Author's Accepted Manuscript

Exchange rate effects on cross-border commuting: Evidence from the Swiss-Italian border

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Acknowledgments

This is a pre-copyedited, author-produced version of an article accepted for publication in Journal of Economic Geography following peer review. The version of record P. Bello Journal of Economic Geography, Volume 20, Issue 4, July 2020, Pages 969–1001 is available online at: https://academic.oup.com/joeg/article-abstract/20/4/969/5573250?redirectedFrom=fulltext, *https://doi.org/10.1093/jeg/lbz025*

This work was supported by the Swiss National Science Foundation (grant Early Postdoc. Mobility -171885). Usual disclaimers apply.

Abstract

Are cross-border workers responsive to changes in the exchange rate between the home and host countries' currencies? I answer this question by examining the effects of appreciation in the Swiss franc (CHF) relative to the euro (EUR) on labour supply decisions of Italian cross-border workers. I use hourly data on traffic flows in Ticino, the southernmost canton of Switzerland, together with three additional datasets (the Cross-border Commuter Statistics, the Swiss Earnings Structure Survey, and Google trend data). The results show that a 10% appreciation in the CHF increases the number of cars along the Swiss-Italian border by 1.6-2.7% more than in the rest of the canton. This effect is found only during specific time intervals, which differ according to the direction of traffic flow; specifically, from Italy to Switzerland in early morning, from Switzerland to Italy in the afternoon, and in both directions in late morning. Moreover, when the CHF is stronger, more people from Italy look for jobs in Ticino, and the number of cross-border workers increases in municipalities within a driving distance of up to 10 km from the border. Finally, additional evidence suggests that cross-border workers also react to the appreciation by increasing their number of hours worked.

Keywords: geographic labour mobility, traffic flows, labour supply

JEL: J61, R41, J22

1. Introduction

While considerable attention has been paid to different kinds of long-term migration, few studies have analysed the determinants of short-term travel. This study intends to contribute to the relevant literature by looking at the effects of exchange rate movements on a new form of mobility: cross-border commuting.

Cross-border commuting is a form of migration that is not accompanied by a change of home or home-country (Tassinopoulos and Werner, 1999), it is periodic (Kondoh, 1999), and it occurs within smaller areas.[1] The decision to commute compared to long-term migration is thus associated with a much lower cost, while still offering the benefits of migration.

Many studies in the migration literature have analysed factors affecting mobility patterns, such as wage differentials, unemployment rates and social security benefits (Todaro, 1969, Dustmann, 2003; Heitmueller, 2005; De Giorgi and Pellizzari, 2009; Fiva, 2009). However, there are very few studies looking specifically at the effects of exchange rate volatility (Nekoei, 2013; Nguyen and Duncan, 2017) and none of them focuses on cross-border commuting.

In this study, I exploit variation in traffic flows across municipalities in Ticino, the southernmost canton of Switzerland, together with three addition datasets, the Cross-border Commuter Statistics, the Swiss Earnings Structure Survey, and Google trends data, in order to analyse the responsiveness of cross-border commuters to changes in the exchange rate that increase the purchasing power of host country wages in their home country. Specifically, I examine the 2005-2015 period, which was characterised by a significant appreciation in the EUR/CHF exchange rate. During the euro crisis, the CHF soared by almost 20% in value against the EUR, with the rise being halted in November 2011 with the introduction of a minimum exchange rate of CHF 1.20 per EUR by the Swiss National Bank (SNB). In January 2015, the CHF appreciated even more sharply when the SNB decided to decouple the franc. From 2005 to 2015 the CHF increased in value by roughly 30%.

[1] The term periodic refers to the fact that cross-border workers usually return home daily or at least one per week.

The main findings of this paper are as follows. First, I show that the appreciation in the Swiss franc produces an increase in traffic flows, in Ticino, near the Swiss-Italian border. In particular, a 10% appreciation in the CHF is associated with an increase of 1.6--2.7% in the number of cars along the border. Interestingly, I observe that the vehicle flow across the border is affected by the exchange rate only during specific hours, which differ according to the direction of the flow: the flow toward Ticino is affected only in early or late morning, while the flow from Ticino to Italy is affected during late morning and the afternoon. These temporal and traffic direction patterns point to the role of cross-border shopping and commuting in explaining this effect. Second, I show that there is a positive relationship between the intensity of Google searches from Lombardy[2] for a job in Ticino and the value of the CHF against the EUR. Third, I find that the number of cross-border workers in Swiss municipalities close to the Swiss--Italian border is positively correlated with the EUR/CHF exchange rate. In particular, a 10% appreciation in the Swiss franc increases the employment of cross-border workers by 2.5% in municipalities within a driving distance of up to 10 km from the border. Lastly, I provide evidence suggesting that cross-border workers also react to the monetary shock through the intensive margin. Specifically, I show that the number of hours worked increases more for cross-border workers than for natives when the Swiss franc appreciates. The estimated elasticity for hourly employees is equal to 1.1. All results are robust to using the Swiss/Italian wage ratio as the main explanatory variable instead of the EUR/CHF exchange rate.

This paper is related to some recent studies that look at cross-border commuting as another form of spatial labour mobility, as distinct from long-term migration (Dustmann et al., 2017; Beerli et al., 2018). In particular, Beerli et al. (2018) focus on Switzerland and analyse the effect of opening the border to cross-border workers on labour market outcomes and firm performance. They exploit the timing of the implementation of the Agreement on the Free Movement of Persons (AFMP), between the EU and Switzerland, which occurred in discrete steps between 1999 and 2007. They find that, between 1999 and 2010, opening the border to

[2] Lombardy is one of the two northern Italian regions bordering Ticino.

cross-border workers produced an increase of foreign workers equal to 10 percentage points of the 1998 total employment in municipalities within 15 minutes travel time to the border. This increase is mostly attributable to the inflow of cross-border workers. Unlike Beerli et al. (2018), this paper looks at what happened between 2010 and 2015, after the monetary shock, when the effects of the agreement are expected to be vanished. While the effects of pull factors are not taken into account in the above-mentioned study, this paper focuses on the role of appreciation in the Swiss franc in explaining the rise of cross-border workers in Switzerland. Certainly, the liberalization of the Swiss labour market allowed cross-border workers to react fully to EUR/CHF exchange rate movements. The findings of this study are thus interesting and informative when compared to those in Beerli et al. (2018).

This paper is structured as follows. Section 2 presents the background and motivation. Section 3 describes the data. Section 4 presents the identification strategy and the results regarding traffic flows. Section 5 provides supporting evidence by using Google Trends data and official statistics on cross-border workers. Section 6 analyses the intensive labour supply response of cross-border workers. Finally, Section 7 and 8, respectively, discuss the results and conclude.

2. Background and motivation

2.1. Exchange rate movements, migration and labour supply

An individual migrates if the expected real wage or income differential between the host and home country exceeds the cost of migration[3] (Todaro, 1969; Harris and Todaro, 1970; Dustmann, 2003).[4] Moreover, for immigrants who want to transfer money home, or plan to return to their home country at some point in the future, the exchange rate, by affecting the purchasing power of wages in their home countries, represents another important determinant of their migration and labour supply decisions. Hanson and Spilimbergo (1999) focusing on

[3] The cost of migration includes non-financial costs, such as psychological costs (e.g., separation from the home culture) or the risks of migration (e.g., costs associated with finding work and/or accommodation) (Carrington et al. 1996)

[4] High levels of unemployment at home relative to the host country (Bauer and Zimmermann, 1999) and access to social security benefits (Heitmueller, 2005; De Giorgi and Pellizzari, 2009; Fiva, 2009) are two further major factors that drive migration.

the US, in fact, show that the number of illegal Mexican immigrants (as estimated by the number of border crossing apprehensions) increases as the purchasing power of US wages in Mexican pesos increases.

While the effects of foreign currency appreciation on the extensive labour supply response of immigrants is more predictable, the sign of the intensive labour supply response is *a priori* ambiguous and depends on whether the substitution effect predominates the income effect or *vice versa*. For instance, Nekoei (2013), using data on Mexican immigrants to the United States, shows that US dollar appreciation, by decreasing the price of remittances, pushes immigrants to cut their annual hours worked. However, Nguyen and Duncan (2017) show that in Australia, a negative relationship between the exchange rate and the labour supply exists only for male immigrants, while female immigrants do not adjust their labour activity in response to exchange rate movements.

Cross-border workers differ from long-term immigrants as they work in a different country from the one where they live, crossing the border every day or at least one per week. Theoretically, they can spend most or all their income in their home country. Kondoh, (1999), specifically, defines cross-border commuting as a case of migration with complete repatriation of income. In this extreme case, the utility function of cross-border workers is defined depending only on their host country wage, the nominal exchange rate between the host country and home country, the price level in the home country, and the cost of commuting. Therefore, commuting and labour supply decisions of cross-border workers are expected to be strongly affected by exchange rate movements. Nevertheless, to my knowledge, there are no studies that explicitly analyse the effects of exchange-rate fluctuations on the labour supply of cross-border workers.

2.2 The free movement policy and the labour market in Ticino

The extent to which the exchange rate can affect mobility across the Swiss-Italian border depends on the level of integration between the labour markets of the two countries.

Since 1999, when the Swiss electorate rejected the opportunity to join the European Economic Area, the economic and political relations between Switzerland and Italy have been pursued on a bilateral basis. The first set of agreements, the Bilateral Agreement I, was signed in 1999, and included, among others, the agreement of the Free Movement of Persons. This agreement made Swiss and Euro-area citizens free to choose their place of work and place of domicile inside the boundaries of the contracting parties. The agreement was gradually implemented, with three distinct phases identified: partial liberalization (1999-2004), full liberalization for cross-border workers (2004-2007), and full liberalization for cross-border workers and EU immigrants (post-2007). Before 1999, Swiss employers had to adhere to work permit quotas or give preference to Swiss nationals during the recruitment process. Moreover, workers with a cross-border work permit were allowed to work only in the Border Region (BR) of Switzerland, had to have resided in the adjacent BR of the neighbouring countries for the previous six months, and were obliged to commute on a daily basis.[5] From 1999 to 2004, these constraints were gradually eased; foreign workers were not required to have resided in the neighbouring BR for the previous six months and could decide to commute weekly instead of daily. Moreover, in 2004, a first step toward labour market liberalization took place when cross-border workers gained full access to the labour market in the BR and firms were allowed to hire cross-border workers under the same conditions as resident workers. However, they still had no access to other regions of Switzerland until 2007, when the labour market was fully opened to both cross-border workers and resident immigrants.

According to SECO (2017), in Switzerland, a net immigration level of 65.500 people was registered during the years following the implementation of the agreement. Beerli (2018) analyse, specifically, the response of the employment of immigrants to the labour market liberalization and show that their labour supply increased by about 10 percentage points in

[5] The Border Region, both in Switzerland and in Italy, was composed of those municipalities whose territory fell totally or partially within a distance of 20 km from the border.

municipalities within 0-15 minutes from the border and that two-thirds of this increase is attributed to the inflow of cross-border workers.

