Price and Consumption Responses to Large Exchange Rate Shocks: Evidence from the 2015 Appreciation in Switzerland*

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December 2017

Preliminary and incomplete.

Abstract

The removal of the lower bound on the CHF/EUR nominal exchange rate in January 2015 provides a unique setting to study the implications of a large, sudden and arguably exogenous appreciation of the nominal exchange rate. Using retail prices from a homescan data of individual consumer goods and the microdata underlying the import price index, we measure the response of border and consumer prices to the CHF appreciation, and how household expenditures responded to these price changes. Our main findings are: (i) changes in the wedge between import prices at the border and retail level account for a significant portion of incomplete exchange-rate pass-through at the consumer level; (ii) cross-section variation in border price changes induced by variation in the currency of invoicing at the border have a significant impact on consumer prices as well as expenditures at the consumer level, and (iii) while the frequency of import price reductions rises, the average size of these price reductions falls in the aftermath of the appreciation (consistent with a s-S pricing model with fat-tailed distributed shocks), contributing to low aggregate import-price pass-through.

JEL classification: E3, E31, E50, F41
Keywords: Large exchange-rate shocks, expenditure switching, price-setting, exchange-rate pass-through, nominal and real price rigidities.

*We thank AC Nielsen Switzerland for preparing the Swiss homescan data, GfK and Kantar worldpanel for the international homescan data, and the SFSO, in particular Robert Larocca and Andreas Fankhauser for providing and explaining the IPI microdata. We furthermore thank our discussants Nathalie Chen, Oleg Itskhoki, Oleksiy Kryvtsov, and Georg Strasser for very constructive comments, and furthermore Fernando Alvarez, Stephen Cecchetti, Francesco Lippi, Ester Faia, Mirko Wiederholt, and participants at SED 2017, the NBER SI, the Sixth BIS Research Network meeting, the CEBRA annual meeting 2017, the Verein für Socialpolitik, the CEPR Annual IMF Programme Meeting, the Bank for International Settlements, the University of Basel, the University of Frankfurt, and the University of Neuchâtel for helpful comments. Maximilian Bastian, Lucienne Brunner and Santiago Alvarez provided excellent research assistance. The views expressed in this paper are those of the authors and not necessarily those of the Bank for International Settlements.

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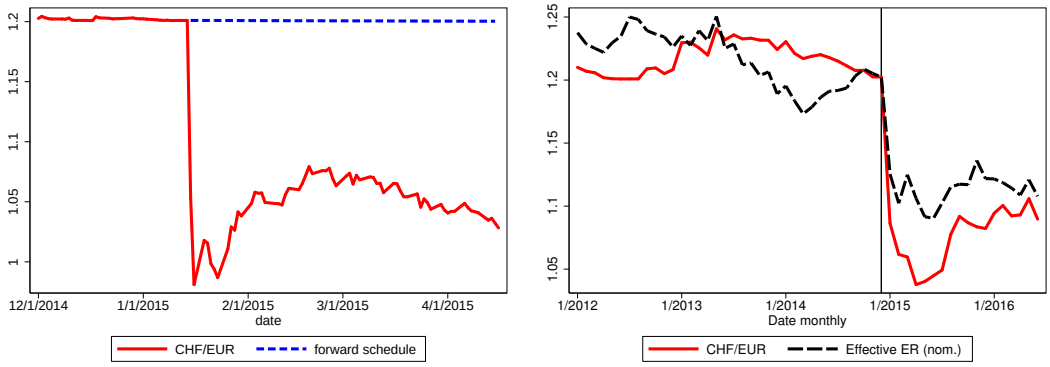
1 Introduction

This paper studies the response of prices and quantities to exchange rate movements based on the large and sudden appreciation of the Swiss franc (CHF) on January 15, 2015. Using a homescan dataset of Swiss purchases of non-durable consumer goods matched to imports at the border, we document the response of border prices, domestic and import consumer prices, and the extent of expenditure switching between domestic and imported goods. We use this case-study to shed some light on classic issues in international macroeconomics such as the sources of incomplete exchange-rate pass-through, nominal rigidities in price adjustment, currency of invoicing in international trade, and expenditure switching by households to changes in international relative prices.

Figure 1: *The 2015 CHF Appreciation*



(a) CHF/EUR and forward schedule (b) CHF/EUR and trade weighted ER

Notes: The red solid line in panel a) shows the nominal CHF/EUR exchange rate, daily data, from December 1, 2014 to April 30, 2015. The dashed line shows the forward schedule based on forward rates overnight, 1 week, 1, 2, and 3 months on January 14th, 2015. Panel b) shows the monthly average CHF/EUR nominal exchange rate in red and the trade-weighted nominal exchange rate, broad index, as calculated by the Bank of International Settlements, in black dashed. The trade weighted ER is indexed to equate the nominal CHF/EUR in December 2014. Sources: SNB, Bank of International Settlements, Bloomberg.

On September 6, 2011, the Swiss National Bank (SNB) put in place a minimum exchange rate of CHF/EUR 1.20 after a steady appreciation of the CHF against the EUR.[1] Between 2012 and 2014 the CHF/EUR was very stable (ranging between 1.2 and 1.25). In the end of 2014, foreign developments, including market participants' anticipation of a large-scale

[1]See Amador et al. (2017) for a theoretical description of the central bank's exchange-rate policy and the effects on capital inflows.

quantitative easing program in the Euro area, led to a rapid surge in safe-haven capital inflows into Switzerland. These capital inflows required large exchange rate interventions, prompting the SNB governing board to unexpectedly abandon the cap on January 15, 2015.[2]

The Swiss experience provides a unique setting to study the consequences of a large and sudden policy-driven change in the nominal exchange rate for three reasons. First, the exchange rate appreciation was relatively large and occurred during a period of an otherwise very stable macroeconomic environment. Panel a) in Figure 1 shows that, relative to its level in December 2014, the CHF/EUR appreciation was larger than 20% on January 15 2015, 13.2% three months later, 14.3% six months later, and 9.4% twelve months later. The trade-weighted appreciation of the CHF was somewhat smaller, as can be seen in Panel b) of Figure 1.[3] These movements in the nominal exchange rate are quite large relative to standard short-term exchange rate fluctuations in advanced economies that have been a main focus of the literature.[4]

Second, the 2015 appreciation followed a three year period of remarkable exchange rate stability, both in nominal and real terms. This makes it unlikely that price dynamics of goods imported form the euro area in the aftermath of January 15, 2015 reflected adjustment lags due to prior CHF-Euro exchange rate movements.

Third, the appreciation was not triggered by a policy change that responded to any domestic shocks. A potential concern, that the patterns on price and quantity that we focus on (such as the increase in Swiss-produced goods prices relative to imported goods prices) are not the response to the policy-induced nominal appreciation of the CHF but instead

[2]The SNB had reiterated its commitment to the minimum exchange rate throughout late 2014. For example, on December 1st, SNB Governor Thomas Jordan (Jordan, 2014) argued that "the minimum exchange rate remains the key instrument for ensuring appropriate monetary conditions." As can be seen in Figure 1, forward rates on January 14, 2015 reveal that investors expected a flat profile of the exchange rate and thus a continuation of the SNB's policy stance. None of 22 economists surveyed by Bloomberg News between Jan. 9 and Jan. 14 expected the SNB to get rid of its cap in 2015. (see Bloomberg, 2015.01.15 4.42 PM CET.)". Further evidence from expectations derived from option prices shows that the probability financial markets assign to the exchange-rate floor being abandoned is 5% in the fall of 2014 (Jermann, 2017).

[3]The CHF/EUR appreciation in the period 2008-2012 was larger (the CHF/EUR ranged between 1.62 and 1) but much more gradual, and therefore it is harder to separate its effects from other contemporaneous aggregate shocks.

[4]While a number of studies have resorted to large devaluations in developing countries to study the effects of large sudden exchange rate changes (see e.g. Burstein et al., 2005; Cravino and Levchenko, 2015), these episodes tend to be accompanied by other major macroeconomic developments such as debt and banking crises that confound the effects of the exchange-rate movement.

are the result of capital inflows (which also led to the SNB's policy change), may not be as severe in our setting. First, while the cap was in place, the SNB intervened whenever market forces threatened to appreciate the CHF beyond the cap, and capital inflows ended up on the SNB's balance sheet. Because the SNB — which by law cannot give credit or buy equity in Switzerland — needs to re-invest the funds abroad, the financing conditions in Switzerland were largely isolated from these capital flows.[5] Once the cap was abandoned, capital flows ceased almost instantaneously. Second, during 2012-13, there was another surge of capital inflows, even more pronounced than the December 2014-January 2015 episode. This large capital inflow during a period in which the cap was still in place was not associated with a real appreciation of the CHF.[6]

To summarize, the CHF-Euro appreciation in January 15, 2015 is quite unusual in that it is large, sudden, driven by a policy change in response to foreign events that arguably have no direct short-term effects on the relative prices and quantities we examine, takes place in the context of a stable aggregate economy, and follows a three-year period with a stable nominal and real CHF-Euro exchange rate.[7]

We first document all layers of exchange-rate pass-through into prices, at the border and at the consumer level.[8] We then perform a simple decomposition of the sources of incomplete pass-through to aggregate consumer prices in our data. The CHF appreciated by 14.3% against the Euro between January and July 2015, and retail prices fell only by 1.5%.

[5]A detailed examination of these capital flows (see Auer (2015) and Auer and Tille (2016)) shows that foreign safe-haven demand for CHF was channelled through branches of foreign banks, which do neither issue credit in Switzerland nor engage in sizable positions with the Swiss financial system. The accumulation of other Swiss assets by foreign investors was not significant.

[6]Relatedly, while in standard models capital inflows typically result in an increase of economic activity, the growth rate of real GDP and real consumption fell slightly in 2015 relative to 2014. See Table A.1 for an overview of the main Swiss economic developments 2013–2016.

[7]Closely related to the part on border prices is Bonadio et al. (2016), who document the response of import unit values after the appreciation on January 15, 2015 and find a very swift response to the exchange-rate shock. Our approach to look at a large shock to understand aggregate and disaggregate dynamics also relates to studies looking at other large shocks, such as devaluations in Burstein et al. (2005), Cravino and Levchenko (2015) and Rodnyansky (2017), inflationary episodes (Gagnon, 2009), the 2008 trade collapse (Gopinath et al., 2012), natural disasters (Lopez-Salido and Gagnon, 2015), VAT changes (Karadi and Reiff, 2014), or recessions (Bems and di Giovanni, 2016).

[8]This relates to the literature documenting exchange-rate pass-through into border prices and the role of currency of invoicing, as for example Gopinath and Itskhoki (2010), Gopinath et al. (2010), Fitzgerald and Haller (2014), Goldberg and Tille (2016), and to the more scarce literature documenting responses of consumer micro prices to exchange rates, as for example Goldberg and Hellerstein (2008) or Burstein and Jaimovich (2012). See Burstein and Gopinath (2013) for a more complete literature review and references therein.

Pass-through was very high for EUR-invoiced border prices and much lower for CHF-invoiced border prices (although, conditional on nominal price changes, the reduction in CHF-invoiced border prices is sizable). In an accounting sense, incomplete pass-through of the exchange rate into border prices invoiced in domestic currency and reductions in the price of imported goods at the border, relative to their price at the retail level (due to a combination of nominal retail price rigidity and changes in retail markups), are the most important components of incomplete pass-through in the first six months after January 2015, while reductions in the retail price of import relative to Swiss-produced retail prices is the most important component at longer horizons.

Second, using cross-sectional variation in price changes and invoicing currency across products, we estimate the response of import prices at the retail level to changes in import prices at the border.[9] According to our estimates, a 10% price reduction at the border results in approximately a 3–4% (depending on the time horizon) price reduction for imported products at the retail level. In order to isolate the variation in prices across imported products arising from the CHF appreciation, we instrument for border price changes using the product's currency of invoicing at the border, and find a similarly large effect. While previous evidence on the role of currency of invoicing is based on border price changes, see e.g. Gopinath et al. (2010) and Gopinath (2016), we find that invoicing has a significant impact on the response of retail prices to a well-identified exchange-rate shock.

Third, we document an 8.3% average increase in the market share of imported goods during the 17 months following the 2015 CHF appreciation. To gauge the responsiveness of import expenditures to relative price changes, we again exploit the cross-sectional variation along the invoicing dimension to instrument for changes in relative prices. Market shares of imported goods in CHF-invoiced product groups increased by only around a third as much as in product groups that are invoiced in EUR. Instrumenting for relative price changes using CHF-invoiced shares at the border implies a sizable elasticity of import retail expenditures

[9] Given lack of product-specific information at the border, we are only able to match individual products at the retail level to 37 comparable product categories at the border. Berger et al. (2012) use the underlying data of the US Bureau of Labor Statistics to match individual identical items at the border and retail levels. Whereas Berger et al. (2012) estimate the evolution of good-specific distribution shares, we examine the impact of changes in border prices on retail prices.

to retail prices one year or more after the CHF appreciation.[10]

Fourth, motivated by our accounting exercise suggesting that nominal (and real) rigidities on imports at the retail level play a role in incomplete pass-through, we examine the response of the intensive and extensive margins of price adjustment.[11] We show that the decline in import retail prices was quite small even though there was a large increase in the frequency of price reductions (on impact, from roughly 10% to 25% monthly) and a small decline in the frequency of price increases. In an accounting sense, had the absolute size of price decreases and increases remained constant at their pre-shock levels, import prices would have fallen by over two times as much as they did.

We show that import prices on average did not fall by much in spite of the large increase in the fraction of firms reducing prices because there was a marked decline in the absolute size of price reductions relative to the pre-shock size of price reductions (and this was not simply the result of temporary sales). In an accounting sense, had the frequency of price decreases and increases remained constant at their pre-shock levels, import prices would have increased on average rather than fallen in 2015. We complement this aggregate evidence showing that the increase in the frequency of price reductions and the decline in the size of price reductions was smaller for products with a larger border price reduction (or a larger share of EUR-invoicing at the border).

We interpret this negative co-movement between intensive and extensive margins of price adjustment through the lens of a pricing rule emerging from a simple menu cost model. We show that in response to a decline in the CHF cost of imported goods, the absolute size of price reductions falls only if new price changes (i.e. that would have been zero in the absence of the shock) are sufficiently small relative to the size of typical price reductions. This is the case

[10] Cravino (2017) uses data on Chilean exports data to estimate the differential response of exports to exchange rate shocks according to the invoicing currency of the transaction. Instead, we use information on the invoicing currency of imports to estimate pass-through of border prices to retail prices and to measure expenditure switching to imports at the consumer level in response to a large exchange-rate shock. The response of importer market shares are quite pronounced compared to elasticity estimates uncovered in the literature based on time-series variation (see e.g. Feenstra et al., 2014, and references therein) or Imbs and Mejean (2015). See also Bems-DiGiovanni(16)

[11] This relates to a larger literature examining the role of intensive and extensive margin and the role of selection effects for aggregate price dynamics, as for example Klenow and Kryvtsov (2008), Nakamura and Steinsson (2008), Gagnon (2009), Midrigan (2011), Alvarez and Lippi (2014), Alvarez et al. (2016), Carvalho and Kryvtsov (2017)

under the form of selection implied by idiosyncratic shocks with a fat-tailed distribution, as in Gertler and Leahy (2008) and Midrigan (2011). We therefore view our finding as providing supporting evidence (in response to an observed aggregate shock) for the form of selection in menu cost models that these authors have argued is important to account for the damped response of aggregate prices to nominal shocks at time horizons in which price rigidities are active.

It is well understood that low exchange-rate pass-through conditional on observing a price change can mute the change in aggregate import prices in response to exchange-rate changes (see e.g. Gopinath et al. (2010) and Gopinath and Itskhoki (2010)). We show that, given the large increase in the fraction of firms changing prices induced by the exchange rate shock, the extent of selection in terms of the set of products whose prices change is important to generate low aggregate pass-through.

The remainder of the paper is organized as follows. In Section 2, we describe the data. In Section 3, we document the response of prices at the border and retail level in the aggregate and cross-section, focusing on the role of invoicing at the border on consumer prices. In Section 4 we document the extent of expenditure switching to imported goods, focusing on the role of currency of invoicing at the border on allocations at the consumer level. In Section 5 we quantify the role of the extensive and intensive margins of price adjustment in response to the appreciation. In Section 6 we interpret the negative comovement between intensive and extensive margins of price adjustment through the lens of a simple menu-cost model.

