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 as well as the heterogeneous welfare benefits from access to cross-border shopping.

Switzerland’s geography makes it an ideal setting to study cross-border shopping, with a large share of the population living in regions near the border and shopping in neighboring countries that use the euro and tend to face lower prices. 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 gap between identical products purchased in Switzerland and abroad rose, the price of cross-border shopping relative to imports within Switzerland fell (see Figure 1), and cross-border-shopping shares rose.1 Furthermore, these shares fell to nearly zero during the 2020 border closure. These facts suggest that the benefits to households arising from access

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1As 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.
to cross-border shopping and the effects of international price changes on households’ costs 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.

The aggregate price of products purchased abroad fell by 7.7% whereas the aggregate price of products purchased in Switzerland fell by 1.7% following the 2015 CHF appreciation. Hence, 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.

We also quantify the welfare gains associated with access to cross-border shopping or, equivalently, 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 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 investigat-
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 \( \log p_{em} = \alpha + FE_e + \sum_{m'=Dec\ 2014}^{m} \beta_{m} + \epsilon_{em} \) 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.

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.

2In 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.

2We 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.

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.
close to the U.S. benefited from the Covid-19-related border lockdown in 2020. 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 presence 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 identifier, European Article Number (EAN) code, quantity purchased, price paid (net of goodspecific discounts due to, e.g., coupons), date of the shopping trip, the name of the re-

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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

<table>
<thead>
<tr>
<th></th>
<th>2014</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Domestic (a)</td>
<td>Cross-border (b)</td>
</tr>
<tr>
<td>Number of products</td>
<td>77,176</td>
<td>12,905</td>
</tr>
<tr>
<td>Expenditures</td>
<td>118.1</td>
<td>1.8</td>
</tr>
<tr>
<td>Transactions</td>
<td>254.6</td>
<td>4.1</td>
</tr>
<tr>
<td>Trips</td>
<td>265.6</td>
<td>7.3</td>
</tr>
<tr>
<td>Households</td>
<td>3,309</td>
<td>1,019</td>
</tr>
</tbody>
</table>

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.

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

5E-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 our framework.
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. 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
Figure 2: Distance to CB shopping and 2014 CB shares by zip code

Expenditure share  Transaction share  Trip share

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).

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

\[
\frac{X_{hf14}}{X_{hf14} + X_{hd14}} = \alpha + \beta \log(\text{Income}_h) + \delta \text{Distance}_h + [\zeta' X_h] + \epsilon_{h14} \tag{1}
\]

where \(X_{hf14}\) is household \(h\)'s expenditures, transactions, or shopping trips in location \(\ell\) 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. These results are robust to our weighting strategy; see Table 7 in Appendix B.

To establish that import shares (defined as import purchases made within Switzerland 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.

6Figure 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.

7In 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.
Figure 3: CB price gaps

Price gap using Swiss data

Price gap also using AUT-FRA-GER data

Notes: Estimation of equation (2) showing estimated coefficients $\beta_q$ and associated 95% confidence intervals. $\log p_{elq}$ is the geometric weighted average of prices across transactions within the $elq$ 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).

Fact 2: Prices are lower across the border from Switzerland and 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,

$$\log p_{elq} = \alpha + FE_{eq} + \sum_{q} I_{q'=q} \beta_q I_{\ell=f} + \epsilon_{elq}$$

using data spanning 2014-16, where $e$ indexes product, $q$ indexes quarter, $\ell$ indexes the location in which the product is purchased (domestically, $\ell = d$, or abroad, $\ell = f$), and $I_{\ell=f}$ 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 $\log p_{elq}$ as the geometric weighted average of prices across transactions within the quarter and location of
purchase, using expenditure weights. In this regression, \( \beta_q \) 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 \( \beta_q \) and associated 95% confidence intervals. The negative estimates of \( \beta_q \) 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.\(^8\)

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.\(^9\)

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

To obtain an estimate of changes in CB shopping activity within households, we estimate the regression

\[
100 \times \frac{X_{hft}}{X_{hft} + X_{hdt}} = \alpha + \text{FE}_h + \sum_{y \neq 2014} \beta_y \mathbb{1}_{y=t} + \epsilon_{ht}
\]

where \( X_{hft} \) denotes household \( h \)'s expenditures, trips, or transactions in location \( \ell \in \{d, f\} \) in period \( t \). The year fixed effects \( \beta_y \) 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 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

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\(^8\)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.