SECO (2017) points out how, in addition to the agreement, Switzerland's generally favourable economic condition in those years explains the strong and positive migration flows. However, the relative proportion of each country of origin to total immigration has changed according to the economic evolution within the European Union (EU) zone. In fact, while during first years following the free movement of persons, the vast majority of immigrants came from north and north-western Europe (mainly from Germany) and to a lesser extent from southern Europe, during the financial and economic crisis the net migration of Germany began to decline gradually while immigration flows from Southern Europe increased sharply.

Moreover, SECO (2017) underlines how the appreciation of the Swiss currency resulting from the euro crisis, led a specific type of worker, the cross-border worker, to benefit from an increase in the domestic value of their wages by 5% on annual average (or 30% in cumulative terms) between 2009 and 2015. This exchange advantage was only partly offset by a higher annual inflation rate in the neighbouring countries, specifically, 1.4% in Italy, 1.2% in France and 1.1% in Germany.

In Ticino, in total, there are more than 60,000 cross-border workers coming from Italy. Table 1 shows the composition of commuters by country and the Italian province of provenience. More than 80% of cross-border workers consist of people coming from the two closest Italian provinces, Varese and Como.

[Table 1 about here]

3. Data

The main dataset consists of data on road traffic flows. The data source is the Sezione Mobilità del Canton Ticino, which provides data on traffic flows in Ticino using information obtained from 60 automatic traffic-counting stations. These traffic-counting stations located along the main roads of the canton record all traffic movement in terms of direction and time

every day. I collected data from these stations for the years 2005--2015. The data consists of vehicle counts crossing a specific traffic-counting station at a certain time of the day and on a certain day of the year, for each direction of travel.

Moreover, I rely on three additional datasets. The first is the Swiss Earnings Structure Survey, which is conducted every two years in enterprises in Switzerland.[6] The survey includes information on the nationality, place of work (macro-region), education level, wage, hours worked and other individual characteristics of a random sample of workers. The other two consist, respectively, of search volume data derived from Google Trends and Cross-Border Commuter Statistics.[7] The latter contains quarterly information on the number of foreign cross-border commuters working in Switzerland and their main characteristics.

Finally, I obtained daily data on the EUR--CHF exchange rate from the Swiss National Bank (SNB) and collected data on the annual average wage at current prices in Switzerland and in Italy from the Organisation for Economic Cooperation and Development (OECD) website.

4 Identification and the results on traffic flows

4.1 Identification

My identification strategy relies on geographical variation in the location of traffic-counting stations. To analyse the impact of the CHF appreciation on cross-border mobility, I identify traffic-counting stations in municipalities located within a driving distance up to 10 km from the border (CLOSE), and compare them to other stations, located further away from the border (FAR). Figure 1 shows the location of the traffic-counting stations. To ensure that long-distance goods-transport traffic flows are not included in the analysis, I disregard all traffic-counting stations located on highways. Stations not active over the entire period of analysis are similarly excluded. Thus, I obtain an unbalanced panel of 25 traffic-counting stations, with 11 located within 10 km from the border.

[Figure 1 about here]

[6] For this dataset I have biennial data from 2004 to 2012.

[7] For these two datasets I have data for the 2005-2015 period.

The distribution of traffic counting stations based on their distance from the border is presented in Figure 2.

[Figure 2 about here]

The assumption is that the traffic flows along the border are those mostly affected by cross-border travel, while changes in trade traffic flows due to appreciation in the Swiss franc pertain to both groups of traffic-counting stations. Thus, by exploiting the geographical variation in traffic flows, I am able to disentangle the impact of monetary shocks on mobility due to the increase in both cross-border commuting and cross-border shopping from other kinds of exchange rate effects on traffic. In addition, by looking at the time of day and traffic-flow direction, I can distinguish flows related to cross-border shopping from those related to cross-border labour supply.

As in Kaiser and Siegenthaler (2016), I claim that CHF exchange-rate fluctuations act as exogenous shocks on the Swiss economy, given the special status of this currency.[8]

4.2 Descriptive statistics

Figure 3 presents the evolution of the EUR--CHF exchange rate, from 2005 through to 2015. During the financial turmoil of 2008, the CHF gained appreciably, since investors started depositing their money in CHF. In the midst of the Eurozone crisis, the value of the CHF soared –so much so that the SNB decided to provide support for the EUR by printing new CHF notes and using them to buy EUR. On 6 September 2011, the SNB introduced a minimum EUR-CHF exchange rate of CHF 1.20; the hope in doing so was to bring down the value of the CHF and help the country maintain its price competitiveness in the export market. Then, in January 2015, the SNB announced that it would no longer hold the CHF at a fixed exchange rate with the EUR, and thus removed the floor. The value of EUR 1 fell to just CHF 0.85. This happened ahead of the move by the European Central Bank (ECB), among other things, to buy up huge amounts of state bonds. In so doing, the SNB managed to protect

[8] The CHF is considered a `safe haven' asset: when financial markets are in turmoil, investors from different parts of the world flock to the CHF, and its value surges dramatically.

the Swiss economy from further volatility and upward pressure on the CHF. Moreover, the figure shows that this appreciation translated to an increase in the value of Swiss wages in euro terms. The ratio between the value of Swiss wages (in euros) and Italian wages increases by the same size of the appreciation.[9]

[Figure 3 about here]

Before turning to direct estimation of the effects, it would be interesting to look at the raw traffic data to appreciate the relevant differences in the traffic flow patterns between the two groups of stations, and to establish that, in terms of traffic flow, appreciation of the Swiss franc matters. Figures 4 and 5 display the hourly distribution of the average number of vehicles in the traffic counting stations close to the border (CLOSE) and in those further from the border (FAR). Figures 4 (a) and (b) show the two distributions during working days (Monday-Friday), while Figures 5 (a) and (b) analyse traffic flows during nonworking days (Saturday and Sunday). Two driving directions are analysed (i.e. north-to-south, and south-to-north). The traffic flows in CLOSE municipalities on working days are clearly affected by cross-border workers who commute on a daily basis, and who enter Switzerland in the morning and return to Italy in the afternoon. For the other group, the two distributions are instead closely aligned, showing that traffic flows in areas further from the border are not related to cross-border workers. Differences between the two groups of traffic-counting stations are found also on nonworking days: while the two distributions overlap for the second group of stations, they remain staggered for those located close to the border.

[Figure 4 about here]

[Figure 5 about here]

Evidence of similar patterns is provided in Table 2, which reports, for each group of traffic-counting stations, the average number of vehicles per hour in five time intervals, which are 5am--9am, 10am--1pm, 2pm--8pm, 9pm--11pm, and 12am--4am.

[Table 2 about here]

[9] The ratio is computed using annual wages at current prices.

Finally, Figures 6 and 7 show the correlation between the average number of vehicles per hour and the exchange rate, by showing the time patterns in trips for the two directions. A clear surge is seen in traffic flows after the currency began to appreciate in 2009, for the first group of stations (CLOSE) in both graphs; meanwhile, the flows seem to remain constant over time among the remaining traffic counting stations (FAR).

[Figure 6 about here]

[Figure 7 about here]

4.3 Empirical strategy

To analyse the effects of the exchange rate on cross-border mobility, the empirical strategy entails comparing the elasticity of crossings with regard to the exchange rate between the two groups: the group of stations located within 10 km from the border and the rest of them.[10] I aggregate the daily traffic flow data on a monthly basis. I preserve the hourly structure of the dataset and distinguish working days from nonworking days. Moreover, I divide the daily hours into five time intervals and utilize the two driving directions separately.

I estimate the following regression:

$$n_{ihmy} = \alpha + \eta_1 \ln e_{my} + \eta_2 \ln e_{my} * CLOSE_i + \eta_3 X_{my} + \eta_4 Post2007_y + f_i + m_m + \varepsilon_{ihmy}$$

where n_{ihmy} is the log of the average number of cars crossing a traffic-counting station i at hour h, month m and year y.

Variable $ln\ e_{my}$ represents the log of the EUR-CHF nominal exchange rate, whereas $CLOSE_i$ is a dummy variable that has value of 1 only for those traffic-counting stations located within 10 km of the border and zero otherwise. $ln\ e_{my} * CLOSE_i$ is the interaction term between the dummy and the exchange rate, and it measures the effect of interest. f_i are traffic-counting station fixed effects, which account for differences across municipalities, and m_m are month fixed effects, which control for strong seasonality in trips; X_{my} is a vector of control variables: the log of the Swiss gross domestic product (GDP), the log of the Italian GDP, and the log of

[10] I check the robustness of my results using alternative distance cut-offs (5, 8, and 12 km). See Section 4.4.

the unemployment rate in Lombardy.[11] Finally, $Post2007_y$ is a dummy for the period after the full liberalization of the Swiss labour market, which was implemented in 2007.

I estimate this equation separately for working days and nonworking days, for each travel direction, and for the five time intervals, i.e. 5am--9am, 10am--1pm, 2pm--8pm, 9pm--11pm, 12am--4am.

Moreover, in order to check the robustness of my results, I replicate my analysis using the log of the relative nominal wages expressed in euros (w_{CH}/w_{IT}) instead of the EUR--CHF nominal exchange rate. This time the observations are aggregated at the annual level.[12]

4.4 Results regarding traffic flows

The results are presented in Table 3. Traffic flow from Italy to Switzerland (namely, from south to north) is analysed in Panel 1, and that from Switzerland to Italy (from north to south) is analysed in Panel 2. For any temporal interval, there are two columns, one for working days, and another for nonworking days.

The results in Columns 1 and 2 show that the traffic flows from Italy to Switzerland during the first time interval (5am--9am) near the border increase more over time compared to those in the rest of Ticino. A 10% appreciation in the CHF seems to increase the number of cars along the Swiss-Italian border in early morning by 2.7% more than in the rest of the canton.

The results suggest that Italian workers responded to exchange-rate variations by increasing their labour supply in Switzerland.[13] In line with this hypothesis, I find that the interaction term is negative and statistically significant also in Column 5 of Panel 2, which speaks to the traffic flows from Switzerland to Italy during 2pm--8pm, when, presumably, cross-border workers are returning to Italy. Conversely, the interaction terms in Columns 1--2 of Panel 2 and 5--6 of Panel 1 are never statistically significant; this suggests that, instead, the labour

[11] For the Swiss GDP, the Italian GDP, and the unemployment rate, I use quarterly data. As a robustness check, I also run the regression using the regional GDP of Lombardy instead of the Italian GDP, and the Italian unemployment rate instead of the unemployment rate in Lombardy. The results are found to be robust to this new specification.

[12] Consistent wage data for the two countries exist only on an annual basis. I use the exchange rate in my main specification as endogeneity concerns may arise using the wage ratio. Moreover, by using monthly data regarding the exchange rate instead of wage annual data I am allowed to exploit much more variation existing in the data.