2 Data

This section describes the data and presents descriptive statistics of the data sets used in the rest of the paper. Our main dataset is the "homescan" database from AC Nielsen Switzerland. We match the homescan data to the microdata underlying the calculation of the Swiss Import Price Index (IPI) from the Swiss Federal Statistical Office (SFSO) by product category. We furthermore complement this data with homescan data from Switzerland's neighbouring euro-area countries collected by GFK (Gesellschaft für Konsumforschung,

Society for Consumer Research) in Austria, France, and Germany.

The AC Nielsen homescan data for Switzerland is a demographically and regionally representative sample consisting of 3,187 households in Switzerland, where one household in the sample represents roughly 1,000 households in the total population.[12] If a household leaves the panel, a new household representing the same socioeconomic group is added.[13] We observe household size, location, education of the main buyer in a household, and income class.[14]

Households are provided with a scanning technology, which allows them to scan the barcode of each product they purchase. We refer to the barcode which uniquely identifies a single product as EAN (European Article Number, comparable to Universal Product Codes, UPC, for the US). The households scan the purchases they make in supermarkets, drugstores, or department stores, including food, non-food grocery items, health and beauty aids, and selected general merchandise. After scanning the EAN, households enter the price and quantity purchased for each product, and a retailer identification number. The homescanner then transfers this information from the household to AC Nielsen.

In the raw data set, a single observation, which we refer to as a 'transaction' below, includes the EAN of the product purchased, quantity purchased, the price paid, the date of the shopping trip, and a retail chain code, which can be linked to the name of the retailer.[15] All products are classified into one of 187 product groups, which are very narrowly defined groups of items, such as apple juice, shampoo, or toilet paper.

We augment the homescan data with information on the actual country of production of each good. The first two digits of the EAN code provide information on the country in which a product has been registered. This is not necessarily the country in which the product has actually been produced. We therefore check all EAN codes that we include in the analysis

[12]The selection of panellists is based upon the Swiss census conducted by the SFSO. The Italian-speaking Canton of Ticino (accounting for 4.4 % of all Swiss households) is excluded from the Nielsen panel.

[13]We can track entry and exit, because entry date and exit date for each household are included in the data set. The monthly average turnover rate of households in the sample is less than 1%.

[14]Location is measured at the two-digit zip code, which is somewhat finer than a US three digit-zip code (state and regional prefixes). We also have information on the "WEMF" (Werbemedienforschungs AG) region a household lives in. Retailers tend to assign common prices across stores within an WEMF, and print WEMF-specific advertising catalogues to advertise their product prices.

[15]We do not have information on coupons, which in contrast to the US do not play a prominent role in Swiss supermarkets.

Table 1: *Product statistics retail prices*

	Transactions	ExpShare (%)	Products
Total	4,838,479	100	9,727
Swiss	3,608,269	73	4,330
Imports	1,230,210	27	5,397
Imports EA	999,874	22	4,586
Imports ROW	230,336	5	811
Balanced Sample			
Total	4,119,241	100	3,782
Swiss	3,199,428	76	2,575
Imports	919,813	24	1,105
Imports EA	747,325	19	885
Imports ROW	172,488	6	220

Notes: The first panel shows the full sample, and the second panel shows the balanced sample. *Transactions* are the number of purchases observed, *ExpSare* is the share of expenditures in total expenditures (in %), and *Products* shows the number of unique products in the respective sample. Swiss goods are produced and sold in Switzerland, imports are sold but not produced in Switzerland, imports EA denote imports from the euro area and imports ROW are imports from outside the euro area.

below for the actual country of origin using first the webpage www.codecheck.info. If no information on a specific EAN code is obtainable from this webpage, information on the product label (which states the correct country of origin) is obtained from the online stores of the respective supermarkets, such as Coop.ch, Migros.ch, or Amazon.ch.[16] We find that the information from the first two digits of the EAN is often but not always correct. We thus use the actual country of origin collected from the product label to classify products into imports and domestically produced goods rather than the information from the EAN.

Our data sample covers the period January 2012 to June 2016. We drop observations for which we do not observe the country of origin according to the searches described above, and we also drop observations which include obvious errors in entering the price.[17] Furthermore, we exclude observations for products purchased via cross-border shopping. Table 1 provides an overview of our product statistics (first panel, labelled full sample). We observe 9,727 unique goods in 4.8 million purchase transactions. The vast majority (4,586 out of 5,397) of imported goods originate from members of the euro area. Even though we observe more

[16]These web sites provide all information that is included on the product label, including the list of ingredients and their origin, as well as the country of production. All mentioned web pages were accessed at various occasions during October 2015 to March 2016.

[17]This step excludes 0.01% of all observations

unique products that are imported than domestic (produced and sold in Switzerland), imports account for only one fourth of total expenditures and total number of transactions.

Since our sample does not cover the universe of products, we aim to minimize the role of changes over time in the mix of covered product by using in our price analysis a balanced set of products that are purchased at least once in each month during the period 2012 to mid-2016.[18]. This excludes some seasonal items, as well as items which supermarkets sell occasionally, yet that are not part of their day-to-day product range. This gives us a sample of 3,782 continuously observed unique EANs. In this balanced sample there are in total 4.1 million purchase transactions (see Table 1).

The data underlying the calculation of the Swiss import price index comes from the SFSO. We refer to these prices as "border prices", to distinguish them from retail prices for imported products. We do not have the information to match each individual product at the border with a product at the retail level. Instead, we match each product group from the AC Nielsen homescan data to the 39 comparable border product categories from the SFSO. Note that there are border product categories that are not matched to retail product groups (e.g. oil). The product groups in the retail data and the matching to the SFSO data are shown in Table A.11 in the Appendix.[19]

We use border price data from 2012 to 2016. Since most of the product categories that can be matched to the Nielsen data are surveyed only on a quarterly basis by the SFSO, we focus on quarterly border prices.[20]

As reported in Table 2, the overall border price sample includes 7,559 products, of which 2,269 are consumer products. Of these, 1,056 products (14,476 quarterly observations) can be matched to retail product categories. Roughly two thirds of these products are invoiced in CHF and one third in EUR (only 47 products are invoiced in other currencies).

[18]Relatedly, statistical offices calculate price indices by tracking price changes of a basket of products that remains constant over some time period

[19]In our regressions and average price statistics we use expenditure weights from the AC Nielsen homescan data. We weight each border product category using expenditures on the corresponding retail product groups and, following procedures of the SFSO, we assign equal weight to border-price observations within each product category. Therefore, border and retail price indices and regressions assign equal weight to each product category.

[20]For quarterly products, surveys are performed in the first two weeks of January, April, July, and October. We exclude price changes due to product replacement.

Table 2: *Product statistics for border prices*

	Observations	Products
All products	91,436	7,559
All consumer goods	27,092	2,269
Matched products	14,476	1,056
Matched CHF invoiced	9,461	634
Matched EUR invoiced	4,555	367
Matched other invoiced	460	47

Notes: Data source: SFSO. The first row shows the number of observations and products for all products included in the 2012–2016 data. The second shows all consumer goods (excluding investment goods and commodities), the third all products in categories that can be matched to the retail price data, and in the three last columns, we show the matched products by invoicing currency.

3 Exchange-rate pass-through to prices

In this section, we document the impact of the 2015 CHF appreciation on border and retail (consumer) prices and quantify the importance of different sources of incomplete pass-through at the retail level. We also measure the role of border price changes and their currency of invoicing on retail price changes. In Section 4 we measure the impact of border price changes (induced by differences in currency of invoicing) on import shares.

3.1 Border prices

Pass-through is much higher for EUR-invoiced border prices than for CHF-invoiced border prices. This is shown in Figure 2, which displays the cumulative change in border prices (separately for EUR and CHF invoiced products) around the CHF appreciation. The CHF appreciated by 13.2% in the first quarter (14.3% in the first six months), EUR-invoiced border prices fell by 12.8% (12.1%) and CHF-invoiced border prices fell by less than a third compared to EUR-invoiced prices, by 4.0% (4.2%).

The different responses to the shock by currency of invoicing holds also when conditioning on a nominal price change in the currency of invoicing. Panel a) in Figure 3 shows, for EUR-invoiced goods, the average price change (in EUR) conditional on a non-zero EUR price change since January 2015. It reveals that even when prices change in EUR, they are largely unresponsive to the exchange-rate shock, implying that pass-through is complete.

While pass-through is larger for CHF invoiced products that have changed prices, pass-trough remains incomplete (Panel b) in Figure 3.

To quantify the extent of exchange-rate pass-trough, we provide a cross-sectional measure of exchange-rate pass-through k quarters after January 2015 based on regressions of the form

$$\Delta_k p_i^b = \Delta_k e \times \left(\beta + \gamma \times D_i^{CHFinv}\right) + \varepsilon_i \tag{1}$$

where $\Delta_k p_i^b$ denotes product i's log change in border price at least once k quarters after January 2015, $\Delta_k e$ is the corresponding log change in the CHF-EUR exchange rate (common across products), and D_i^{CHFinv} is equal to one if good i is invoiced in CHF.[21] Table 3 reports estimates for $k = 1, 2, 4$.

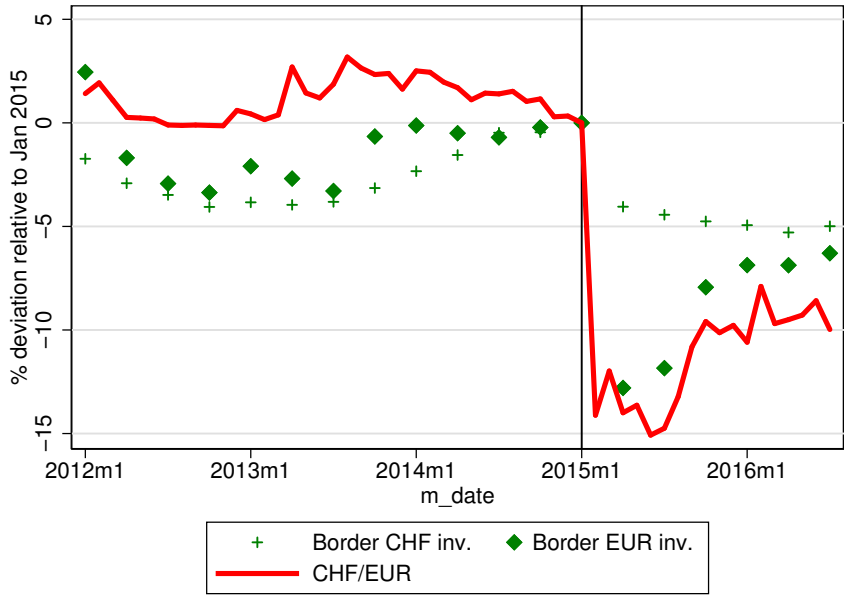
Exchange-rate pass-through β is in the range of $0.75 - 1$ for EUR invoiced products (columns 1-3), while pass-trough for CHF invoiced products $\beta + \gamma$ is roughly 0.2. This confirms that EUR invoiced products' pass-trough is complete in the short-run, as β is not significantly different from one in the first quarter (column 1), whereas it is incomplete for CHF invoiced products. Columns 4 and 5 show that, conditional pass-through in the first two quarters is 0.8 for EUR invoiced goods and 0.3 for CHF invoiced goods, which is still sizable.

In the Appendix we present tables when considering the sample of all imported goods and for all imported consumer goods (not only the sample of matched consumer goods). The results for all consumer goods is in line with the matched sample we use here, such that we are confident that the sample we use is not systematically different from all consumer goods (Tables A.2 and A.3). We also estimate short-, medium-, and long-term pass-through, see Gopinath and Rigobon (2008), for the full 2011-2016 period for the matched products we use here (Table A.4) and for all products included in the Swiss IPI (Table A.5). Results are qualitatively consistent with the 2015 cross-sectional results discussed above.[22]

[21] Border prices are collected within the first two weeks of each quarter, so January 2015 prices were collected just before the shock

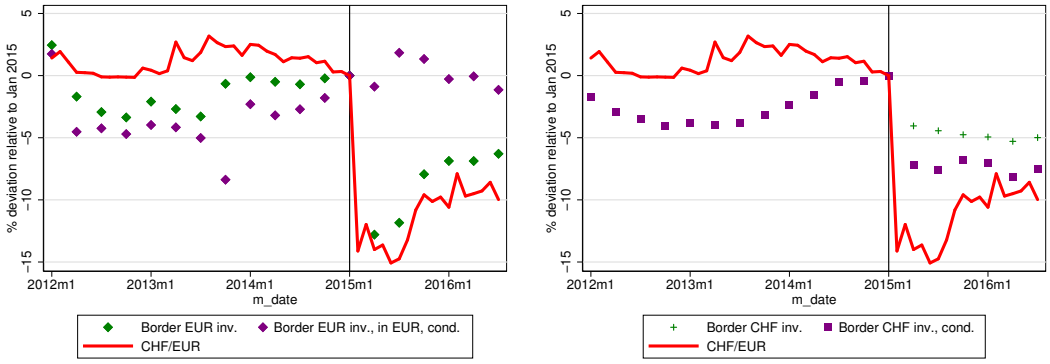
[22] This is not surprising since identification is largely based on the 2015-appreciation shock.

Figure 2: *CHF/EUR and border prices*



Notes: The red solid sline shows the log-difference in the exchange rate between Jan 14, 2014 and a given month. The crosses and diamonds show the log difference in border prices of EUR and CHF invoiced products between the period in the horizontal axis and January 2015 (Jan 2015=0). Source: SNB (exchange rate), and own calculations based on SFSO data.

Figure 3: *CHF/EUR and border prices conditional on a price change in the currency of invocing*



(a) EUR invoiced

(b) CHF invoiced

Notes: The red solid sline shows the log-difference in the exchange rate between Jan 14, 2014 and a given month. Panel a) shows the log difference in border prices of EUR invoiced products between the period in the horizontal axis and January 2015. Green diamonds show unconditional prices converted to CHF, purple diamonds prices in EUR, conditional on observing a nonzero price change compared to January 2015. Panel b) shows the same indices for CHF invoiced products, purple squares are border prices conditional on a price change, green crosses are all prices in CHF, including zero price changes. Source: SNB, and own calculations based on SFSO data.

Table 3: *Pass-through into border prices, cross-sectional estimates*

	(1)	(2)	(3)	(4)	(5)
	1Q	2Q	4Q	2Q CHF	2Q EUR
		Unconditional		Conditional	
$\Delta\ CHF/EUR$	1.048***	0.795***	0.750***	0.299***	0.804***
	(0.0474)	(0.0519)	(0.120)	(0.0526)	(0.0555)
$\Delta\ CHF/EUR \times$ CHFinvoiced	-0.825***	-0.611***	-0.180		
	(0.0573)	(0.0626)	(0.147)		
Observations	636	636	554	267	215
R^2	0.459	0.293	0.133	0.108	0.495

Notes: This table reports estimates for the pass-trough into border prices across products. The dependent variable is the log-difference between the border price one (two, four) quarter(s) after the shock and January 2015 (the price right before the shock). The right-hand side includes the log-change in the exchange rate between January 2015 and the one (two, four) quarter(s) after the shock. Because this variable does not vary over the cross-section, we do not include a constant in the regression. We furthermore interact each product price by a dummy that is equal to one if a product is invoiced in CHF and zero otherwise. Columns (4) and (5) regress nonzero price changes in their currency of invoicing between the first and third quarter in 2015 on the log-change in the exchange rate in the same period. RRobust standard errors in parantheses, *** p<0.01, ** p<0.05, * p<0.1.

3.2 Retail prices

In the homescan data, a product's price might be observed several times in a given period. To structure the price data, we follow procedures from statistical offices when collecting data for CPI (consumer price index) measurement. We first calculate a price per retailer, region, and month. We then calculate price changes and average these changes per product, and then aggregate product-level price changes, using 2014 expenditures as weights, to an aggregate retail price index.

To do so, we define the log change in retail price between month $t-1$ and t of product i (EAN) in region r (given by the WEMF code defined above), and retailer s as $\Delta p_{irs,t} = p_{irs,t} - p_{irs,t-1}$. If we observe more than one i, r, s, t price observation in month t, we follow Eichenbaum et al. (2014) and use the mode of the observed prices to obtain a value for $p_{irs,t}$.[23] We then compute average price changes per product and month, across regions and retailers, and then average these product-level price changes to product-category level $g(i)$ average price changes in a given month t. Finally, we compute an aggregate retail price index by weighting each product category by expenditure weights to obtain an aggregate average change in the price level in a given month t. We then accumulate these changes over time and index at January 2015 = 0.[24]

Figure 4 displays the aggregate change in retail prices (separately for imported goods and for Swiss-produced goods). This figure also includes the cumulative change in the CHF exchange rate and border prices (including CHF and EUR-invoiced imported goods).

