Cross-border shopping: evidence and welfare implications for Switzerland*

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Abstract

Consumers access foreign goods by purchasing them domestically or shopping abroad. We present new facts on cross-border shopping by Swiss households showing, for example, that prices of identical products are lower in neighboring countries, cross-border shopping shares fall with distance to the border, and price gaps and cross-border shopping shares rose following the 2015 Swiss Franc appreciation. We use a simple model of cross-border shopping to quantify how variation across space in cross-border shopping results in heterogeneous changes in cost-of-living in response to changes in international prices such as the 2015 Swiss Franc Appreciation and the 2020 Covid-19-related closing of the border.

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1 Introduction

The impact of changes in international prices on the cost of living is shaped by the share of expenditures on foreign goods. Households most frequently access foreign goods by purchasing them from domestic retailers. However, consumers can also cross the border and shop abroad, especially those who live nearby. In this paper, we present new facts on cross-border shopping in Switzerland. We then use a simple model of spatial shopping to quantify the heterogeneous effects on the cost of living of factual changes in international prices and from access to cross-border shopping.

Switzerland provides an ideal setting to study cross-border shopping. Prices are substantially lower abroad, providing an incentive to shop there. And a large share of the Swiss population lives close to the border, able to take advantage of these incentives. We measure cross-border shopping prices and quantities over time at the household level for a subset of consumer non-durable goods purchased in supermarkets and drugstores using Swiss Nielsen Homescan data, as described in Section 2. For each transaction, we observe whether the purchase was made in Switzerland or abroad. In a typical year, approximately 30% of households in the dataset engage in any cross-border shopping and this share is nearly 75% in regions close to the border. Our data covers two salient shocks to foreign prices: the abrupt appreciation of the Swiss Franc against the euro on January 15, 2015—which occurred against the backdrop of stable economic aggregates and induced a marked decline in cross-border retail prices relative to within-border retail prices, as shown in Figure 1—and the three month Covid-19-related border closure in 2020.

In Section 3, we use the Nielsen data to document a set of facts. Cross-border shopping shares by household (measured using a household's cross-border share of retail expenditures, transactions, or trips) are high near the border (up to 8% or 17% in regions near the border, depending on the measure used) and fall to nearly zero with distance (measured as the distance to the nearest retail location across the border). Prices of identical products are lower in neighboring countries than in Switzerland. On the other hand, prices of goods purchased in Switzerland (both produced domestically and imported) do not vary with distance to the border. Following the 2015 CHF appreciation, the price of cross-border shopping relative to imports within Switzerland fell (see Figure 1)—even for identical products purchased in Switzerland and abroad—and cross-border-shopping shares rose. As a consequence, locations closer to the border experienced a larger decline in retail employment (but not in non-retail employment) following the 2015 CHF appreciation. Furthermore, during the 2020 border closure cross-border shopping shares fell to nearly zero. These facts suggest that the benefits to households arising from access to cross-border shopping and the effects of international price changes on the cost of living are heterogeneous across geographic regions.

In Section 4, we present a simple model of cross-border shopping to quantify these heterogeneous welfare effects. Each household takes many shopping trips in each period. For a given shopping trip, a household makes a discrete choice over shopping location—either within Switzerland or abroad—where they will purchase a bundle of (potentially location-specific) goods. This choice depends on systematic (household-specific) and idiosyncratic (household- and trip-specific) pecuniary and non-pecuniary location-specific variable costs and amenities.

Constructing household-specific changes in the cost of living in response to given factual or counterfactual changes in retail prices and non-retail costs domestically and abroad requires a measure of the initial share of total expenditures on cross-border shopping by household and the elasticity of the ratio of cross-border to domestic total expenditure (including retail and non-retail costs) with respect to prices. In the presence of non-retail costs, the retail expenditure share (which we observe in the data) is a biased measure of the total expenditure share on cross-border shopping (which is not observable) whereas, in our model, the trip share is not. Hence, we use the observable trip share of cross-border shopping in the welfare analysis. Because we observe retail price changes for domestic and cross-border purchases, we are able to calibrate the elasticity of total expenditure (of approximately 1.25) to match changes in cross-border relative to domestic trips at the household level.

Our first application is the 2015 CHF appreciation, after which prices fell on average by 7.7% for products purchased abroad and by 1.7% for those purchased in Switzerland. Through the lens of our model, the welfare-relevant cost of living fell for households in all regions, but did so substantially more for those living near the border. This decline is 2.8% in regions with the highest initial rate of cross-border shopping, but only 1.7% in more distant regions.

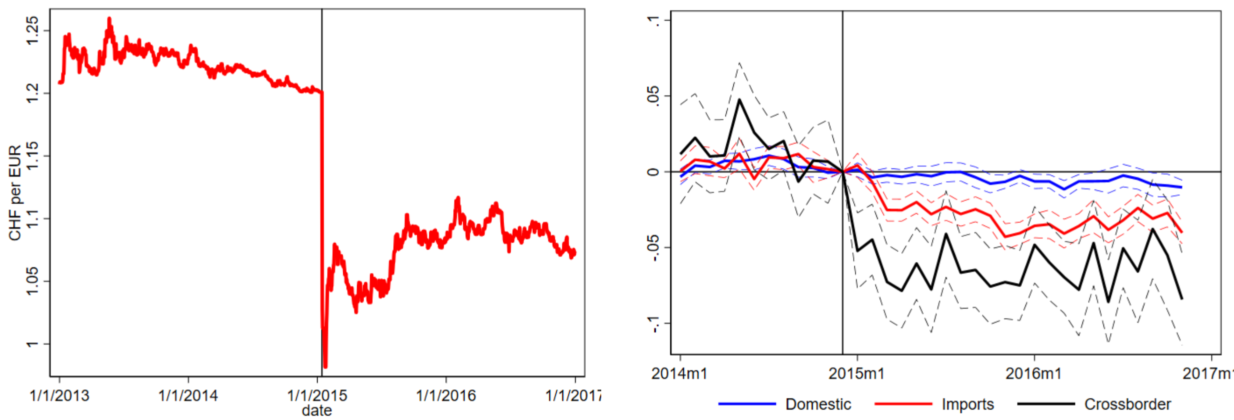
In our second application, we quantify the welfare gains associated with access to cross-border shopping. This is equivalent to quantifying the losses caused by prohibiting cross-border shopping, as occurred during the Covid-19-related border lockdown in 2020. Cross-border shopping lowers the cost of living by over 14% in the region with the highest observed cross-border share.

While both sets of quantitative results are constructed using data for groceries, we provide evidence that the cross-border shopping share in groceries is lower than across all debit card payments of Swiss consumers. This evidence suggests that our measured

Figure 1: Swiss Franc appreciation and resulting price changes

January 2015 Swiss Franc appreciation (relative to the Euro)

Price changes for cross-border, import, and domestic purchases



Notes: The left panel displays the CHF per EUR exchange rate with a vertical line at January 15, 2015; source: Swiss National Bank (2016). The right panel displays price differences relative to December 2014 separately for imports, domestic, and cross-border purchases (and associated 95% confidence intervals) from estimating equation $\log p_{em} = \alpha + \mathbb{FE}_e + \sum_{m' \neq \text{Dec 2014}} \mathbb{I}_{m'=m} \beta_m + \varepsilon_{em}$ where e indexes barcode products and m indexes months. We weigh each observation by total expenditure on that product in 2014 (separately for each mode of purchase). Robust standard errors are clustered at the product level.

changes in costs of living when considering groceries may provide a lower bound for changes in costs of living across the broader expenditure categories paid by debit cards.

Our paper is related to a growing body of empirical and quantitative work investigating heterogeneous effects of international price changes on the cost of living; see e.g. Porto (2006), Fajgelbaum and Khandelwal (2016), Cravino and Levchenko (2017), Borusyak and Jaravel (2021), and Auer et al. (2022). This literature focuses exclusively on consumption of "imports" (foreign purchases made by a consumer in his or her country, excluding cross-border shopping) and emphasizes differences in import expenditure shares across incomes.[1] We take an analogous approach but focus on cross-border shopping and differences across space; there are no systematic differences across incomes in cross-border shopping shares in our data.[2]

Our paper is also related to the literature on cross-border shopping and exchange rate movements. Chandra et al. (2014) show that exchange rate movements are correlated with U.S. - Canada border crossings and that distance inhibits crossings. Campbell and Lapham (2004) and Baggs et al. (2018) find that real exchange rate movements affect the

[1]In theory, goods purchased across the border are imports. In practice, however, official Swiss imports data only include data on commercial merchandise. Imports of "personal items" purchased on cross-border shopping trips are not included in Swiss import statistics.

[2]Auer et al. (2022) focuses on differences in expenditure switching across incomes, which magnify the unequal welfare effects of large changes in prices. In this paper, we abstract from non-homotheticities in preferences because the elasticity of shopping location to changes in prices does not vary systematically with income or distance to cross-border shopping in our data.

number of establishments and their average employment in U.S. and Canadian retail industries located near the border. Baggs et al. (2022) show that small Canadian retailers close to the U.S. benefited from the Covid-19-related border lockdown in 2020.[3] Relative to this literature, we directly observe household-level cross-border expenditure, transactions, and trips as well as price differences between identical goods. We use our empirical evidence to calculate the welfare implications of exchange rate shocks and border closures in the presences of cross-border shopping.

The idea that shopping patterns respond to changes in relative prices across retail locations is at the core of a growing literature on spatial shopping; see e.g. Agarwal et al. (2020), Davis et al. (2019), Allen et al. (2020), and Miyauchi et al. (2021). We provide evidence on this mechanism, leveraging a large exchange rate shock and a temporary border closure. Because we observe both cross-border shopping and changes in retail prices, we calibrate the cross-border shopping elasticity that shapes welfare responses using plausibly exogenous variation. Rather than modeling the Swiss supply side (i.e. the response of Swiss prices to international price changes), our welfare calculations make use of observed price changes in our data in response to both the 2015 CHF appreciation and of the 2020 border closure.

Our insights apply much more broadly, not only to cross-border shopping along international borders (in the presence of differences in international prices) but also to cross-border shopping along intra-national borders (in the presence of spatial heterogeneity in sales taxes, for instance). See, e.g., Goolsbee (2000), Einav et al. (2014), Agarwal et al. (2017), and Baker et al. (2021) for empirical work on the shopping implications of such spatial variation.

2 Data

Our measures of domestic and cross-border (CB) shopping are based on the AC Nielsen Homescan data, Nielsen Switzerland (2016), which contains information on household characteristics and shopping transactions of a demographically and regionally representative sample in Switzerland, as described in detail in Auer et al. (2021, 2022).

Participating households record purchases—of food, beverages, personal care (health and beauty aids), and other selected general merchandise—in supermarkets and drugstores. In the raw data, an observation is a transaction including the household identi-

[3] Friberg et al. (2022) finds that the sensitivity of store-level sales to the foreign price is hump-shaped in driving distance from the closest foreign store. Beck et al. (2020) use price gaps for goods that are purchased via cross-border shopping to estimate border trade costs in Europe.

Table 1: Nielsen data summary statistics in 2014 and 2019

	2014		2019	
	Domestic (a)	Cross-border (b)	Domestic (c)	Cross-border (d)
Number of products	77,176	12,905	88,418	14,715
Expenditures	118.1	1.8	129.5	2.5
Transactions	254.6	4.1	290.2	6.4
Trips	265.6	7.3	323.1	9.8
Households	3,309	1,019	4,602	1,340

Notes: Summary statistics reported in columns (a) and (b) are for year 2014 whereas in (c) and (d) are for the year 2019. Purchases made within Switzerland (*Domestic* purchases) are reported in columns (a) and (c) whereas those made abroad (*Cross-border* purchases) are reported in (b) and (d). *Number of products* is the number of distinct products that are sold within each sample. *Expenditures* and *Transactions* are total expenditures (in hundreds of thousands of CHF) and the number of household-product-day triplets with positive expenditures (in tens of thousands) in each sample. *Trips* is the number of household-day pairs on which expenditure is positive (in thousands). *Households* is the number of households engaged in non-CB and CB shopping.

fier, European Article Number (EAN) code, quantity purchased, price paid (net of good-specific discounts due to, e.g., coupons), date of the shopping trip, the name of the retailer for purchases in Switzerland, and whether the purchase was made in Switzerland or abroad.[4,5] We augment the Homescan data with information on whether individual products purchased within Switzerland are produced domestically or produced abroad, as described in Auer et al. (2021).

The data ranges from January 2013 to August 2020. This period covers the 2015 appreciation as well as the first wave of the COVID-19 pandemic during which Switzerland and its neighbors imposed restrictions on cross-border shopping. We examine the periods 2013-2016 and 2019-2020 separately because of two substantial changes that occurred between them. First, there was a major and gradual re-sampling of the AC Nielsen household sample in 2017 and 2018. Second, there was a change in the technology used for recording household purchase information, which moved to a smart-phone-based scanning technology.

Table 1 provides basic summary statistics of the Nielsen data in 2014 and 2019, sep-

[4]Cross-border purchases (excluding personal traveling provisions such food and beverages for the day of travel) are subject to VAT for amounts that exceed a daily allowance (the daily tax-free limit is CHF 300 per person in 2022) and to custom duties on certain goods (e.g. meat, butter, and cream in excess of 1 kg or liter). For additional details, see https://www.bazg.admin.ch/bazg/en/home/information-individuals/travel-and-purchases–allowances-and-duty-free-limit/importation-into-switzerland.html. These restrictions tend to be non-binding for the CB transactions observed in our data.

[5]E-commerce purchases abroad in the grocery sector, which we do not observe in our data, are likely small. E-commerce purchases abroad in non-grocery goods sectors, e.g., electronics or apparel, may be substantial. Since households typically do not travel abroad to make these purchases, cross-border e-commerce transactions are considered to be conventional imports rather than cross-border shopping in the framework in Section 4.

arately for goods purchased within Switzerland ("Domestic" purchases) and goods purchased abroad ("Cross-border" purchases).