[13] Specifically, the effect for nonworking days (column 2) can be driven by cross-border workers who work in the retail or hotel/restaurant sector.

force commuting from Switzerland to Italy is not affected by the monetary shocks. Columns 3-4 of Panels 1 and 2 refer to the second time interval (10am--1pm). The interaction terms remain negative and statistically significant in both panels. The estimated effect for this time interval is 0.16-0.18%. A cross-border shopping hypothesis can explain these results: the stronger the CHF, the larger the number of trips by Swiss consumers to the less-expensive Italian shops.[14] Moreover, Table 4 presents the results for night-time traffic flows. It seems that border crossings made during the night do not adjust in response to exchange rate fluctuations. The coefficient of the interaction term is never statistically significant, with only one exception, in Column 2 of Panel 1, where the coefficient is positive.[15][16]

[Table 3 about here]

[Table 4 about here]

Finally, the estimates obtained using the relative wages instead of the exchange rate are shown in Table B.1 and in Table B.2. The coefficients of the interaction terms appear even stronger. In particular, a 10% increase in the annual wage ratio between Switzerland and Italy leads to a 4% increase in the number of cars crossing the Swiss--Italian border in early morning (column 1, Table B.1)

5. Robustness checks

5.1 Official statistics on cross-border workers

In the previous section, I showed that early morning traffic flows from Italy to Switzerland, and afternoon traffic flows from Switzerland to Italy, are affected by the exchange rate. These differences across hours and directions point to the role of cross-border labour supply in explaining the exchange rate effect on traffic flows. The appreciation of the CHF against the EUR, thereby increasing the value of Swiss wages relative to the EUR wages, induces more

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14 Moreover, this increase might also reflect part-time cross-border workers travelling back home.

15 A reduction in cross-border demand for commercial sex in Ticino because of the stronger CHF could explain this result.

16 Similar results are obtained using 5, 8 and 12 km as alternative distance cut-off point. In the case of a threshold equal to 5, the control group consists of traffic counting stations located at least at 10 km from the border. The results are available upon request.

Italian workers to cross the border to work in Switzerland. To provide additional supporting evidence for this hypothesis, I use official statistics on commuters in Ticino, to show that the number of cross-border workers in municipalities close to the border is strongly affected by the value of the CHF. I use driving distance to determine the distance between each municipality and the closest border post and then distinguish those municipalities exposed to the shock according to alternative distance cut-offs (5, 10, 15, or 20 km). Table 5 shows the average number of cross-border workers across groups of municipalities.

[Table 5 about here]

Then, I estimate the following equation.

$$s_{iqy} = \alpha + \eta_1 \ln e_{qy} + \eta_2 X_{qy} + \eta_3 \mathrm{t} + \eta_4 t^2 + \eta_5 Post2007_y + f_i + q_q + \varepsilon_{iqy}$$

where s_{iqy} denotes the log of the number of cross-border workers in municipality i in quarter q and year y The variable $ln\ e_{qy}$ represents the log of the EUR-CHF exchange rate, and f_i and q_q are, respectively, municipal fixed effects and quarter fixed effects. X_{qy} is a vector of control variables, and includes the log of the Swiss GDP, the log of the Italian GDP, and the log of the unemployment rate in Lombardy. Moreover, I add a dummy for the period after 2007, a linear and quadratic time trend and indicate them with $Post2007_y$, t, t^2, respectively.

Table 6 presents the results of the estimation. In line with the previous analysis, the nominal exchange rate seems to affect the number of cross-border workers in municipalities within a driving distance up to 10 km from the border. The supply of cross-border workers increases by 2.5% in response to a 10% appreciation in the CHF.

[Table 6 about here]

In Table B.3 I show the estimates obtained using the wage ratio instead of the exchange rate as the main explanatory variable. The magnitude of the coefficient of the variable of interest appears, again, even larger.

5.2 Google Trends data

Does the increase in cross-border workers reflect changes in the labour supply, rather than in labour demand? To answer this question, I look for evidence in Google Trends search volume data. I test whether people in Lombardy increased their job hunting in Ticino when the CHF

appreciated, compared to the previous period — in other words, in response to the economic incentives created by appreciation in the Swiss franc.[17]

Google has started to provide access to aggregated information on the volume of queries for different search terms, and on how these volumes change over time, via the publicly available service Google Trends. This facility shows how often a particular search-term is entered, relative to the total search volume for a given region and time.

The aim of this section, therefore, is to demonstrate that a link exists between the volume of job-related searches from Lombardy for positions in Ticino, and the EUR--CHF exchange rate. I collect data for three different queries: `Offerte lavoro in Ticino' (`Job Vacancies in Ticino'), and `Offerte lavoro in Lombardia' (`Job Vacancies in Lombardy'), `Cambio Euro Franco Svizzero' (`Euro Swiss Franc exchange rate'). I focus exclusively on data from Lombardy.

Before turning to the direct estimation, in Figure 8, I plot the volume of searches for the query `Offerte lavoro in Ticino' (`Job Vacancies in Ticino') and for the query `Cambio Euro Franco Svizzero' (`Euro Swiss Franc exchange rate') over time, along with the value of the EUR/CHF exchange rate. The figure clearly shows how the volumes of both queries increase in correspondence with the beginning of Swiss franc appreciation. Moreover, the volume of the query "Job vacancies in Ticino" is quite high also in 2005, the year after the full liberalization of the Swiss labour market for cross-border workers. This represents an evidence of the explanatory power of the Google Trends data.

[Figure 8 about here]

I use this data set to test my hypothesis: while people resident in Lombardy intensify their searches for a job in Ticino under the influence of monetary shocks, the exchange rate does not affect the intensity with which people look for a job in their own region. A comparison of the two trends allows me to disentangle the effects of the exchange rate from other factors that could affect the labour supply of Italian workers.

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[17] Piedmont is the other Italian region bordering Ticino. However, I focus only on Lombardy as the volume of Google search data for Piedmont is low.

$$s_{imy} = \alpha + \eta_0 Ticino_i + \eta_1 \ln e_{my} + \eta_2 \ln e_{my} * Ticino_i + \eta_3 X_{my} + \eta_4 Post2007_y + m_m + \varepsilon_{imy}$$

where s_{imy} denotes the volume of searches carried out on Google in Lombardy for query i in month m and year y relative to the total number of searches carried out during the 2005--2015 period.[18] The variable $ln\ e_{my}$ represents the log of the EUR--CHF exchange rate, whereas $Ticino_i$ is a dummy equal to 1 for Ticino-related searches, and 0 otherwise. $ln\ e_{my} * Ticino_i$ is the interaction term between the dummy and the log of the exchange rate; X_{my}, meanwhile, is a vector of control variables, which includes the log of the Swiss GDP, the log of the Italian GDP, and the log of the unemployment rate in Lombardy. Also included are month fixed effects and a dummy for the period after 2007, which are indicated with m_m and $Post2007_y$, respectively.

Table 7 reports the results. Columns 1 and 2 estimate the equation without the interaction term, so as to analyse solely the trend in the search volume of the two different queries, `Job Vacancies in Ticino' and `Job Vacancies in Lombardy', respectively. As the coefficient on the term $ln\ e_{my}$ in Column 1 is significant and negative, no statistically significant effect of the exchange rate emerges in Column 2. This result is robust to the use of the full model.

The coefficient on the interaction term in Column 3 is in fact negative and statistically significant. This suggests that the appreciation of the Swiss franc leads to an increase in the volume of searches made in Lombardy for a job in Ticino, while it does not affect the volume of searches for a job in Lombardy.

[Table 7 about here]

The evidence presented supports the hypothesis that Italian workers increase their labour supply in Ticino in response to a stronger CHF and confirms the role of cross-border commuters in explaining the surge in traffic flows at the border during CHF appreciation phases. I replicate the analysis using the wage ratio as the main explanatory variable, as in the previous sections. The results are presented in Table B.4 and appear quite similar.

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[18] A value of 100 for a term indicates that term's peak popularity; a value of 50 means that the term is half as popular. Likewise, a score of 0 means that the term is less than 1% as popular as the peak term.

6. Intensive labour supply response

So far, I have provided evidence for an extensive labour supply response of cross-border workers to changes in the EUR/CH exchange rate. In this section, I investigate whether they react also along the intensive margin, namely, by increasing their number of hours worked. To do this, I use data from the Swiss Earnings Structure Survey (SESS). The dataset lacks a municipality identifier, so I use data on the entire Ticino canton for my analysis.[19] Descriptive statistics are shown in Table 8. I distinguish hourly employees from salary workers. For salaried workers, the survey provides the number of hours worked per week, while for hourly employees, the information refers to the total number of hours worked per month.[20]

[Table 8 about here]

In order to investigate the intensive labour supply response of cross-border workers, I compare the sensitivity of hours worked to changes in the exchange rate, between Swiss resident and cross-border workers, separately, for salaried workers and hourly employees.

I estimate the following model:

$$n_{iy} = \alpha + \eta_0 CBW_i + \eta_1 \ln e_y + \eta_2 \ln e_y * CBW_i + \eta_3 Y_{iy} + \eta_4 X_y + \eta_5 Post2007_y + \varepsilon_{iy}$$

where n_{iy} is the log of the monthly (weekly) number of hours worked by the worker i interviewed in year y.[21] Variable $ln\ e_y$ represents the log of the EUR--CHF nominal exchange rate, whereas CBW_i is a dummy for cross-border workers. $ln\ e_y{*}CBW_i$ is the interaction term between the dummy and the log of the exchange rate. Moreover, Y_{iy} is a vector of individual control variables: age, sex and education level of the worker, and sector of the firm. Finally, as in the previous sections, I control for the log of the Swiss GDP, the log of the Italian GDP, and the log of Lombardy's unemployment rate (X_y) and include a dummy for the period after 2007 ($Post2007_y$).

[19] While some authors of previous studies have this information, the OFS has changed its policy in recent years and the variable regarding the municipality is no longer available.

[20] The table shows that cross-border workers paid on an hourly basis represent 20% of the total number of cross-border workers in the sample.

[21] Specifically, the survey is conducted on a biennial basis (2004-2012).

The results, which are reported in Table 9, show that cross-border workers paid on an hourly basis respond strongly to the Swiss franc appreciation. Specifically, the average number of hours worked increases by 11% more for cross-border workers than for natives when the Swiss franc appreciates by 10%. The coefficient of the interaction term in the column regarding salaried workers is also significant but closer to 0. The Table B.5 shows the results for the same analysis conducted using the wage ratio instead of the exchange rate. The results appear similar in sign and in magnitude.

[Table 9 about here]

7. Discussion

In the previous sections, I showed that cross-border workers increased their labour supply in response to exchange rate movements. However, since the introduction of the free movement of persons between Europe and Switzerland took place some years before appreciation of the Swiss franc, it may raise the concern that my results are driven by a gradual response to this policy change. In this section, I discuss why this is not likely to be the case.

The first step of the liberalization for cross-border workers was enacted in 2002, when cross-border workers were no longer required to have resided in the BR for the previous six months and were allowed to commute weekly rather than daily. Then, in 2004, when the second step of the reform took place, employers in BR municipalities were allowed to hire cross-border workers under the same conditions as Swiss residents, though cross-border workers were still not allowed to work in municipalities not included in the border region (NBR)(Beerli et al., 2018). Finally, in 2007, the residence requirement and the distinction between the BR and NBR in Italy and Switzerland were completely removed, and cross-border workers as well as other migrants were allowed to work anywhere in Switzerland (Losa et al., 2012; SECO, 2017).