\(^9\)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.
increase in the CB share using expenditures is smaller and significant in only a subset of months.$^{10}$ 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).$^{11}$ The Swiss ban on cross-border shopping lasted until June 15, when the neighboring countries also lifted their travel restrictions (Swiss Federal Council, 2020b).

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.

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$^{10}$For robustness, we estimate (3) using $\log((X_{hft} + 1)/(X_{ht1} + 1))$ and $\log(X_{hft}/X_{ht1})$ instead of $100 \times X_{hft}/(X_{hft} + X_{ht1})$; see Figures 14 and 15 in Appendix B.

$^{11}$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.

land. 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.\(^\text{12}\) 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

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\(^{12}\) 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.
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

\[ \log(\text{emp}_{zt}) = \alpha_t + \alpha_z + \sum_{y \neq 2014} \mathbb{I}_{y=t} (\beta_t \text{Distance}_z + \delta_t \log(\text{Income}_z)) + \varepsilon_{zt} \quad (4) \]

where we index 4-digit zip codes by \( z \), \( \text{emp}_{zt} \) is employment in \( z \) in year \( t \), \( \text{Distance}_z \) is the log of travel time from each 4-digit zip code to cross-border shopping, and \( \text{Income}_z \) 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 \( \beta_t \) identifies the change, within 4-digit zip code, in the log employment in retail and, separately, in non-retail between year \( t \) and 2014 in zip codes that are farther from CB shopping relative to those that are nearer.

The right panel of Figure 6 displays point estimates for \( \beta_t \) 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

\[ \frac{X_{hdt}}{X_{hdt} + X_{hft}} + \frac{X_{hft}}{X_{hdt} + X_{hft}} = 1 \text{ at } t_0 = 2014, \]

\[ d \log \frac{X_{hdt}}{X_{hdt} + X_{hft}} = \frac{X_{hft_0}}{X_{hdt_0} + X_{hft_0}} (d \log X_{hdt} - d \log X_{hft}) \quad (5) \]

According to Fact 1, the budget share of CB purchases, \( \frac{X_{hft_0}}{X_{hdt_0} + X_{hft_0}} \), 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.\textsuperscript{13} 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).

\section{4 \ A simple model of cross-border shopping}

\textbf{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 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.

\textsuperscript{13}We assume that households shopping within Switzerland are more likely to shop in the region in which they live than elsewhere within Switzerland.
Specifically, utility of household $h$ at time $t$ is given by

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

Here, $c_{ht\ell}(z)$ is the quantity of goods purchased in location $\ell$ in trip $z$, which is a homothetic aggregator of individual goods (including domestic and imported goods). The term $a_{ht\ell}$ represents the non-pecuniary valuation of household $h$ over amenities in location $\ell$ across all trips in period $t$ whereas the term $(\varepsilon_{ht\ell}(z))^{1-\chi}$ represents the non-pecuniary valuation of household $h$ over amenities in location $\ell$ that is idiosyncratic across trips $z$. According to the previous expression, domestic and cross-border consumption are perfect substitutes 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 $c_{ht\ell}(z)$, is flexible.