Figure 5 presents estimates of exchange-rate pass-through on retail prices separately for imported and domestically produced goods based on regressions of the form $\Delta_k p_i = \beta_k \Delta_k e + \varepsilon_i$, where Δ_k now denotes monthly (as opposed to quarterly) differences in prices relative to

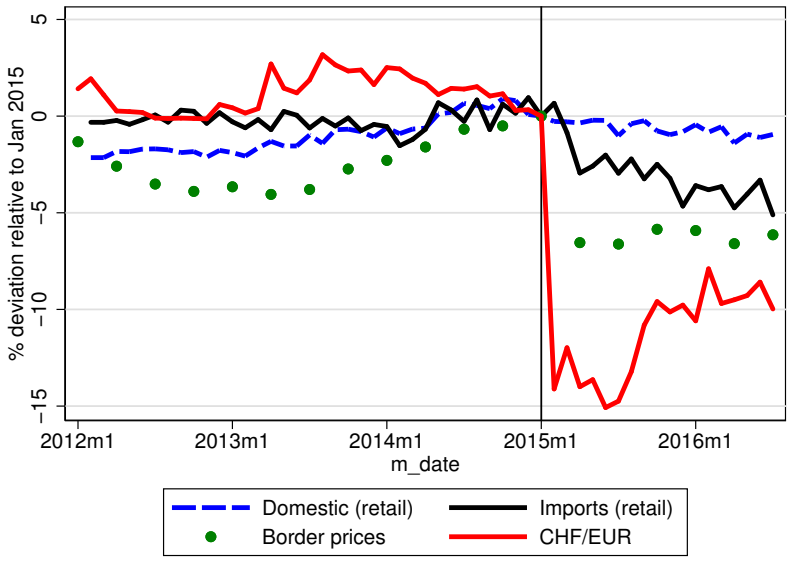
[23] Eichenbaum et al. (2014) argue that using the modal price reduces potential measurement errors. Our results are robust to using averages or medians (rather than mode) and to removing V-shaped movements in modal prices.

[24] In the following section, we also report statistics showing frequency and size of price changes at the retail level. We use the same definition of price changes, $\Delta p_{irs,t} = p_{irs,t} - p_{irs,t-1}$, and define a price change if we observe a change at the level of the product, region, and retailer, from one month to the next. It may be difficult to obtain statistics for frequency and size of price changes from homescan data in markets with a large number of retailers. This is not a concern in Switzerland, where there are two leading chains, Migros and Coop, which have a combined share of roughly 80% (so that many households repeatedly buy in the same store). Furthermore, retailers tend to set identical prices within regions.

January 2015.

The price response of Swiss-produced goods is very muted. Domestic prices fell, on average, by less than 0.5% six months since the appreciation (exchange-rate pass-through, β, is below 0.1 in the first 12 months.[25] Pass-through at the retail level is higher for imported goods, but much lower than for imported goods at the border. The retail price of imports fell on average by 2% between January 2015 and April 2015 and by 2.4% six months after the shock.[26] Exchange-rate pass-through for imported goods is roughly 0.2 three months after the appreciation and increases to roughly 0.4 after the first year, where the rise in β over time partly reflects the exchange-rate overshooting. The share of imports in the overall retail price index is around 25%, thus the pass-trough to retail prices is on average quite low.

Figure 4: *CHF/EUR and consumer prices*

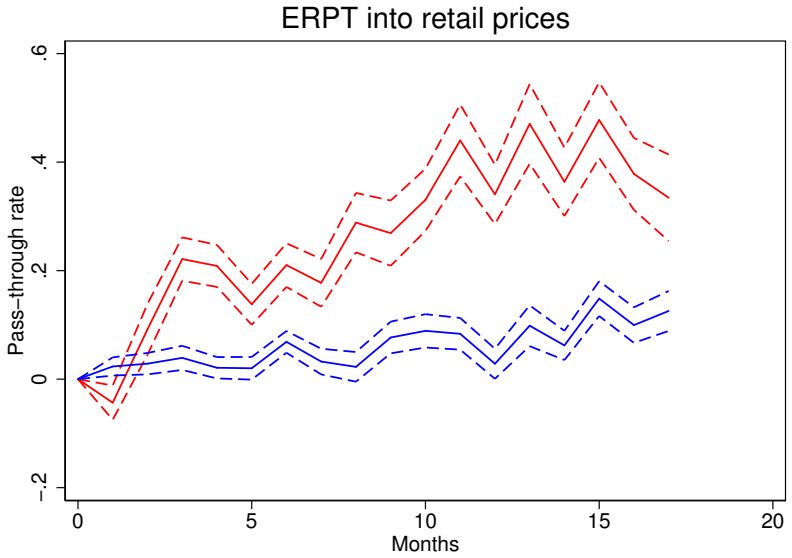


Notes: The red solid line shows the log-difference in the exchange rate between Jan 14, 2014 and a given month. The blue dashed line is the price index for retail prices produced in Switzerland, the solid black line for retail prices produced abroad and the green dots show the border price index for the matched product categories, weighted by the same expenditure shares as retail prices (Jan 2015=0). Source: SNB, and own calculations based on SFSO data.

[25]For comparison, also the official CPI combining the categories food, beverages and tobacco fell by only 0.8% six months after the appreciation. The official CPI including all consumer goods and services did not fall by much more either.

[26]The aggregate price of imported goods from the euro area fell by roughly 1PP more than the price index for all imports (including non-euro area imports) six months after the appreciation.

Figure 5: *Pass-through into retail prices*



Notes: Cross-sectional estimates, the solid lines show the point estimate of the regression $\Delta_k p_i = \beta_k \Delta_k e + \varepsilon_i$ where Δ_k denotes monthly differences in prices relative to January 2015. The horizontal axis displays k. The blue line shows β_k based on the regression for domestic products, the red line for imports. Dashed lines show 95% confidence intervals.

3.3 Retail prices, border prices, and invoicing currency

We now study to what extent import prices at the retail level respond to import prices at the border. To estimate how much retail prices of an imported product i change in response to change in border prices in the product category $g(i)$, we consider a regression of the form

$$\Delta_k p_i = \alpha + \beta \Delta_k p^b_{g(i)} + \varepsilon_i \tag{2}$$

where $p^b_{g(i)}$ corresponds to the change in border prices k quarters after January 2015.[27] Table 4 reports OLS results for $k = 1, 2, 4$.[28]

According to these estimates, retail prices fall by 3.5% for product categories with a 10% decline in border prices one quarter after the shock (column 1), 3.5% two quarters after the shock (column 4), and 4.1% four quarters after the shock (column 7).

Next, we estimate how much retail prices change depending on the fraction of CHF invoiced

[27] Recall that we cannot match individual goods at the retail level to individual products at the border, but a narrowly defined border product category $g(i)$.

[28] We use quarterly frequencies here because border prices are surveyed quarterly.

products within the same border product category, $g(i)$. Specifically, in equation (2) we replace $\Delta_k p^b_{g(i)}$ by $CHFinvoiced_{g(i)}$. Our estimates imply that retail prices decline in the first quarter by 4.9% for goods belonging to border product categories fully invoiced in EUR, and by 2.1% for goods in border product fully invoiced in CHF (Table 4, column 2). Pass-through from border prices to retail prices remains significantly different according to the currency of invoicing at the border two and four quarters after the shock (columns 5 and 8).

Finally, in equation (2) we instrument border price changes, $\Delta_k p^b_{g(i)}$ by the fraction of CHF invoiced products, $CHFinvoiced_{g(i)}$. We report the second-stage results for $k = 1, 2, 4$ in Table 4, columns 3, 6, and 9. The resulting IV estimates largely confirm the OLS estimates, suggesting that a 10% price reduction at the border results in approximately a 30-40% (depending on the time horizon) price change for imported products at the retail level.

Table 4: *Pass-through from border prices to retail prices*

	(1) 1Q	(2) 1Q	(3) 1Q (IV)	(4) 2Q	(5) 2Q	(6) 2Q (IV)	(7) 4Q	(8) 4Q	(9) 4Q (IV)
Border price	0.350***		0.276***	0.345***		0.408***	0.329***		0.409**
	[0.071]		[0.102]	[0.071]		[0.109]	[0.075]		[0.178]
Fr. CHF inv.		0.028***			0.043***			0.022**	
		[0.010]			[0.011]			[0.010]	
Constant	-0.006	-0.049***	-0.011	-0.008	-0.062***	-0.004	-0.021***	-0.055***	-0.016
	[0.005]	[0.008]	[0.007]	[0.005]	[0.009]	[0.008]	[0.005]	[0.007]	[0.011]
Observ.	1044	1044	1044	1044	1044	1044	1037	1037	1037
R^2	0.023	0.007	0.022	0.022	0.013	0.021	0.018	0.005	0.017

Notes: This table reports estimates for the pass-trough of border prices into retail prices across products. The dependent variable is the log-difference between the retail price one (two, four) quarter(s) after the shock and January 2015 (the price right before the shock). The right-hand side of the regression includes the log-change in the border prices in the corresponding product category over the same period (columns 1, 4, 7). Columns 2, 5, and 7 include the invoicing share in CHF in the border prices of the corresponding product category over the same period as right-hand side variables in the regressions. Columns 3, 6, and 9 again include the border prices as right-hand side variables and instrument them with the invoicing share in CHF in the corresponding product category. Robust standard errors in parantheses, *** p<0.01, ** p<0.05, * p<0.1.

3.4 Accounting for incomplete pass-through to retail prices

Table 5 summarizes how the appreciation of the CHF translates at different time horizons into average price changes for the various layers between the border and the retail level. As discussed above, the exchange-rate shock is only partially passed-through to border prices invoiced in domestic currency. Changes in border prices of imported goods are only partially

passed-through to retail prices of imported goods which, combined with a small response of domestically produced retail prices, results in a very muted change in average consumer prices. In this section, we provide a simple decomposition of incomplete exchange-rate pass-through to final consumer prices into different layers: EUR-invoiced border prices, CHF-invoiced border prices, distribution costs, nominal and real rigidities at the retail level (given changes in retail costs), and Swiss-produced good prices.

In order to separate the extent to which incomplete pass-through from border prices to retail prices of imported goods is driven by non-traded distribution costs versus nominal and real rigidities at the retail level, we must measure the share of distribution costs in the retail price of imported goods, which is not directly observed in our data. Specifically, we assume that k-month changes after January 2015 in the cost of supplying imported good i at the retail level are given by $(1 - s_d) \times \Delta_k p^b_{g(i)} + s_d \times \Delta_k p_N$, where s_d denotes the share of distribution costs in the cost of supplying imported goods at the retail level, and where the change in the price of distribution services is given by the change in the domestic producer price index.

We measure the distribution share, s_d, by estimating the cross-sectional relationship across product categories g between retail price changes, $\Delta_k p_g$, and retail cost changes, $(1 - s_d) \times \Delta_k p^b_g + s_d \times \Delta_k p_N$. Since nominal rigidities are likely to play an important role disconnecting retail prices from retail costs in earlier months, we use an estimate $s_d = 0.45$ obtained at a 5 quarter horizon.[29]

Table 5: *Summary of price responses at various layers*

	3m	6m	12m
1) CHF-EUR	-13.2	-14.3	-9.4
2) Border prices, EUR invoiced	-12.8	-12.1	-7.0
3) Border prices, all	-6.6	-6.5	-5.9
4) Border prices + distribution	-4.2	-4.3	-4.5
5) Retail prices imports	-2.1	-2.4	-4.0
6) Retail prices, all	-1.1	-1.5	-2.1

Table 6 provides a decomposition of the sources of incomplete pass-through (from the

[29]For $k = 1, 2, 3, 4, 5$ we obtain $s_d = 0.70$, 0.69, 0.77, 0.66, and 0.45. Using a higher value of s_d increases the role of distribution costs in accounting for incomplete pass-through at the retail level and reduces the role of nominal and real rigidities at the retail level, leaving the total contribution of incomplete pass-through between CHF-invoiced border prices and retail import prices unchanged.

CHF exchange rate to retail prices including domestic goods) at different horizons implied by price responses provided in Table 5.For example, the contribution of distribution costs to incomplete retail price pass-through in the first 3 months after January 2015 (row 4) in Table 6) is 18%. This is obtained from the figures in Table 5 as $[ln(row3/row4)]/[ln(row1/row6)] = ln(-6.6/-4.2)/ln(-13.2/-1.1) = 0.18$. Rows 2-6 in each column add up to 1.

Incomplete pass-through of EUR-invoiced border prices play a small role, while incomplete pass-through of CHF-invoiced border prices play a significant role in the first six months (accounting for roughly 28% of the overall incomplete pass-through). Reductions in the price of imported goods at the border relative to their price at the retail (due to a combination of distribution costs and changes in retail markups) account for roughly 50% of incomplete pass-through in the first six months after January 2015. Of this import retail wedge, distribution costs account for roughly 18% at every horizon, while changes in retail markups (due to nominal and real rigidities) account for a large share of incomplete pass-through in the first six months but plays a small role at longer horizons. Low pass-through for Swiss-produced goods (relative to the price of imported goods) accounts for an increasing share of the overall incomplete pass-through (up to 43% after one year).

Table 6: *Sources of incomplete pass-trough into retail prices*

	3m	6m	12m
1) CHF-EUR	-13.2	-14.3	-9.4
2) + Border EUR invoiced	0.01	0.07	0.20
3) + Border CHF invoiced	0.27	0.28	0.11
4) + Distribution costs	0.18	0.18	0.18
5) + Retail imports	0.28	0.26	0.08
6) + Retail domestic	0.26	0.21	0.43

4 Expenditure switching to imports

This section examines the response of retail expenditures on imported goods to the 2015 appreciation. We first focus on the average increase in import shares: depending on the time horizon, the log of market share of imported products increased in the order of magnitude of 5% to 10%. Second, we use the cross-sectional variation along the invoicing dimension to gauge

the responsiveness of imports expenditure switching to relative price changes. Consistent with our earlier findings regarding the impact of invoicing on prices, we find that invoicing is also a main determinant of expenditure switching: the market shares of imported goods in CHF-invoiced product groups increased by only around a third as much as in product groups that are invoiced in other currencies.

We start by documenting average changes in market shares at the product (EAN) level for imported goods. In any given period, the market share of good i which belongs to product category $g(i)$ is constructed as $MS_i = expenditures_i / \sum_{j \in g(i)} expenditures_j$, where $expenditures_i$ are measured in CHF from our Nielsen homescan data.

We first report average switching in the full post-appreciation period January 2015 - May 2016 (the end of our sample) relative to the same 17-months period prior to the appreciation (January 2013 - May 2014). Specifically, we regress the log change of the market share from January 2013 - May 2014 to January 2015 - May 2016 for the set of imported goods expenditures in good i against a constant, where observations are weighted by the pre-appreciation level of expenditures.

The average change in the market share in this sample of 2367 imported goods was 8.3%, as reported in column (1) of Table 7. In column (2) we consider a 12-months period comparing January 2013 - December 2013 to January 2015 - December 2015.[30] The average increase in the market share of imported goods was slightly smaller if we restrict to 2015, 5.9%. In column (3), we consider the last 12 months in the data and compare June 2013 - May 2014 to June 2015 - May 2016, which results in an average switching estimate of 10.1%. These results suggest that expenditure switching towards imports continued in the first half of 2016.

In columns (4) to (6) of Table 7, we examine average switching when measured in terms of expenditure in good i relative to total expenditures across all products, $ES_i = expenditures_i / totalexpenditures$ rather than relative to expenditures in good i's product group, MS_i. The evolution of ES_i and MS_i can differ if there are compositional shifts across different product groups. Indeed, across all time horizons (17 months ending in May 2016 in

[30] When we consider time periods that span more than 12 months, we must start our pre-appreciation period in January 2013. When we consider a 12 month time period, results are very similar if the pre-appreciation period covers 2013 or 2014, as import shares did not display any trends in the pre-appreciation period.

column (4), 12 months ending in December 2015 in (5), and 12 months ending in may 2016 in (6)), switching is larger when measured in terms of expenditure shares than when measured in terms of market shares (compare columns (1), (2) and (3), respectively). This is because expenditures shifted towards product groups with higher initial import shares.