The first concern might be that my results are driven by the increase in the Italian population that is "eligible" as cross-border workers following the removal of the residence requirement in 2007. I address this concern as follows.

First, in Table 1, I present the share of cross-border workers by Italian province of origin.[22] The Italian municipalities included in the BR (defined until 2007) were those located within 20 km of the border. The BR included almost all the municipalities in the province of Como, around 90% of the municipalities in the province of Varese, 80% of the municipalities of the province of Verbanio-Cusio-Ossola, and 30% of the municipalities of the province of Lecco.[23] The table shows that, even in 2015, the number of cross-border workers from provinces that were not included in the BR represented a small percentage of the total number of cross-border workers. One reason for such a low response might be the different tax treatment that has remained in place even after 2007 between the two groups of Italian provinces. In fact, while people from municipalities within 20 km from the border still benefit in Italy from a special tax treatment that allows them to pay taxes only in Switzerland, cross-border workers resident in other provinces are taxed in Italy.[24] Given the huge differences in tax rates between the two countries, it is likely that after 2007, people from the second group of provinces, who were willing to work in Switzerland, decided to apply for a residence permit rather than a cross-border commuter permit and to move their residence to the foreign country.

Second, in Table A.1, I report the growth rate of the number of cross-border workers coming from the province of Como (almost all of whose municipalities were included in the BR) and that regarding cross-border workers coming from "other Italian provinces"[25] (all of whose municipalities were not included in the BR). The table clearly shows how the number of workers coming from the province of Como grew at a higher rate after the beginning of the appreciation, that is, after 2010. The growth rate in the number of people coming from "other" Italian provinces instead decreased after an initial jump.

Third, I claim that this policy change might even have contributed to reducing my estimation of the exchange rate effect on the labour supply of cross-border workers. In my empirical

[22] These data are only available at the aggregation level shown in the table.
[23] Municipalities of the province of Sondrio were included in the Border Region of Grigioni, but not in that of Ticino. Source: https://www.ocst.ch/imposte-alla-fonte/comuni-di-frontiera
[24] For details, see http://www.europarl.europa.eu/workingpapers/soci/w16/summary_en.htm
[25] "Other Italian provinces" includes all Italian provinces except Como, Lecco, Sondrio, Varese, Verbanio-Cussola-Ossola.

strategy, I compare municipalities within 10 km from the border to municipalities located farther away from the border. My results might be downward biased, as this additional level of liberalization allows cross-border workers to work everywhere in Switzerland.[26]

The second concern might be that, since the six months requirement was no longer valid after 2002, people from other parts of Italy moved to Italian provinces at the border to work as cross-border workers. To deal with this point, I collected data on the number of inhabitants at the province level in Lombardy and Piedmont, the two Italian provinces bordering Ticino, and using a year-by-year analysis, I check that, since 2002, the number of residents in Italian provinces included in the BR has not increased in a manner different from that in other provinces. The results shown in Table A.2 confirm that the two groups experienced similar dynamics.

The last concern might be that I am capturing the effect of the full liberalization of the Swiss labour market to cross-border workers implemented in 2004. Since the appreciation of the Swiss franc started in 2008-2010, it seems unlikely that I am confounding the two effects. However, to remove any concern related to the introduction of the bilateral agreement, by using the traffic flows data, I run a regression similar to my main specification in which I replace the exchange rate with year dummies. Figure A.1 shows the plot of the coefficients of year dummies interacting with the CLOSE dummy.[27] The figure shows that the coefficients regarding the period before 2009 are almost not statistically significant, with the exception of 2008. The coefficient becomes statistically significant and increases in magnitude in correspondence with appreciation of the Swiss franc. This graph appears similar to Figure 8, which shows how the interest of Lombardy people towards the EUR/Swiss franc exchange rate increases after 2009 and is correlated with the volume of job searches in Ticino.

It is reasonable to conclude that the implementation of the free movement of people allowed cross-border workers to react fully to the changes in the EUR/CHF exchange rate that were making Swiss wages more and more attractive to Italian workers.

[26] All traffic counting stations within 10 km from the border were in municipalities included in the Border Region.
[27] The graph is obtained using data on traffic flows from Italy to Switzerland during the time interval 5-9am.

8 Concluding remarks

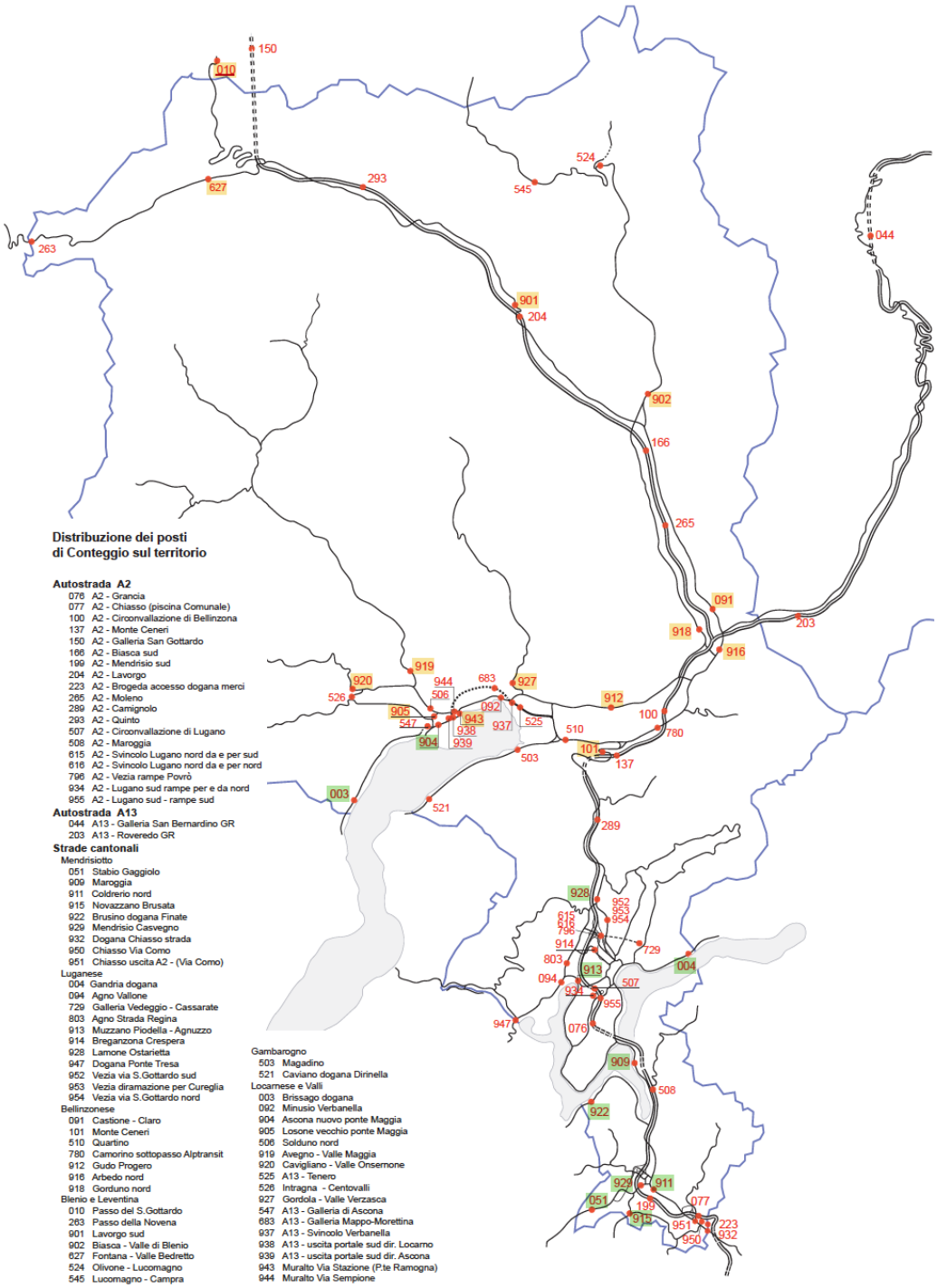
According to Fries-Tersch et al. (2018), the number of cross-border workers in EFTA and EU countries was approximately 1.8 million in 2016. Given the magnitude of this new form of mobility, it is essential to understand its determinants in order to design optimal taxation, migration, and labour policies.

In this study, I analysed the effects of exchange-rate fluctuations on cross-border mobility and provided the first estimate of cross-border commuter sensitivity to a currency appreciation. I focused on Switzerland, which is the main country of work for EU-28 cross-border workers (Fries-Tersch et al., 2018). Switzerland is a small country with relatively easy-to-cross borders, given the Schengen agreement, and has strong integration with neighbouring countries in terms of language and culture. Indeed, it represents the ideal setting for analysing the response of border crossings to exchange rate fluctuations. Moreover, since most of the other European countries have adopted the euro, and therefore do not see any kind of relative currency change, it is one of the few European countries in which a cross-border analysis of this sort is possible.

By exploiting changes in traffic flow along the Swiss-Italian border, I provide evidence for an extensive labour supply response of cross-border workers to Swiss franc appreciation. The results are confirmed by using search volume data from Google Trends and official statistics on cross-border commuters in Switzerland. When the CHF is stronger, more people resident in Lombardy look for jobs in Ticino, and the number of cross-border workers increases in municipalities within a driving distance of up to 10 km from the border. Moreover, I analysed the intensive labour supply response of cross-border workers to appreciation of the Swiss franc. My results suggest that the average number of hours worked by cross-border workers paid on an hourly basis increases when the purchasing power of their wages in their home country increases.