The budget constraint of household $h$ is

$$I_{ht} = \sum_{\ell=d,f} p_{ht\ell} \tau_{ht\ell} \int_0^1 c_{ht\ell}(z) \times (\varepsilon_{ht\ell}(z))^{-\chi} dz$$

Here, $p_{ht\ell}$ is the retail price of the consumption good in location $\ell$, which does not vary across trips within a period. The term $\tau_{ht\ell}$ 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 $\ell$ across all trips in period $t$ whereas the term $(\varepsilon_{ht\ell}(z))^{-\chi}$ represents pecuniary non-retail costs for this household of shopping in location $\ell$ that are idiosyncratic across trips $z$. The ratio of the

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14 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.

15 The parameter $\rho$, which governs the substitutability of consumption across shopping trips, plays no role in our results.

16 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, $p_{htd}$, as well as a common cost and amenity per household across Swiss regions, $a_{htd}$ and $\tau_{htd}$. Therefore, if a household shops domestically we abstract from where in Switzerland it chooses to shop.

17 For a simple way of incorporating shopping time into our consumer problem, suppose that consumption $c_{ht\ell}(z)$ results from a Cobb-Douglass combination of goods (with weight $1 - \tau_{ht\ell}$ and price $p_{ht\ell}$) and time (with weight $\tau_{ht\ell}$ and price given by the wage $w_{ht}$). In the budget constraint, $p_{ht\ell} = \bar{p}_{ht\ell}^{1-\tau_{ht\ell}}$, $\tau_{ht\ell} = w_{ht} / \bar{w}_{ht}$, 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 $\tau_{ht\ell}$ (unless we consider a shift to CB
idiosyncratic amenity relative to the idiosyncratic cost of shopping in location \( \ell \) in trip \( z \) is simply \( \varepsilon_{h\ell t}(z) \). We assume that \( \varepsilon_{h\ell t}(z) \) is distributed Fréchet, \( G(\varepsilon) = \exp(-\varepsilon^{-\theta}) \) 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 \( \ell \) in shopping trip \( z \) if \( \ell = \arg \max_{\ell'} \{ a_{h\ell't} \varepsilon_{h\ell t}(z) / (\tau_{h\ell t} \rho_{h\ell t}) \} \). The optimal choice of shopping location is invariant to the parameter \( \chi \). Given the distribution of \( \varepsilon \), the share of trips the household makes to location \( \ell \) in period \( t \) is

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

The elasticity of the CB share of trips with respect to retail prices is equal to \( \theta \). The lower is the dispersion of the combination of idiosyncratic amenity and cost draws (higher \( \theta \)), the higher is this elasticity.\(^{18}\)

The share of total expenditures the household incurs shopping in location \( \ell \) 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.\(^{19}\)

**Welfare changes.** Consider changes in household \( h \)'s income from \( I_{ht0} \) to \( I_{ht1} \), prices from \( p_{ht0} \) to \( p_{ht1} \), and pecuniary non-retail costs from \( r_{ht0} \) to \( r_{ht1} \) (these vectors contain an element for each location). We measure welfare changes by the compensating variation: \(^{20}\)

\(\text{autarky, as in one of our counterfactuals). Note that if } \tau_{ht1} > \tau_{ht0}, \text{ then higher wage households effectively face higher CB costs and engage in less cross-border shopping.}\)

\(\text{The assumption that this elasticity does not vary across locations is consistent with Fact 3 that log changes in CB shares in 2015 do not vary systematically with distance to CB shopping.}\)

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

\(\text{Since preferences are homothetic, compensating variation is equal to equivalent variation.}\)
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,\(^{21} \) we can express welfare changes as the log change in nominal income minus the welfare-relevant price deflator:

\[
\text{welfare}_h = \log \left( \frac{I_{ht1}}{I_{ht0}} \right) - \log \left( \frac{\bar{\theta}}{\bar{\theta}} \right) \left\{ \sum_{\ell=d, f} \frac{\pi_{h\ell t0}}{\tau_{h\ell t0}} \left( \frac{p_{h\ell t1}}{p_{h\ell t0}} \right)^{-\theta} \right\}^{-\frac{1}{\theta}} - \frac{1}{\theta} \left( u_{ht1} - u_{ht0} \right)
\]

