same specification as in equation 1 with import values, quantities and prices as dependent variables. Results in columns 1-3 of Table 14 show that the agreement led to a differential increase in imports for treated localities. Consistent with the proposed mechanism, for the localities within fifteen minutes from the border this is driven by an increase in both quantities and prices. Moreover, the positive effect on import prices is especially strong for intermediate products coming from border countries (Column 4 of Table 14) and for the intermediates coming from border countries that are used

[16] Please, note that in the case of imports it is not possible to apply the methodology of Khandelwal et al. (2013) because we lack information on the seller firm and thus the estimated quality would vary across origin countries and time but not across firms.

Table 14: The effect of the EU-Swiss Agreement on Free Movement of Persons on Imports

	(1) Log Imp_{ipct}	(2) Log Q^{Imp}_{ipct}	(3) Log P^{Imp}_{ipct}	(4) Log P^{Imp}_{ipct}	(5) Log P^{Imp}_{ipct}	(6) Log P^{Imp}_{ipct}	(7) Log P^{Imp}_{ipct}
R_{it}	-0.0279^a	-0.0350^a	0.0071^a	-0.0092^a	-0.0091^a	-0.0138^a	-0.0156^a
	(0.005)	(0.005)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
R_{it}*$D1_i$	0.0468^a	0.0315^a	0.0153^a	0.0058^c	0.0057^c	0.0055	0.0057
	(0.007)	(0.008)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
R_{it}*$D2_i$	0.0415^a	0.0525^a	-0.0110^a	-0.0226^a	-0.0226^a	-0.0268^a	-0.0276^a
	(0.006)	(0.007)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
R_{it}*$D1_i$*Interm&Border$_{pc}$				0.0214^a			
				(0.005)			
R_{it}*$D2_i$*Interm&Border$_{pc}$				0.0229^a			
				(0.005)			
R_{it}*$D1_i$*IntermExp&Border$_{pct}$					0.0218^a		
					(0.005)		
R_{it}*$D2_i$*IntermExp&Border$_{pct}$					0.0230^a		
					(0.005)		
R_{it}*$D1_i$*IntermExp&EU15$_{pct}$						0.0196^a	
						(0.005)	
R_{it}*$D2_i$*IntermExp&EU15$_{pct}$						0.0276^a	
						(0.004)	
R_{it}*$D1_i$*IntermExp&EU25$_{pct}$							0.0190^a
							(0.005)
R_{it}*$D2_i$*IntermExp&EU25$_{pct}$							0.0284^a
							(0.005)
Obs.	13,466,440	13,466,440	13,466,440	9,908,975	9,908,975	9,908,975	9,908,975
R^2	0.7001	0.8253	0.8892	0.8809	0.8872	0.8509	0.8809
R_{it}+R_{it}*$D1_i$	0.0217^a	-0.0034	0.0250^a				
R_{it}+R_{it}*$D2_i$	0.0140^b	0.0187^b	-0.0047				
R_{it}+R_{it}*$D2_i$+R_{it}*$D1_i$*Interm&Border$_{pct}$				0.0180^a			
R_{it}+R_{it}*$D2_i$+R_{it}*$D2_i$*Interm&Border$_{pct}$				-0.0089^b			
R_{it}+R_{it}*$D1_i$+R_{it}*$D1_i$*IntermExp&Border$_{pct}$					0.0184^a		
R_{it}+R_{it}*$D2_i$+R_{it}*$D2_i$*IntermExp&Border$_{pct}$					-0.0087^b		
R_{it}+R_{it}*$D1_i$+R_{it}*$D1_i$*IntermExp&EU15$_{pct}$						0.0113^b	
R_{it}+R_{it}*$D2_i$+R_{it}*$D2_i$*IntermExp&EU15$_{pct}$						-0.0130^b	
R_{it}+R_{it}*$D1_i$+R_{it}*$D1_i$*IntermExp&EU25$_{pct}$							0.0091^c
R_{it}+R_{it}*$D2_i$+R_{it}*$D2_i$*IntermExp&EU25$_{pct}$							-0.0148^a

Note: All regressions include locality-product-destination and time fixed effects. Columns 4 to 8 have also the interaction of D1 and D2 with the dummy indicating the intermediate inputs coming from the different origin countries considered. Standard errors clustered at the postal code-year level in parentheses. ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

in the production of the exported products (Column 5 of Table 14).[17] Moreover, the positive effect on intermediates becomes weaker and weaker by enlarging the set of origin countries to EU15 and EU25 countries (Columns 6-7 of Table 14). These results provide evidence that localities that experienced a strong increase in exports started purchasing more expensive inputs from the foreign workers' origin countries following the AFMP.