We consider three alternative measures for cross-border shopping activity—expenditures, transactions, and trips—defined as follows. For each date, product, and country of purchase (Switzerland or abroad), a household makes either zero transactions (if its expenditure is zero) or one transaction (if its expenditure is positive). For each date and country of purchase, a household makes either zero trips (if its transactions are zero) or one trip (if it has positive transactions). For a given household and country of purchase, we sum the number of transactions and trips across dates within a given time horizon. According to Table 1, in 2014 aggregate CB shares of expenditures, transactions, and trips was 1.5%, 1.6%, and 2.7%, respectively, while the share of households that engaged in any cross-border shopping was 30.8%. In 2019, the CB shares of expenditures, transactions, and trips was 1.9%, 2.2%, and 2.9%, respectively, while the share of households that engaged in any cross-border shopping was 29.1%.

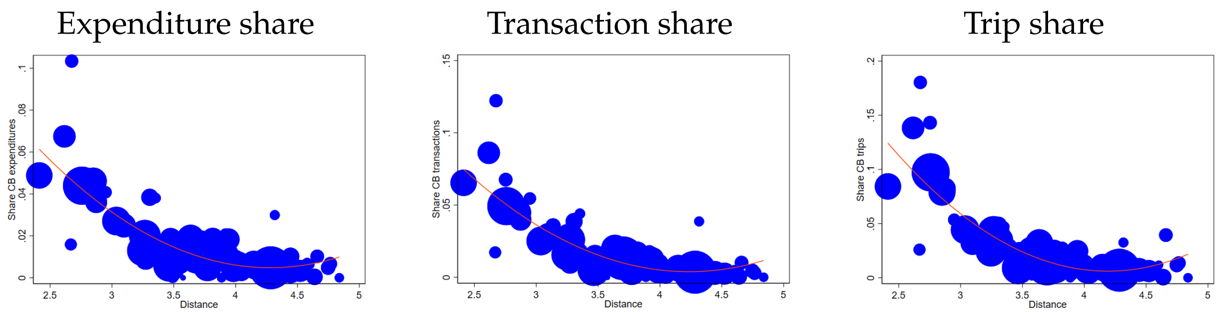
The Nielsen data comes with a rich set of socioeconomic characteristics for each household, including the education of the household's main earner, total household pre-tax annual income (reported in seven bins), and the 2-digit zip code (henceforth zip code) of residence. We measure the income of each household as the mid point of each of the income bins, and the income of the top bin at CHF 250,000, which is approximately the median annual taxable income for households with income in the top bin. We calculate a measure of distance to cross-border shopping by identifying the set of supermarkets abroad that are close to the Swiss border and measuring the driving time between each zip code in Switzerland and these cross-border retail outlets using Google Maps. For each zip code, we take the log of the minimum of these driving times and refer to this as *distance*. Additional details are provided in Appendix A.

For certain analyses on price gaps, we also use Homescan data obtained from GfK provided by Aimark for Austria, France, and Germany. Finally, to examine changes in retail employment by region, we measure employment by four-digit zip code and industry in 2014-2016 using the Statistik der Unternehmensstruktur (Business and Employment Statistics), which covers the universe of Swiss firms and is compiled by the Swiss Federal Statistical Office (SFSO), see also Swiss Federal Statistical Office (2018).

3 Facts

In this section, we report a number of facts about cross-border shopping activity around the 2015 CHF appreciation and the pandemic-related border lockdown in spring 2020.

Figure 2: Distance to CB shopping and 2014 CB shares by zip code



Notes: CB shares in 2014 by two-digit zip code—measured by expenditures, transactions, and trips—plotted against distance—measured by the log of travel time to the closest supermarket abroad. Solid lines display the fit of a quadratic regression (weighted by number of HHs, which also determines the size of the circles).

Additional details and robustness are provided in Appendix B.

Fact 1: Cross-border shares are higher for households closer to foreign retailers whereas import shares of all purchases made in Switzerland are not.

Figure 2 highlights the strong relationship between each of the three CB shares and distance to CB shopping in 2014; results in 2019—displayed in Figure 11 in Appendix B—are very similar. These shares vary from close to zero far from the border to approximately 8%, 9%, and 17% using expenditure, transaction, and trip shares, respectively.[6]

To show that the relationship between CB shares and distance to the border documented in Figure 2 continues to hold at the household level when controlling for additional household characteristics, we estimate

$$\frac{X_{hf14}}{X_{hf14} + X_{hd14}} = \alpha + \beta \log(Income_h) + \delta Distance_h + [\zeta' X_h] + \varepsilon_{h14} \qquad (1)$$

where $X_{h\ell t}$ is household h's expenditures, transactions, or shopping trips in location ℓ in year t, where $\ell = d$ represents domestic and $\ell = f$ represents cross-border (or foreign) purchases.[7]

Table 5 in Appendix B reports our results. Across measures and specifications (including additional household controls or not), we find a strong negative relationship between a household's distance to CB shopping and its CB share; and we find no relationship between any other household characteristic and its CB share.[8]

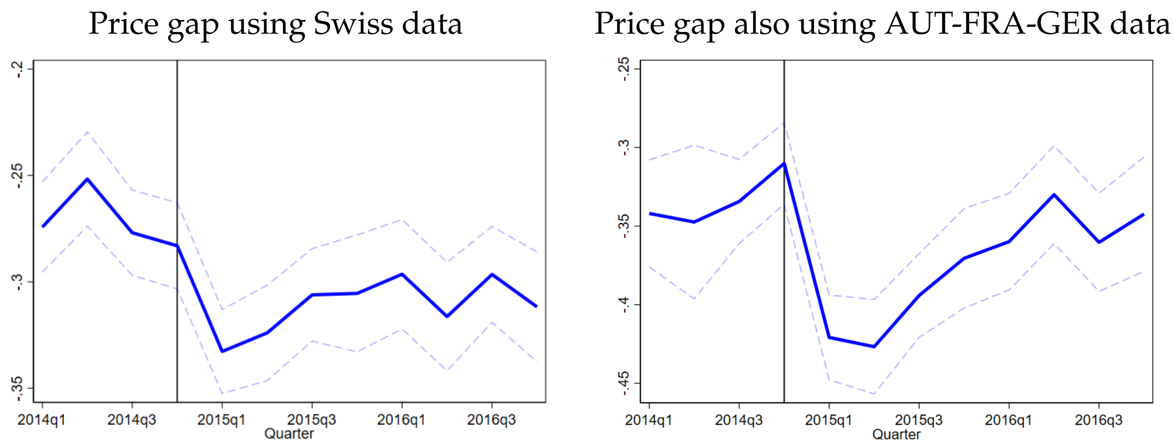
To establish that import shares (defined as import purchases made within Switzer-

[6] Figure 10 in Appendix B displays a map with the spatial distribution of driving times to CB shopping and each of the three measures of CB shares across zip codes.

[7] In all household-level regressions, we weight observations by $X_{hd14} + X_{hf14}$ and cluster by 2 digit zip code. We report sensitivity to not weighting observations.

[8] These results are robust to our weighting strategy; see Table 6 in Appendix B.

Figure 3: CB price gaps



Notes: Estimation of equation (2) showing estimated coefficients β_q and associated 95% confidence intervals. $\log p_{e\ell q}$ is the geometric weighted average of prices across transactions within the $e\ell q$ triplet, using expenditure weights. The left panel uses a sample of Swiss consumers both in Switzerland ($\ell = d$) and abroad ($\ell = f$). The right panel uses a sample of purchases by Swiss consumers in Switzerland ($\ell = d$) and by German, French, and Austrian consumers in their respective countries, in addition to the Swiss consumers purchases abroad ($\ell = f$). Robust standard errors are clustered at the product level and observations are weighted by expenditures per product in the year 2014 (in the Swiss Nielsen data).

land relative to all purchases made within Switzerland) do not vary systematically with distance to the border, we consider a specification of (1) where the dependent variable is the expenditure share of goods purchased within Switzerland that are produced abroad; see Table 7 in Appendix B. We find an insignificant relationship between a household's distance to CB shopping and its import share.

Fact 2: Prices are lower across the border from Switzerland. Cross-border prices fell more than prices of goods purchased in Switzerland following the 2015 CHF appreciation.

Figure 1 in the Introduction shows that CB prices fell by approximately 7 percentage points more than the prices of domestic goods purchased within Switzerland following the 2015 CHF appreciation. The same figure shows that CB prices also fell by approximately 5 percentage points more than prices of foreign goods purchased in Switzerland (what we refer to as imports).

While goods purchased abroad may differ from those purchased within Switzerland, the relative decline in CB prices is not driven by differences across the bundles of products purchased domestically or abroad. We estimate the following regression on the sample of products purchased by Swiss consumers both in Switzerland and abroad,

$$\log p_{e\ell q} = \alpha + \mathbb{FE}_{eq} + \sum_{q} \mathbb{I}_{q'=q} \beta_q \mathbb{I}_{\ell=f} + \varepsilon_{e\ell q} \tag{2}$$

using data spanning 2014-16, where e indexes product, q indexes quarter, ℓ indexes the location in which the product is purchased (domestically, $\ell = d$, or abroad, $\ell = f$), and $\mathbb{I}_{\ell=f}$ is an indicator function that equals one if the location of purchase is abroad. We consider quarters rather than months to reduce measurement error given the small number of goods purchased both in Switzerland and abroad. We measure $\log p_{e\ell q}$ as the geometric weighted average of prices across transactions within the quarter and location of purchase, using expenditure weights. In this regression, β_q identifies the log price gap for a given good purchased within Switzerland and abroad in quarter q, averaged across goods.

The left panel of Figure 3 displays point estimates for β_q and associated 95% confidence intervals. The negative estimates of β_q throughout the sample period indicate that Swiss consumers pay less to buy an identical good abroad. This price gap increased from roughly 27% to 33% in quarter one of 2015 following the 2015 CHF appreciation.[9]

This price gap and its rise following the 2015 CHF appreciation is not specific to the set of goods that Swiss consumers purchase abroad. Using Homescan data obtained from GfK provided by Aimark for Austria, France, and Germany (see Appendix A for details), we find similar results comparing instead the prices of identical goods purchased by Swiss consumers in Switzerland ($\ell = d$) and by German, French, and Austrian consumers in their respective countries ($\ell = f$) in regions close to the Swiss border; see the right panel of Figure 3. We find that goods are less expensive abroad and that this price gap increased following the appreciation.[10]

Fact 3: Cross-border shares increased following the 2015 CHF appreciation.

To obtain an estimate of changes in CB shopping activity by household, we estimate the regression

$$100 \times \frac{X_{hft}}{X_{hft} + X_{hdt}} = \alpha + \mathbb{FE}_h + \sum_{y \neq 2014} \beta_y \mathbb{I}_{y=t} + \varepsilon_{ht} \tag{3}$$

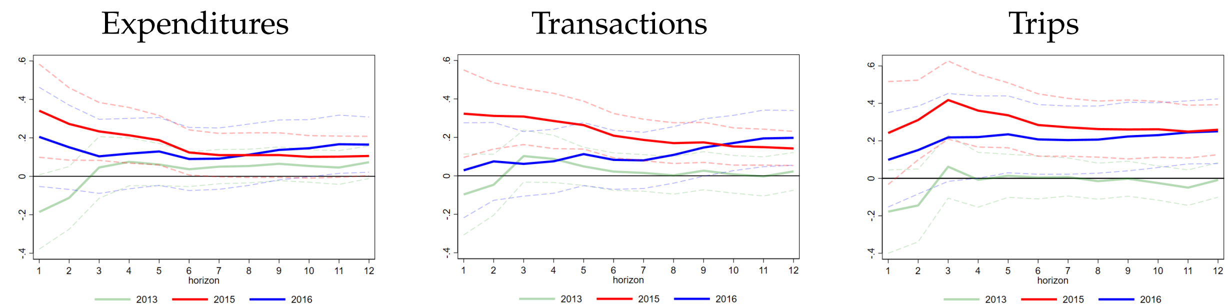
where $X_{h\ell t}$ denotes household h's expenditures, trips, or transactions in location $\ell \in \{d, f\}$ in period t. The year fixed effects β_y identify the percentage point change in the CB share between year y and 2014.

Figure 4 displays year fixed effects when estimating regression (3) separately for each

[9]Prices of imported goods purchased within Switzerland (relative to domestic goods) do not vary significantly with distance to the border. Moreover the decline in 2015 of import prices relative to domestic prices does not vary systematically with distance to the border. See Table 3 in Appendix A.

[10]We also document an increase in prices that Swiss consumers pay when shopping in Germany, France, and Austria relative to prices that German, French, and Austrian consumers pay when shopping near the Swiss border in their respective countries; see Figure 13 in Appendix B. This suggests price discrimination in shops frequented by Swiss consumers abroad and that new CB consumers have less information on lower-price options. While search is an interesting feature of cross-border shopping, we abstract from this feature in our model.

Figure 4: Changes in CB shares compared to 2014



Notes: Estimation of equation (3) showing estimated coefficients β_y and associated 95% confidence intervals, where the outcome variable is $100 \times \frac{X_{hft}}{X_{hft}+X_{hdt}}$ and $X_{h\ell t}$ for $\ell = f, h$ is defined using expenditures (left), transactions (middle), and trips (right) in the relevant horizon within each year. Robust standard errors are clustered by zip code and observations are weighted by $X_{hft} + X_{hdt}$ in 2014.

of twelve horizons, where we define horizon j as the first j months both in year t and in 2014; our annual regressions are equivalent to horizon 12. Across all horizons, there are no economically or statistically significant differences between 2013 and 2014 for any of our three CB shares. On the other hand, the CB share based on trips or transactions was higher in 2015 than it was in 2014, and this persists, to some extent, through 2016. The increase in the CB share using expenditures is smaller and significant in only a subset of months.[11] Our model rationalizes different patterns of adjustment across CB shares measured using trips and expenditures; in Section 4, we show that the CB trip share is the model-consistent measure to calibrate the elasticity of CB shopping to changes in prices given the existence of CB costs that are not measured in retail expenditures.

We additionally show in Tables 8 and 9 in Appendix B that there is no robust relationship between log changes in CB shares and either household income or distance to CB shopping following the 2015 CHF appreciation.