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 \( p_{h\ell t1} / p_{h\ell t0} \) and non-retail costs \( \tau_{h\ell t1} / \tau_{h\ell t0} \), we need to assign values to the initial share of total expenditures on cross-border shopping by household \( \pi_{h\ell t0} \), and to the parameter \( \theta \) 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 horizons (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

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\(^{21}\)The expenditure function for household \( h \) at time \( t \) which faces a vector of retail prices \( p_{ht} \) and pecuniary non-retail costs \( r_{ht} \) can be written, using equation (6), as

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

where \( \bar{\theta} \) is a function of \( \theta \).
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, 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

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22 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.
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.23

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 \( \theta \) 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, \( \pi_{hlt0} \), using the initial CB trip share.

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

23 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.
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 $\theta$. The log change in household $h$’s total CB expenditures relative to total domestic expenditures is

$$d \log \frac{X_{hf}}{X_{hd}} = -\theta \left( d \log p_{hd} - d \log p_{hf} \right) + \nu_{ht},$$

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

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, $d \log p_{ht} = d \log p_{lt}$, 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 $\nu_{ht}$ 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: $\theta = 1.25$. 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 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

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24 Fixed expenditure shares would be equivalent to $\theta = 0$.
and transaction shares (rather than trip shares as in our baseline). Estimates of \( \theta \) range between 1.1 and 1.5 (the estimate of \( \theta \) 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.\(^{25}\)

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.\(^{26}\)

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.

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

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\(^{25}\)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.

\(^{26}\)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.
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 $\theta$. 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 $\theta$ 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 consumers purchasing imported goods indirectly through domestic retailers and those crossing the border to purchase foreign goods directly. Cross-border shopping is particularly salient in countries with a large share of population along open international borders and price gaps that are large and vary over time.

Switzerland provides us with an ideal empirical laboratory to study spatial shopping
and the effects of exogenous price changes on shopping behavior and welfare across space. We document a number of facts, highlighting 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 exogenous 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 effects of changes in international prices caused by the 2015 CHF appreciation.

Our framework focuses exclusively on demand, taking price changes as given. Since the observed changes in prices of goods sold in Switzerland across regions do not vary systematically with distance to the border, we did not need to model the supply side. However, 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 inhibit consumers’ import shares because imported and non-imported goods’ prices charged in Switzerland are quite 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.

References


### A Data appendix

**Processing the Nielsen data.** Households record if a purchase occurs within Switzerland or in a retailer abroad. Throughout the analysis, we focus on prices including the local VAT.

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 Euro at the place of purchase. 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

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27 Legislation in Austria, France, Germany, and Italy requires prices to be specified in the local currency.
country, in which case they instead must pay the equivalent Swiss VAT rate as a customs
duty (for a transaction that exceeds the allowance of 300 CHF). Given the relatively high
cost of doing so (and our focus on price changes rather than levels), we do not adjust our
data to incorporate the potential VAT reimbursement.

There exist 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, \( s \in S \)
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 “supermar-
ket” 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 Switzer-
land 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.
\[ \text{time}_z = \min_{s \in S} \{ \text{time}_{zs} \}, \]
where \( \text{time}_{zs} \) 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 em-
ployment analysis, we keep driving times at the 4-digit zip code level.\(^{28}\) 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

\[ \log p_{ej} = \alpha + \text{FE}_e + \text{FE}_j + \varepsilon_{ej} \quad (9) \]

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

\(^{28}\) The google maps search was performed in May and June 2020.
Figure 9: Border distance and price level in Switzerland in 2014

All goods

Imported goods

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

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<thead>
<tr>
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<th>2014 levels</th>
<th>2014–2015 changes</th>
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</thead>
<tbody>
<tr>
<td><strong>Distance × Import</strong></td>
<td>-0.001</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>[0.001]</td>
<td>[0.001]</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>230030</td>
<td>152623</td>
</tr>
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</table>