Table 7: *Average import expenditure switching estimates*

	(1) MS, 1/15-5/16	(2) MS, 1-12/15	(3) MS, 6/15-5/16	(4) ES, 1/15-5/16	(5) ES, 1-12/15	(6) ES, 6/15-5/16
Constant	0.083***	0.059***	0.101***	0.102***	0.080***	0.122***
	[0.008]	[0.008]	[0.009]	[0.008]	[0.008]	[0.009]
Observations	2367	2211	2262	2367	2211	2262
R^2	0.000	0.000	0.000	0.000	0.000	0.000

Table 8: *Cross-sectional import switching estimates, 01/2015-05/2016*

	(1) OLS border	(2) reduced form	(3) 2SLS border	(4) OLS retail	(5) 2SLS retail
Rel. border price	0.602**		-2.052***		
	[0.270]		[0.667]		
Invoicing share		-0.105***			
		[0.033]			
Rel. retail price				-0.034	-4.239**
				[0.095]	[1.830]
Constant	0.112***	0.155***	-0.016	0.083***	-0.003
	[0.015]	[0.024]	[0.033]	[0.008]	[0.039]
Observations	2367	2367	2367	2367	2367
R^2	0.002	0.004	.	0.000	.

We next examine the cross section of expenditure switching towards imported goods, focusing on the full post-appreciation period between January 2013 - May 2014 and January 2015 - May 2016. We consider an estimation of the form

$$\Delta ms_i = \alpha + \beta * \Delta p_{g(i)}^{relborder} + \varepsilon_i \tag{3}$$

where Δms_i denotes the change in market share of imported good i between January 2013 - May 2014 and January 2015 - May 2016, and $\Delta p_{g(i)}^{relborder}$ denotes the change (for the same time period) in the log border price of imported goods in product category $g(i)$ relative to the domestic producer price in the same product category. In this regression, the constant

α captures the average increase in import shares (as in the specification of Table 7) and β captures the cross-sectional relationship between market shares and relative prices. Column (1) of Table 8 shows that in the OLS estimates, not only is α positive, but the relationship between changes in market shares and relative border prices, β, is positive as well.

In order to focus on the variation in relative price changes across product groups arising from the CHF appreciation, we rely on the findings in Section 3.3 and utilize heterogeneity in the share of CHF-invoicing in border product category $g(i)$, $CHFinvoiced_{g(i)}$, as a driver of sensitivity of prices to the common shock.

We first document in Column (2) of Table 8 the reduced form relationship between changes in market shares and CHF invoicing share by estimating specification (3) where we replace $\Delta p_{g(i)}^{relborder}$ by $CHFinvoiced_{g(i)}$. The constant is estimated at 15.5%, implying in product groups without CHF-invoicing, the market share of imported goods on average increased by 15.5%. The coefficient of the CHF-invoicing share is estimated at -10.5%, implying that the market share of imported goods in sectors that are fully invoiced in CHF on average increased by 5%.

Underlying the reduced-from estimation in column (2), invoicing affects expenditure switching via its impact on price setting (established in Section 3.3). In column (3), we examine this in a two-stage least square estimation relating first CHF invoicing to border price changes, and then border price changes to changes in market shares. We find that a 1% decline in the relative border price is associated with an increase of market share of around 2%.[31]

We next evaluate the relationship between expenditure switching towards imported goods and relative prices at the retail level (as opposed to relative prices at the border). Specifically, we consider estimates of the form:

$$\Delta ms_i = \alpha + \beta * \Delta p_i^{relretail} + \varepsilon_i \tag{4}$$

[31] Both the large appreciation and the use of invoicing as an instrument for border price changes are necessary for this result. The same two-stage least squares estimation does not uncover any significant relationships when estimated during 2014 or earlier times when exchange rate movements were small.

where $p_i^{relretail}$ is defined as the log of the good's retail price divided by the aggregate domestic retail price.

Column (4) of Table 8 presents OLS estimates, which in this case gives non-significant estimates of β. In column (5), we present the same specification but instrumenting for the relative retail price of good i with the associated border product category's CHF invoicing share, $CHFinvoiced_{g(i)}$. Following the previous logic, invoicing affects the pass through rate at the border, which in turn affects the response of retail prices, which in turn can identify the cross section of expenditure switching across goods. The responsiveness of the market share of imported goods with respect to price movements induced by the interaction of the exchange rate shock and the cross-sectional sensitivity is quite large, with an estimated elasticity of the market share with respect to the relative retail price of -4.2. Again, this differs starkly from the insignificant OLS estimate in column (4).

In Table A.8 in the Appendix we use as the dependent variable expenditures in good i relative to total expenditures across all products, ES_i, rather than relative to expenditures in good i's product group, MS_i. In this set of exercises, the impact of invoicing of switching is somewhat more pronounced that in our baseline estimations, and the uncovered elasticities in the two stage least square estimations are comparable to our baseline. We also reproduce Table 8 for two different time horizons. In Table A.10, we focus on changes between June 2013 - May 2014 and June 2015 - May 2016. In Table A.9, we focus on changes between January - December 2013 and January - December 2015. Consistent with the relative magnitude of average expenditure switching over the various time horizons shown in Table 7, we find that also in the cross section, the impact of invoicing on switching is somewhat less pronounced in the January - December 2015 sample (see the reduced-form estimation in column (2) of Table 8).

The patterns presented in this section are not driven by underlying nonlinearities or outliers in the data. Figure 6 shows a scatter plot relating decile bins of CHF invoicing in the x-axis to the expenditure response of imported goods in the y-axis (using the log change in market share, Δms_i as the dependent variable), qualitatively confirming previous results: expenditure switching towards imported goods is more limited for CHF-invoiced goods than for goods

invoiced in EUR.

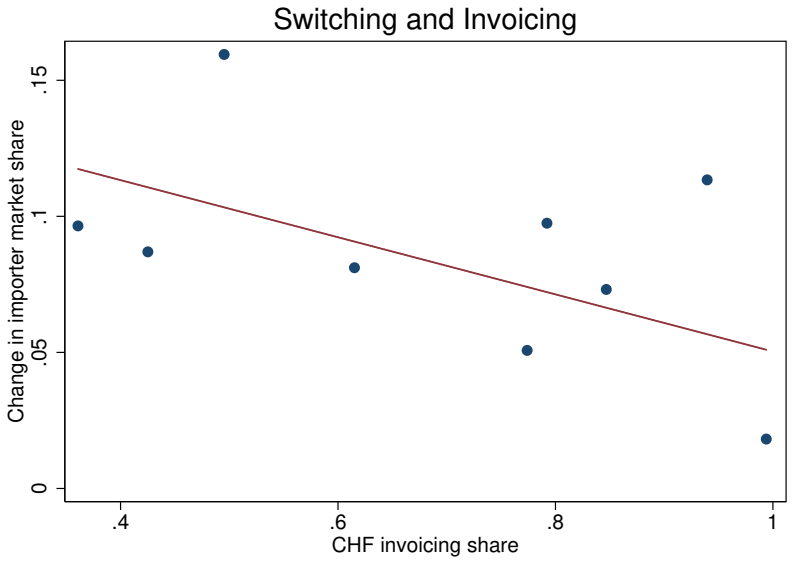
Zooming in on the time dimension of expenditure switching, Figure 7 shows the reduced-from relationship between the change in market share of imported goods and CHF invoicing share over time. Specifically, we estimate

$$\Delta_k ms_i = \alpha_k + \beta_k * CHFinvoiced_{g(i)} + \varepsilon_i \tag{5}$$

where $\Delta_k ms_i$ denotes the log change in market share of imported good i between January 2013 plus k months, and January 2015 plus k months. We consider value of k between 1 and 16, that is we add months sequentially between January 2015 and May 2016 (and between January 2013 and May 2013).

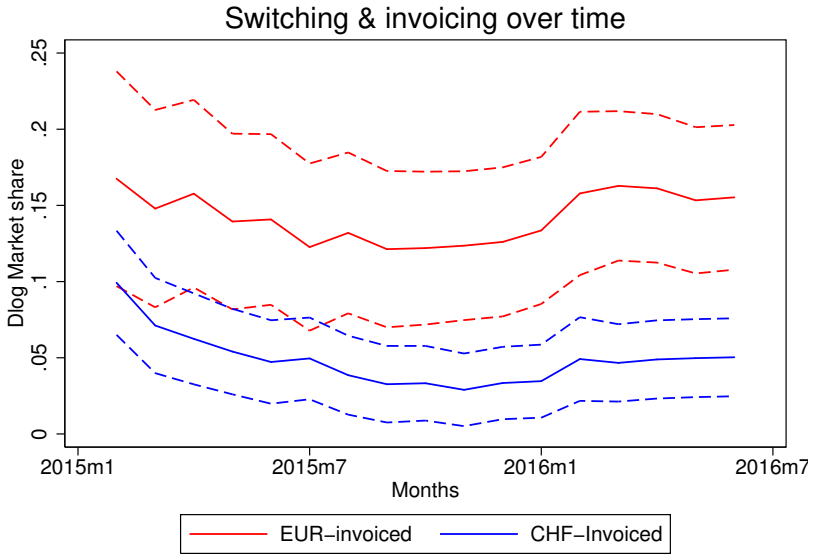
The blue line in Figure 7 reports the resulting estimate of α_k over time, corresponding to average switching for goods in a border categories without CHF-invoicing (i.e. EUR-invoiced). The red line in the Figure shows the average switching for goods in a border-category with full CHF-invoicing (i.e. the red line reports the sum of α_k and β_k). Figure 7 also shows the associated 95% confidence intervals for CHF-invoiced and EUR-invoiced goods. After around 1 year, the change in market share has stabilized at around 5% (significantly different from 0) for CHF-invoiced goods, and at around 15% for EUR-invoiced goods.

Figure 6: *Change in import market share by invoicing bin*



Notes: Bin scatter plot of the change in importer market share between January 2013 - May 2014 and January 2015 - May 2016 by invoicing share of the product group. 10 bins.

Figure 7: *Invoicing and expenditure switching over time*



Notes: Estimates of α_k and β_k in equation (5) for k between 1 and 16. Dashed lines show 95% confidence intervals.

5 Intensive and extensive margins of price adjustment

Nominal rigidities at the retail level, which play a non-trivial role in incomplete pass-through during the first months after the appreciation, are the subject of this section. We characterize the shift in the distribution of price changes for imported goods at the retail level. We decompose average price changes into the fraction of price adjustments and their average size, and show that the decline of import prices is accounted for by a large increase in the fraction of price reductions which more than offsets a *decline* in the absolute size of price reductions. These patterns are absent in the exact same set of goods sold in Germany, France, and Austria, as well as in the set of domestic goods, produced and sold in Switzerland.

The average change in prices can be decomposed into an extensive margin, defined as the fraction or frequency of products changing prices within period, and an intensive margin, defined as the average size of nonzero price changes.[32] We can further decompose the fraction of price changes into the fraction of increases during a period t, fr_t^{up}, and the fraction of decreases during the same period, fr_t^{up}, multiplied by the respective absolute sizes of increases and decreases, $size_t^{up}$ and $size_t^{down}$:

$$Average\ price\ change_t = fr_t \times size_t = fr_t^{up} \times size_t^{up} - fr_t^{down} \times size_t^{down}.$$

To calculate the frequency of price adjustment for a group of products, we first calculate the fraction of price changes per month by product i (across regions and retailers) and then average this fraction across all products.[33] The average size of price changes in a given month is obtained in a similar manner by first calculating the size of nonzero price changes per month by product i and then averaging across all EANs. We use figures to illustrate the dynamics of each component between 2012 and 2016.

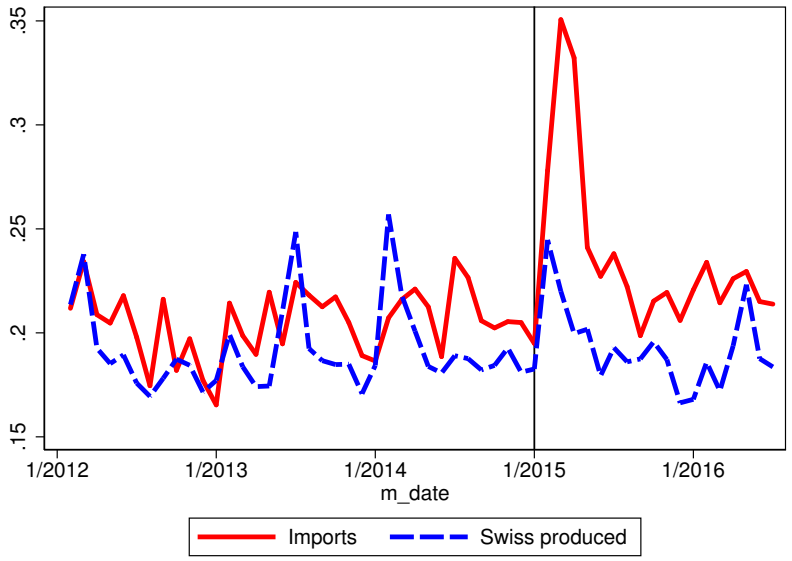
[32] See, for example, Gagnon (2009).

[33] Weighting the frequency of individual products using product-level expenditure weights does not change the conclusions.

5.1 Extensive margin of price adjustment

We first document the evolution of the frequency of price changes over time (the extensive margin). There was a pronounced increase in the fraction of price changes, fr_t, of EA imported goods following the CHF appreciation in January 2015 (Figure 8). This is largely because the frequency of price reductions, fr_t^{down}, roughly doubles (Figure 9, panel b). On the other hand, the frequency of price increases, fr_t^{up} falls, but only slightly. For Swiss-produced goods (Figure 9, panel a) there are no noticeable changes in the fraction of price increases or decreases.

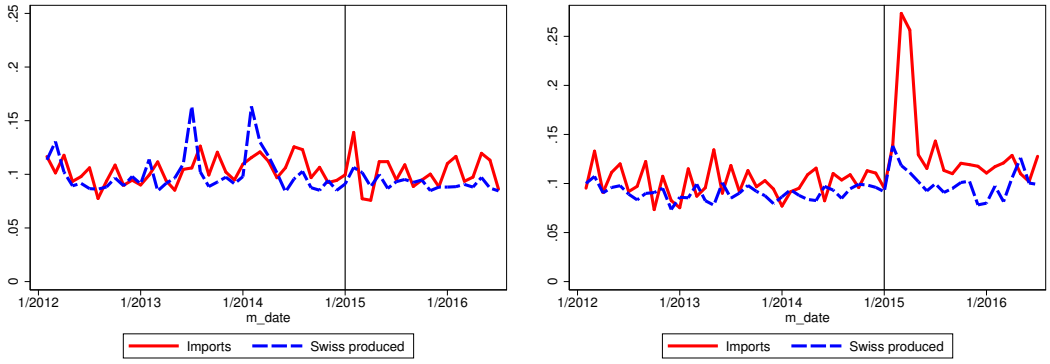
Figure 8: *Frequency of price changes*



Notes: the red solid line shows the average fraction of price changes for all EANs imported from the euro area, the blue dashed line for all domestically produced EANs. The aggregate fraction of price changes is calculated as a weighted average over all EANs per month: the fraction of price changes per EAN and month is the fraction of individual price changes observed for each EAN within the same month. An individual price change is defined as a non-zero log-difference of the modal price observed per EAN, retailer, region and month, from one month to the next. Vertical lines indicate the period January 2015, right before the appreciation. Calculations based on AC Nielsen Switzerland homescan data.