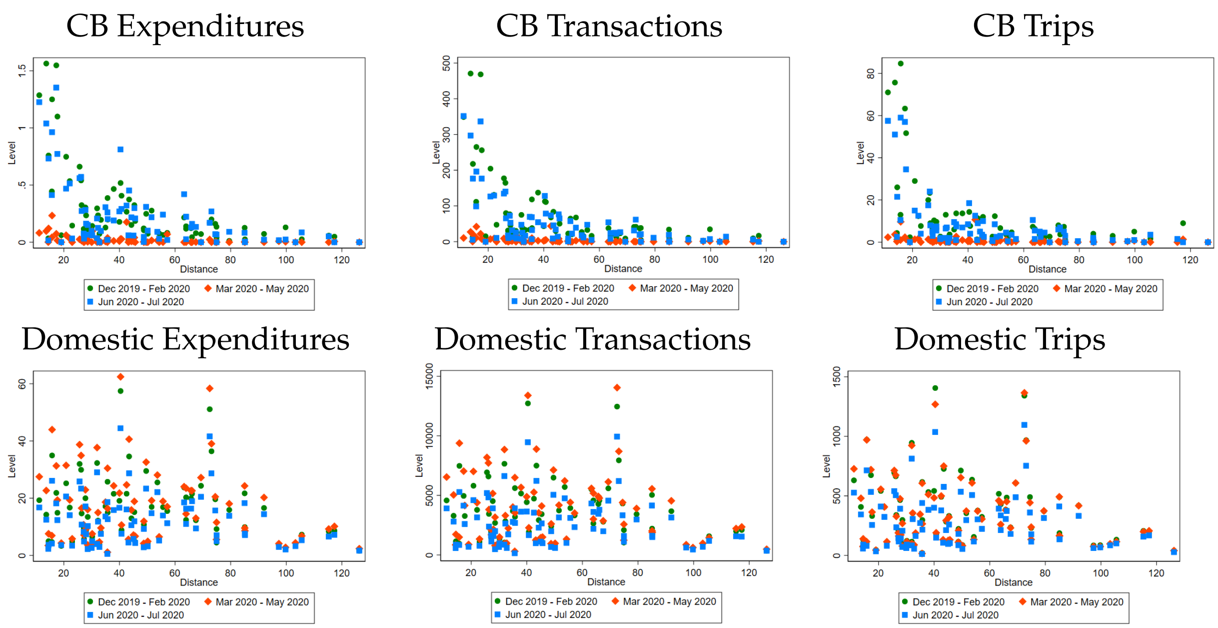
Fact 4: Cross-border shares fell to nearly zero during the 2020 border closure.

On March 16, 2020 the Swiss federal government announced a range of Covid-related measures (effective midnight that day), including the closing of the border for most activities (Swiss Federal Council, 2020a).[12] The Swiss ban on cross-border shopping lasted until June 15, when the neighboring countries also lifted their travel restrictions (Swiss Federal Council, 2020b).

[11] For robustness, we estimate (3) using $\log((X_{hft}+1)/(X_{hdt}+1))$ and $\log(X_{hft}/X_{hdt})$ instead of $100 \times X_{hft}/(X_{hft}+X_{hdt})$; see Figures 14 and 15 in Appendix B.

[12] The federal government's travel ban only explicitly included cross-border shopping from April 16 onwards. Germany and Austria restricted entry from Switzerland effective March 16, requiring a negative Covid-19 test for all travelers other than cross-border work commuters (see i.e. German Federal Ministry of the Interior, Building, and Community, 2020). France put in place a general lockdown effective on March 17, also severely restricting travel across any international borders.

Figure 5: Cross-border and domestic expenditures, transactions, and trips before, during, and after the border closure.



Notes: 2-digit zip code cross-border (in the top three panels) and domestic (in the bottom three panels) expenditures (in 1000 CHF), transactions, and trips averaged across months in the three months before, three months during, and two months after the Swiss border is closed to limit transmission of Covid-19.

Figure 5 displays the levels of expenditures, transactions, and trips averaged across months in the three months before the border lockdown, the three months during the border lockdown, and the two months after the closure was lifted. The top three panels show the levels of CB activity by distance to the border whereas the bottom three panels show levels of expenditures, transactions, and trips for purchases made within Switzerland. Before the border closure in late 2019 and early 2020, there was a strong negative relationship between distance to CB shopping and levels of CB shopping. During the three month border closure, cross-border shopping fell to nearly zero in all regions. After the border closure was lifted, cross-border shopping levels returned roughly to initial levels. In the domestic grocery sector, however, there is very little change in domestic expenditures, transactions, or trips during the lockdown, as shown in the bottom panel of Figure 5.

We complement the above evidence in Figure 16 in Appendix B using data obtained from Monitoring Consumption Switzerland (MCS). Using debit card expenditures on Food, Beverages, and Tobacco by week between January 2019 and June 2020, we show a dramatic reduction in cross-border purchases with little decline in domestic purchases.

Fact 5: Retail employment fell in regions relatively near foreign retailers after the 2015 CHF appreciation.

We obtain annual industry employment across approximately 3,000 four-digit zip codes from the Business Census.[13] The left panel of Figure 6 displays a binscatter across 4-digit zip codes of log changes in retail and, separately, non-retail employment between 2014 and 2016 in which we include no additional controls and weigh each 4-digit zip code by total employment in 2014. Employment in retail falls disproportionately in 4-digit zip codes closer to CB shopping. The opposite occurs within non-retail.

To document this fact more formally across the years 2013-2016 (and control for the time-varying effect of 4-digit zip code income), we estimate

$$\log(emp_{zt}) = \alpha_t + \alpha_z + \sum_{y \neq 2014} \mathbb{I}_{y=t} \left(\beta_t Distance_z + \delta_t \log(Income_z) \right) + \varepsilon_{zt} \tag{4}$$

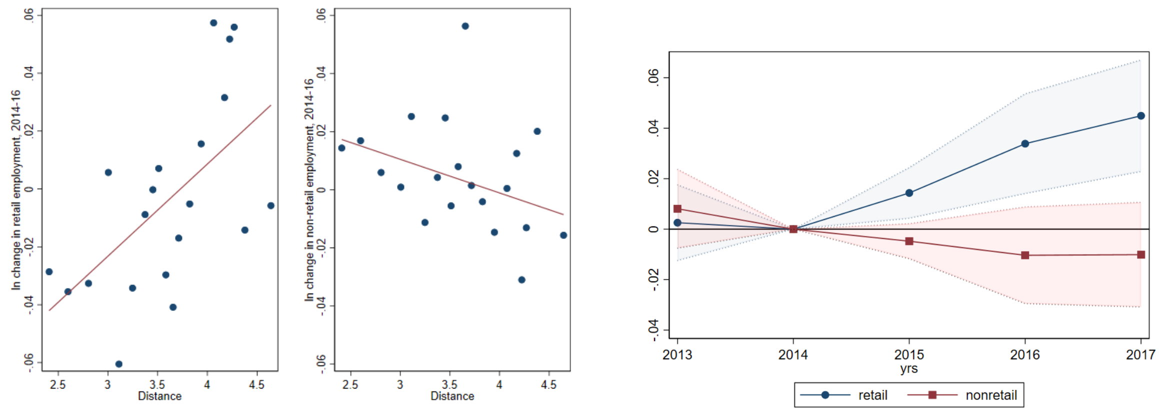
where we index 4-digit zip codes by z, emp_{zt} is employment in z in year t, $Distance_z$ is the log of travel time from each 4-digit zip code to cross-border shopping, and $Income_z$ denotes median income per household by 4-digit zip code using Federal Tax Administration data (see Appendix A for details). We estimate (4) separately for retail employment and non-retail employment. The coefficient β_t identifies the change in log employment in retail and, separately, in non-retail between year t and 2014 within four-digit zip codes that are farther from CB shopping relative to those that are nearer.

The right panel of Figure 6 displays point estimates for β_t and corresponding 95% confidence intervals. We find that 4-digit zip codes with longer drives to CB shopping experienced statistically significant increases (relative to those closer to CB shopping) in retail employment following the 2015 CHF appreciation; the coefficient is approximately 0.014 and 0.034 in 2015 and 2016, respectively. Retail employment in a 4-digit zip code at the 90th percentile of log travel time to CB shopping rose by 0.025 and 0.058 log points relative to one at the 10th percentile between 2014 and 2015 and between 2014 and 2016, respectively. This pattern is not a continuation of pre-existing trends. To establish that this differential pattern of employment responses is related to differential spatial shopping behaviors, rather than local business cycles, the right panel also shows that the employment response of non-retail is small, of the opposite sign, and insignificantly different from zero.

Fact 5 is closely related to Facts 1 and 3, as can be seen from a log-linearization of

[13] We use 4-digit zip codes for our baseline employment analysis because we are not restricted by the Nielsen data's more aggregated geographic scheme. Employment results are essentially the same when restricted to 2-digit zip codes or without controlling for income.

Figure 6: Retail and non-retail employment around the 2015 appreciation



Notes: The left panel displays a binscatter, with 20 bins, of the log change in retail (left) and, separately, non-retail (right) employment between 2014 and 2016 on distance (i.e., the log of driving time to CB shopping) across all 4-digit zip codes; there are no controls and observations are weighted by 4-digit zip code total employment in 2014. The right panel displays point estimates of β_t and associated 95% confidence intervals from estimating equation (4) separately for retail and non-retail employment; robust standard errors are clustered at the 4-digit zip code and observations are weighted by 4-digit zip code total employment in 2014.

$\frac{X_{hdt}}{X_{hdt}+X_{hft}} + \frac{X_{hft}}{X_{hdt}+X_{hft}} = 1$ at $t_0 = 2014$,

$$d \log \frac{X_{hdt}}{X_{hdt} + X_{hft}} = \frac{X_{hft_0}}{X_{hdt_0} + X_{hft_0}} \left(d \log X_{hdt} - d \log X_{hft} \right). \tag{5}$$

According to Fact 1, the budget share of CB purchases, $X_{hft_0}/(X_{hdt_0} + X_{hft_0})$, is higher for zip codes closer to CB shopping. According to Fact 3, in response to the 2015 CHF appreciation $d \log X_{hdt} - d \log X_{hft} < 0$ and this difference does not vary with distance to the border. Hence, equation (5) implies that in response to the 2015 CHF appreciation, the share of expenditures on goods purchased domestically falls disproportionately in regions that are closer to CB shopping.[14] Local retail expenditure also falls more in these regions if changes in total expenditures do not vary with distance to CB shopping. This result extends to local retail employment if it is an increasing function of local retail expenditures (due to, e.g. sticky wages in the retail sector or local wages being determined by aggregate local economic conditions rather than conditions only within the retail sector).

4 A simple model of cross-border shopping

Setup. Every period, households have preferences for consumption over a continuum of shopping trips indexed by $z \in [0, 1]$. Each trip, households choose whether to shop

[14] We assume that households shopping within Switzerland are more likely to shop in the region in which they live than elsewhere within Switzerland.

domestically, $\ell = d$, or across the border in a foreign country, $\ell = f$. Each trip is subject to household-specific pecuniary and non-pecuniary per-unit costs and benefits that depend on the location the household chooses to shop. In addition to these costs that are common across trips, we also incorporate idiosyncratic pecuniary and non-pecuniary costs that vary across trips for each household, a combination of which is distributed Fréchet.

Specifically, utility of household h at time t is given by

$$u_{ht} = \int_0^1 \left[\sum_{\ell=d,f} a_{h\ell t} \left(\varepsilon_{h\ell t}(z)\right)^{1-\chi} c_{h\ell t}(z) \right]^{\frac{\rho-1}{\rho}} dz$$

Here, $c_{h\ell t}(z)$ is the quantity of goods purchased in location ℓ in trip z, which is a homothetic aggregator of individual goods (including domestic and imported goods).[15] The term $a_{h\ell t}$ represents the non-pecuniary valuation of household h over amenities in location ℓ across all trips in period t whereas the term $(\varepsilon_{h\ell t}(z))^{1-\chi}$ represents the non-pecuniary valuation of household h over amenities in location ℓ that is idiosyncratic across trips z. According to the previous expression, the elasticity of substitution between domestic and cross-border consumption is infinite within each trip. On the other hand, the elasticity of substitution across individual goods within a shopping location, which is encoded in the homothetic aggregator $c_{h\ell t}(z)$, is flexible.[16]

The budget constraint of household h is

$$\mathrm{I}_{ht} = \sum_{\ell=d,f} p_{h\ell t} \tau_{h\ell t} \int_0^1 c_{h\ell t}(z) \times \left(\varepsilon_{h\ell t}(z)\right)^{-\chi} dz$$

Here, $p_{h\ell t}$ is the retail price of the consumption good in location ℓ, which does not vary across trips within a period.[17] The term $\tau_{h\ell t}$ represents pecuniary non-retail costs (monetary costs that are not paid directly to the retailer such as costs of transportation, exchanging money, or shopping time) associated with shopping in location ℓ across all trips in period t whereas the term $(\varepsilon_{h\ell t}(z))^{-\chi}$ represents pecuniary non-retail costs for this

[15] We assume that preferences are homothetic because, as we showed in Section 3, initial CB shares and changes in CB shares in 2015 do not vary systematically with household income. On the other hand, Auer et al. (2022) document significant differences in price elasticities within groceries across households. It is straightforward to extent the model to allow for generalized non-homotheticities CES preferences as in Auer et al. (2022). We do not do so to keep the presentation simpler.

[16] The parameter ρ, which governs the substitutability of consumption across shopping trips, plays no role in our results.

[17] Since average prices within Switzerland do not vary much across regions (see Figure 9 in Appendix A), we assume a common price that household h faces for domestic shopping across all Swiss regions, p_{hdt}, as well as a common cost and amenity per household across Swiss regions, a_{hdt} and $\tau_{h\ell t}$. Therefore, if a household shops domestically we abstract from where in Switzerland it chooses to shop.

household of shopping in location ℓ that are idiosyncratic across trips z.[18] The ratio of the idiosyncratic amenity relative to the idiosyncratic cost of shopping in location ℓ in trip z is simply $\varepsilon_{h\ell t}(z)$. We assume that $\varepsilon_{h\ell t}(z)$ is distributed Fréchet, $G(\varepsilon) = \exp\left(-\varepsilon^{-\theta}\right)$ with $\theta > \rho - 1$.

This formulation nests two standard extreme cases of discrete choice models in which idiosyncratic costs or benefits are assumed to be either purely pecuniary, $\chi = 1$, or non-pecuniary, $\chi = 0$. We show that this distinction matters for welfare measurement.