Notes: We estimate \( y_{ez} = \alpha_z + \alpha_e + I_{e \in E_M} Distance_z \) where \( \alpha_z \) and \( \alpha_e \) 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 \( I_{e \in E_M} \) 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

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

The large outlier with prices being around 4.5% lower than in the reference zip code is “Engadin, Val Müstair,” where only 8 households in the dataset live.
GfKs. We match the prices for all EANs observed in Switzerland to the prices paid in the regions bordering Switzerland for France and Germany, where such regional information is available.\footnote{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).} 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 debit cards.\footnote{See http://monitoringconsumption.com/switzerland.} The website provides weekly payments made with debit cards issued to Swiss residents by sector (i.e. “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).\footnote{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.} 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).\footnote{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).} 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

\[
d \log(\text{Income}_z) = \alpha + \beta \text{Distance}_z + \text{FE}_c(z) + \epsilon_z
\]

(10)

using OLS, where \(z\) indexes 4-digit zip code, \(d \log(\text{Income}_z)\) is the log change in zip-code mean or median income between 2014 and 2015 measured as described above, and \(\text{FE}_c(z)\)
Table 4: Income changes and distance to CB shopping

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<th>Household income</th>
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<td>(1) Median</td>
<td>(2) Mean</td>
<td>(3) Median</td>
<td>(4) Mean</td>
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<td>0.009 [0.009]</td>
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<tr>
<td>Observations</td>
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<td>3162</td>
<td>3162</td>
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</tbody>
</table>

Notes: Estimation of equation (10). In the first and second columns, the dependent variable, $d \log(\text{Income}_{z})$, 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.

is a canton fixed effect. We include canton fixed effects because of income tax changes that 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

Distance

Expenditure share

Trip share

Transaction share

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

Expenditure share

Transaction share

Trip share

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

<table>
<thead>
<tr>
<th></th>
<th>Expenditures (1)</th>
<th>Expenditures (2)</th>
<th>Transactions (3)</th>
<th>Transactions (4)</th>
<th>Trips (5)</th>
<th>Trips (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>-0.095</td>
<td>-0.171</td>
<td>-0.063</td>
<td>-0.158</td>
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<td>[0.144]</td>
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<td>-4.449***</td>
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<tr>
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<tr>
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<td>3309</td>
<td>3309</td>
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<td>3309</td>
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</tbody>
</table>

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

<table>
<thead>
<tr>
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<th>Trips</th>
</tr>
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<tr>
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<td>Kids</td>
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</table>

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

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<td>3308</td>
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<tr>
<td>Adjusted $R^2$</td>
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<td>0.002</td>
</tr>
</tbody>
</table>

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

\[
\frac{X_{h14}}{X_{h14} + X_{hd14}} = \alpha + \beta \log(\text{Income}_h) + \delta \text{Distance}_h + [\zeta' X_h] + \varepsilon_{h14}
\]

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 \(\ell\) in year \(t\), where \(\ell = d\) represents domestic and \(\ell = f\) represents cross-border (or foreign) purchases. \(\text{Distance}_h\) 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: Prices are lower across the border from Switzerland and CB 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, \(\text{FE}_{eq}\), with EAN code and quarter fixed effects, \(\text{FE}_e\) and \(\text{FE}_q\).

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 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. 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 \( \log \left( \frac{X_{hft}}{X_{hdt}} \right) \) and \( \log \left( \frac{(X_{hft} + 1)}{(X_{hdt} + 1)} \right) \), respectively. The inclusion of \( X_{hlt} + 1 \) 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

---

34 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

**Price gap Swiss CB vs AT-FRA-DE border regions**

**Price gap FR-DE border regions vs. non-border regions**

Notes: Estimation of (2) showing estimated coefficients \( \beta_q \) and associated 95% confidence intervals in both left and right panels. \( \log p_{c\ell q} \) is the geometric weighted average of prices (all in CHF) across transactions within the \( c\ell q \) 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: \( X_{hft}/(X_{hft} + X_{hdt}) \)