To understand if the increase in the prices of inputs led to an increase in the quality of output I perform a simple horse race between intermediate coming from the origin country of the foreign workers and those coming from other origin countries. This means that I interact R_{it}*$D1_i$ and R_{it}*$D2_i$ with the weighted average prices of inputs used in the production of exported products coming from border countries, P^{ior}_{it}, and

[17]I use information on the IO table for Switzerland in 2000 (the first available) to identify intermediates that are used in the production of exported products. Since IO tables are quite aggregated and account for only 22 products, the differences across all imported inputs (Column 4 of Table 14) and those that are actually used for the exported products is very small (Column 5 of Table 14).

Table 15: The Effect of Input Prices on Export Prices and Quality

VARIABLES	(1) Log P_{ipct}	(2) Log P_{ipct}	(3) $\hat{\eta}_{ipct}$	(4) $\hat{\eta}_{ipct}$
R_{it}	0.0007	-0.0009	-0.0038	-0.0055
	(0.004)	(0.004)	(0.006)	(0.006)
R_{it}*$D1_i$	0.0068	0.0033	0.0250[a]	0.0253[a]
	(0.006)	(0.006)	(0.008)	(0.008)
R_{it}*$D2_i$	-0.0100[b]	-0.0074	0.0002	0.0018
	(0.005)	(0.005)	(0.006)	(0.006)
R_{it}*$D1_i$*P_{it}^{ior}	0.0016[a]	0.0015[a]	0.0021[a]	0.0022[a]
	(0.001)	(0.001)	(0.001)	(0.001)
R_{it}*$D2_i$*P_{it}^{ior}	0.0018[b]	0.0012	0.0006	-0.0000
	(0.000)	(0.001)	(0.001)	(0.001)
R_{it}*$D1_i$*P_{it}^{iot}		-0.0022[c]		-0.0036[a]
		(0.001)		(0.001)
R_{it}*$D2_i$*P_{it}^{iot}		0.0001		0.0004
		(0.003)		(0.003)
Observations	5,134,111	5,128,745	4,301,751	4,296,997
R-squared	0.919	0.918	0.641	0.641
R_{it}+R_{it}*$D1_i$+R_{it}*$D1_i$*P_{it}^{ior}	0.0074[a]	0.0024[a]	0.0213[a]	0.0197[a]
R_{it}+R_{it}*$D2_i$+R_{it}*$D2_i$*P_{it}^{ior}	-0.0089	-0.0084	-0.0036	-0.0038
R_{it}+R_{it}*$D1_i$+R_{it}*$D1_i$*P_{it}^{iot}		0.0024[a]		0.0197[a]
R_{it}+R_{it}*$D2_i$+R_{it}*$D2_i$*P_{it}^{iot}		-0.0084		-0.0038

Note: All regressions include locality-product-destination and time fixed effects and all the interactions of D1 and D2 with the dummy indicating the intermediate inputs. The coefficients of the interaction of R_{it}*$D1_i$ and R_{it}*$D2_i$ with P_{it}^{ior} and P_{it}^{iot} are multiplied by 10,000. Standard errors clustered at the postal code-year level in parentheses. [a] p<0.01, [b] p<0.05, [c] p<0.1

those coming from other countries, P_{it}^{iot}. The idea is that the price of the exported products for the regions within fifteen minutes from the border should be increasing in the price of inputs coming from border countries but not in the price of inputs coming from other countries. The assumption in this exercise is that any omitted variable that can drive both input and export prices affects symmetrically both the treated and control localities (i.e. it is orthogonal to the shock).

Table 15 shows that indeed, the prices of intermediate inputs coming from border countries are positively related to the price and quality of exports for the region within fifteen minutes from the border. At the same time, the prices of inputs coming from other regions are not positively related to the increase in export prices and quality. While the differential effect is small, this is evidence that higher quality inputs are related to the increase in the quality of exported products. Therefore, foreign workers used their knowledge to optimize the upstream part of the global value chains of localities close to the border and induced them to buy better inputs. Better intermediates increased also the quality of the output, thus making Swiss products produced close to the border more intensively used downstream.