Trip and expenditure shares by location. Household h chooses to shop in location ℓ in shopping trip z if $\ell = \arg\max_{\ell'}\{a_{h\ell' t}\varepsilon_{h\ell' t}(z)/(\tau_{h\ell' t}p_{h\ell' t})\}$. The optimal choice of shopping location is invariant to the parameter χ. Given the distribution of ε, the share of trips the household makes to location ℓ in period t is

$$\pi_{h\ell t} = \frac{\left[a_{h\ell t}/\left(\tau_{h\ell t}p_{h\ell t}\right)\right]^{\theta}}{\sum_{\ell'=d,f}\left[a_{h\ell' t}/\left(\tau_{h\ell' t}p_{h\ell' t}\right)\right]^{\theta}} \tag{6}$$

The elasticity of the CB share of trips with respect to retail prices is equal to θ. The lower is the dispersion of the combination of idiosyncratic amenity and cost draws (higher θ), the higher is this elasticity.[19]

The share of total expenditures the household incurs shopping in location ℓ including retail and non-retail costs is also equal to $\pi_{h\ell t}$. However, the share of retail expenditures (which we measure in the data and which does not include non-retail costs) is generically not equal to $\pi_{h\ell t}$. Moreover, the elasticity of the CB share of retail expenditures with respect to retail prices is generically not equal to the elasticity of the CB share of total expenditures.[20]

[18] For a simple way of incorporating shopping time into our consumer problem, suppose that consumption $c_{h\ell t}(z)$ results from a Cobb-Douglass combination of goods (with weight $1-\tau_{h\ell t}$ and price $\bar{p}_{h\ell t}$) and time (with weight $\tau_{h\ell t}$ and price given by the wage w_{ht}). In the budget constraint, $p_{h\ell t} = \bar{p}_{h\ell t}^{1-\tau_{h\ell t}}$, $\tau_{h\ell t} = w_{ht}^{\tau_{h\ell t}}$, and income I_{ht} is the product of the wage w_{ht} and the time endowment. To perform counterfactuals with respect to changes in retail prices requires knowledge of the parameter $\tau_{h\ell t}$ (unless we consider a shift to CB autarky, as in one of our counterfactuals). Note that if $\tau_{hft} > \tau_{hdt}$, then higher wage households effectively face higher CB costs and engage in less cross-border shopping.

[19] The assumption that this elasticity does not vary across locations is consistent with Fact 3 that log changes in CB shares in 2015 do not vary systematically with distance to CB shopping.

[20] The distribution of *total* expenditures across trips in ℓ is determined by the distribution of $p_{h\ell t}\tau_{h\ell t}c_{h\ell t}(z)(\varepsilon_{h\ell t}(z))^{-\chi}$ conditional on shopping in ℓ during trip z. This distribution is independent of ℓ, which implies that the total expenditure share of CB shopping equals the trip share. The distribution of *retail* expenditures across trips in ℓ is determined by the distribution of $p_{h\ell t}c_{h\ell t}(z)$ conditional on shopping in ℓ during trip z. In general, this distribution depends on ℓ; hence, the retail expenditure CB share does not equal the total expenditure CB share or the trip CB share. In the special case of $\chi = 0$, whereas the retail expenditure share does not equal the total expenditure share (because of non-retail costs $\tau_{h\ell t}$), the elasticity of each to retail prices $p_{h\ell t}$ is θ. In general, however, if $\chi > 0$ then the elasticity of the retail expenditure share does not equal the elasticity of the total expenditure share.

Welfare changes. Consider changes in household h's income from I_{ht_0} to I_{ht_1}, prices from $\mathbf{p}_{ht_0}$ to $\mathbf{p}_{ht_1}$, and pecuniary non-retail costs from $\mathbf{r}_{ht_0}$ to $\mathbf{r}_{ht_1}$ (these vectors contain an element for each location). We measure welfare changes by the compensating variation:[21] the reduction in income (in logs) under the final budget set that makes the household equally well-off as under the initial budget set. If household h is better off under the final than initial budget set, then $CV_h > 0$.

Using the expenditure function,[22] we can express welfare changes as the log change in nominal income minus the welfare-relevant price deflator:

$$\begin{aligned} \text{welfare}_h &= \log\left(\frac{\mathrm{I}_{ht_1}}{\mathrm{I}_{ht_0}}\right) - \log\left(\frac{e\left[\mathbf{p}_{ht_1}, \mathbf{r}_{ht_1}, u_{ht_0}\right]}{e\left[\mathbf{p}_{ht_0}, \mathbf{r}_{ht_0}, u_{ht_0}\right]}\right) \\ &= \log\left(\frac{\mathrm{I}_{ht_1}}{\mathrm{I}_{ht_0}}\right) - \underbrace{\log\left(\sum_{\ell=d,f} \pi_{h\ell t_0}\left(\frac{p_{h\ell t_1}}{p_{h\ell t_0}}\frac{\tau_{h\ell t_1}}{\tau_{h\ell t_0}}\right)^{-\theta}\right)^{\frac{-1}{\theta}}}_{\text{price deflator}} \end{aligned} \tag{7}$$

Given our emphasis on the expenditure-side effects of changes in cross-border shopping prices, in our quantitative exercises below we consider welfare changes across households with common income changes and heterogeneous price deflators across space. To construct the change in price deflators in response to changes in retail prices $p_{h\ell t_1}/p_{h\ell t_0}$ and non-retail costs $\tau_{h\ell t_1}/\tau_{h\ell t_0}$, we need to assign values to the initial share of total expenditures on cross-border shopping by household $\pi_{h\ell t_0}$, and to the parameter θ that controls the elasticity of the share of total expenditure on cross-border shopping with respect to changes in retail prices. In response to non-marginal changes in CB to non CB prices, the increase in the price deflator is smaller, or the decrease is larger, the higher is this elasticity.

Discussion of modeling choices. In our model, households make a continuum of shopping trips every period. We make this assumption so that CB shares are common across households with common observable characteristics. However, this assumption implies that the fraction of households that engage in CB shopping is constant across time hori-

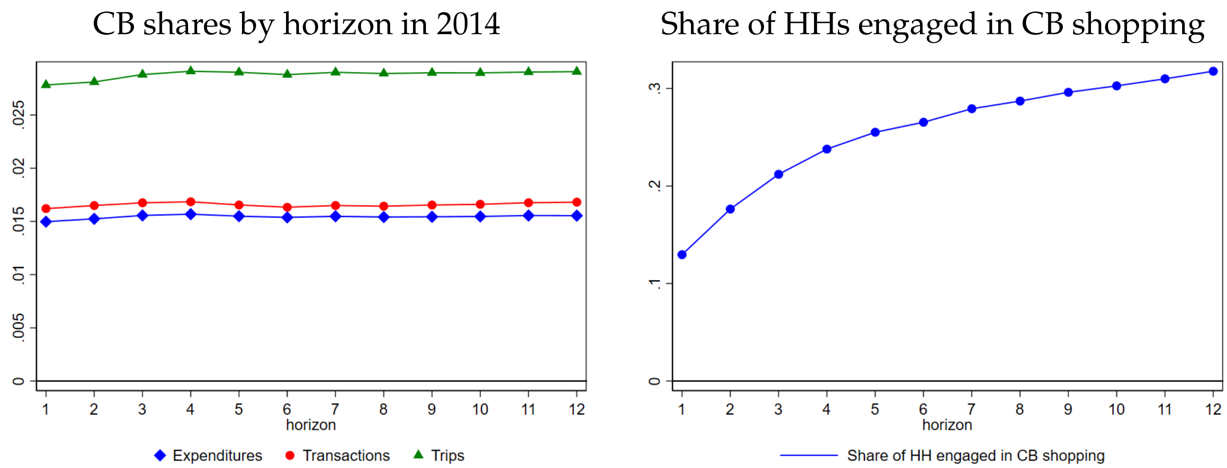
[21]Since preferences are homothetic, compensating variation is equal to equivalent variation.

[22]The expenditure function for household h at time t which faces a vector of retail prices $\mathbf{p}_{ht}$ and pecuniary non-retail costs $\mathbf{r}_{ht}$ can be written, using equation (6), as

$$e\left(\mathbf{p}_{ht}, \mathbf{r}_{ht}, u_{ht}\right) = \bar{\theta}\left[\sum_{\ell=d,f}\left(\frac{\tau_{h\ell t} p_{h\ell t}}{a_{h\ell t}}\right)^{-\theta}\right]^{\frac{-1}{\theta}} u_{ht},$$

where $\bar{\theta}$ is a parameter that is a function of θ.

Figure 7: CB shares and share of households engaged in CB shopping by horizon in 2014



Notes: The left panel shows the aggregate share of CB activity $X_{ft}/(X_{ft} + X_{dt})$ where $X_{\ell t}$ for $\ell = f$ is defined using total expenditures, transactions, and trips over each horizon within the year 2014. The right panel plots the share of households that made at least one CB shopping trip over each horizon in the year 2014.

zons (in the absence of price changes), which is inconsistent with the data; see the right panel of Figure 7. Of course, if we assume that we observe in our data a random, finite sample of shopping trips for each household, our model is consistent with this rising share of households observed to be engaged in CB shopping over time horizons.[23]

In our model, households do not incur fixed costs of shopping and do not have access to a technology allowing them to store goods. In order to study whether households respond to the appreciation differently for products that are more storable, we manually code perishable products—e.g., fruits, vegetables, fish, bread and other bakery items, etc.—as non-storable. We find that CB shares are higher for storable items, which is consistent with a model of higher fixed shopping costs abroad and heterogeneous storage costs by good; see Agarwal et al. (2020) for a model incorporating spatial shopping decisions with storage costs. However, while introducing dynamic considerations into a model of CB shopping is an interesting and realistic extension in its own, we do not incorporate this feature both because it makes the model less tractable and, more importantly, because we find that CB shares in both storable and non-storable items fall with distance to CB shopping, see Figure 18 in Appendix B, and that switching to CB shopping is similar for storable and non-storable items in response to the 2015 CHF appreciation,

[23]Instead of making a continuum of trips, we could instead assume that households make a fixed, finite number of trips. In this case, if we set $\rho = 1$ all of our analytic expressions continue to hold, but these now apply to averages across households; households differ in their CB shares; some households do not make any CB (or domestic) shopping trips; and the share of households engaged in any CB (or domestic) shopping rises with time. In any of these model specifications, CB shares are common across horizons within a year, as shown in the left panel of Figure 7.

as shown in Figures 19 and 20 in Appendix B.

Finally, we abstract from the joint determination of cross-border commuting and cross-border shopping given the very small share of Swiss residents who work abroad; see Miyauchi et al. (2021) for a model incorporating joint commuting and spatial shopping decisions. According to Swiss Federal Statistical Office (2020a), approximately 25,000 cross-border commuters lived in Switzerland and worked abroad—averaged across the years 2014 - 2016—of whom more than half did not have Swiss citizenship. This number represents approximately one half of one percent of the total workforce in Switzerland, which is substantially smaller than the 30% of households that cross-border shop in our data.Very few people choose to live in Switzerland and work abroad because wages and costs of living are much higher in Switzerland than in neighboring countries.[24]

5 Parameterization and counterfactuals

Parameterization. To construct changes in the welfare-relevant deflator in response to given changes in prices, defined in (7), we need to assign values to *(i)* the initial share of expenditures on cross-border shopping by household, and *(ii)* the parameter θ that governs the elasticity of the share of total expenditure on cross-border shopping with respect to changes in retail prices.

We measure initial CB shares using our Nielsen data, which covers only groceries. Using debit card payments of Swiss consumers from Monitoring Consumption Switzerland, we observe lower shares of debit payments abroad in the Retail (food, beverage, and tobacco) sector than in most other consumption sectors and lower than the overall share; see Appendix A for data details. We do not use this data in our quantification both because the share of debit relative to cash payments abroad is likely higher than within Switzerland and because total expenditure shares, not retail expenditure shares, are the relevant input for our welfare calculations.

In our Nielsen data, we observe the share of retail expenditures on cross-border shopping (the retail expenditure share) and the share of shopping trips abroad. As discussed above, the retail expenditure share does not equal the total expenditure share given the existence of non-retail shopping costs such as costs of transportation, exchanging money, and shopping time. However, under our model assumptions, the CB trip share equals the total CB expenditure share. Hence, we measure initial expenditure shares in the grocery sector, $\pi_{h\ell t_0}$, using the initial CB trip share.

[24] In contrast, the number of commuters who choose to live abroad and work in Switzerland in 2014 - 2016 is over 12 times greater than the number that live in Switzerland and commute abroad.

According to Fact 1, there are no systematic differences in CB trip shares across household incomes. Hence, we construct initial CB trip shares as the average value of the CB trip share across all households within a given two-digit zip code. This share varies across locations from a low of approximately 0% to a high of approximately 17%; see the right panel of Figure 2.

We use data on retail prices and household-specific CB shares around the 2015 CHF appreciation to calibrate θ. The log change in household h's total CB expenditures relative to total domestic expenditures is

$$d \log \frac{X_{hft}}{X_{hdt}} = -\theta \left(d \log p_{hdt} - d \log p_{hft} \right) + \nu_{ht}, \tag{8}$$

where $\nu_{ht} \equiv \theta \left(d \log \frac{a_{hft}}{\tau_{hft}} - d \log \frac{a_{hdt}}{\tau_{hdt}} \right)$.

We measure the left-hand side of equation (8) using trip shares; we report robustness to using transaction and retail expenditure shares. We measure the log change in the retail price of goods purchased domestically or abroad as the (initial) expenditure-weighted average of changes in prices during the corresponding time period of individual products purchased within Switzerland or abroad. We impose common changes in prices across zip codes and households, $d \log p_{h\ell t} = d \log p_{\ell t}$, because we find that there are no systematic differences in price changes across zip codes, as shown in Table 3 in Appendix A. We find that $d \log p_{ft} = -0.077$ and $d \log p_{dt} = -0.017$, implying an approximately 6.1% reduction in the relative retail price of cross-border shopping between 2014 and 2015.

The term ν_{ht} in equation (8) reflects changes in demand and in non-retail costs between CB and domestic shopping. By taking differences between $t = 2014$ and 2015, level differences in demand and non-retail costs across households do not enter the residual. Our assumption is that, on average, there are no demand shocks or changes in non-retail costs for CB shopping between 2014 and 2015. In a robustness check, we include changes in shares and prices across 2013 - 2016, slightly relaxing this assumption. In this case, we assume that demand and non-retail cost shocks are not systematically correlated with prices changes.