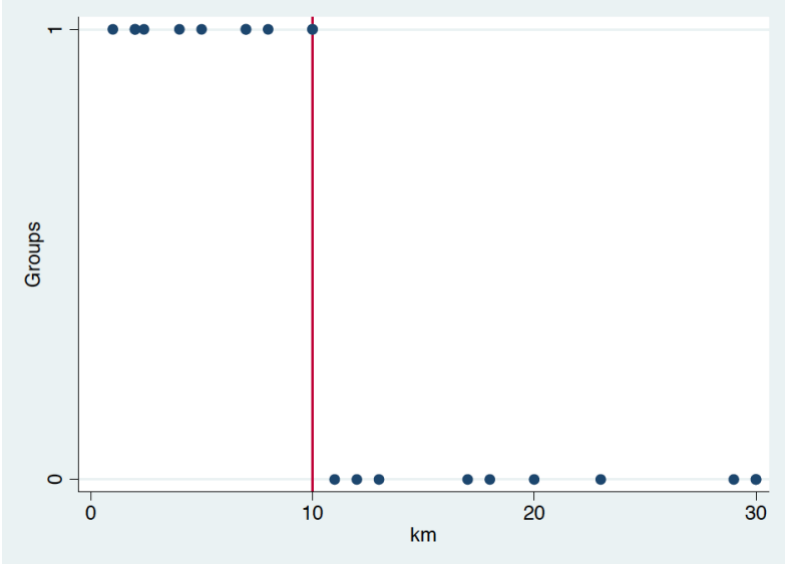
Figures and Tables

Figure 1: Location of traffic-counting stations



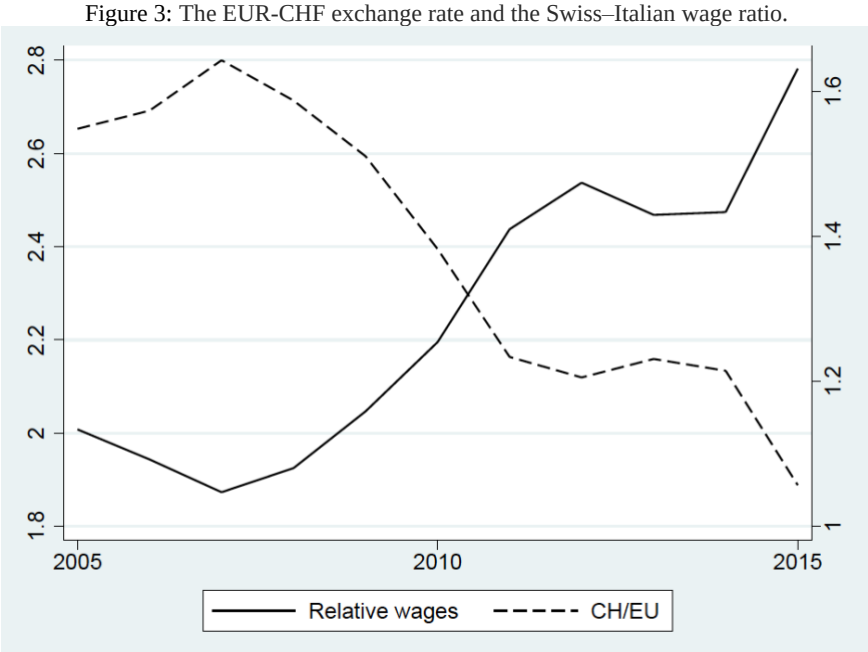
Notes: The map shows the location of traffic-counting stations throughout the canton of Ticino. Traffic-counting stations located within 10 km of the border are in green on the map, while the remaining traffic-counting stations used in the analysis are in yellow. Traffic-counting stations on highways and those not active over the entire period of analysis are not included in the analysis.

Figure 2: Distribution of traffic-counting stations.



Notes: Distribution of traffic-counting stations based on their distance from the border. For readability purposes, data for traffic counting stations located further than 30 km from the border are excluded from the graph. In total, there are four traffic-counting stations located further than 30 km. In four cases a single point represents two traffic-counting stations.

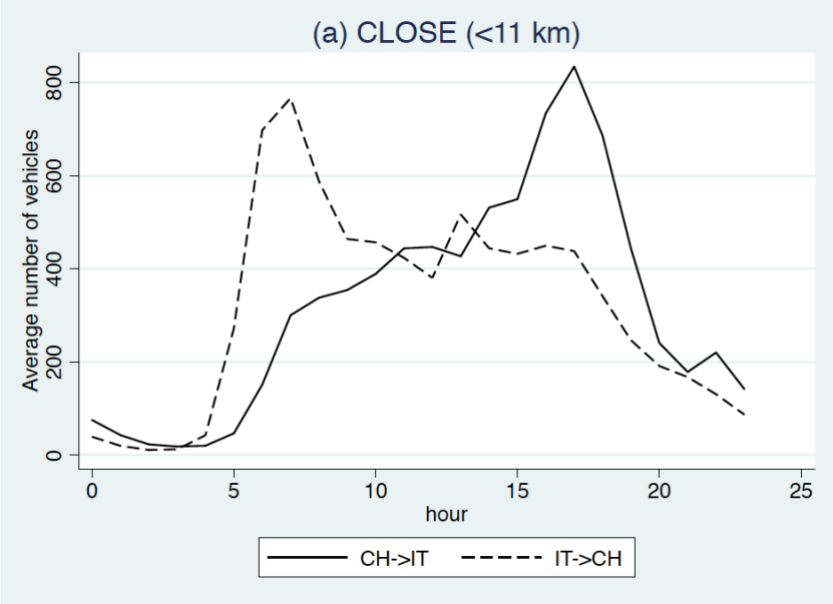
Figure 3: The EUR-CHF exchange rate and the Swiss–Italian wage ratio.



Notes*:* The graph shows the annual EUR/CHF exchange rate (right axis) and the relative average annual wage of Switzerland to Italy in euros and current prices (left axis). On 6 September 2011, the SNB introduced the minimum exchange rate of CHF 1.20 per EUR. On January 2015, this floor was removed.

Source*:* SNB and OECD website (2005–2015).

Figure 4: Distribution of traffic flows by time and direction (Monday–Friday).



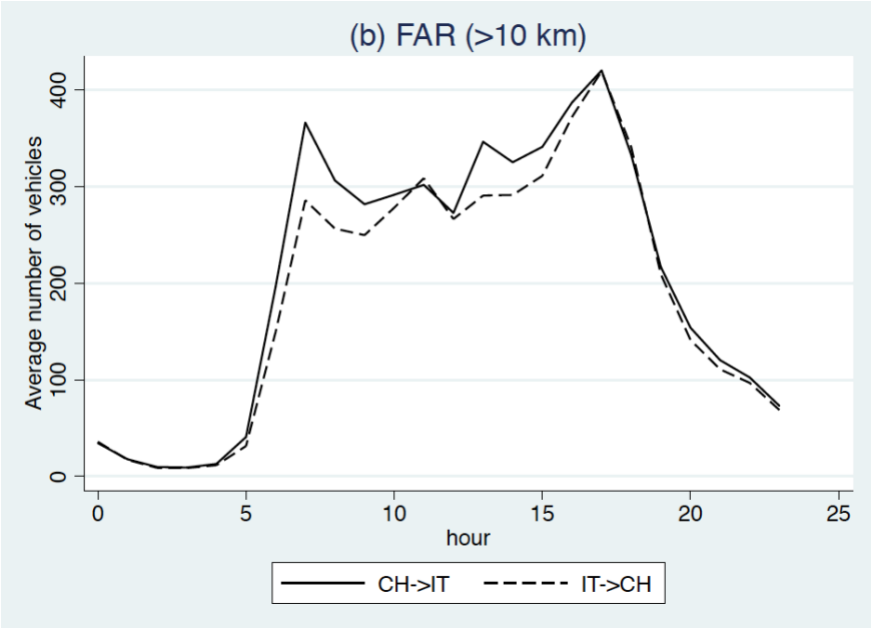
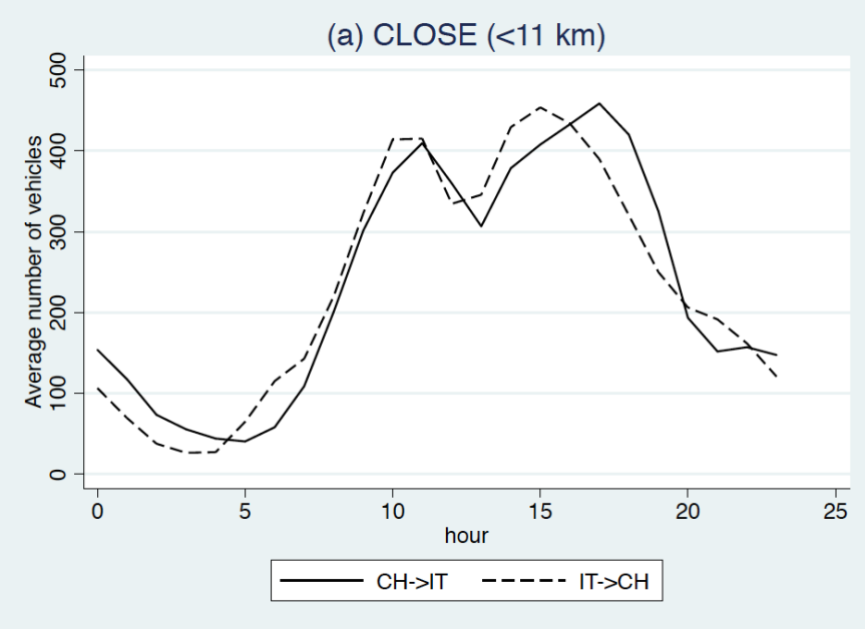
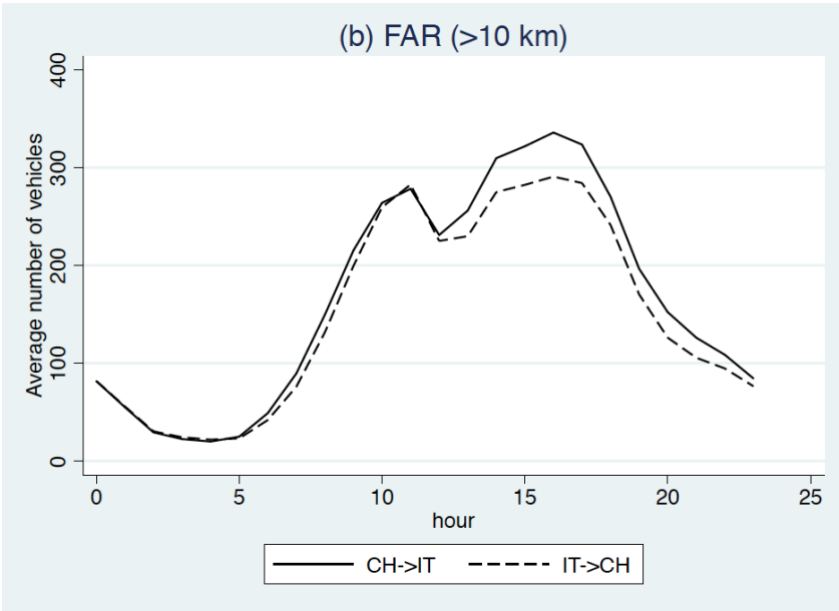


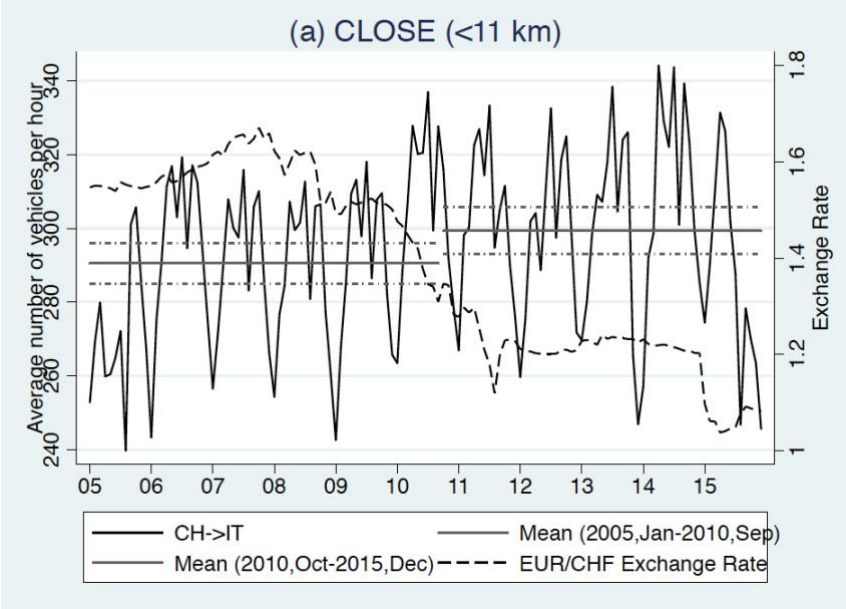
Figure 5: Distribution of traffic flows by time and direction (Saturday–Sunday).