These results provide evidence of a new mechanism by which foreign workers can affect trade. Since Gould (1994) papers concentrated on two possible mechanisms: the information channel and the taste channel. The first relates to the trade-relevant infor-

mation that foreigners can provide to host countries in order to export to their origin country. This mechanism is especially binding for trade from developed to developing countries (e.g. Bahar et al., 2019; Olney and Pozzoli, 2018; Parsons and Vézina, 2018), but it is less relevant in a setting where trade is mostly among developed countries. The second highlights the bias of immigrants that prefer to purchase goods from their origin country and thus increase the exports from their origin to their host country. The mechanism that I find in this paper provides evidence that information frictions can be important also among developed countries. Searching for producers of intermediates is costly and acquiring information on the quality of their products is not trivial. Foreign workers can provide this information and help improving the quality of inputs sourced. Better intermediates improve the quality of the output produced using them and makes these products more appealing for international markets. In this sense, the quality improvement led by foreign workers is similar to that of an intermediate products liberalization described in Amiti and Khandelwal (2013). Moreover, my results qualify the taste mechanism in so that they show that part of the bias towards home-country products is due to better information about better quality intermediates. Finally, these results highlight that in a world where global value chains are crucial for producing successful products (e.g. Antràs and Chor, 2013), foreign workers can be crucial to organize them efficiently by providing information on upstream producers and making products more appealing downstream.

5.3 Discussion

I discuss in this subsection potential alternative mechanisms that could explain my results.

- *Compositional changes*

Can the increase in import prices be due to an increase in wages due to the outflow of foreign workers from border countries? In this scenario, we should have observed a consequent decrease in imported quantities from the origin countries of foreign workers and potentially an increase from other origin countries. At the same time, the increase in import prices for goods arriving in border countries should not be related to an increase in quality of exports. My results instead show that both quantities and prices of imports increased and that prices of inputs are positively related to prices and quantities of exports. Therefore, result cannot be driven by an increase in wages of border countries.

- *Constrained firms*

Suppose that due to the immigration restrictions firms were not able to hire enough workers and thus operated at an inefficient scale. In this case, the labor supply shock due to the AFMP could have solved this issue making firms able to hire the necessary workers. This could have led to both more imports and more exports. Under the assumption that a minimum scale is required for producing higher quality, it is also possible to explain higher export quality and, to the extent that higher input quality is needed for increasing the quality of output also the increase in import quality can be a potential mechanism at work. However, my findings clearly point out that the increase in import quality comes from the origin country of the foreign workers and only those inputs are responsible for the increase in the quality of exports. Therefore, a simple explanation based on constrained firms is not enough to rationalize the findings of this paper.

- *Rybczynski effect*

The increase in the supply of highly skilled workers from Europe represents an increase of a factor of production that could have led to more export. Moreover, employing relatively more high-skilled in production could have led to import higher quality inputs (if more high-skilled workers are complementary to higher quality inputs) and to higher quality exports (because products are now more high-skilled intensive). However, similar to the previous point, such explanation would not be able to explain why higher quality inputs came solely from the origin country of the foreign workers and why only those are responsible for the increase in export quality. Therefore, also this mechanism cannot fully explain my empirical results.

- *Swiss emigrants*

If the agreement had led more Swiss workers into Europe, their presence might have facilitated the exports of intermediates of higher quality from European countries to Switzerland, thus causing also the quality and values of Swiss exports to increase. This mechanism would totally be in line with my results, except for two reasons. First, in this case there should have also been an increase in Swiss exports especially towards the hosting countries of Swiss workers. Second, the AFMP had a very asymmetric effect because while it led to an important inflow of EU workers in Switzerland, it did not induce Swiss worker to leave for Europe. More specifically, as shown in in section 3, Swiss emigration patterns remained the same before and after the agreement. Therefore, it is unlikely that this type of mechanism can be the major explanation of my results.

6 Conclusion

In times in which international labor mobility is considered to be a threat for domestic workers and the economy, it is important to highlight what we would loose without it. This paper uses the gradual opening of the Swiss labor market to European citizens to show that high-skilled foreign workers lead to lower information frictions, better products and thus to more trade and a more efficient structure of global value chains. Their increasing presence in Switzerland due to the AFMP helped affected postal codes to find higher quality intermediate inputs from their origin country. Better intermediates affected positively the appealing of produced products and caused export growth. This new mechanism is binding also in contexts in which information frictions should not be substantial, i.e. for trade between developed countries. Therefore, episodes of labor markets jeopardization such as Brexit, can have the unintended consequence of harming the capacity to innovate and exchange goods internationally and thus, of hurting domestic firms and workers.