Column 1 of Table 2 displays our baseline result: $\theta = 1.25$.[25] Column 2 reports results if we use data spanning 2013 - 2016 (rather than only between 2014 and 2015 as in our baseline), taking differences in each year t relative to 2014. Column 3 reports results in which we do not weigh observations (rather than weighing each observation by household total shopping trips in 2014 as in our baseline). Columns 4 - 6 report results using

[25] Fixed expenditure shares would be equivalent to $\theta = 0$.

Table 2: Choosing θ

	(1) Baseline	(2) Panel	(3) Unwght	(4) 3M	(5) 6M	(6) 9M	(7) Expend.	(8) Transact.
$dlog\frac{p_{ft}}{p_{dt}}$	-1.247***	-1.100***	-1.367***	-1.534***	-0.769*	-1.127***	-1.103*	-1.100*
	[0.427]	[0.394]	[0.461]	[0.462]	[0.423]	[0.422]	[0.659]	[0.601]
Observations	762	3417	762	426	569	678	762	762

Notes: Estimation of equation (8). Our baseline, column 1, uses changes between 2014 and 2015 over the full year, measures $X_{h\ell t}$ as the number shopping trips made by household h to location ℓ in year t, and weighs each observation by the number of total shopping trips made by h in 2014. Column 2 uses data spanning 2013 - 2016, taking differences relative to 2014. Column 3 does not weigh observations. Columns 4 - 6 replicate column 1 but use horizons 3, 6, and 9 months instead of horizon 12 months. Columns 7 and 8 measure the dependent variable and weigh observations using expenditures and transactions, respectively. Robust standard error are clustered at the zip code level. *p<.1; **p<.05; ***p<.01

changes in relative CB shares and prices measured over the first 3, 6, and 9 month horizons in both 2014 and 2015 (rather than over both full years as in our baseline). Columns 7 and 8 report results constructing the dependent variable using retail expenditure shares and transaction shares (rather than trip shares as in our baseline). Estimates of θ range between 1.1 and 1.5 (the estimate of θ at 6 month horizon is lower but less tightly estimated).

Welfare implications of changes in CB prices. We consider two (factual) episodes: the fall in prices following the 2015 CHF appreciation and the sharp, temporary decline in cross-border shopping during the Covid-19 border lockdown in 2020. In both cases, we calculate the change in the welfare-relevant deflator defined in (7) since our focus is on the heterogeneous expenditure-side effects of changes in cross-border shopping prices.[26]

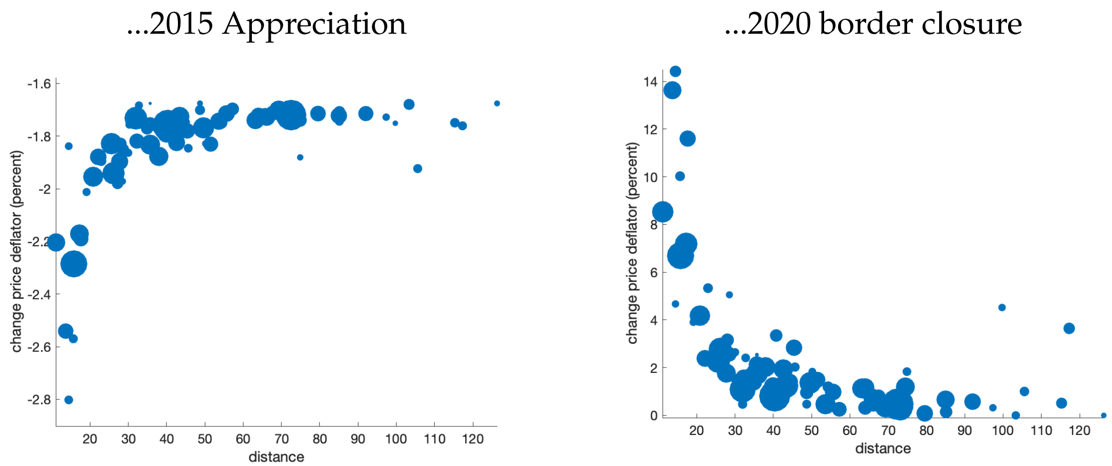
First, we quantify the heterogeneous welfare effects across space in response to the fall in prices following the 2015 CHF appreciation. In particular, we feed in 12-month changes in prices from the Nielsen data assuming no variation in retail price changes across Swiss regions, consistent with the Swiss data (see Table 3 in Appendix A). The price of domestically purchased goods falls by 1.7% and the price of foreign purchased goods falls by 7.7.[27]

The left panel of Figure 8 shows that regions that are closer to CB shopping experience a larger decline in price deflator. Whereas regions that do not engage in CB shopping experience a reduction of roughly 1.8%, regions close to the border experience a reduction of roughly 2.6%, with large variation across zip codes according to their pre-shock CB shares.

[26] We thus abstract from differences across locations in income changes due to CB shopping. Table 4 in Appendix B shows that pre-tax income changes across 3161 4-digit zip codes between 2014 and 2015 did not vary significantly with distance to CB shopping.

[27] We construct these price changes as an expenditure-weighted average of changes in the price of individual goods, either purchased in Switzerland or abroad. This is a first-order approximation of the expenditure function of a homothetic aggregator of individual goods.

Figure 8: Changes in price deflator associated with the...



Notes: Quantification of changes in welfare-relevant deflator in each zip code associated the 2015 CHF appreciation and the temporary 2020 border closure plotted against travel time to CB shopping. Distance is measured as travel time.

Second, we quantify the welfare losses of losing access to cross-border shopping due to, for example, the Covid-19-related border lockdown in 2020. We assume that prices of goods purchased within Switzerland do not change differentially across zip codes. This assumption is consistent with Fact 6 in Appendix B showing that there was no systematic relationship between non-CB price changes during the 2020 border closure and distance to CB shopping. The right panel of Figure 8 shows that the price deflator rises substantially (up to approximately 14%) close to the border, whereas regions that do not engage in much CB shopping are largely unaffected. Given the magnitude of the shock, these results are sensitive to the value of the CB elasticity θ. Figure 21 in the appendix provides robustness for the range of elasticities displayed in Table 2: $\theta = 1$ and $\theta = 1.5$. At our low (and high) estimate of θ values, the price deflator close to the border rises by approximately 18% (and 12%).

In summary, there are substantial welfare gains associated with access to cross-border shopping in regions near the Swiss border as well as large distributional effects across Swiss regions of changes in international prices.

6 Conclusions

A vast literature studies patterns of international trade, responses of trade to trade policy and other international price shocks, and the welfare implications of these patterns. However, this literature does not separate between consumption of imports purchased indirectly through domestic retailers or purchased directly from foreign retailers across the border.

Switzerland provides an ideal laboratory to study spatial shopping. We document that cross-border shopping shares vary substantially across regions (a pattern not evident in import shares omitting cross-border shopping) and (like imports) respond elastically to changes in relative prices across the border. We use these and other facts to calibrate a simple discrete choice model of cross-border shopping. We show that there are substantial welfare benefits in Swiss regions near the border from access to cross-border shopping and quantify the heterogeneous effects across space of changes in international prices—such as those caused by the 2015 CHF appreciation—on the cost of living.

Our framework focuses exclusively on demand, taking observed price changes as given. For certain counterfactuals—such as quantifying the long-run (rather than three-month) effects of a border closure—it might be important to endogenize price changes across regions in general equilibrium.

Our empirical evidence documents substantial variation in cross-border shopping shares with distance to the border, but no such systematic variation in import shares. Distance to the border does not reduce consumption of imports purchased in Switzerland because imported and non-imported goods' retail prices in Switzerland are uniform across space. This suggests that retailers and wholesalers have access to technologies that consumers do not. Cross-border shopping may also change retailers' incentives to price discriminate across space. These are interesting areas for future research.

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A Data appendix

Additional details on how we process the Nielsen data.

For expositional purposes, to examine the period around the January 2015 appreciation we shift the data of all transactions by 15 days, so that the appreciation coincides with the change in the calendar year. For example, what is referred to as 2015 (or the first quarter of 2015) includes the actual calendar dates January 15, 2015-January 14, 2016 (January 15, 2015 - April 14, 2015).

Participating households manually enter data on their transactions. We remove potential errors in the data using a two-step procedure. First, for each transaction we calculate the unweighted average log price across all other transactions of the same product. We then identify all transactions with a price level exactly equal to one and, within this set of transactions, drop any transaction for which the absolute value of the log average price excluding this transaction is greater than 2; we do this because it appears that some transactions are accidentally coded as having a price of one. Second, on the remaining sample, for each transaction we re-calculate the unweighted average log price across all other transactions in the same product and drop each transaction for which the absolute value of the log price minus the log average price excluding this transaction within the product is greater than 2. These transactions may correspond to instances in which quantity and price have been switched. This two-step procedure drops very few transactions: e.g., 274 in 2014, 613 in 2015, and 693 in 2019. In addition, we drop 592 observations in the whole dataset, where either the price or the quantity purchased is entered as a non-positive number.

All cross-border purchases are originally specified in EUR at the place of purchase.[28] Nielsen explicitly asks their panelists to record all CB purchases in EUR. In the raw data provided to us by Nielsen, prices for all purchases have been converted to CHF. To convert from EUR to CHF, Nielsen uses an exchange rate that is updated only infrequently. To correct for this infrequency, we convert the CB prices back to EUR (using Nielsen's exchange rate, which they provided to us) and then convert the EUR prices back to CHF, using the official daily CHF/EUR exchange rate on the day of the transaction. To do so, we use the daily exchange rate data from the SNB, which is shown in Figure 1.

Throughout the analysis, we focus on prices including the local VAT. In practice, Swiss CB shoppers can have the VAT in the country they shop reimbursed when exiting the country, in which case they instead must pay the equivalent Swiss VAT rate as a customs duty (for transactions that exceed the allowance of 300 CHF). Given that the transaction

[28] Legislation in Austria, France, Germany, and Italy requires prices to be specified in the local currency.

costs involved makes it unlikely that the VAT reimbursement is requested, and given our focus on price changes rather than levels, we do not adjust our data to incorporate potential VAT reimbursements.

There are 93 different two-digit zip codes in Switzerland, which uniquely identify cities such as Basel or Zurich, or, in rural areas, smaller regions such as such "Engadin and Val Müstair." The education groups identified in the Homescan data are defined as 1=obligatory school (9 years) "obligatorische Schule", 2=Vocational Education and Training "Berufsausbildung", 3=University entrance qualification "Matura", 4=College of Higher Education "hoehere Berufsausbildung", 5=College "hoehere Fachschule", 6= University "Hochschule / Universitaet", 7= other "andere Ausbildung."

Details on construction of distance to CB shopping. We calculate measures of distance to cross-border shopping as follows. We first identify the set of supermarkets, $s \in \mathcal{S}$, in Austria, France, Germany, and Italy that are close to the Swiss border. We identify the address of cross-border retail outlets via a manual search for the term "supermarket" in Google Maps in all regions bordering Switzerland in Austria, Germany, Italy, and France. We then calculate the driving time between each 4-digit zip code z in Switzerland and all identified cross-border retail outlets using google maps. Within each z, the starting point is the center of the zip code determined automatically by google maps. In the next step, we take the minimum of the identified driving times for each zip code, i.e. $time_z = \min_{s\in\mathcal{S}} \{time_{zs}\}$, where $time_{zs}$ denotes the driving time in minutes of a one way car trip from t_z to supermarket s. For our main analysis in the Nielsen data, we average the driving time across 4-digit zip codes within each 2 digit zip code region. For our employment analysis, we keep driving times at the 4-digit zip code level.[29] In our analysis, we use the log of driving time to CB shopping as our measure of distance (referred to as *distance*).

Prices across regions within Switzerland. Average prices across individual products do not vary much across regions within Switzerland. To document this fact, we estimate

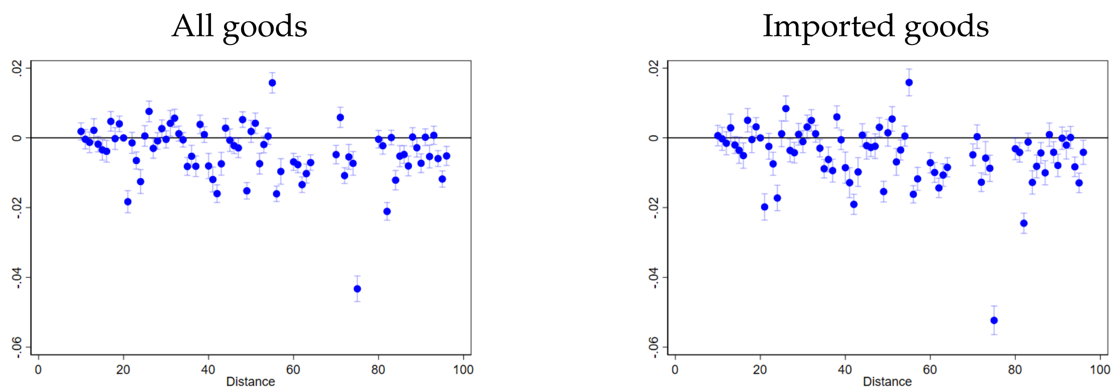
$$\log p_{ej} = \alpha + \mathbb{FE}_e + \mathbb{FE}_j + \varepsilon_{ej} \tag{9}$$

where $\log p_{ej}$ is the weighted average log price for domestic purchases in 2014 of product e within 2-digit-zip code j, $\mathbb{FE}_j$ is a 2-digit zip-code specific fixed effect, and $\mathbb{FE}_e$ is a product-specific fixed effect. We consider separately all goods and imported goods purchased in Switzerland. We weigh observations by expenditures in 2014.

Figure 9 displays our estimated 2-digit-zip code fixed effects—Neuchâtel (the two-

[29] The google maps search was performed in May and June 2020.

Figure 9: Border distance and price level in Switzerland in 2014



Notes: Estimation of equation (9), showing estimated zip code fixed effects and associated 95% confidence intervals, with robust standard errors clustered at the two-digit zip code level. The omitted zip code is Neuchatel (the two-digit zip code location with the median distance to the border). The outlier is a two-digit zip code with only 8 households in the dataset. The estimation sample of products are those purchased within Switzerland.