**Expenditures**

**Transactions**

**Trips**

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

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

**Expenditures**

**Transactions**

**Trips**

Notes: Replicates Figure 4 except the outcome variable is \( \log [(X_{hft} + 1)/(X_{hdt} + 1)] \) rather than \( X_{hft}/(X_{hft} + X_{hdt}) \).
shares—expenditures, transactions, and trips—the following regression

\[ y_{ht} = \text{FE}_t + \text{FE}_h + \sum_{y \neq 2014} \mathbb{I}_{y=t} \left[ \beta_y \text{Inc}_h + \delta_y \text{Distance}_h + \left[ \zeta'_y K_h \right] \right] + \epsilon_{ht} \]  

(11)

The dependent variable \( y_{ht} \) in equation (11) is given by \( \log(X_{ht}/X_{hdt}) \) or \( \log\left(\frac{X_{ht}+1}{X_{hdt}+1}\right) \). In these regressions, the coefficient \( \beta_y \) 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 \( \delta_y \) 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 \( \log\left(\frac{X_{ht}+1}{X_{hdt}+1}\right) \) 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 \( \log\left(\frac{X_{ht}}{X_{hdt}}\right) \). 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

<table>
<thead>
<tr>
<th></th>
<th>Expenditures</th>
<th></th>
<th>Transactions</th>
<th></th>
<th>Trips</th>
</tr>
</thead>
<tbody>
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<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
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</tr>
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<td>[0.088]</td>
<td>[0.070]</td>
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<td>[0.053]</td>
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<td>-0.076</td>
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<tr>
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<td>[0.082]</td>
<td>[0.072]</td>
<td>[0.077]</td>
<td>[0.045]</td>
</tr>
<tr>
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<td>-0.164**</td>
<td>-0.167**</td>
<td>-0.051</td>
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</tr>
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<td>-0.148*</td>
<td>-0.171**</td>
<td>-0.166**</td>
<td>-0.106*</td>
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<tr>
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<td>X</td>
<td>X</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><strong>Kids</strong></td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td>X</td>
<td>X</td>
<td>X</td>
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</tr>
<tr>
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<td>0.721</td>
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<td>0.831</td>
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Notes: Estimation of equation (11) measuring $y_{it}$ as $\log \left( \frac{X_{hf_{it}}}{X_{hd_{it}}} \right)$. 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

<table>
<thead>
<tr>
<th></th>
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<th>Transactions</th>
<th></th>
<th>Trips</th>
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<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
</tr>
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<td>Income 2013</td>
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<td>[0.134]</td>
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<td>[0.040]</td>
<td>[0.042]</td>
<td>[0.022]</td>
<td>[0.026]</td>
</tr>
<tr>
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<td></td>
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<td>[0.038]</td>
<td>[0.046]</td>
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<td>Income 2016</td>
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<td>-0.015</td>
<td>-0.058</td>
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<td>Distance 2013</td>
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<tr>
<td>Distance 2015</td>
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<td>0.234*</td>
<td>0.037</td>
<td>0.037</td>
<td>0.004</td>
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<td>[0.119]</td>
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<td>Distance 2016</td>
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Notes: Estimation of equation (11) measuring $y_{ht}$ as $\log \left( \frac{(X_{ht} + 1)}{(X_{dt} + 1)} \right)$. 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
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

Perishable goods

Expenditure share  
Transaction share  
Trip share

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

Expenditures  
Transactions  
Trips

Notes: Estimation of equation (3) separately for goods coded as perishable and goods coded as non-perishable, showing estimated coefficients $\hat{\beta}$ and associated 95% confidence intervals. The outcome variable is $\log\left(\frac{X_{hft}}{X_{hdt}}\right)$ and $X_{hft}$ 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

Expenditures  
Transactions  
Trips

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

Figure 21: Changes in price deflator after 2020 border closure: alternative values of $\theta$

$\theta = 1$  
$\theta = 1.5$

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