Notes: The figures show the average number of cars per hour and per traffic-counting station by time of the day and direction across the two groups of traffic-counting stations. The symbol 'CH->IT' indicates north-to-south flows, and 'IT->CH' indicates south-to-north flows. The first group (CLOSE) consists of traffic-counting stations located within a driving distance of up to 10 km from the border, and the second group (FAR) includes the remaining traffic-counting stations.
Source: Sezione Mobilità del Canton Ticino (2005–2015).

Figure 6: Annual and monthly variations in traffic flows. Direction: IT.



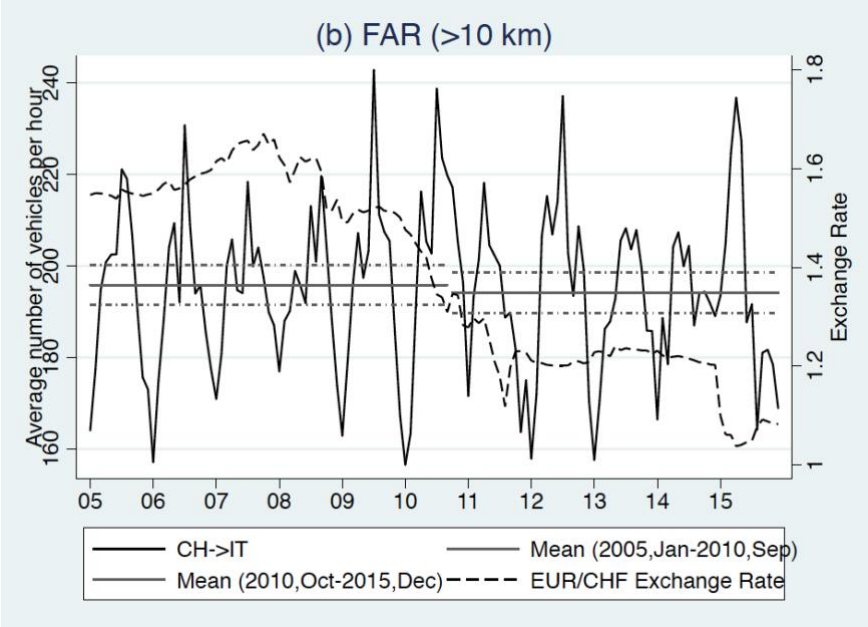
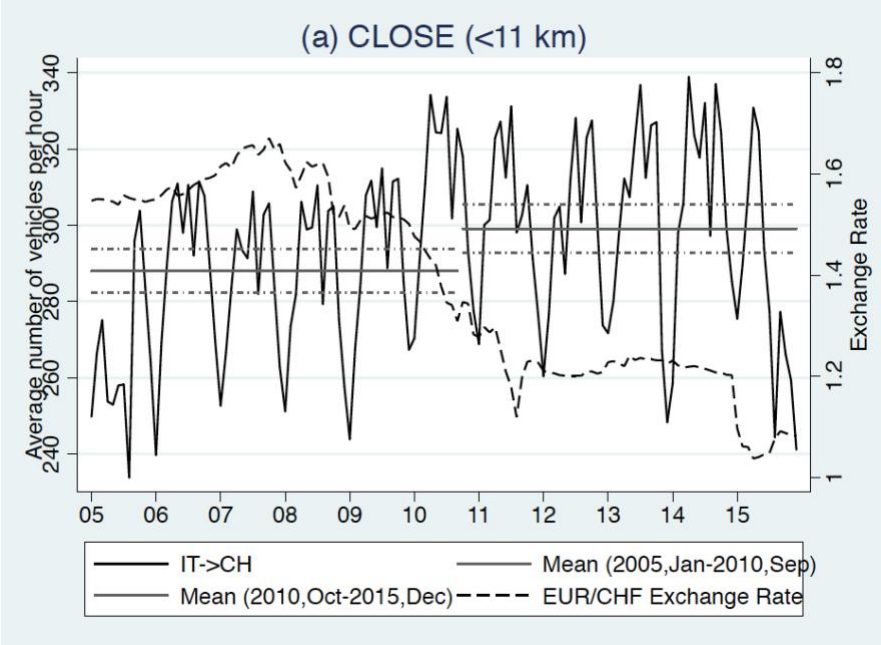
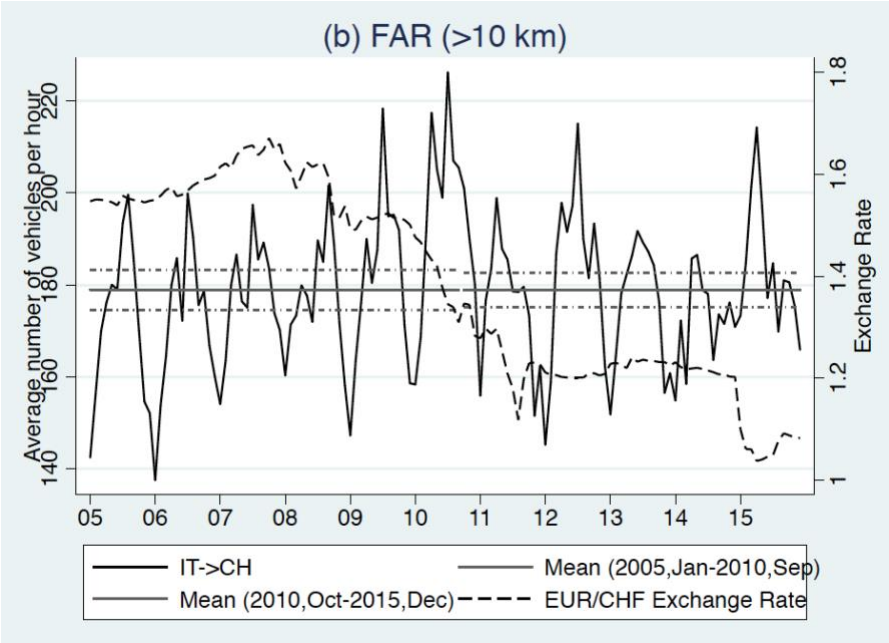


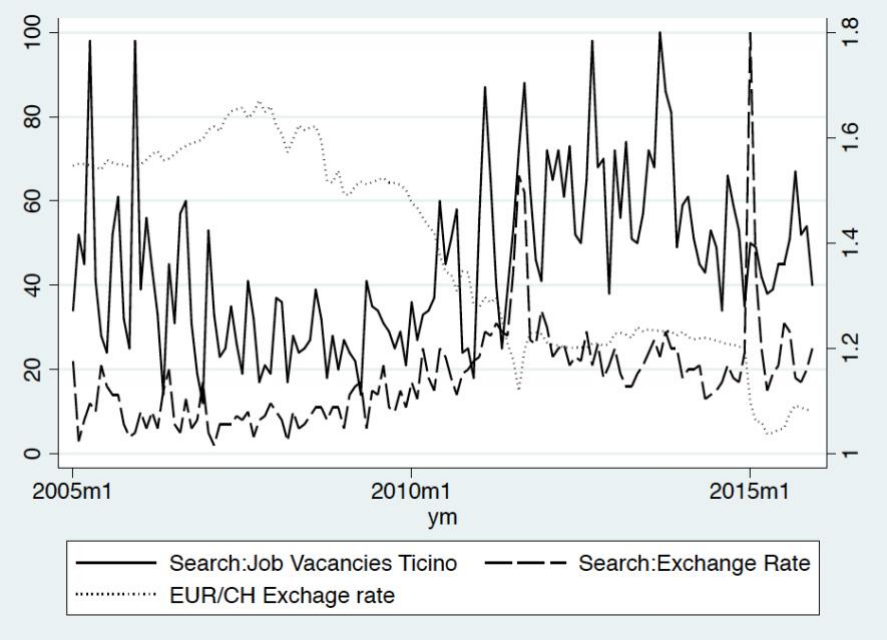
Figure 7: Annual and monthly variations in traffic flows. Direction: CH.





Notes: The figures show the average number of cars per hour and per traffic-counting station by time of the day and direction across the two groups of traffic-counting stations. The symbol 'CH->IT' indicates north-to-south flows, and 'IT->CH' indicates south-to-north flows. The first group (CLOSE) consists of traffic-counting stations located within a driving distance of up to 10 km from the border, and the second group (FAR) includes the remaining traffic-counting stations.
Source: Sezione Mobilità del Canton Ticino (2005–2015).

Figure 8: Google Search Volume data.



Notes: The figure shows how the Google search volume for the queries 'Job Vacancies in Ticino' and 'Euro Swiss franc Exchange rate' in Lombardy changed over time along with the value of the EUR/CHF exchange rate.
Source: Google Trends (2005–2015).

Table 1:Number of cross-border workers by province or country of origin

	2005	2015
Tot	35.749	62.714
Como	0.418	0.406
Lecco	0.002	0.006
Sondrio	0.003	0.006
Varese	0.471	0.421
Verbano-cusio-Ossola	0.106	0.087
Other Italian provinces	0.000	0.074
Other UE/AELS countries	0.000	0.002

Notes: The table reports the number of cross-border workers in the canton of Ticino by Italian province/country of origin. "Other Italian provinces" includes all Italian provinces except Como, Lecco, Sondrio, Varese, Verbanio-Cussola-Ossola. Source: Swiss Federal Statistical Office.

Table 2: Descriptive Statistics (Traffic flow data)

Cantonal Roads, CH->IT						
	24h	0-4am	5-9am	10am-1pm	2pm-8pm	9pm-11pm
FAR	186.4053	29.2667	171.9699	280.3436	291.2795	102.363
sd	224.631	48.3523	205.401	234.3734	260.4344	109.4027
N	8.00E+04	1.70E+04	1.70E+04	1.30E+04	2.30E+04	1.00E+04
CLOSE	278.1741	62.5332	190.5697	395.5651	475.5426	166.5352
sd	275.0054	61.3431	206.3302	256.1325	305.6815	101.4469
N	6.50E+04	1.30E+04	1.30E+04	1.10E+04	1.90E+04	8.10E+03
Cantonal Roads, IT->CH						
	24h	0-4am	5-9am	10am-1pm	2pm-8pm	9pm-11pm
FAR	170.5726	29.5987	144.5017	267.8024	267.9147	92.1897
sd	197.4892	41.2444	176.2326	206.6756	225.3251	83.0089
N	8.00E+04	1.70E+04	1.70E+04	1.30E+04	2.30E+04	1.00E+04
CLOSE	276.2393	39.384	366.9809	411.9516	359.957	143.4716
sd	277.6979	45.3082	317.5042	271.9219	270.2242	103.8385
N	6.50E+04	1.30E+04	1.30E+04	1.10E+04	1.90E+04	8.10E+03

Notes: The table reports the average number of cars per hour by time-interval and direction in the two groups of traffic-counting stations. The symbol `CH->IT' indicates north-to-south flows, and `IT->CH' indicates south-to-north flows. The first group (CLOSE) includes traffic-counting stations located within a driving distance of up to 10 km from the border, and the second group (FAR) includes the remaining traffic-counting stations. An observation is a traffic-counting station-month-year-hour. Source: Sezione Mobilità del Canton Ticino (2005-2015).