Table 3: Import relative to non-import price differences (levels + changes) across zip codes

	2014 levels	2014–2015 changes
	(1)	(2)
Distance × Import	-0.001	-0.001
	[0.001]	[0.001]
Observations	230030	152623

Notes: We estimate $y_{ez} = \alpha_z + \alpha_e + \mathbb{I}_{e \in \mathcal{E}_M} Distance_z$ where α_z and α_e are 2-digit zip code and product (EAN) fixed effects, $Distance_z$ is the log of travel time from zip code z to CB shopping, and $\mathbb{I}_{e \in \mathcal{E}_M}$ is an indicator that equals one if e is imported. We weigh observations by expenditure in 2014 within zip code z on product e and cluster by zip code. We define y_{ez} as the log price level in 2014 in column 1 and the log price change between 2014 and 2015 in column 2. *p<.1; **p<.05; ***p<.01

zip code location with the median distance to the border) is the omitted fixed effect—and associated 95% confidence intervals, with standard errors clustered at the 2-digit-zip code level. There are small differences in average prices across regions (conditioning on the range of offered products), both for all goods and for imported goods only.[30] Similar results hold in 2015.

Column 1 of Table 3 shows formally that the price of imported products relative to domestically produced products (both purchased within Switzerland) does not vary systematically with distance to CB shopping. Column 2 shows that the same is true of the change in the relative price of imports to domestically produced output.

Gesellschaft für Konsumforschung (GfK) Homescan provided by Aimark. To compare the prices Swiss households pay with the prices paid in neighboring countries, we use Homescan data for Austria, France, and Germany from AiMark collected by the national GfKs. We match the prices for all EANs observed in Switzerland to the prices paid in the

[30]The large outlier with prices being around 4.5% lower than in the reference zip code is "Engadin, Val Münstair," where only 8 households in the dataset live.

regions bordering Switzerland for France and Germany, where such regional information is available.[31] We convert all prices into CHF using the daily CHF-EUR exchange rate from the SNB.

Monitoring Consumption Switzerland. Monitoring Consumption collects aggregated payment data provided by the major Swiss payment service providers from the start of 2019 onwards for debits cards.[32] The website provides weekly payments made with debit cards issued to Swiss residents by sector (ie "retail food, beverages, and tobacco" or "other retail") and the region or country in which the payment was made. Brown et al. (2022) provide a detailed description of the dataset. The figures do not include online transactions because debit cards issued in Switzerland did not allow for card-not-present transactions during 2019-2020; i.e. they were not usable for online purchases.

Data for income at the regional level from the Federal Tax Administration. To obtain a measure of income per 4-digit zip code in 2014 and 2015, we use the mean and median of household gross-of-tax income at the level of municipalities, which is provided by Federal Tax Administration (2021).[33] In addition to income, the Federal Tax Administration provides measures of mean and median income for each municipality, correcting for household size and marital status. To concord municipalities with 4-digit zip codes, we use a municipality-to-zip-code concordance table provided by the SFSO (Swiss Federal Statistical Office, 2020b).[34] We use this income data as a control in the employment regressions of Fact 6, and in the following Table 4 showing the relationship between income changes and distance to the border between 2014 and 2015.

Table 4 presents results from estimating the following equation

$$d\log(Income_z) = \alpha + \beta Distance_z + \mathbb{FE}_{c(z)} + \varepsilon_z \qquad (10)$$

using OLS, where z indexes 4-digit zip code, $d\log(Income_z)$ is the log change in zip-code mean or median income between 2014 and 2015 measured as described above, and $\mathbb{FE}_{c(z)}$ is a canton fixed effect. We include canton fixed effects because of income tax changes that

[31] See Beck and Lein (2020) for a description of the collection procedures and sample statistics of the European Homescan data collected by GFK. For Germany, we use the data for the German Land Baden-Württemberg and for France the zip-codes starting with 1, 25, 39, 68, 70, 74, and 90. Unfortunately, no such regional information is available for Austria. We thus use the entire data set (rather than restricted to regions bordering Switzerland).

[32] See http://monitoringconsumption.com/switzerland.

[33] The measure of income is adjusted for certain canton-specific deductions but is gross of canton-specific income taxes. Mean and medians are calculated over all households (excluding legal entities and including households without direct federal tax liabilities). The data also includes the number of tax-payers per municipality.

[34] In some cases, one zip code is concorded to more than one municipality. In these cases, we weight municipalities according to the share of buildings in the zip code across municipalities (as of Jan 1st, 2016).

Table 4: Income changes and distance to CB shopping

	Household income		Equiv.-adjusted income	
	(1)	(2)	(3)	(4)
	Median	Mean	Median	Mean
Distance	0.000	-0.000	0.001	-0.001
	[0.001]	[0.003]	[0.001]	[0.002]
Constant	-0.002	0.008	-0.004	0.009
	[0.005]	[0.010]	[0.004]	[0.009]
Observations	3162	3162	3162	3162

Notes: Estimation of equation (10). In the first and second columns, the dependent variable, $d\log(Income_z)$, is defined as the median and mean (respectively) of household gross-of-tax income. In the third and fourth columns the dependent variable is defined as the median and mean (respectively) equivalence-adjusted income. Standard errors are clustered by 2-digit zip code and observations are weighted by the number of taxpayers in the 4-digit zip code in 2014.

vary substantially between the 26 Swiss cantons. Across specifications, we find (precisely estimated) zero effects of distance to cross-border retail on income changes between 2014 and 2015.

B Empirical appendix

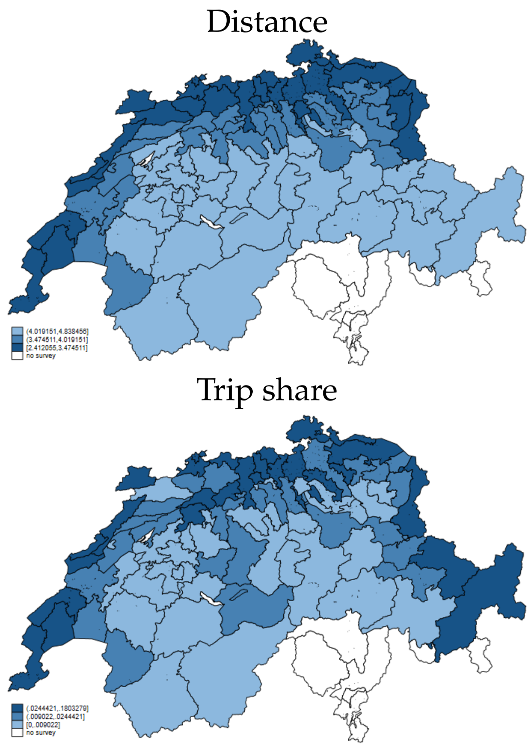
In this section of the Appendix, we provide additional details, tables, and figures associated with our empirical facts on cross-border shopping, presented in Section 3.

Fact 1: Cross-border shares are higher for households closer to foreign retailers shopping whereas intermediated import shares are not.

The top-left panel of Figure 10 shows the spatial distribution of driving times to CB shopping across zip codes. Regions in the interior of Switzerland face higher driving times, on average, but there is also heterogeneity across regions along the border, due to the spatial distribution of populations within each zip code and the spatial distribution of grocery stores across the border. Furthermore, the regions in the south that are near the French and Italian borders but have relatively high driving times are alpine regions, where crossing the border requires long driving times. The three remaining panels of Figure 10 show the spatial distribution of our three measures of CB shares in 2014. Zip codes facing lower driving times have had higher CB shares in 2014.

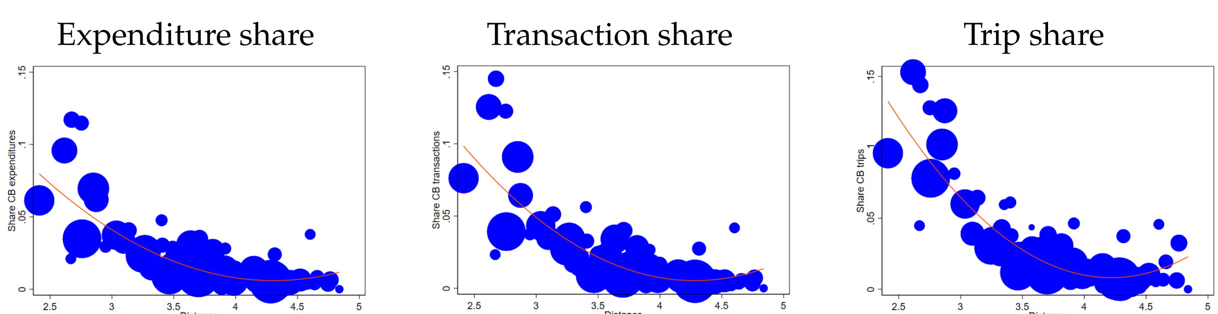
To show that the relationship between CB shares and distance to the border documented in Figure 2 continues to hold at the household level when controlling for addi-

Figure 10: The spatial distribution of CB shares and distance to CB shopping in 2014



Notes: Distance is measured as the log of driving time. Darker zip codes are closer to CB shopping (in the top left panel) and have higher CB shares (in the other panels). Most of the Italian-speaking part of Switzerland, which accounts for approximately 4% of the total population, is not included in the Nielsen data.

Figure 11: Distance to CB shopping and 2019 CB shares by zip code



Notes: CB shares between December 2019 and February 2020 by two-digit zip code—measured by expenditures, transactions, and trips—plotted against distance—measured by the log of travel time. Solid lines display the fit of a quadratic regression (weighted by number of HHs, which also determines the size of the circles).

Table 5: Household characteristics and 2014 CB shares

	Expenditures		Transactions		Trips	
	(1)	(2)	(3)	(4)	(5)	(6)
Income	-0.095	-0.171	-0.063	-0.158	-0.088	-0.381
	[0.129]	[0.140]	[0.140]	[0.144]	[0.258]	[0.330]
Distance	-2.120***	-2.118***	-2.605***	-2.614***	-4.435***	-4.449***
	[0.252]	[0.253]	[0.327]	[0.332]	[0.612]	[0.608]
HH size		0.088		0.207		0.545*
		[0.168]		[0.197]		[0.317]
Education		0.228		0.073		0.520
		[0.202]		[0.201]		[0.391]
Kids		0.018		0.083		-0.305
		[0.191]		[0.237]		[0.300]
Elderly		0.012		0.027		-0.176
		[0.207]		[0.222]		[0.262]
Adjusted R^2	0.06	0.06	0.07	0.07	0.12	0.12
Observations	3309	3309	3309	3309	3309	3309

Notes: Estimation of equation (1). Income is the log of the median value associated with the seven income bins, distance is the log of travel time to cross-border shopping for the HH's zip code, HH size is the number of household members, Education is an indicator for whether the HH's main earner has completed college or university, Kids is an indicator for whether there is a child under 10, and Elderly is an indicator if everyone in the HH is older than 70. Robust standard errors are clustered by zip code and observations are weighted by the product of the number of households in a zip code $\times$ income bin and the household's share of expenditure in 2014 within its zip code $\times$ income bin. *p<.1; **p<.05; ***p<.01

Table 6: Replicating Table 5 without including regression weights

	Expenditures		Transactions		Trips	
	(1)	(2)	(3)	(4)	(5)	(6)
Income	-0.226	-0.357	-0.172	-0.357	-0.128	-0.353
	[0.186]	[0.229]	[0.202]	[0.237]	[0.221]	[0.287]
Distance	-3.141***	-3.140***	-3.518***	-3.525***	-4.513***	-4.530***
	[0.414]	[0.411]	[0.428]	[0.430]	[0.580]	[0.581]
HH size		0.215		0.393		0.514
		[0.279]		[0.310]		[0.313]
Education		0.407		0.408		0.298
		[0.343]		[0.353]		[0.364]
Kids		-0.200		-0.173		-0.226
		[0.309]		[0.329]		[0.350]
Elderly		-0.006		0.085		-0.119
		[0.340]		[0.386]		[0.293]
Adjusted R^2	0.05	0.05	0.06	0.06	0.09	0.09
Observations	3309	3309	3309	3309	3309	3309

Notes: Robustness of Table 5, estimated without weights. *p<.1; **p<.05; ***p<.01

Table 7: Replicating Table 5 for expenditure shares on imports purchased in Switzerland

	No Controls	Controls
	(1)	(2)
Distance	-0.195	-0.170
	[0.237]	[0.236]
Income		-0.216
		[0.205]
HH size		-0.167**
		[0.082]
Education		0.348
		[0.250]
Kids		0.244
		[0.251]
Elderly		-0.447
		[0.364]
Observations	3308	3308
Adjusted R^2	0.000	0.002

Notes: Robustness of Table 5, estimated for the ratio of expenditures on imports purchased in Switzerland relative to all expenditures on goods for which we observe country of production. *p<.1; **p<.05; ***p<.01

tional household characteristics, we estimate

$$\frac{X_{hf14}}{X_{hf14} + X_{hd14}} = \alpha + \beta \log(Income_h) + \delta Distance_h + [\zeta' X_h] + \varepsilon_{h14}$$

separately for our three measures of CB shares at the household level. In equation (1), $X_{h\ell t}$ is household h's expenditures, transactions, or shopping trips in location ℓ in year t, where $\ell = d$ represents domestic and $\ell = f$ represents cross-border (or foreign) purchases. $Distance_h$ refers to the log of travel time between the 2-digit zip code in which household h lives and the nearest cross-border shopping.

Table 5 reports our results. Across all three of our measures of CB shares and across specifications (including additional household controls or not), we find a strong negative relationship between a household's distance to CB shopping and its CB expenditure, transaction, and trip shares; we also find no relationship between any other household characteristic and its CB expenditure share. These results are robust to our weighting strategy; see Table 6.

Fact 2: Fact 2: Prices are lower across the border from Switzerland. Cross-border prices fell more than prices of goods purchased in Switzerland following the 2015 CHF appreciation.