Figure 10 displays for every month of the year the fraction of imported products with a price that is lower than in December of the previous year. For example, a value of 0.35 for the 3rd month of 2015 means that 35% of the prices were lower in March 2015 than in December 2014. Comparing this cumulative fraction of price reductions for the four years 2012-2015 shows that in 2015 there was a significant increase in the fraction of imported products with a

Figure 9: *Frequency of price changes: increases and decreases*



(a) Increases (b) Decreases

Notes: the left panel shows the average fraction of price increases for all EANs imported from the euro area in red and the blue dashed line for all domestically produced EANs. The right panel shows price decreases. The fractions are calculated as a weighted average over all EANs per month: the fraction of price changes per EAN and month is the fraction of individual price changes observed for each EAN within the same month. An individual price change is defined as a non-zero log-difference of the modal price observed per EAN, retailer, region and month, from one month to the next. Vertical lines indicate the period January 2015, right before the appreciation. Calculations based on AC Nielsen Switzerland homescan data.

price decline: more than 40% of products decreased prices by April 2015 and more than 50% by the end of the year (compared to 20% in previous years).[34] This figure also shows that the jump in the frequency of price decreases for imported goods was not due to temporary sales, but rather due to persistent reductions in prices.[35]

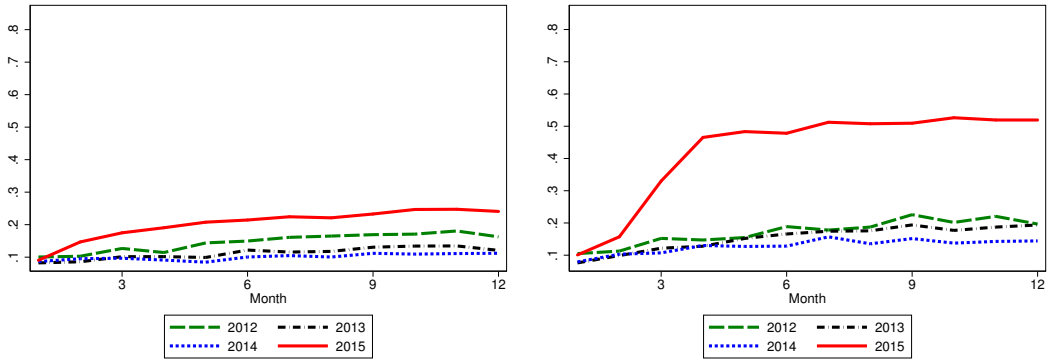
To show that the increase in the frequency of price reductions around the CHF appreciation was specific to the Swiss market, we augment our dataset by adding the homescan data from GFK Germany, which is constructed in a similar manner as the Swiss data.[36] We restrict

[34] Table A.6 in the Appendix shows that this increase is statistically significant.

[35] We do not report the dynamics of sales here. When we compute the frequency of sales (calculated using a simple v-shaped sales filter, dropped a bit after the exchange rate shock in January 2015 while the frequency of regular price reductions rose. This is consistent with evidence in Malin et al. (2015) for the US, who show that in response to a positive cost shock, regular prices rise and sales (or temporary price changes) fall. In the episode studied here, the frequency of sales declines after a *decline* in marginal costs while the frequency of changes of regular price changes increases.

[36] To compare the Swiss prices paid with the prices paid in the neighboring countries, we use homescan data for Austria, France, and Germany collected by the national GfKs. We match the prices for all EAN codes observed in Switzerland to the prices paid in the regions bordering Switzerland for France and Germany, where such regional information is available. We only consider prices in geographical areas close to Switzerland. For Germany, we use the data for the German Bundesland Baden-Württemberg and for France the zip-codes starting with 1, 25, 39, 68, 70, 74, and 90. For Austria, no such regional information is available, and we thus use the entire data set, which is small compared to the one of France or Germany. See Beck and Lein (2015) for a description of the collection procedures and sample statistics of the European homescan data collected by GFK.

Figure 10: *Fraction of products with price reductions at different horizons*

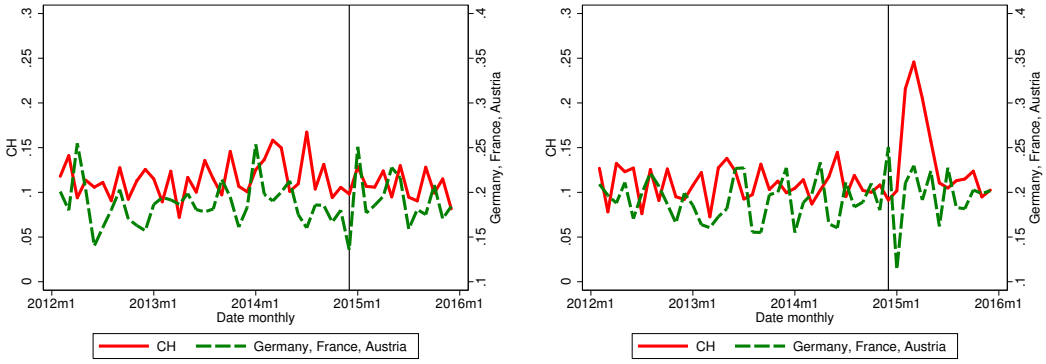


(a) Swiss (b) Imports

Notes: Panel a) shows the fraction of Swiss products with a price that is different to the price in December of the previous year as a function of the number of months since December. For example, the frequency of price changes for 2015 in month 3 would show the average fraction of goods, which changed prices between March 2015 and December 2014. Panel b) shows the same figures for imported products from the euro area. Solid lines show the year 2015, dotted lines the year 2014, dash-dotted lines 2013, and dashed lines 2012.

the set of goods to products that are imported in Switzerland and also purchased in either Germany, France, or Austria. Figure 11 reveals that the increase in the frequency of price decreases can be observed in Switzerland for this subset of the data, but not in Germany, France and Austria during the same time period.

Figure 11: *Frequency of price changes in neighboring countries and Switzerland: increases and decreases*



(a) Increases (b) Decreases

Notes: Panel a) shows the fraction of price increases in Switzerland (solid line) and in the three neighboring countries Austria, Germany, and France (dashed lines). It is based on a sample of 822 EANs, which are observed in both Switzerland and Germany, France and/or Austria. The data for neighboring countries is available up to 2015. Sources: own calculations based on homescan data provided by AC Nielsen Switzerland, GfK Germany, GfK France, GfK Austria.

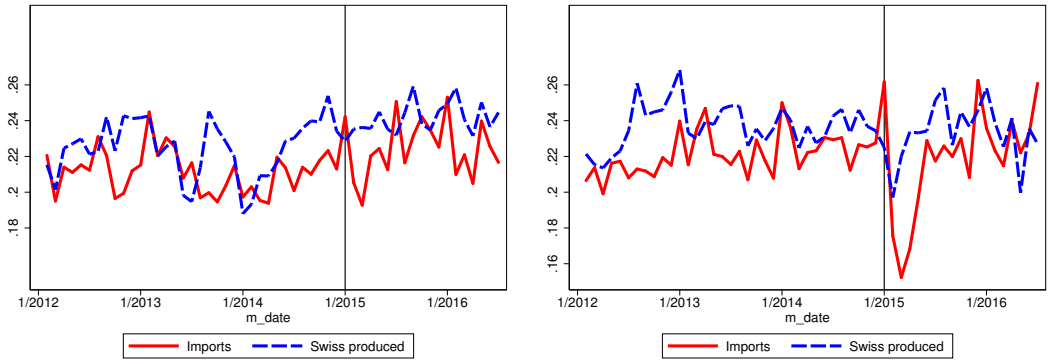
5.2 Intensive margin of price adjustment

We next turn to documenting the evolution of the average size of nonzero price changes over time (the intensive margin). Figure 12 documents separately the absolute size of price increases and price decreases, $size_t^{up}$ and $size_t^{down}$, respectively. There is a significant decline in the absolute size of price reductions for EA imported goods in early 2015 (in the appendix we show that this decline in the size is statistically significant) while the absolute size of price increases falls only slightly. The size of price changes hardly changes for Swiss-produced goods.

Figure 13 shows, for every month of the year, the average of the absolute price changes for imported products with a price that is lower than in December of the previous year. The reduction in the size of price changes in early 2015 was not driven by temporary price reductions that were quickly reverted. Furthermore, the declines in the average size of price decreases can be observed on the Swiss market only, and it cannot be observed in the exact same sets of goods sold in Germany, Austria and France (Figure 14).[37]

[37]For this Figure, we again restrict the sample to those goods that can continuously be observed in both Switzerland and at least one of the three neighboring countries.

Figure 12: *Size of price changes: increases and decreases*

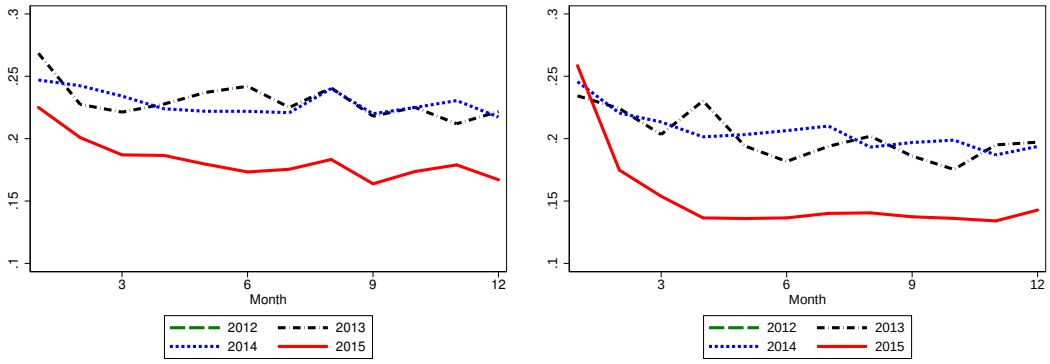


(a) Increases (b) Decreases

Notes: Panel a) shows the absolute average size of price increases for imports from the euro area (solid line) and domestically produced goods (dashed line). Panel b) shows the size of price decreases defined accordingly. The average size is calculated over all individual price changes, averaged over all retailers and regions per EAN and month. An individual price change is defined as the absolute value of the non-zero log-difference of the modal price observed per EAN, retailer, region and month, from one month to the next. All sizes are standardized. Vertical lines indicate the period August 2011, right before the introduction of the lower bound on the CHF/EUR exchange rate, and the period December 2014, right before the Great Appreciation. Calculations based on AC Nielsen Switzerland homescan data.

To zoom into the decline in the average size of price changes in the first months of 2015, we plot the distribution of nonzero standardized price changes across individual products between January and February 2015 and compare it with the distribution of price changes between the same months in 2014. Figure 15 displays a Kernel estimate of these distributions, for Swiss-produced goods (left panel) and for imported goods (right panel). For Swiss-produced goods, there is no noticeable shift in the distribution of standardized price changes between 2014 and 2015. For imported goods, the 2015 appreciation shifts the distribution to the left. In the presence of small price changes, as can be observed in the figure, it is possible that the absolute size of price reductions decreases as the distribution shifts to the left and the number of price reductions rises.

Figure 13: *Average size of product price reductions at different horizons*



(a) Swiss (b) Imports

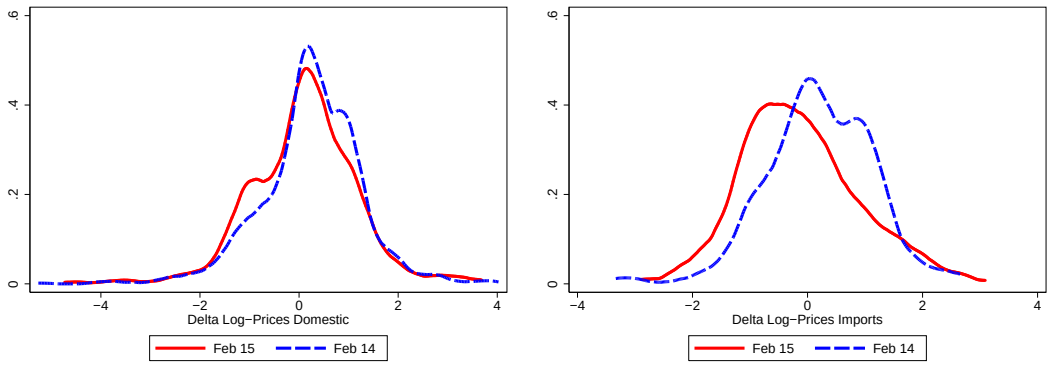
Notes: Panel a) shows the a size of price changes of Swiss products with a price that is different to the price in December of the previous year as a function of the number of months since December. For example, the size of price changes for 2015 in month 3 would show the average absolute size of the price difference between March 2015 and December 2014 (only for products, which changed prices). Panel b) shows the same figures for imported products from the euro area. Solid lines show the year 2015, dotted lines the year 2014, dash-dotted lines 2013, and dashed lines 2012.

Figure 14: *Size of price changes in neighboring countries and Switzerland: increases and decreases*

(a) Increases (b) Decreases

Notes: Panel a) shows the average absolute size of price increases in Switzerland (solid line) and in the three neighboring countries Austria, Germany, and France (dashed lines). Panel b) shows the average absolute size for price decreases. All sizes are standardized. The figure is based on a sample of 667 EANs, which are observed in both Switzerland and Germany, France and/or Austria in all months during the period beginning of 2010 to end 2015. The data for neighboring countries is available up to 2015. Sources: own calculations based on homescan data provided by AC Nielsen Switzerland, GfK Germany, GfK France, GfK Austria.

Figure 15: *Distribution of euro area import price changes and domestic price changes in Feb 2014 and Feb 2015*



(a) Domestic (b) EA imports

Notes: Panel a) shows a Kernel estimate of the distribution of monthly log nonzero standardized price changes (dashed line for price changes between January and February 2014, and solid line for price changes between January and February 2015) for Swiss-produced goods. Panel b) shows the analogous distribution for EA-imported products.

5.3 Robustness

In the Appendix we show that increase in the fraction, and the decrease in size of import price reductions are robust to the following variations:

- Standardized price changes region, product-group level,
- Separating more and less sticky goods,
- Excluding sales in price changes,
- Separating large and small market shares ,
- Separating single and multi-product firms,
- Focusing only on the two largest retailers

FIGURES TO BE ADDED

We also find similar results during the 2011 appreciation of the CHF.

5.4 Margins of adjustment and counterfactual changes in import prices

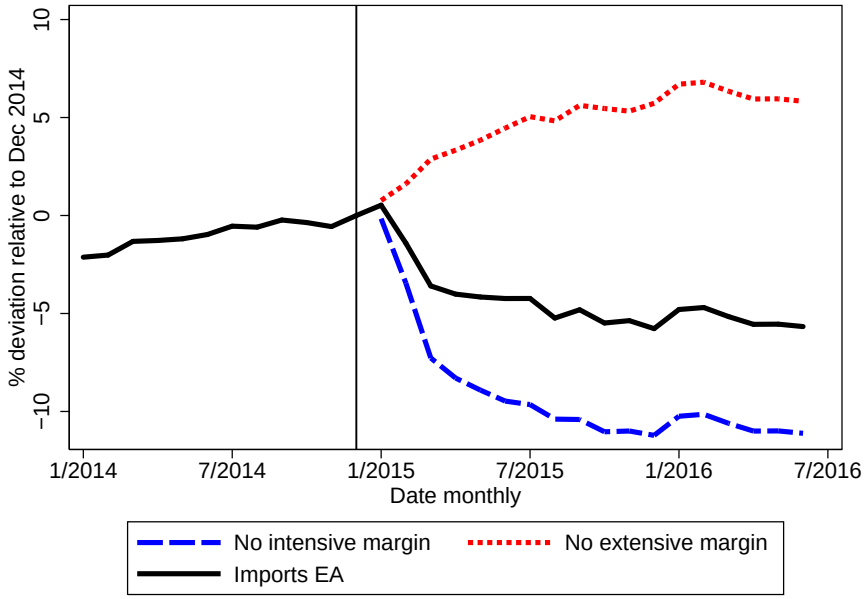
In order to quantify the role of changes in the intensive and extensive margins on average price changes, we perform simple data-based counterfactuals using the decomposition equation (6).

We first feed the actual path (for January-December 2015) in the average size of price increases and decreases while we fix the frequency of import price increases and decreases at their levels in the respective month in 2014. In the second counterfactual, we feed the actual path (for January-December 2015) in the average frequency of price increases and decreases while we fix the average size of import price increases and decreases at their levels in the respective month in 2014.