Table 3: Log Crossings

Panel 1: IT->CH, Day						
	(1)	(2)	(3)	(4)	(5)	(6)
	Mon-Frid	Sat-Sun	Mon-Frid	Sat-Sun	Mon-Frid	Sat-Sun
	5am-9am	5am-9am	10am-1pm	10am-1pm	2pm-8pm'	2pm-8pm'
ln e	-0.137	0.049	-0.010	0.025	-0.083	-0.039
	(0.118)	(0.097)	(0.060)	(0.070)	(0.067)	(0.063)
CLOSE*ln e	-0.266*	-0.269**	-0.161*	-0.111	0.020	0.112
	(0.136)	(0.116)	(0.083)	(0.088)	(0.087)	(0.089)
Observations	15,037	15,015	12,040	12,024	21,063	21,032
R-squared	0.710	0.601	0.936	0.909	0.857	0.828
Panel 2: CH->IT, Day						
	(1)	(2)	(3)	(4)	(5)	(6)
	Mon-Frid	Sat-Sun	Mon-Frid	Sat-Sun	Mon-Frid	Sat-Sun
	5am-9am	5am-9am	10am-1pm	10am-1pm	2pm-8pm'	2pm-8pm'
ln e	-0.082	-0.097	-0.032	0.022	-0.026	0.043
	(0.086)	(0.089)	(0.052)	(0.055)	(0.072)	(0.053)
CLOSE*ln e	-0.181	-0.025	-0.177**	-0.163**	-0.165*	-0.001
	(0.158)	(0.118)	(0.069)	(0.075)	(0.085)	(0.065)
Observations	15,100	15,089	12,087	12,080	21,145	21,129
R-squared	0.647	0.555	0.942	0.917	0.825	0.828
Controls FE	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES
Station FE	YES	YES	YES	YES	YES	YES

Notes: The dependent variable is the log of the monthly average number of cars crossing a specific traffic-counting station in a given hour. The symbol `CH->IT' indicates north-to-south flows, and `IT->CH' indicates south-to-north flows. CLOSE is a dummy for traffic-counting stations located within a driving distance of up to 10 km from the border. Controls include the log of the Swiss GDP, the log of the Italian GDP, and the log of the unemployment rate in Lombardy. A dummy for the period after 2007 is also included, but the coefficient is not reported. Robust standard errors (in parentheses) are clustered at the traffic-counting station level. An observation is a traffic-counting station-month-year-hour. The following symbols indicate different significance levels: *** p<0.01, ** p<0.05, * p<0.1. Source: Sezione Mobilità del Canton Ticino (2005-2015).

Table 4: Log crossings

Panel 1: IT->CH, Night				
	(1)	(2)	(3)	(4)
	Mon-Frid	Sat-Sun	Mon-Frid	Sat-Sun
	9pm-11pm	9pm-11pm	0am-4am	0am-4am
ln e	-0.234**	-0.254**	-0.022	-0.035
	(0.099)	(0.096)	(0.177)	(0.163)
CLOSE*ln e	0.267	0.364**	-0.663	-0.232
	(0.167)	(0.162)	(0.560)	(0.539)
Observations	9,021	9,006	14,978	14,963
R-squared	0.903	0.927	0.750	0.806
Panel 1: CH->IT, Night				
	(1)	(2)	(3)	(4)
	Mon-Frid	Sat-Sun	Mon-Frid	Sat-Sun
	9pm-11pm	9pm-11pm	0am-4am	0am-4am
ln e	-0.078	-0.092	-0.181	-0.110
	(0.082)	(0.093)	(0.117)	(0.106)
CLOSE*ln e	0.036	0.243	-0.026	0.152
	(0.110)	(0.144)	(0.652)	(0.665)
Observations	9,056	9,048	15,025	15,005
R-squared	0.903	0.941	0.794	0.823
Controls FE	YES	YES	YES	YES
Month FE	YES	YES	YES	YES
Station FE	YES	YES	YES	YES

Notes: The dependent variable is the log of the monthly average number of cars crossing a specific traffic-counting station in a given hour. The symbol `CH->IT' indicates north-to-south flows, and `IT->CH' indicates south-to-north flows. CLOSE is a dummy for the traffic-counting stations located within a driving distance of up to 10 km from the border. Controls include the log of the Swiss GDP, the log of the Italian GDP, and the log of the unemployment rate in Lombardy. A dummy for the period after 2007 is also included, but the coefficient is not reported. Robust standard errors (in parentheses) are clustered at the traffic-counting station level. An observation is a traffic-counting station-month-year-hour. The following symbols indicate different significance levels: *** p<0.01, ** p<0.05, * p<0.1. Source: Sezione Mobilità del Canton Ticino (2005-2015).

Table 5: Descriptive Statistics (Cross-border commuter statistics)

km<5	
mean	697.78
sd	980.66
Obs.	836
km<11	
mean	788.82
sd	1821.1
Obs.	2112
km<16	
mean	679.11
sd	1579.81
Obs.	2904
km<21	
mean	608.24
sd	1475.77
Obs.	3388

Notes: The table shows the mean and standard deviation of the average number of cross-border workers in municipalities located within X km from the border. Alternative distance cut-offs are considered. Source: Swiss Federal Statistical Office (2005-2015).

Table 6: Number of cross-border workers

	5km	10km	15km	20km
ln e	-0.236*	-0.252**	-0.166	-0.133
	(0.123)	(0.110)	(0.124)	(0.116)
R-squared	0.595	0.478	0.383	0.373
Observations	836	2,112	2,904	3,388
Controls	YES	YES	YES	YES
Municipal FE	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES

Notes: The dependent variable is the log of the quarterly number of cross-border workers located in municipalities within X km from the border. Alternative distance cut-offs are considered. Controls include the log of the Swiss GDP, the log of the Italian GDP, and the log of the unemployment rate in Lombardy. A linear and a quadratic time trend, and a dummy for the period after 2007 are also included, but the coefficients are not reported. Robust standard errors (in parentheses) clustered at the municipal level. The following symbols indicate different significance levels: *** p<0.01, ** p<0.05, * p<0.1. Source: Swiss Federal Statistical Office (2005-2015).

Table 7: Google search volume

Searches made in Lombardy			
	(1)	(2)	(3)
	Jobs in Ticino	Jobs in Lombardy	Jobs in Ticino/Lombardy
ln e	-40.217*	-19.360	-10.523
	(22.558)	(22.110)	(16.531)
Ticino			4.730
			(4.213)
Ticino*ln e			-38.530***
			(12.189)
Observations	132	132	264
R-squared	0.468	0.503	0.472
Controls	YES	YES	YES
Month FE	YES	YES	YES

Notes: The dependent variable is the search volume for the queries `Job vacancies in Ticino' or `Job vacancies in Lombardy', relative to the total search volume in the time interval (2005--2015). Ticino is a dummy equal to 1 for Ticino-related searches. I control for the log of the Swiss GDP, the log of the Italian GDP, and the log of the unemployment rate in Lombardy. A dummy for the period after 2007 is also included, but the coefficient is not reported. Robust standard errors are in parentheses. The following symbols indicate different significance levels: *** p<0.01, ** p<0.05, * p<0.1. Source: Google Trends (2005-2015).

Table 8: Descriptive Statistics (Swiss Earnings Structure Survey)

Panel 1: Salaried employees			
	Hours worked	Age	Female
Swiss	36.2582	42.3796	0.4340
sd	9.3045	11.0343	0.4956
N	130890	130890	130890
CBW	39.4031	40.2527	0.4014
sd	6.0952	10.0597	0.4902
N	59495	59495	59495
Panel 2: Hourly employees			
	Hours worked	Age	Female
Swiss	76.8147	43.1426	0.6993
sd	61.394	12.5878	0.4586
N	11135	11135	11135
CBW	149.1724	40.4598	697.78
sd	52.4078	10.4984	980.66
N	16020	16020	16020

Notes: The table reports the average number of hours worked per week (month), the average age and the share of women, respectively, among salaried (hourly) employees for Swiss and cross-border workers. Source: Swiss Earnings Structure Survey (2004-2012, biennial).

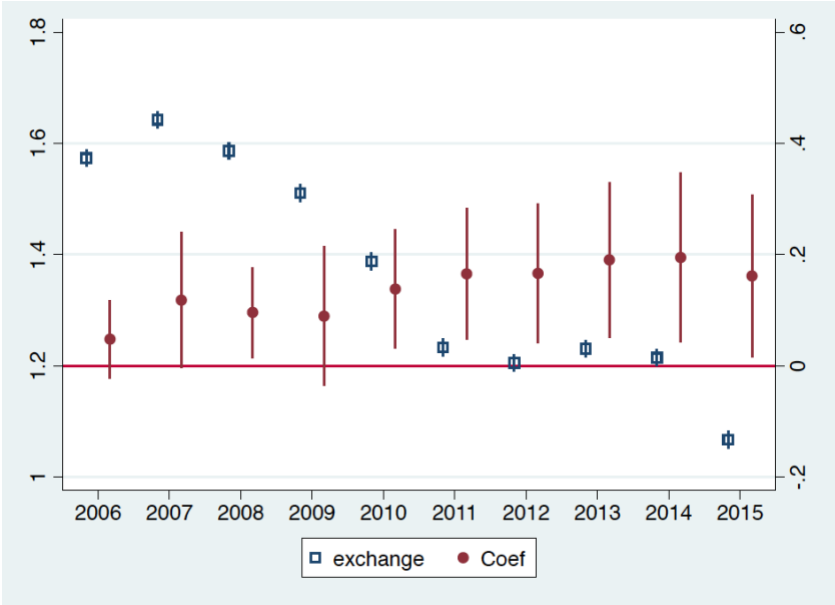
Table 9: Intensive Labour Supply Response

	Salaried empl.	Hourly empl.
ln e	0.388***	0.930
	(0.131)	(0.848)
CBW	0.078***	0.802***
	(0.005)	(0.046)
CBW*ln e	-0.061***	-1.117***
	(0.013)	(0.111)
Observations	190,353	27,155
R-squared	0.258	0.482
Controls	YES	YES

Notes: The dependent variable is the log of the number of hours worked per employee. The sample includes only cross-border workers and Swiss residents. Controls include dummies for sex, age, education level, and sector of the firm (at NOGA 2-digit level), the log of the Italian GDP, the log of the Swiss GDP, the log of unemployment rate in Lombardy. A dummy for the period after 2007 is also included, but the coefficient is not reported. Robust standard errors in parentheses. The following symbols indicate different significance levels: *** p<0.01, ** p<0.05, * p<0.1. Source: Swiss Earnings Structure Survey (2004-2012, biennial).

Appendix A

Figure A1: Plot of the year-by-year regression coefficients.