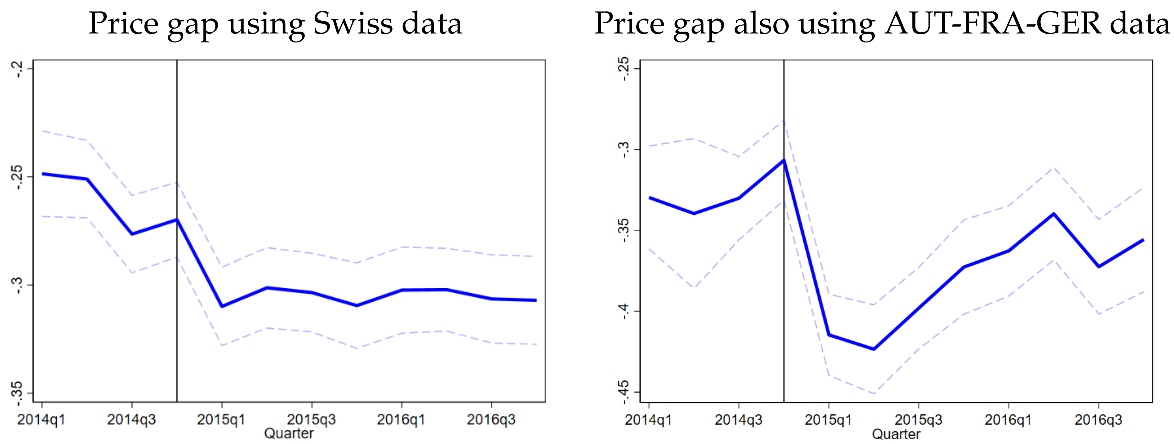
There are 7,792 unique EANs in our data that are purchased by Swiss consumers both domestically and abroad in at least one common quarter between 2014 and 2016 and that have positive expenditures in 2014. These are the products that are included in the sample on which equation (2) is estimated in the left panel of Figure 3.

There are 12,945 unique EANs in our data that are purchased by Swiss consumers domestically and by either German, French, or Austrian consumers in their respective countries in at least one common quarter between 2014 and 2016 and that have positive expenditures by Swiss consumers in 2014. These are the products that are included in the sample on which equation (2) is estimated in the right panel of Figure 3.

Figure 12 displays robustness of the left and right panels of Figure 3 in which we replace the EAN code $\times$ quarter fixed effects, $\mathbb{FE}_{eq}$, with EAN code and quarter fixed effects, $\mathbb{FE}_e$ and $\mathbb{FE}_q$.

We also document an increase in prices that Swiss consumers pay when shopping in Germany, France, and Austria relative to prices that German, French, and Austrian consumers pay when shopping near the Swiss border in their respective countries (all converted into CHF using the daily CHF-EUR exchange rate). This fact, displayed in the left panel of Figure 13, is based on estimating equation (2) on the 5,599 unique products in our data that are purchased by Swiss consumers abroad and by either German, French, or

Figure 12: CB price gaps robustness



Notes: Robustness of Figure 3 replacing EAN $\times$ quarter fixed effects, $\mathbb{FE}_{eq}$, with separate EAN code and quarter fixed effects, $\mathbb{FE}_e$ and $\mathbb{FE}_q$.

Austrian consumers in their respective countries in at least one quarter between 2014 and 2016 and that have positive expenditures in 2014 in the Swiss data. Results are displayed in the left panel of Figure 13.

The increase in prices that Swiss consumers pay abroad relative to prices that foreign consumers pay abroad for the same goods is not a result of an increase in local prices set by supermarkets close to the Swiss border. The right panel of Figure 13 shows price differences between regions close to the Swiss border and regions further away from the Swiss border in the German and French data.[35] To make the two panels in Figure 13 comparable, we restrict the sample to the 5,599 products that are also included in Swiss CB purchases.

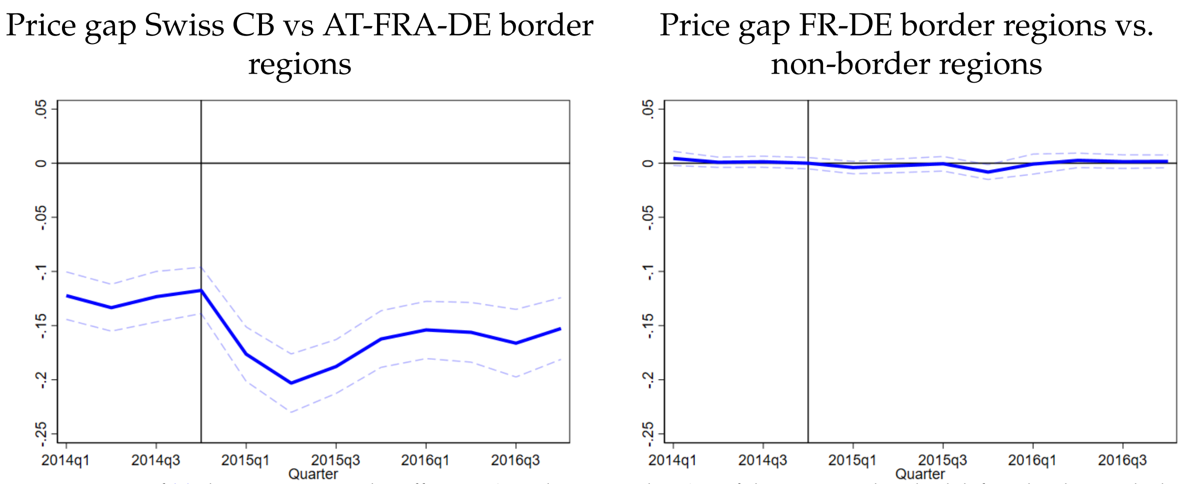
Fact 3: Cross-border shares increased following the 2015 CHF appreciation.

We first provide robustness for Fact 3. Figure 4 displays estimates of time fixed effects in equation (3) where CB shares are defined as $\frac{X_{hft}}{X_{hft}+X_{hdt}}$. Figures 14 and 15 provide robustness using CB shares defined as $\log\left(X_{hft}/X_{hdt}\right)$ and $\log\left[\left(X_{hft}+1\right)/\left(X_{hdt}+1\right)\right]$, respectively. The inclusion of $X_{h\ell t}+1$ is a simple non-structural approach to address the issue that many households do not shop abroad and, therefore, we would drop the many observations with $X_{hft}=0$ for which $\log(X_{hft})$ is not defined. Results are robust if we do not use regression weights.

In the text of Fact 3, we also state that the increases in CB shares following the 2015 CHF appreciation displayed therein are uncorrelated with either household income or distance to CB shopping. To do so, we estimate separately for our three measures of CB

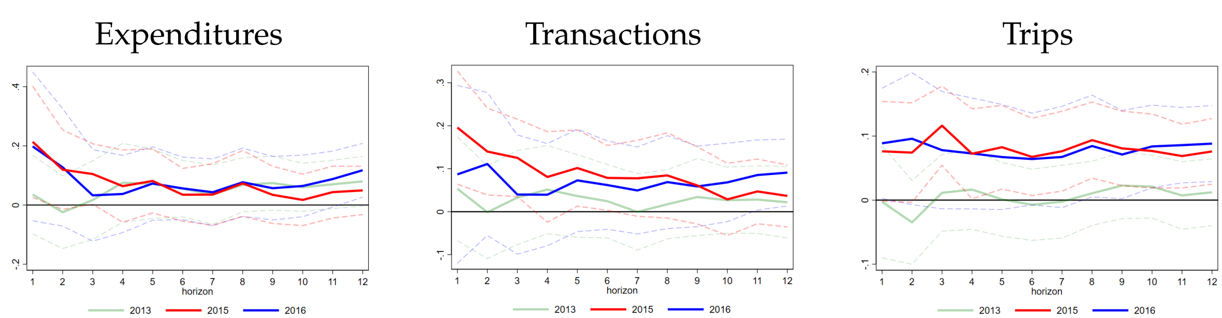
[35] We do not include Austria here, because, as mentioned above, the Austrian homescan data does not include information on the region in which panelists live.

Figure 13: Price gap for common goods purchased by German, French, and Austrian vs. Swiss consumers shopping in Germany, France, and Austria



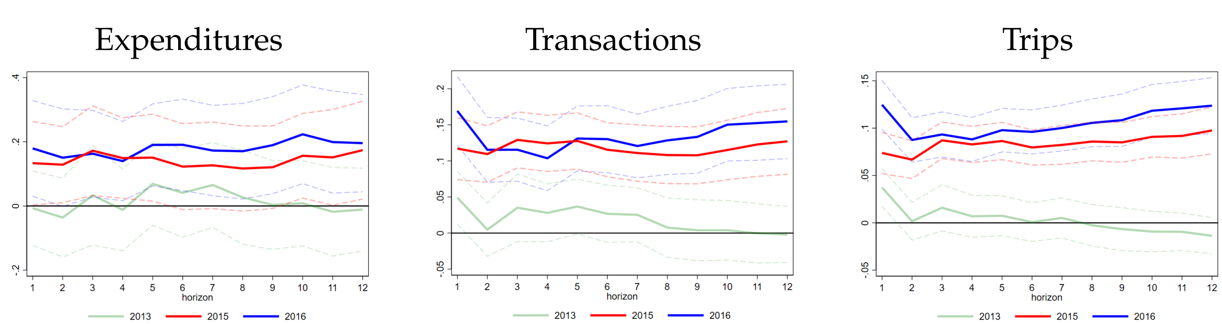
Notes: Estimation of (2) showing estimated coefficients β_q and associated 95% confidence intervals in both left and right panels. $\log p_{e\ell q}$ is the geometric weighted average of prices (all in CHF) across transactions within the $e\ell q$ triplet. In the left panel, $\ell = d$ indicates Swiss consumers shopping in Germany, France, and Austria whereas $\ell = f$ indicates German, French, and Austrian consumers shopping in their respective countries near the Swiss border. In the right panel, which additionally includes country-by-time fixed effects, $\ell = d$ indicates German and French consumers shopping in their respective countries near the Swiss border while $\ell = f$ indicates German and French consumers shopping in their respective countries that are not near the Swiss border. In the left panel, observations are weighted by expenditures per product in 2014 in the Swiss Nielsen data. In the right panel, observations are not weighted. Robust standard errors are clustered at the product level.

Figure 14: Increase in CB shares Robustness 1: $\log\left(X_{hft}/X_{hdt}\right)$



Notes: Replicates Figure 4 except the outcome variable is $\log\left(X_{hft}/X_{hdt}\right)$ rather than $X_{hft}/(X_{hft}+X_{hdt})$.

Figure 15: Changes in CB shares Robustness 2: $\log\left[(X_{hft}+1)/(X_{hdt}+1)\right]$



Notes: Replicates Figure 4 except the outcome variable is $\log\left[(X_{hft}+1)/(X_{hdt}+1)\right]$ rather than $X_{hft}/(X_{hft}+X_{hdt})$.

shares—expenditures, transactions, and trips—the following regression

$$y_{ht} = \mathbb{FE}_t + \mathbb{FE}_h + \sum_{y \neq 2014} \mathbb{I}_{y=t} \Big[\beta_y Inc_h + \delta_y Distance_h + [\zeta_y' K_h] \Big] + \varepsilon_{ht} \qquad (11)$$

The dependent variable y_{ht} in equation (11) is given by $\log(X_{hft}/X_{hdt})$ or $\log[(X_{hft}+1) / (X_{hdt}+1)]$. In these regressions, the coefficient β_y identifies the difference-in-difference—between year y and 2014 and between higher relative to lower income households—in the log of CB shopping relative to non-CB shopping. The coefficient δ_y identifies the same difference-in-difference, but comparing households that live far from CB shopping outlets relative to households that live close.

Results are displayed in Tables 8 and 9. These tables show that there is no robust relationship between household distance to the border or income and changes in CB shares. Whereas Table 8 shows that the CB share defined as $\log\left[(X_{hft}+1) / (X_{hdt}+1)\right]$ using expenditures increases more in 2015 for households living further from the border, this relation is not significant for either transactions or trips, or for $\log\left(X_{hft}/X_{hdt}\right)$. We have also experimented with non-monotonic relationships between distance and changes in the CB share, in the spirit of Friberg et al. (2022); these are largely insignificant.

Fact 4: Cross-border shares dropped close to zero during the 2020 border closure.

We complement the evidence displayed in Figure 5, from the Nielsen data, using data from Monitoring Consumption Switzerland (MCS) compiled by Brown et al. (2022). Figure 16 displays debit card expenditures on Food, Beverages, and Tobacco by week between January 2019 and June 2020 from MCS. During the Covid-19-related border closure, we observe a substantial reduction in cross-border purchases of Food, Beverages, and Tobacco with little decline in domestic purchases. This finding is consistent with our Nielsen data shown in Figure 5. The pattern for cross-border purchases in non-grocery goods and service sectors recorded in the MCS data exhibit similar substantial declines during the lockdown. However, in these two other sectors, there was also a substantial reduction in non-CB purchases (e.g. a decline in expenditures in high-contact service sectors).

Fact 5: Retail employment fell in regions relatively near foreign retailers after the 2015 CHF appreciation.

No additional details to provide.

Fact 6: There is no systematic relationship between non-cross-border price changes during the 2020 border closure and distance to foreign retailers.