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Appendix

A Additional Tables and Figures

Figure A-1: Distance in Minutes from the Closest Border Crossing

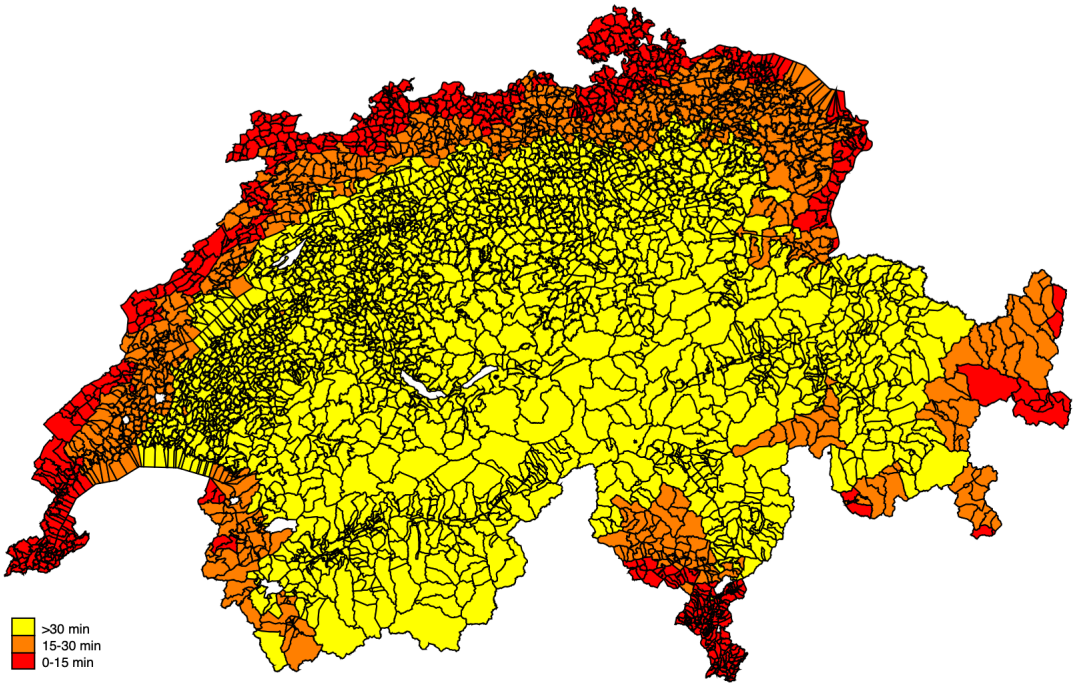

Table A-1: Descriptive Statistics

	Obs	Mean	Std. Dev.	Min	Max
Kg Imports	16,378,801	38,904	2,903,457	0.001	2.42e+09
Value Imports (CHF)	16,378,801	124,403	3,673,972	1,000	3.17e+09
Kg Exports	6,855,255	29,787	810,023	0.001	5.59e+08
Value Exports (CHF)	6,855,255	313,187	5,869,346	1,000	2.13e+09

Table A-2: Number of Swiss Citizens Abroad

	1996-2001	2002-2010
Total	566 904	648 684
Europe	61.7%	62.1%
Africa	3.0%	2.9%
Americas	6.9%	25.6%
Asia	4.1%	5.1%
Oceania	4.3%	4.3%

Source: Swiss Office for National Statistics

Table A-3: Event Study Regression, D1

	Log Exp_{ipct}	Log Q_{ipct}	Log P_{ipct}	Log $\hat{\eta}_{ipct}$
$D1_i * I_t^{1996}$	-0.0211	-0.0204	-0.0008	-0.0061
	(0.033)	(0.033)	(0.012)	(0.014)
$D1_i * I_t^{1997}$	-0.0182	-0.0163	-0.0018	-0.0147
	(0.029)	(0.028)	(0.011)	(0.014)
$D1_i * I_t^{1998}$	-	-	-	-
	-	-	-	-
$D1_i * I_t^{1999}$	-0.0034	-0.0020	-0.0085	
	(0.027)	(0.026)	(0.012)	(0.016)
$D1_i * I_t^{2000}$	-0.0072	0.0035	-0.0106	-0.0243^{c}
	(0.026)	(0.027)	(0.012)	(0.014)
$D1_i * I_t^{2001}$	0.0075	0.0041	0.0034	-0.0077
	(0.026)	(0.026)	(0.010)	(0.014)
$D1_i * I_t^{2002}$	0.0445^{c}	0.0444^{c}	0.0001	0.0012
	(0.024)	(0.026)	(0.010)	(0.012)
$D1_i * I_t^{2003}$	0.0709^{a}	0.0720^{a}	-0.0010	0.0161
	(0.023)	(0.025)	(0.011)	(0.012)
$D1_i * I_t^{2004}$	0.0655^{a}	0.0626^{b}	0.0029	0.0162
	(0.024)	(0.026)	(0.011)	(0.013)
$D1_i * I_t^{2005}$	0.0722^{a}	0.0660^{a}	0.0062	0.0193
	(0.024)	(0.025)	(0.010)	(0.014)
$D1_i * I_t^{2006}$	0.0844^{a}	0.0786^{a}	0.0058	0.0162
	(0.027)	(0.027)	(0.011)	(0.015)
$D1_i * I_t^{2007}$	0.1034^{a}	0.0878^{a}	0.0156	0.0372^{b}
	(0.031)	(0.030)	(0.011)	(0.015)
$D1_i * I_t^{2008}$	0.1030^{a}	0.0909^{a}	0.0121	0.0284^{c}
	(0.035)	(0.034)	(0.012)	(0.017)
$D1_i * I_t^{2009}$	0.1273^{a}	0.1150^{a}	0.0123	0.0299^{c}
	(0.035)	(0.034)	(0.012)	(0.016)
$D1_i * I_t^{2010}$	0.0685	0.0722^{c}	-0.0036	0.0099
	(0.043)	(0.043)	(0.015)	(0.019)
Observations	5,429,361	5,429,361	5,429,361	4,545,135
R^2	0.7538	0.8531	0.9171	0.6349