Figure 16 displays the implied average price change of imported goods under these two counterfactuals, and compares them with the average price change in the data. Under the first counterfactual scenario in which we fix the frequency of price adjustment at pre-shock levels, import prices would have risen by 5.0% in July 2015 rather than fallen by 3.7% in July 2015 as they did in the data. This is because the size of price reductions (which contribute to reducing prices) fell around that period. Conversely, under the second counterfactual scenario in which we fix the average size of price changes at pre-shock levels, import prices would have fallen by more than twice as much as they did in the data (-9.6% in July 2015). This is

because the frequency of price reductions increased substantially during this period.[38]

Figure 16: *Extensive, intensive margins and average price changes*



Notes: The solid line shows the actual development of euro area import prices based on the homescan data. The dotted line (no extensive margin) shows the counterfactual with the size of price changes following their actual path in 2015, while the faction of price changes is fixed at its respective month in 2014. The dashed line (no intensive margin) shows the counterfactual with the fraction of price changes following their actual path in 2015, while the size of price changes is fixed at its respective month in 2014. Vertical lines indicate the period January 2015, right before the 2015-appreciation. Calculations are based on AC Nielsen Switzerland homescan data.

5.5 Invoicing and margins of price adjustment

In the previous two subsections we showed that the fraction of price reductions of Swiss imported goods increases substantially after the exchange rate shock, while the absolute size of price reductions falls. In this subsection, we exploit variation across individual goods to show that these margins of price adjustment for imported goods at the retail level vary systematically with the intensity of border price changes. Specifically, larger reductions in border prices (or, similarly, a higher extent of EUR invoicing of border prices) result in a larger probability of price reductions and larger reductions in the size of price reductions.

[38]Changes in these margins played a small role in accounting for the inflation dynamics of Swiss-produced goods, since neither the intensive nor the extensive margin changed substantially after the appreciation of the Swiss franc.

We first use a Probit regression to estimate how the probability that the retail price of imported good i decreases in the first 3 months after the CHF appreciation (between January 2015 and April 2015 – recall that border prices are collected quarterly) is related to the 3 month log change in the border price of product category associated to product i, $g(i)$. Column (1) in Table 9 reports the results. As expected, a larger decline in the border price leads to a higher probability of price reduction. From the estimated coefficients we infer that a 10% larger decline in border prices between January and April 2015 is associated with a 61% higher probability of a price decrease.

Table 9: *The probability to decrease retail prices and border prices/invoicing, all after 6M*

	(1) Probit, 3M	(2) Probit, 3M	(3) IV Probit, 3M
Border price	-6.095***		-2.867***
	[0.570]		[0.792]
Fraction CHF inv.		-0.293***	
		[0.080]	
Observations	4210	4210	4210
R^2			

Notes: All probit regressions have an indicator variable on the left hand side, which is equal to one, if a price decline is observed between January and April 2015 at for product i sold at retailer s, in region r, and zero otherwise. In column (3), we instrument border prices with the fraction of CHF invoiced from column (2).

In a second step, we use a similar Probit regression, but we now estimate how the probability of a reduction in the retail price of imported good i covaries with the share of CHF invoicing of border prices in product category $g(i)$. The coefficients displayed in Column (2) of Table 9 imply that the probability of a price reduction between January 2015 and April 2015 is 29% lower for a product invoiced in CHF, as compared to a product invoiced in EUR.

Finally, we repeat the first step by instrumenting border price changes in step 1 using the CHF invoicing share in step 2 as an instrument. The Probit IV regressions results (column 3) are consistent with the OLS estimates, but the magnitude of the effects are smaller.

We next study how the size of retail price reductions varies across individual imported goods. We present in Table 10 estimates of a linear relation (plus a constant) between the size of retail price reductions of imported goods and the respective change in border price (column 1), share of CHF invoicing of border prices (column 2) and border prices instrumented

by CHF invoicing (column 3).

The decline in the size in retail price is more pronounced for goods whose associated border price declines by more: the size of price reductions is 22.3% for a product with zero border price change, but only half as large if the border price decline is 10% (column 1). Relatedly, the size of retail price reductions for a products whose border price is invoiced in CHF is 15.1%, where it is only 2.6% for EU invoiced border prices. (column 2). IV estimates (column 3) largely confirm the OLS estimates.

Table 10: *Size of price reductions*

	(1) OLS, 3M	(2) OLS, 3M	(3) IV, 3M
Border price	-1.185***		-1.400***
	[0.086]		[0.112]
Fraction CHF inv.		0.151***	
		[0.012]	
Constant	0.223***	0.026***	0.239***
	[0.007]	[0.009]	[0.009]
Observations	2032	2032	2032
R^2	0.09	0.07	0.08

Notes: The dependent variable for all three regressions in this table is the price difference between January and April 2015, conditional on observing a lower price in April than in January for product i sold at retailer s, in region r. All observations are weighted by expenditure shares. In the last column, we report an IV regression, where border price is instrumented with the fraction of CHF invoiced products in the same product category.

6 Understanding the decline in the size of price reductions in a menu cost model

We use a simple menu cost pricing model to understand the negative co-movement between the change in the frequency of price adjustment and the change in the absolute size of price changes of imported goods at the consumer level that we documented in response to the 2015 CHF appreciation. We show that this observation can be accounted for quite naturally in a menu cost model with a selection of price changes induced by a fat-tailed distribution of idiosyncratic cost shocks.

Consider the following pricing rule for goods produced abroad and imported into Switzerland. Firm i's desired or reset price denominated in CHF is denoted (in logs) by p^*_{it}. We

assume that $p_{it}^* = c + w_t + z_{it}$, where c is a constant, w_t is the aggregate component of marginal costs (production and local costs) measured in Swiss francs, and z_{it} is the idiosyncratic component of marginal costs. An appreciation of the CHF reduces w_t for imported goods.

Following Gertler and Leahy (2008) and Midrigan (2011), we allow for the possibility that changes in the idiosyncratic component of marginal costs arrive infrequently according to a Poisson process. Specifically, $z_{it} - z_{it-1} = \varepsilon_{it}$ where

$$\varepsilon_{it} = \begin{cases} 0 & \text{with prob } 1-\lambda \\ N(0,\sigma) & \text{with prob } \lambda. \end{cases}$$

We assume that single-product firms change their price to p_{it}^* if the price gap (i.e. the difference between the actual log price, p_{it}, and the desired log price, p_{it}^*) exceeds y.[39] This implies that the actual log price evolves according to

$$p_{it} = \begin{cases} p_{it-1} & \text{if } |p_{it-1} - p_{it}^*| < y \\ p_{it}^* & \text{if } |p_{it-1} - p_{it}^*| \geq y \end{cases}$$

This policy function allows us to provide a simple characterization of how the average absolute size of price changes responds to an aggregate cost shock. Consider first the pre-shock steady-state, in which the aggregate component of costs w_t is constant over time. Every period a fraction f of firms reduce their price by an average size of $s \geq y$, a fraction f raise their price by the same average size s, while the remaining fraction of firms $1-2f$ leave their price unchanged.

Consider now the response of prices after a one-time permanent decline in w_t of size $\Delta > 0$. The fraction of firms reducing their prices increases from f to f'. Of these f' firms reducing their price after the shock, f would have reduced their price even if $\Delta = 0$ and they will do so by an average size equal to $s + \Delta$. Hence, for this subset of firms, the average price reduction

[39] Alvarez and Lippi (2014) derive this approximation under the assumption that marginal cost shocks follow a random walk process and desired markups are constant.

grows by Δ relative to the pre-shock equilibrium.[40] A fraction $f' - f$ of firms, which would have either increased or left their price unchanged if $\Delta = 0$, now reduce their price by $\tilde{s}$.

Putting these two pieces together, the change in the average size of price reductions is

$$s' - s = \frac{f}{f'}\Delta + \frac{f' - f}{f'}(\tilde{s} - s). \tag{6}$$

The first term in equation (6) contributes to increasing the average size of price reductions. The second term in equation (6) contributes to decreasing the average size of price reductions if new price changes are on average small relative to pre-shock price changes ($\tilde{s} < s$). The average size of price reductions falls if the second term in equation (6) is large and negative because there is a large increase in the fraction of price reductions and these new price reductions are small compared to pre-shock price reductions.[41]

We now show in a calibrated version of this simple pricing model that if shocks are Gaussian distributed ($\lambda = 1$), the first term in the right hand side of equation (6) dominates, and the average size of prices reductions rises. This result can be overturned if the Poisson rate of arrival of shocks λ is sufficiently small, in which case $\tilde{s}$ is low relative to s and the second term in the right hand side of equation (6) dominates.

We show this result numerically in the following calibration of the model. A time period is a month. For any given value of λ, we choose σ and y to target the following pre-shock equilibrium moments: (i) fraction of prices changing (increasing or decreasing) every month = 0.21, and (ii) average absolute size of price changes = 0.22. We consider two alternative values of λ: 1 (Gaussian) and 0.3 (Poisson). In order to match our two calibration targets, the Poisson specification requires thinner s-S bands y and more volatile cost shocks σ.[42].

[40] In the presence of expected CHF overshooting (as observed in Figure 1) or strategic complementarities, the desired price may fall by less than Δ. Our qualitative results below hold when we consider a smaller decline in desired prices, parameterized as a smaller value of Δ.

[41] If we make the length of the time interval sufficiently short (reducing σ correspondingly) then price reductions before the shock are of size y (so that $s = y$) and new price changes after the shock are no smaller than y (so that $\tilde{s} \geq s$), implying $s' > s$. Therefore, a necessary condition for $s' < s$ is that the time interval is sufficiently long such that there is a non-degenerate distribution of price changes greater than y.

[42] With $\lambda = 1$, we set $\sigma = 0.105$ and $y = 0.16$. With $\lambda = 0.3$, we set $\sigma = 0.21$ and $y = 0.08$. To assess the role of λ, we considered two alternative parameterizations. First, if we fix y and σ at their Gaussian-calibration levels and set $\lambda = 0.3$, the average size of price reductions falls after the CHF appreciation. Second, if we fix y and σ at their Poisson-calibration levels and set $\lambda = 1$, then the average size of price reductions rises after the CHF appreciation

As discussed in Midrigan (2011), the Poisson specification gives rise to a more Leptokurtic distribution of cost changes (the kurtosis of price changes is 2.2 with $\lambda = 0.3$ and 1.3 with $\lambda = 1$).[43]

Starting in the pre-shock steady state distribution of price gaps in which $w_t = 0$, we consider a one-time 4.2 percent permanent reduction in the aggregate component of marginal cost for imported goods at the retail level, that is, $w_t = \Delta = -0.042$ for $t \geq 0$. This choice of Δ corresponds to the average decline in the import price at the border plus distribution costs three months after the CHF appreciation that we estimate as discussed in Section 3.[44]

Table 11: *Price statistics of imported goods in menu cost model and data*

	Data		Model			
			Gaussian	($\lambda = 1$)	Poisson	($\lambda = 0.3$)
	pre-shock	shock	pre-shock	shock	pre-shock	shock
Fraction up	0.12	0.09	0.11	0.06	0.11	0.08
Fraction down	0.09	0.25	0.11	0.18	0.11	0.18
Size up	0.21	0.20	0.22	0.22	0.23	0.21
Size down	0.22	0.15	0.22	0.23	0.22	0.20
Size new price reductions ($\tilde{s}$)	n.a.	n.a.	n.a.	0.18	n.a.	0.10
Size down large	0.30	0.31	0.22	0.23	0.28	0.28
Frac. down small	0.34	0.64	0.00	0.00	0.33	0.48

Notes: large is more than 15%, *small* less than 15%. Pre-shock corresponds to the period 2014 in the data and the pre-shock steady-state in the model. Shock corresponds to the first quarter of 2015 in the data and the first period after the appreciation in the model.

Table 11 displays price statistics for EA imported goods in the data, in the model with Gaussian shocks ($\lambda = 1$), and in the model with Poisson shocks ($\lambda = 0.3$). The "pre-shock" period corresponds to February 2014 in the data and to the pre-shock steady-state in the model. The "shock" period corresponds to February 2015 in the data and to the first period after the appreciation in the model.

Both model specifications imply a reduction in the fraction of price increases and a rise in

[43] Gertler and Leahy (2008) and Midrigan (2011) consider a slightly smaller probability of receiving an idiosyncratic cost shock ($\lambda = 0.2$). If the aggregate component of marginal costs, w_t, is constant in the pre-shock equilibrium, the fraction of price changes (our first calibrated moment above) is bounded above by λ. If we were to target our moment (i) above by setting $\lambda = 0.21$, this would require setting $y = 0$, so that prices are fully flexible. Our choice of λ implies that not all prices adjust after the appreciation of the CHF, as observed in our data.

[44] Specifically, $\Delta = (1 - s_D) *$ border price $+ s_D *$ domestic price, where $s_D = 0.447$ is the distribution cost share, border price is the weighted-average change in border prices between January and April, and domestic price is the average change in domestic producer prices in this period.

the fraction of prices decreases and a small reduction in the size of price increases, as observed in the data on retail prices of imported goods reviewed above. However, while the model with Gaussian shocks implies an increase in the size of price reductions (from 0.22 to 0.23), the model with Poisson shocks implies a drop in the size of price reductions (from 0.22 to 0.20). In the data, the average size of price reductions for imported goods falls from 0.22 to 0.15.

We can understand these results using equation (6). Both specifications of the model are calibrated to the same pre-shock frequency and absolute size of price adjustment, f and s. Both specifications produce roughly the same increase in the frequency of price reductions, f' (see Table 11). The key difference between the two specifications is in terms of the absolute size of new price reductions: $\tilde{s} = 0.18$ with Gaussian shocks and $\tilde{s} = 0.10$ with Poisson shocks. With Poisson shocks, more firms are subject to small cost shocks, which only reduce their price in response to the aggregate cost reduction. This shift in the composition of price changes toward small values reduces the average size of price reductions. Consistent with this intuition, Table 11 shows that with Poisson shocks, the average size of large price reductions (those larger than 15 percent) increases after the shock, as well as the fraction of firms with small price reductions (those smaller than 15 percent)

If we consider a larger reduction in border prices (i.e. a larger value of Δ), the increase in the frequency of price reductions and the reduction in the average size of price reductions are both larger.[45] This is consistent with the empirical results reported in section 5.5: larger reductions in border prices (or EU invoiced border prices) lead to more frequent but smaller price reductions.

Finally, we discuss the implication of the model for average (zero and non-zero) price changes. Denoting the average price change after k months by p_k, $p_1 = -0.029$, $p_3 = -0.040$, and $p_6 = -0.042$ with Gaussian shocks, and $p_1 = -0.017$, $p_3 = -0.030$, and $p_6 = -0.038$ with Poisson shocks.[46] As discussed in detail in Midrigan (2011), the model with Poisson

[45] In our baseline results, we assume $\Delta = 0.041$ corresponding to the average decline in border prices adjusted for distribution costs. If we set $\Delta = 0.059$ (corresponding to the top 75 percentile decrease in border prices), then the frequency of price reductions rises by 0.11 and the average size of price reductions falls by 0.027 (rather than 0.072 and 0.025, respectively)

[46] Both model specifications imply average price reductions that are too large and rapid relative to the data reported in Table 5. A smaller value of Δ, for the reasons discussed in footnote 29, would imply a smaller reduction in average prices, while keeping the other model implications discussed in this section qualitatively unchanged.

shocks implies a smaller reduction in prices, on average, because of a weaker "selection effect" in the set of firms changing price. What we showed is that this selection effect also has very different implications for the direction of the intensive margin of price changes in response to an aggregate cost shock.[47]

7 Conclusion

To be added

[47] We also considered two alternative model specifications which can produce a more Leptokurtic distribution of price changes: one with multi-product firms, and one in which every period the sS band y is zero (i.e. zero menu costs) with a certain probability. When parameterized with Gaussian product-level shocks, the average size of price reductions implied by these alternative model specifications increases in response to a decline in aggregate costs, as in the single-product model with Gaussian shocks.

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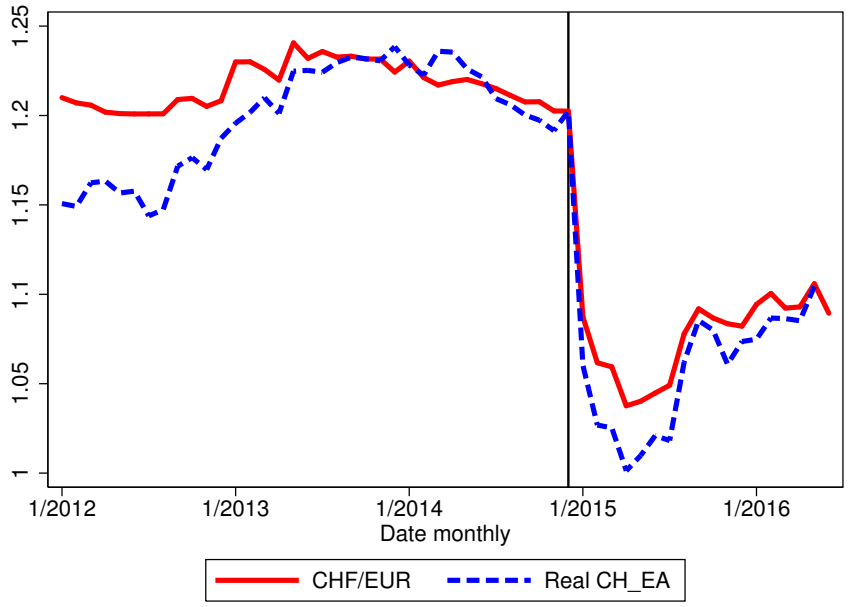
A Additional Figures and Tables

Additional figures on the EUR/CHF exchange rate and macroeconomic background

Figure A.1: *EUR/CHF (nominal and real)*



Notes: The real rate is indexed to equal the nominal rate in December 2014.