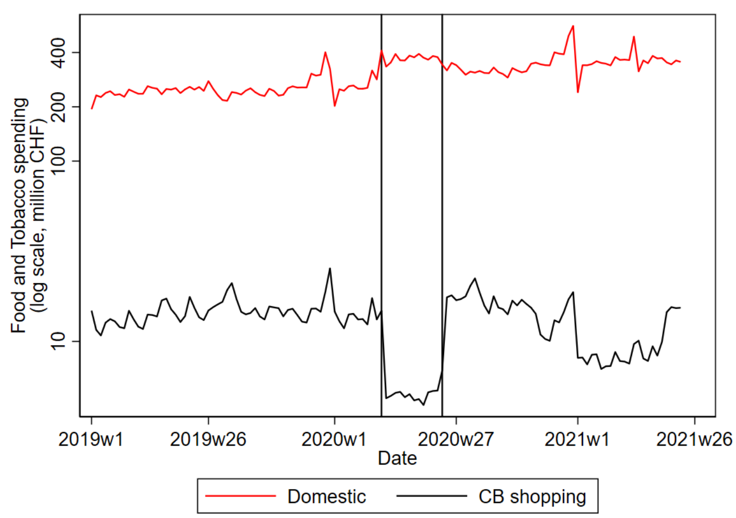
Fact 6 is not included in Section 3. In our welfare evaluation of the border closure, we

Table 8: Heterogeneous CB responsiveness: log ratio

	Expenditures		Transactions		Trips	
	(1)	(2)	(3)	(4)	(5)	(6)
Income 2013	0.002	0.031	-0.008	-0.019	0.022	-0.008
	[0.085]	[0.088]	[0.070]	[0.077]	[0.053]	[0.061]
Income 2015	-0.121*	-0.117	-0.077	-0.076	0.010	-0.021
	[0.072]	[0.082]	[0.072]	[0.077]	[0.045]	[0.049]
Income 2016	-0.108	-0.083	-0.164**	-0.167**	-0.051	-0.081
	[0.078]	[0.090]	[0.070]	[0.078]	[0.052]	[0.057]
Distance 2013	-0.154*	-0.148*	-0.171**	-0.166**	-0.106*	-0.101*
	[0.084]	[0.082]	[0.084]	[0.083]	[0.053]	[0.051]
Distance 2015	-0.053	-0.053	-0.085	-0.078	-0.064*	-0.060
	[0.066]	[0.065]	[0.053]	[0.054]	[0.038]	[0.037]
Distance 2016	0.072	0.077	0.028	0.037	0.013	0.019
	[0.074]	[0.072]	[0.055]	[0.057]	[0.049]	[0.047]
Observations	3417	3417	3417	3417	3417	3417
Size		X		X		X
Elderly		X		X		X
Kids		X		X		X
Education		X		X		X
Adjusted R^2	0.720	0.721	0.777	0.777	0.831	0.832

Notes: Estimation of equation (11) measuring y_{ht} as $\log\left(X_{hft}/X_{hdt}\right)$. Robust standard errors are clustered by 2-digit zip code and observations are weighted by the household's share of expenditures, transactions, or trips in 2014.
*p<.1; **p<.05; ***p<.01

Figure 16: In person debit card transactions of Swiss residents at home and abroad



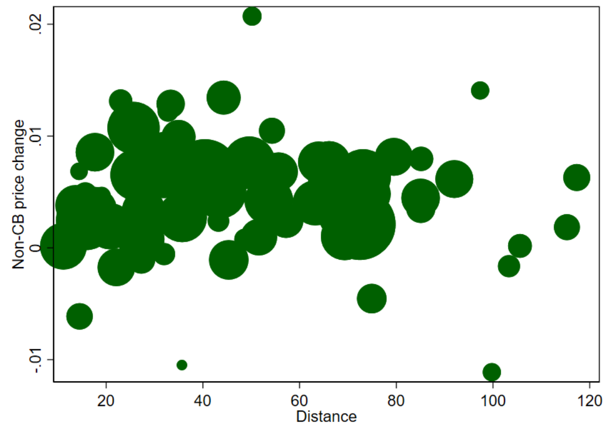
Notes: This figure is constructed using debit card data from Monitoring Consumption Switzerland. "Domestic" refers to retail expenditure of Swiss residents using debit cards in person within Switzerland whereas "Foreign" refers to retail expenditure of Swiss residents using debit cards in person abroad. The two vertical lines represent the start and end of the formal border closure.

Table 9: Heterogeneous CB responsiveness: log ratio plus one

	Expenditures		Transactions		Trips	
	(1)	(2)	(3)	(4)	(5)	(6)
Income 2013	-0.063	-0.121	-0.028	-0.038	-0.027	-0.039
	[0.134]	[0.143]	[0.040]	[0.042]	[0.022]	[0.026]
Income 2015	-0.016	-0.143	-0.009	-0.037	0.002	-0.015
	[0.142]	[0.176]	[0.038]	[0.046]	[0.019]	[0.023]
Income 2016	0.058	-0.118	-0.015	-0.058	-0.007	-0.027
	[0.132]	[0.143]	[0.035]	[0.040]	[0.020]	[0.022]
Distance 2013	0.069	0.071	-0.019	-0.015	-0.002	0.001
	[0.133]	[0.133]	[0.046]	[0.046]	[0.023]	[0.023]
Distance 2015	0.236*	0.234*	0.037	0.037	0.004	0.004
	[0.119]	[0.119]	[0.043]	[0.043]	[0.022]	[0.022]
Distance 2016	-0.013	-0.019	0.003	0.000	0.012	0.011
	[0.141]	[0.139]	[0.049]	[0.050]	[0.028]	[0.029]
Observations	11648	11648	11648	11648	11648	11648
Size		X		X		X
Elderly		X		X		X
Kids		X		X		X
Education		X		X		X
Adjusted R^2	0.721	0.721	0.808	0.809	0.852	0.853

Notes: Estimation of equation (11) measuring y_{ht} as $\log\left(\left(X_{hft}+1\right)/\left(X_{hdt}+1\right)\right)$. Robust standard errors are clustered by 2-digit zip code and observations are weighted by the household's share of expenditures, transactions, or trips in 2014. *p<.1; **p<.05; ***p<.01

Figure 17: Distance to CB shopping and non-CB price changes during 2020 border closure



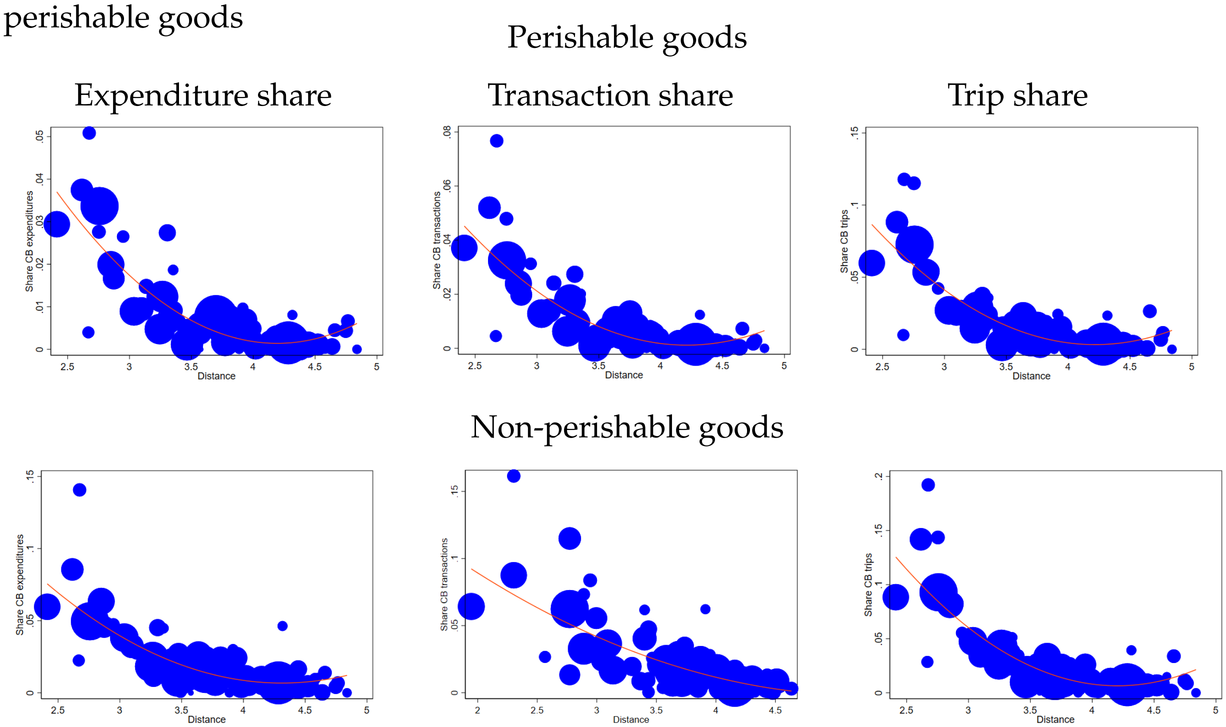
Notes: The non-CB price change measures the weighted average log change in prices across products purchased within Switzerland, measured at the zip code level, with weights given by expenditure by product in the relevant zip code during the three months before the lockdown period. Two outlier zip codes, with absolute value price change greater than 2%, are dropped.

assume that prices of goods available within Switzerland do not change differentially across zip codes. Here, we show that there is no systematic relationship between non-CB price changes and distance to CB shopping. We construct a zip code-specific measure of average price changes—for non-CB purchases—between the three months prior to the border closure and the three months during the border closure. Specifically, we construct a Laspeyres index measuring zip code-specific changes in product prices and weighing these price changes using zip code-specific expenditure shares in the three months before the border closure (including only products purchased within the zip code both in the three months before and during the border closure). Figure 17 displays the results. There is no statistically or economically significant relationship between non-CB price changes and distance to CB shopping.

Facts 1 and 3 separately for perishable and non-perishable goods.

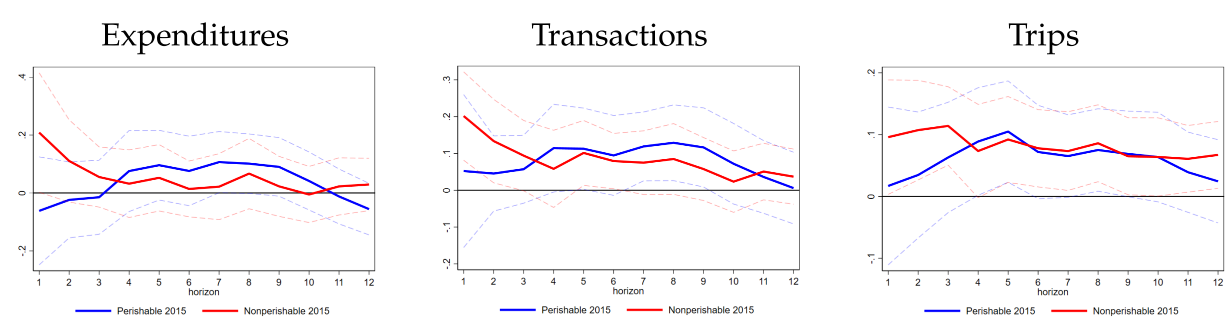
Here, we replicate Figure 2 and Figure 4, separately for perishable and non-perishable goods.

Figure 18: Distance to CB shopping and 2014 CB shares by zip code: perishable and non-perishable goods



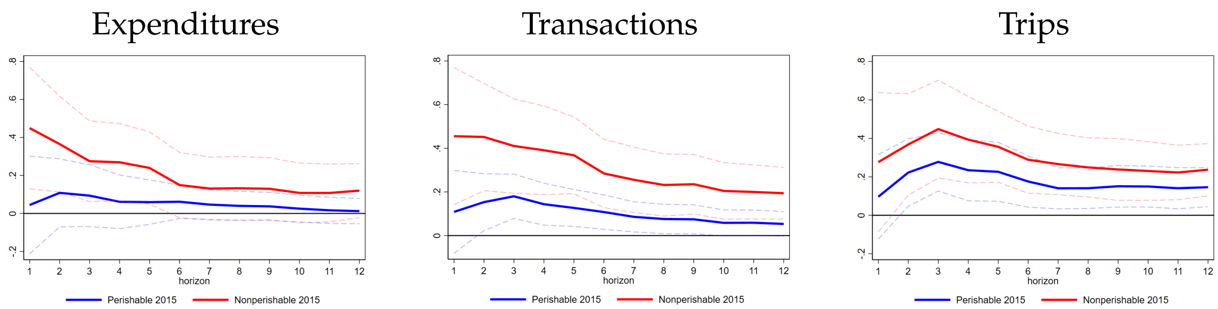
Notes: CB shares in 2014 at the two-digit zip code level—measured by expenditures (left), transactions (middle), and trips (right)—plotted against distance—measured by the log of travel time measured separately for perishable and non-perishable goods. Solid lines display the fit of a quadratic regression (weighted by number of HHs, which also determines the size of the circles).

Figure 19: Change in log CB share for perishable and non-perishable goods



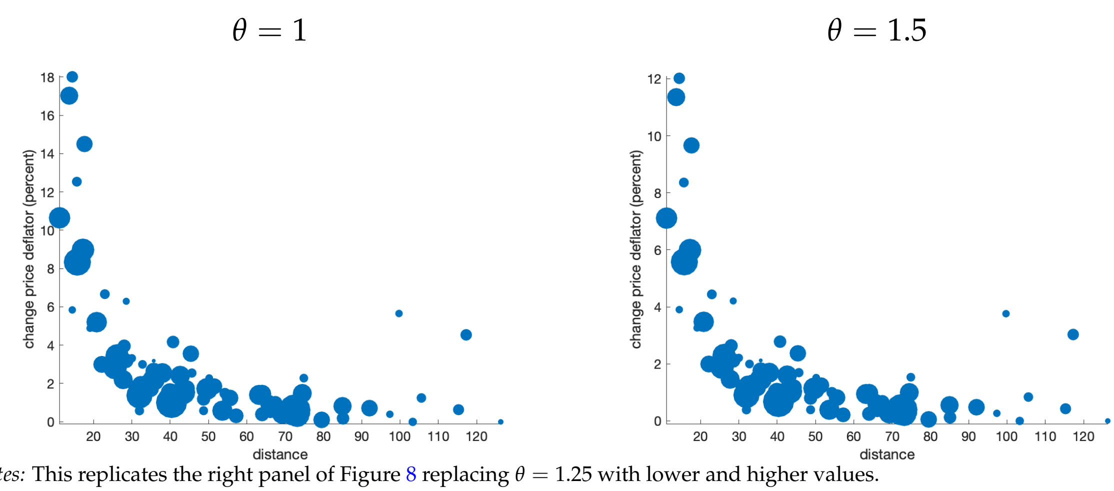
Notes: Estimation of equation (3) separately for goods coded as perishable and goods coded as non-perishable, showing estimated coefficients β_y and associated 95% confidence intervals. The outcome variable is $\log\left((X_{hft})\,/\,(X_{hdt})\right)$ and $X_{h\ell t}$ is defined using expenditures (left), transactions (middle), and trips (right) within either perishable or non-perishable goods in the relevant horizon within each year. Robust standard errors are clustered by zip code and observations are weighted by $X_{hft} + X_{hdt}$ in 2014.

Figure 20: Change in CB share for perishable and non-perishable goods: Robustness



Notes: Replication of Figure 19, where the outcome variable is $100 \times X_{hft}/(X_{hft} + X_{hdt})$.

Figure 21: Changes in price deflator after 2020 border closure: alternative values of θ



Notes: This replicates the right panel of Figure 8 replacing $\theta = 1.25$ with lower and higher values.