Note: All regressions include locality-destination-product and year fixed effects. Standard errors clustered at the locality-year level in parenthesis. ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1.

Table A-4: Event Study Regression, D2

	Log Exp_{ipct}	Log Q_{ipct}	Log P_{ipct}	Log $\hat{\eta}_{ipct}$
$D2_i * I_t^{1996}$	-0.0257	-0.0288	0.0031	-0.0055
	(0.022)	(0.024)	(0.010)	(0.013)
$D2_i * I_t^{1997}$	-0.0231	-0.0241	0.0010	-0.0088
	(0.019)	(0.020)	(0.010)	(0.012)
$D2_i * I_t^{1998}$	-	-	-	-
	-	-	-	-
$D2_i * I_t^{1999}$	0.0176	0.0242	-0.0066	0.0063
	(0.017)	(0.019)	(0.009)	(0.011)
$D2_i * I_t^{2000}$	0.0014	0.0172	-0.0159^c	-0.0130
	(0.018)	(0.021)	(0.009)	(0.011)
$D2_i * I_t^{2001}$	0.0013	0.0186	-0.0173^c	-0.0054
	(0.017)	(0.019)	(0.009)	(0.012)
$D2_i * I_t^{2002}$	0.0062	0.0187	-0.0125	-0.0006
	(0.018)	(0.019)	(0.009)	(0.012)
$D2_i * I_t^{2003}$	0.0156	0.0261	-0.0105	0.0048
	(0.017)	(0.019)	(0.009)	(0.012)
$D2_i * I_t^{2004}$	0.0174	0.0360^c	-0.0186^b	-0.0040
	(0.018)	(0.020)	(0.009)	(0.012)
$D2_i * I_t^{2005}$	0.0250	0.0449^b	-0.0199^b	0.0005
	(0.018)	(0.020)	(0.009)	(0.011)
$D2_i * I_t^{2006}$	0.0339^c	0.0591^a	-0.0251^a	-0.0020
	(0.018)	(0.020)	(0.010)	(0.012)
$D2_i * I_t^{2007}$	0.0287	0.0537^a	-0.0250^a	-0.0005
	(0.019)	(0.021)	(0.010)	(0.012)
$D2_i * I_t^{2008}$	0.0267	0.0467^b	-0.0200^c	-0.0035
	(0.021)	(0.022)	(0.011)	(0.014)
$D2_i * I_t^{2009}$	0.0221	0.0411^c	-0.0190^c	-0.0077
	(0.021)	(0.023)	(0.011)	(0.013)
$D2_i * I_t^{2010}$	-0.0087	0.0120	-0.0207	-0.0162
	(0.027)	(0.029)	(0.013)	(0.016)
Observations	5,429,361	5,429,361	5,429,361	4,545,135
R^2	0.7538	0.8531	0.9171	0.6349

Note: All regressions include locality-destination-product and year fixed effects. Standard errors clustered at the locality-year level in parenthesis. ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1.

Table A-5: Products involved in concurrent agreements

HS 2-digit code	**Name**
30	Pharmaceutical products
84	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof
85	Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles
87	Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof
90	Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; parts and accessories thereof
95	Toys, games and sports requisites; parts and accessories thereof