Table A.1: *Main marcoeconomic indicators for Switzerland 2013–2016*

	2012	2013	2014	2015	2016
Real GDP Growth	1.1%	1.8%	2%	0.8%	1.3%
Real Consumption Growth	2.5%	2.2%	1.3%	1.2%	1.3%
Exports/GDP	66.2%	75%	69%	67%	72.2%
Imports/GDP	55.4%	61.7%	55.8%	57.7%	58.6%
Inflation	-0.7%	-0.2%	0%	-1.1%	-0.4%

Sources: State Secretariat of Economic Affairs (SECO), SFSO.

Pass-trough into border prices: additional results

Table A.2: *Pass-through into border prices for all products, cross sectional estimates*

	(1)	(2)	(3)	(4)	(5)
	1Q	2Q	4Q	2Q CHF	2Q EUR
		Unconditional		Conditional	
$\Delta\ CHF/EUR$	0.806***	0.666***	0.690***	0.368***	0.665***
	(0.0294)	(0.0248)	(0.0380)	(0.0227)	(0.0308)
$\Delta\ CHF/EUR \times$ CHFinvoiced	-0.589***	-0.413***	0.146***		
	(0.0381)	(0.0321)	(0.0496)		
Observations	4,264	4,264	3,552	1,749	1,668
R^2	0.163	0.171	0.223	0.131	0.219

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.3: *Pass-through into border prices for all consumer goods, cross-sectional estimates*

	(1)	(2)	(3)	(4)	(5)
VARIABLES	1Q	2Q	4Q	Q2 CHF Cond	Q2 EUR Cond.
$\Delta EUR/CHF$	1.048***	0.795***	0.750***	0.299***	0.795***
	(0.0474)	(0.0519)	(0.120)	(0.0526)	(0.0544)
$\Delta EUR/CHF \times CHFinv.$	-0.825***	-0.611***	-0.180		
	(0.0573)	(0.0626)	(0.147)		
Observations	636	636	554	267	227
R^2	0.459	0.293	0.133	0.108	0.486

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In this section of the Appendix, we present additional estimates for exchange rate pass-through into border prices. We use the data from the SFSO for the product categories that match the Nielsen data for the period 2011–2016. Because of survey frequency, we report quarterly estimates. We provide estimates for the full set of product categories in the import price index (IPI) in the Appendix. All regressions are weighted using product-category expenditures in 2014 from the Nielsen data.

Following the definitions in Gopinath and Rigobon (2008) and Burstein and Gopinath (2013), we estimate short-run, medium-run and long-run exchange-rate pass-through (SRPT, MRPT, and LRPT, respectively).

SRPT:

$$\Delta p_{i,t}^{border} = \alpha_i + \beta_1 \Delta e_{i,t} + \beta_2 \Delta e_{i,t} \times D^{CHFinv.} + \varepsilon_{i,t} \tag{7}$$

where lowercase letters are in logs. $p_{i,t}^{border}$ is the import price of product i in quarter t, $e_{i,t}$ is the CHF/EUR exchange rate, and $D^{CHFinv.}$ is a dummy, which is equal to one if a product is invoiced in CHF and zero otherwise. We estimate panel regressions with fixed effects.

MRPT:

$$\Delta p_{i,t}^{border} = \alpha_i + \beta \Delta_c e_{i,t} + \varepsilon_{i,t} \tag{8}$$

where $\Delta_c e_{i,t}$ is the cumulative change in the exchange rate over the duration for which the previous price was in effect. For estimating MRPT, we restrict the sample to nonzero price changes and estimate the regression first only for CHF invoiced products (restricting to nonzero price changes in CHF) and second only for EUR invoiced products (restricting to nonzero price changes in EUR).

LRPT:

$$\Delta p_{i,t}^{border} = \alpha_i + \sum_{k=0}^{5} \beta_{1,k} \Delta e_{i,t-k} + \sum_{k=0}^{5} \beta_{2,k} \Delta e_{i,t-k} \times D^{CHFinv.} + \varepsilon_{i,t} \tag{9}$$

where LRPT is estimated as the sum of the β_k's.

Table A.4 reports the results for SRPT, LRPT and MRPT. SRPT is 0.94 for EUR invoiced and only 0.11 for CHF invoiced products (column 1). LRPT is not significantly different from one for EUR invoiced, slightly lower for CHF invoiced (0.79, column 2).[48]. The MRPT rate is at 0.22 for CHF invoiced products and very close to one for EUR invoiced products (columns 3 and 4).

Margins of price adjustment: robustness checks

This subsection in the Appendix shows robustness checks on the regularities in frequency and size of price adjustment we establish in the main body of the paper.

First, we split the sample into products displaying a high or low frequency of price changes before 2015. Specifically, we group products into those whose price changed more than twice

[48] A t-test for the difference between the estimated LRPT for CHF invoiced products and one is significant at the 10%, but not at the 5% level, with a t-statistic of 1.77.

Table A.4: *Pass-through into border prices 2011-16*

	(1) SRPT	(2) LRPT	(3) MRPT CHF	(4) MRPT EUR
$\Delta\ CHF/EUR$	0.935***	1.109***		
	(0.0482)	(0.189)		
$\Delta\ CHF/EUR \times$ CHFinvoiced	-0.825***	-0.323		
	(0.0580)	(0.224)		
$\Delta_c\ CHF/EUR$			0.224***	0.892***
			(0.0431)	(0.0453)
Observations	11,876	7,548	4,425	4,081
R^2	0.034	0.053	0.007	0.095
Number of product_id	939	754	547	378

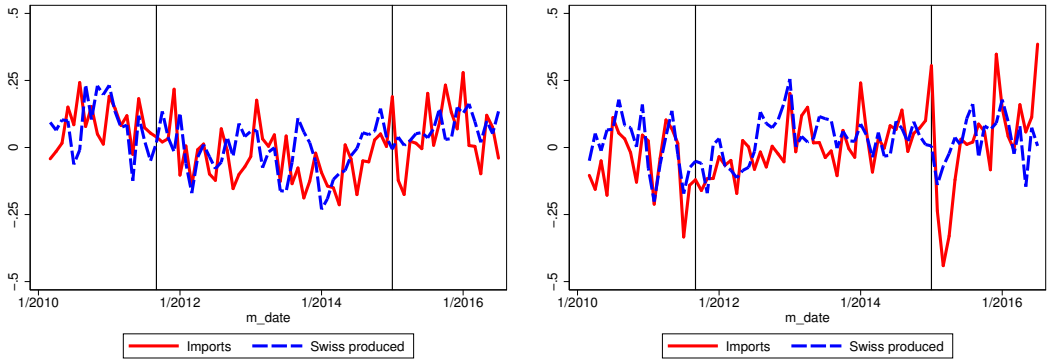
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.5: *Pass-through into border prices 2011-16, All products*

	(1) SRPT	(2) LRPT	(3) MRPT CHF	(4) MRPT EUR
$\Delta\ CHF/EUR$	0.692***	0.683***		
	(0.0222)	(0.0691)		
$\Delta\ CHF/EUR \times$ CHFinvoiced	-0.609***	-0.139		
	(0.0287)	(0.0873)		
$\Delta_c\ CHF/EUR$			0.150***	0.677***
			(0.0182)	(0.0197)
Observations	80,552	49,010	31,840	31,618
R^2	0.013	0.027	0.002	0.040
Number of product_id	7,167	4,991	3,924	3,129

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

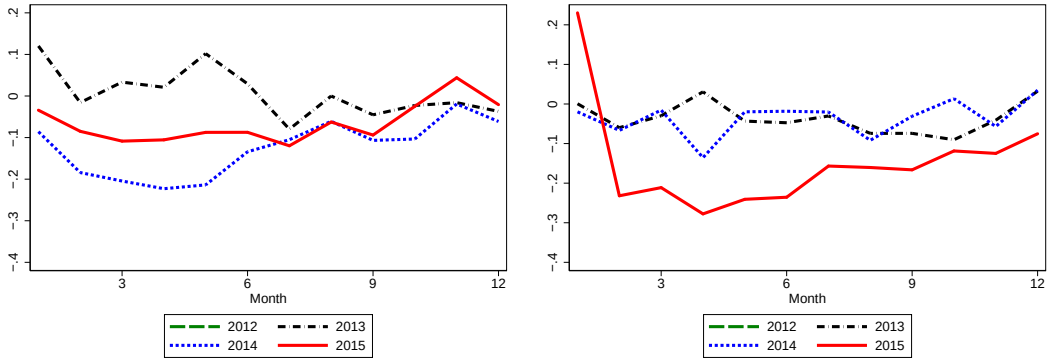
Figure A.2: *Size of price changes: increases and decreases (standardized)*



(a) Increases (b) Decreases

Monthly average absolute size of non-zero price changes (prices for imports from EA only). Panel a) shows price increases, panel b) price decreases. Standardize by calculating mean and standard deviation by product class and region for imports and Swiss produced goods separately for all periods excl 2015Q1.

Figure A.3: *Average size of product price changes at different horizons: all changes by year (standardized)*

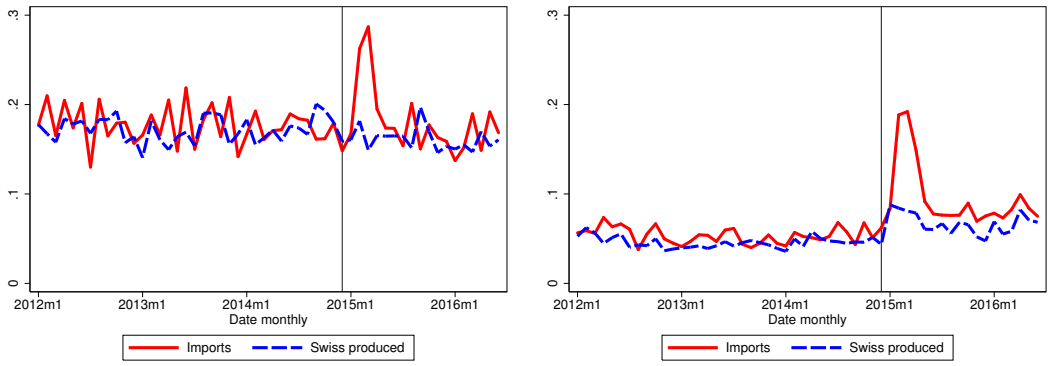


(a) Swiss (b) EA imports

(less sticky) or less than twice (more sticky) per year during the period 2012-2014 (two is the median number of price adjustments per good per year in this period). We do so separately for imported and Swiss-produced goods. Figures A.4 and Figure A.5 show that the increase in the frequency and the decline in the absolute size of price reductions around February 2015 is present in both the set of less and more sticky price goods. For the group of imported goods with more price stickiness, for example, the average frequency of price decreases was 0.06 per month in the period 2012-2014 and spiked to over 0.2 in early 2015. For goods with less sticky prices, the increase in the frequency of price reductions was slightly less

pronounced. A similar pattern can be observed for the absolute size of price reductions in imported goods. Once again, these changes in the frequency and size of price reductions are absent for Swiss-produced goods.

Figure A.4: *Frequency of price decreases by degree of stickiness*



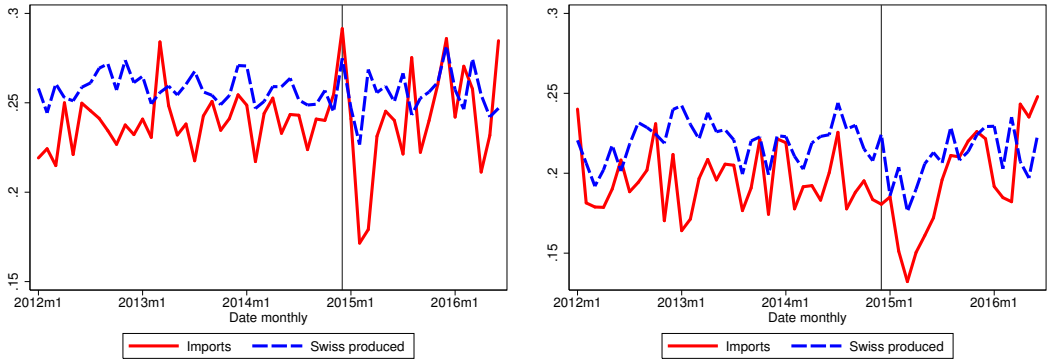
(a) Less sticky (b) More sticky

Notes: Panel a) shows the fraction of price decreases for euro area imports (solid line) and domestically produced EANs (dashed line) for all EANs, which changed prices more than twice per year in the period 2012–2014 (two price changes are the number of price changes of the median item in terms of numbers of price changes per year). Panel b) shows the fraction of price decreases for all EANs, which change prices less often than twice per year in the period 2012–2014. The fraction of price decreases per EAN and month is the fraction of individual price decreases observed for each EAN within the same month. An individual price decrease is defined as a negative non-zero log-difference of the modal price observed per EAN, retailer, region and month, from one month to the next. Vertical lines indicate the period December 2014, right before the 2015-appreciation. Calculations based on AC Nielsen Switzerland homescan data.

The increase in the fraction of price decreases and the decline in the average absolute size of price decreases after the 2015-appreciation is not specific to products with high or low market shares. Figures A.6 and A.7 show the fraction and size of price decreases by firm's market share, respectively. We allocate producers by market share within each product group into two bins, one with market share below the market share of the median firm (median in terms of market share) within product group, and one for median and above-median market share. Price decreases for EA imports are clearly elevated in the aftermath of the appreciation for firms with both below-median (Figure A.6, Panel a)) and above-median (Panel b)) market share. Also the absolute size of price reductions declines for both below- and above-median market shares (Figure A.6).

Third, to reduce the role of measurement error and underlying heterogeneity across goods,

Figure A.5: *Size of price decreases by degree of stickiness*



(a) Less sticky (b) More sticky

Notes: Panel a) shows the average absolute size of price decreases (standardized) for euro area imports (solid line) and domestically produced EANs (dashed line) for all EANs, which changed prices more than twice per year in the period 2012–2014 (two price changes are the number of price changes of the median item in terms of numbers of price changes per year). Panel b) shows the size of price decreases for all EANs, which change prices less often than twice per year in the period 2012–2014. The average size is calculated over all individual price changes, averaged over all retailers and regions per EAN and month. An individual price change is defined as the absolute value of the non-zero log-difference of the modal price observed per EAN, retailer, region and month, from one month to the next. All sizes are standardized. Vertical lines indicate the period December 2014, right before the 2015-appreciation. Calculations based on AC Nielsen Switzerland homescan data.

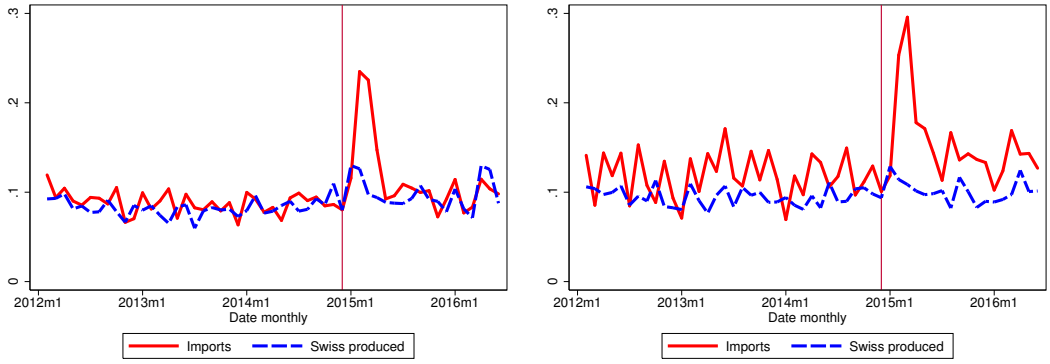
we redo our analysis using standardized price changes (as discussed in Alvarez et al. (2017)). Standardized price changes for good i are defined as (price change of good i minus average price change) divided by standard deviation of price changes. Following Alvarez et al. (2017), average and standard deviation of price changes are calculated over all months with a nonzero price change (excluding the first quarter of 2015) across goods in the same product group and country of origin (Swiss or import from the euro area) sold in the same region as product i. In the appendix we include a standardized version of the figures presented above. Our results are robust to using this alternative measure of price changes.