Notes: Plot of the coefficients of interaction variables of the following equation: $n_{ihmy} = \alpha + \sum_{n=2006}^{2015} \beta_n Year_{ny} + \sum_{n=2006}^{2015} \gamma_n Year_{ny} CLOSE_i + \eta_1 X_{my} + f_i + m_m + \varepsilon_{ihmy}$, where n_{ihmy} is the log of the average number of cars crossing the traffic-counting station i at hour h, month m and year y, $\sum_{n=2006}^{2015} Year_{ny}$ represents year dummies for the years 2006-2015 and $CLOSE_i$ is a dummy for traffic-counting stations located within 10 km of the border. $\sum_{n=2006}^{2015} Year_{ny} Close_i$ indicates the interaction terms between year dummies and the CLOSE dummy. X_{my} is the vector of control variables: the log of the Swiss GDP, the log of the Italian GDP, and the log of the Lombardy unemployment rate. Finally, m_m and f_i indicate month fixed effects and traffic-counting station fixed effects, respectively. The graph also shows the value of the EUR/CH exchange rate over time. Source: Sezione Mobilità del Canton Ticino (2005-2015).

Table A.1: Growth rate (%) of the number of cross-border workers

	2008	2009	2010	2011	2012	2013	2014	2015
Como	4.8	3.32	4.34	6.66	7.19	6.05	6.56	0.84
Other IT Provinces	346	53	21	23	14	14	13	1

Notes: The table reports the growth rate of the number of cross-border workers coming from the province of Como (almost all of whose municipalities were included in the BR) and that regarding the number of cross-border workers coming from "other Italian provinces" (whose municipalities were not included in the BR). "Other Italian provinces" includes all Italian provinces except Como, Lecco, Sondrio, Varese, Verbanio-Cussola-Ossola. Since 2007 people residing outside the Border Region in Italy are allowed to apply for a cross-border worker permit. Source: Swiss Federal Statistical Office (2007-2015).

Table A.2: Resident population in the two Italian regions bordering the Canton of Ticino

	(1) Lombardy	(2) Piedmont
Treatment*2002	0.001	-0.000
	(0.002)	(0.002)
Treatment*2003	0.001	-0.002
	(0.004)	(0.003)
Treatment*2004	0.001	-0.005
	(0.006)	(0.005)
Treatment*2005	0.001	-0.007
	(0.007)	(0.006)
Treatment*2006	0.002	-0.008
	(0.008)	(0.008)
Treatment*2007	-0.001	-0.013
	(0.010)	(0.010)
Treatment*2008	-0.001	-0.019
	(0.012)	(0.010)
Treatment*2009	-0.002	-0.019
	(0.013)	(0.012)
Treatment*2010	-0.001	-0.020
	(0.013)	(0.014)
Treatment*2011	-0.001	-0.020
	(0.014)	(0.014)
Treatment*2012	-0.002	-0.021
	(0.014)	(0.015)
Treatment*2013	-0.005	-0.024
	(0.014)	(0.017)
Treatment*2014	-0.006	-0.023
	(0.015)	(0.018)
Treatment*2015	-0.006	-0.023
	(0.015)	(0.018)
Observations	180	120
R-squared	0.99	0.99
Year FE	YES	YES
Province FE	YES	YES

Notes: The dependent variable is the log of the number of inhabitants. Data at the province level. Lombardy and Piedmont are the two Italian regions bordering Ticino. The treatment variable is equal to 1 for the provinces of Como, Varese, Lecco (Lombardy) and for the province of Verbano-Cusio-Ossola (Piedmont). Robust standard errors (in parentheses) are clustered at the province level. The following symbols indicate different significance levels: *** p<0.01, ** p<0.05, * p<0.1. Source: ISTAT (2001—20

Appendix B

Table B.1: Log Crossings

Panel 1: IT->CH, Day						
	(1)	(2)	(3)	(4)	-5	(6)
	Mon-Frid	Sat-Sun	Mon-Frid	Sat-Sun	Mon-Frid	Sat-Sun
	5am-9am	5am-9am	10am-1pm	10am-1pm	2pm-8pm	2pm-8pm
ln wage ratio	0.450*	-0.112	0.201	0.038	0.255	0.096
	(0.254)	(0.148)	(0.198)	(0.198)	(0.158)	(0.172)
CLOSE*ln wage ratio	0.399**	0.356**	0.235**	0.203*	0.009	-0.058
	(0.174)	(0.146)	(0.107)	(0.115)	(0.098)	(0.099)
Observations	1,325	1,325	1,060	1,060	1,855	1,855
R-squared	0.729	0.599	0.974	0.966	0.881	0.861
Panel 2: CH->IT, Day						
	(1)	(2)	(3)	(4)	(5)	(6)
	Mon-Frid	Sat-Sun	Mon-Frid	Sat-Sun	Mon-Frid	Sat-Sun
	5am-9am	5am-9am	10am-1pm	10am-1pm	2pm-8pm	2pm-8pm
ln wage ratio	0.377	0.145	0.179	-0.052	0.155	0.045
	(0.236)	(0.147)	(0.175)	(0.169)	(0.196)	(0.188)
CLOSE*ln wage ratio	0.252	0.082	0.214**	0.220**	0.196*	0.023
	(0.185)	(0.156)	(0.083)	(0.096)	(0.096)	(0.081)
Observations	1,330	1,330	1,064	1,064	1,862	1,862
R-squared	0.651	0.551	0.980	0.974	0.853	0.851
Controls FE	YES	YES	YES	YES	YES	YES
Station FE	YES	YES	YES	YES	YES	YES

Notes: The dependent variable is the log of the annual average number of cars crossing a specific traffic-counting station in a given hour. The symbol `CH->IT' indicates north-to-south flows, and `IT->CH' indicates south-to-north flows. CLOSE is a dummy for traffic-counting stations located within a driving distance of up to 10 km from the border. Controls include the log of the Swiss GDP, the log of the Italian GDP, and the log of the unemployment rate in Lombardy. A dummy for the period after 2007 is also included, but the coefficient is not reported. Robust standard errors (in parentheses) are clustered at the traffic-counting station level. An observation is a traffic-counting station-year-hour. The following symbols indicate different significance levels: *** p<0.01, ** p<0.05, * p<0.1. Source: Sezione Mobilità del Canton Ticino (2005-2015).

Table B.2: Log Crossings

Panel 1: IT->CH, Night				
	(1)	(2)	(3)	(4)
	Mon-Frid	Sat-Sun	Mon-Frid	Sat-Sun
	9pm-11pm	9pm-11pm	0am-4am	0am-4am
ln wage raio	0.190	0.361**	-0.555	-0.294
	(0.223)	(0.157)	(0.375)	(0.328)
CLOSE*ln wage ratio	-0.245	-0.358*	0.622	0.217
	(0.181)	(0.178)	(0.590)	(0.574)
Observations	795	795	1,325	1,325
R-squared	0.941	0.952	0.781	0.822
Panel 2: CH->IT, Night				
	(1)	(2)	(3)	(4)
	Mon-Frid	Sat-Sun	Mon-Frid	Sat-Sun
	9pm-11pm	9pm-11pm	0am-4am	0am-4am
ln wage ratio	0.107	0.253	-0.411	-0.214
	(0.247)	(0.188)	(0.321)	(0.316)
CLOSE*ln wage ratio	0.001	-0.279	-0.032	-0.204
	(0.132)	(0.176)	(0.665)	(0.682)
Observations	798	798	1,330	1,330
R-squared	0.948	0.964	0.835	0.853
Controls FE	YES	YES	YES	YES
Station FE	YES	YES	YES	YES

Notes: The dependent variable is the log of the annual average number of cars crossing a specific traffic-counting station in a given hour. The symbol `CH->IT' indicates north-to-south flows, and `IT->CH' indicates south-to-north flows. CLOSE is a dummy for traffic-counting stations located within a driving distance of up to 10 km from the border. Controls include the log of the Swiss GDP, the log of the Italian GDP, and the log of the unemployment rate in Lombardy. A dummy for the period after 2007 is also included, but the coefficient is not reported. Robust standard errors (in parentheses) are clustered at the traffic-counting station level. An observation is a traffic-counting station-year-hour. The following symbols indicate different significance levels: *** p<0.01, ** p<0.05, * p<0.1. Source: Sezione Mobilità del Canton Ticino (2005-2015).

Table B.3: Number of cross-border workers

	5km	10km	15km	20km
ln wage ratio	0.545***	0.332	0.349*	0.303*
	(0.178)	(0.209)	(0.176)	(0.170)
R-squared	0.634	0.538	0.422	0.409
Observations	209	528	726	847
Controls	YES	YES	YES	YES
Municipal FE	YES	YES	YES	YES

Notes: The dependent variable is the log of the annual average number of cross-border workers located in municipalities within X km from the border. Alternative distance cut-offs are considered. Controls include the log of the Swiss GDP, the log of the Italian GDP, and the log of the unemployment rate in Lombardy. A linear and a quadratic time trend, and a dummy for the period after 2007 are also included, but the coefficients are not reported. Robust standard errors (in parentheses) clustered at the municipal level. The following symbols indicate different significance levels: *** p<0.01, ** p<0.05, * p<0.1. Source: Swiss Federal Statistical Office (2005-2015).

Table B.4: Google search volume

	Searches made in Lombardy		
	(1)	(2)	(3)
	Jobs in Ticino	Jobs in Lombardy	Jobs in Ticino/Lombardy
ln wage ratio	57.901**	33.020	23.999
	(24.177)	(23.625)	(17.728)
Ticino			-41.658***
			(10.446)
Ticino*ln wage ratio			42.923***
			(12.949)
Observations	132	132	264
R-squared	0.477	0.509	0.480
Controls	YES	YES	YES
Month FE	YES	YES	YES

Notes: The dependent variable is the search volume for the queries `Job vacancies in Ticino' or `Job vacancies in Lombardy', relative to the total search volume in the time interval (2005--2015). Ticino is a dummy equal to 1 for Ticino-related searches. I control for the log of the Swiss GDP, the log of the Italian GDP, and the log of the unemployment rate in Lombardy. A dummy for the period after 2007 is also included, but the coefficient is not reported. Robust standard errors are in parentheses. The following symbols indicate different significance levels: *** p<0.01, ** p<0.05, * p<0.1. Source: Google Trends (2005-2015).

Table B.5: Intensive Labour Supply Response

	Salaried empl.	Hourly empl.
ln wage ratio	-0.225***	-0.863*
	(0.073)	(0.482)
CBW	0.007	-0.487***
	(0.010)	(0.084)
CBW*ln wage ratio	0.064***	1.171***
	(0.014)	(0.114)
Observations	190,353	27,155
R-squared	0.258	0.483
Controls	YES	YES

Notes: The dependent variable is the log of the number of hours worked per employee. The sample includes only cross-border workers and Swiss residents. Controls include dummies for sex, age, education level, and sector of the firm (at NOGA 2-digit level), the log of the Italian GDP, the log of the Swiss GDP, the log of unemployment rate in Lombardy. A dummy for the period after 2007 is also included, but the coefficient is not reported. Robust standard errors in parentheses. The following symbols indicate different significance levels: *** p<0.01, ** p<0.05, * p<0.1. Source: Swiss Earnings Structure Survey (2004-2012, biennial).

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