We report point estimates and confidence intervals for the change in the fraction of price reductions in 2015, compared to 2014. We estimate

$$I(Decrease, t) = \alpha + \beta * D_{2015} + \varepsilon_{i,t} \tag{10}$$

where $I(Decrease, t)$ is an indicator function, which is equal to one if a price has declined since January of the same year and zero otherwise (as before, we define a price change at the

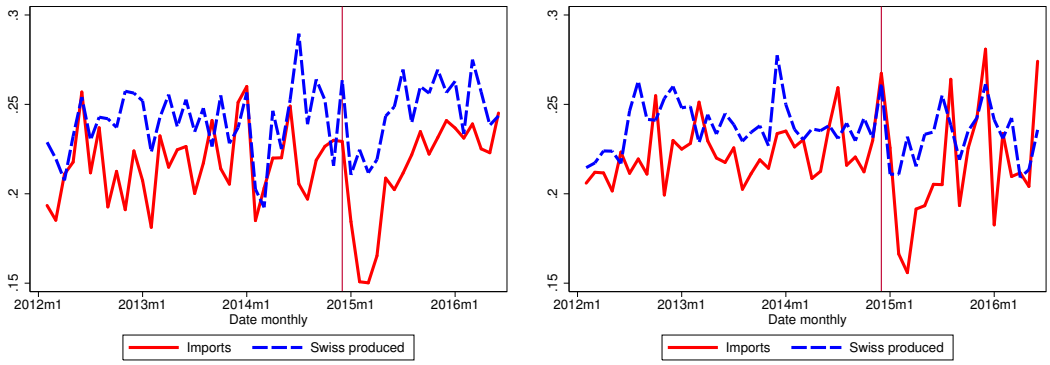
Figure A.6: *Frequency of price decreases by market share*



(a) Small (b) Large

Monthly average fraction of price decreases (prices for imports from EA only). Panel a): firms with less than median market share within a product group, Panel b) more and equal to median (median calculated for the year 2014).

Figure A.7: *Size of price decreases by market share*



(a) Small (b) Large

Monthly average absolute size of price decreases (prices for imports from EA only). Panel a): firms with less than median market share within a product group, Panel b) more and equal to median (median calculated for the year 2014).

level of a region and retailer, from one month to the next). We report estimates for 1 month (that is, February), 3 months, 6 months and 12 months horizons. These estimates are thus comparable to the cumulated fraction of adjusters, which we show in Figure 10. The dummy D_{2015} is equal to one in 2015 and zero otherwise. Thus, the constant estimates the fraction of adjusters in 2014 and $\alpha + \beta$ the fraction of adjusters in 2015.

Columns (1) to (4) report the different horizons, thus in 2014, the share of prices, which have adjusted since January, is 27.2% in February, and 44.7% in January of the following year. This share is significantly larger, at 25.8% in February 2015 and at 72.9% in January

2016.[49]

Table A.6: *The fraction of retail price declines of imports in 2015, compared to 2014*

	(1) 1M	(2) 3M	(3) 6M	(4) 12M
D2015	0.051***	0.360***	0.392***	0.400***
	[0.007]	[0.009]	[0.009]	[0.009]
Constant	0.099***	0.119***	0.118***	0.121***
	[0.005]	[0.006]	[0.007]	[0.006]
Observations	8816	8927	8060	8755
R^2	0.006	0.155	0.179	0.183

In parallel to above, we estimate how the size of adjustment differs between 2014 and 2015.

$$|Size_{i,t}| = \alpha + \beta * D_{2015} + \varepsilon_{i,t} \tag{11}$$

where $|Size_{i,t}|$ is the absolute size of price reductions. We report estimates for 1 month (that is, February), 3 months, 6 months and 12 months horizons. These estimates are thus comparable to the cumulated sizes of adjustment, which we show in FIGURE 13. The dummy D_{2015} is equal to one in 2015 and zero otherwise. Thus, the constant estimates the size of adjustment in 2014 and $\alpha + \beta$ the size of adjustment in 2015.

Table A.7: *The absolute size of retail price declines of imports in 2015*

	(1) 1M	(2) 3M	(3) 6M	(4) 12M
D2015	-0.088***	-0.047***	-0.058***	-0.064***
	[0.008]	[0.007]	[0.007]	[0.007]
Constant	0.226***	0.180***	0.171***	0.197***
	[0.007]	[0.006]	[0.006]	[0.007]
Observations	3343	2645	2514	2810
R^2	0.037	0.019	0.030	0.025

Expenditure switching and invoicing: robustness checks

[49] We use OLS here, because the coefficients are in a format that is straightforward to interpret, in particular the constant. Probit regressions (not reported here) confirm that the estimates are very precise.

Table A.8: *Switching estimates, Expenditure relative to total expenditures*

	(1) OLS, border	(2) reduced-form	(3) 2SLS, border	(4) OLS, retail	(5) 2SLS, retail
Rel. border price	0.388		-2.340***		
	[0.272]		[0.674]		
Invoicing share		-0.120***			
		[0.034]			
Rel. retail price				0.125	-4.833**
				[0.096]	[1.994]
Constant	0.121***	0.184***	-0.012	0.104***	0.003
	[0.015]	[0.024]	[0.034]	[0.008]	[0.042]
Observations	2367	2367	2367	2367	2367
R^2	0.001	0.005	.	0.001	.

Table A.9: *Switching estimates, 01/2015-12/2015*

	(1) OLS, border	(2) reduced-form	(3) 2SLS, border	(4) OLS, retail	(5) 2SLS, retail
Rel. border price	-0.178		-1.525***		
	[0.295]		[0.545]		
Invoicing share		-0.093***			
		[0.033]			
Rel. retail price				-0.188*	-5.485*
				[0.097]	[2.991]
Constant	0.051***	0.126***	-0.013	0.056***	-0.037
	[0.016]	[0.025]	[0.027]	[0.008]	[0.054]
Observations	2211	2211	2211	2211	2211
R^2	0.000	0.004	.	0.002	.

Table A.10: *Switching estimates, 06/2015-05/2016*

	(1) OLS, border	(2) reduced-form	(3) 2SLS, border	(4) OLS, retail	(5) 2SLS, retail
Rel. border price	0.616**		-1.695***		
	[0.253]		[0.602]		
Invoicing share		-0.105***			
		[0.037]			
Rel. retail price				0.109	-2.961**
				[0.091]	[1.268]
Constant	0.135***	0.172***	0.006	0.104***	0.026
	[0.017]	[0.026]	[0.035]	[0.009]	[0.034]
Observations	2262	2262	2262	2262	2262
R^2	0.003	0.004	.	0.001	.

Table A.11: *Product categories in the retail and border price data*

Retail product class	Retail product group	SFSO product categories
AKKU	BATTERIEN	Batterien und Akkumulatoren
ALCO POPS	ALCOPOPS	Spirituosen
ALKALI	BATTERIEN	Batterien und Akkumulatoren
ALUFOLIE	BEUTEL/FOLIEN	Aluminiumfolien
ANDERE PATISSERIE	PATISSERIE	Dauerbackwaren
ANDERES CHARCUTERIE	CHARCUTERIE	Fleischprodukte
ANDERES FLEISCH	FLEISCH	Anderes Fleisch
ANDERES GEFLUEGEL	GEFLUEGEL	Geflgelfleisch
ANDERES TIERFUTTER	TIERNAHRUNG	Futtermittel fr Haustiere
ANDERES WURSTWAREN	WURSTWAREN	Fleischprodukte
ANTIPASTI	HEIMKONSUM	Sonstiges verarbeitetes Obst und Gem
APERITIF	SPIRITUOSEN	Spirituosen
APERO GEBAECK	SNACKS/APERO	Dauerbackwaren
APERONUESSE/NUSSMIX	SNACKS/APERO	Sonstige Nahrungsmittel
APFELSAFT	SAEFTE	Frucht- und Gemsesfte
APFELWEIN	WEINSPEZ	Schaumwein
ASSORTIERT	WARMGETRAENKE	Tee
AUGEN	DEKO KOSMETIK	Krperpflegemittel und Duftstoffe
AUTOMAT	GESCHIRRSPUELER	Seifen, Wasch-, Reinigungsmittel
BABY NAHRUNG	DIV. NAHRUNGSMITTEL	Homogenisierte und ditet. Nahrungsmi
BACKPAPIER	BEUTEL/FOLIEN	Haushalts-, Hygiene- und Toilettenartikel aus Zells
BACKZUTATEN	DESS/BACKZUTATEN	Sonstige Nahrungsmittel
BADEZUSATZ	KOERPERREINIGUNG	Krperpflegemittel und Duftstoffe
BEHANDLUNG	HAARPFLEGE	Krperpflegemittel und Duftstoffe
BEUTEL	BEUTEL/FOLIEN	Haushalts-, Hygiene- und Toilettenartikel aus Zells
BIER M/ALK	BIER	Bier
BIER O/ALK	BIER	Bier
BIER PANACHEES	BIER	Bier
BINDEN	DAMEN	Haushalts-, Hygiene- und Toilettenartikel aus Zells
BISCUITS	BISCUITS	Dauerbackwaren
BONBONS	ZUCKERCONFISERIE	Zuckerwaren
BOUILLON UNGEK	SUPPEN/BOUILLON	Suppen und Brhen
BREATH FRESHENER	ZUCKERCONFISERIE	Zuckerwaren
BROTPRODUKTE	DIV.BAECKEREI	Backwaren (ohne Dauerbackwaren)
BUBBLE GUM	ZUCKERCONFISERIE	Zuckerwaren
BUERSTEN/KAEMME	HAARPFLEGE	Haushalts-, Hygiene- und Toilettenartikel aus Zells
BUTTER	MOLKEREIPROD	le und Fette (ohne Margarine)
CHAMPAGNER	WEINSPEZ	Schaumwein
COLORATIONEN	HAARPFLEGE	Krperpflegemittel und Duftstoffe
DAMEN	DUEFTE	Krperpflegemittel und Duftstoffe
DEO	KOERPERPFLEGE	Krperpflegemittel und Duftstoffe
DESSERTPRODUKTE	DESS/BACKZUTATEN	Zuckerwaren
DESSERTS	MOLKEREIPROD	Sonstige Milchprodukte
DUSCH	KOERPERREINIGUNG	Krperpflegemittel und Duftstoffe
EINKAUFSHILFEN	BEUTEL/FOLIEN	Haushalts-, Hygiene- und Toilettenartikel aus Zells
ESSIGKONSERVEN	KONS NAHRUNGSMITTEL	Sonstiges verarbeitetes Obst und Gem
F.TUE.	BABY	Haushalts-, Hygiene- und Toilettenartikel aus Zells
FERTIGGERICHTE CONVENIENCE	HALTB.CONVENIENCE	Fertiggerichte
FERTIGGERICHTE HEIMKONSUM	HEIMKONSUM	Fertiggerichte
FERTIGSALATE	GASSENKONSUM	Fertiggerichte
FEUCHT	TOILETTENPAPIER	Haushalts-, Hygiene- und Toilettenartikel aus Zells
FISCH	FISCH	Fisch und Fischprodukte

Table A.12: *Continued: Product categories in the retail and border price data*

Retail product class	Retail product group	SFSO product categories
FISCHKONSERVEN	KONS NAHRUNGSMITTEL	Fisch und Fischprodukte
FL/GEFLUEGELKONS	KONS NAHRUNGSMITTEL	Fleischprodukte
FOLIEN	BEUTEL/FOLIEN	Haushalts-, Hygiene- und Toilettenartikel aus Zellstoff und
FRISCH KSE	KAESE	Kse
FRUCHT/NUSSMISCHUNG	KONS NAHRUNGSMITTEL	Sonstiges verarbeitetes Obst und Gemse
FRUCHTGUMMI	ZUCKERCONFISERIE	Zuckerwaren
FRUCHTSAFT	SAEFTE	Frucht- und Gemsesfte
FRUCHTSPIRITUOSEN	SPIRITUOSEN	Spirituosen
FRUECHTE GETROCKNET	KONS NAHRUNGSMITTEL	Sonstiges verarbeitetes Obst und Gemse
FRUECHTEKONSERVEN	KONS NAHRUNGSMITTEL	Sonstiges verarbeitetes Obst und Gemse
FUSS	KOERPERPFLEGE	Krperpflegemittel und Duftstoffe
FW ROSE	WEIN	Rotwein
FW ROT	WEIN	Rotwein
FW WEISS	WEIN	Weisswein
GEK FERTIGSAUCEN	HEIMKONSUM	Suppen und Brhen
GELIERMITTEL	DIV. NAHRUNGSMITTEL	Strke und Strkeerzeugnisse
GEMUESE GETROCKNET	KONS NAHRUNGSMITTEL	Sonstiges verarbeitetes Obst und Gemse
GEMUESE/ANTIPASTI	KONS NAHRUNGSMITTEL	Sonstiges verarbeitetes Obst und Gemse
GEMUESEKONSERVEN	KONS NAHRUNGSMITTEL	Sonstiges verarbeitetes Obst und Gemse
GEMUESESAFT	SAEFTE	Frucht- und Gemsesfte
GESUESST	BROTAUFSTRICH	Zuckerwaren
GETREIDE/ERZEUGNISSE	GRUNDNAHRUNGSMITTEL	Sonstige Mllereiprodukte
GEWEBEVEREDLER	TEXTIL/BEHANDLUNG	Seifen, Wasch-, Reinigungsmittel
GEWUERZE	WUERZEN	Wrzen und Saucen
GLUEHWEIN/PUNSCH	WARMGETRAENKE	Spirituosen
GROSSBROT	BROT	Backwaren (ohne Dauerbackwaren)
HAARENTFERNUNG	DAMENPFLEGE	Krperpflegemittel und Duftstoffe
HALBHART	KAESE	Kse
HAND	GESCHIRRSPUELER	Seifen, Wasch-, Reinigungsmittel
HART	KAESE	Kse
HAUSHALT	PAPIERWAREN	Haushalts-, Hygiene- und Toilettenartikel aus Zellstoff und
HB/SUESSGEBAECK	BISCUITS	Dauerbackwaren
HERREN	DUEFTE	Krperpflegemittel und Duftstoffe
HUEHNEREIER	EIER	Eier
HUNDEFUTTER	TIERNAHRUNG	Futtermittel fr Haustiere
ICE-TEA	SUESSGETRAENKE	Erfrischungsgetrnke
INTIM	KOERPERPFLEGE	Krperpflegemittel und Duftstoffe
JOGHURT	MOLKEREIPROD	Sonstige Milchprodukte
K/H PFL.	KOERPERPFLEGE	Krperpflegemittel und Duftstoffe
KAFFEE BOHNEN	WARMGETRAENKE	Kaffee
KAFFEE LOESLICH	WARMGETRAENKE	Kaffee
KAFFEEERGAENZUNGEN	WARMGETRAENKE	Kaffee
KAFFEEFILTER	PAPIERWAREN	Haushalts-, Hygiene- und Toilettenartikel aus Zellstoff und
KALB FLEISCH	FLEISCH	Anderes Fleisch
KALB WURST	WURSTWAREN	Fleischprodukte
KALT UNGEK	SAUCEN	Wrzen und Saucen
KARTOFFELSTOCK	HALTB.CONVENIENCE	Fertiggerichte
KATZENFUTTER	TIERNAHRUNG	Futtermittel fr Haustiere
KAUGUMMI	ZUCKERCONFISERIE	Zuckerwaren
KEHRICHTSACK	BEUTEL/FOLIEN	Haushalts-, Hygiene- und Toilettenartikel aus Zellstoff und
KETCHUP	WUERZEN	Wrzen und Saucen
KLEINBROT	BROT	Backwaren (ohne Dauerbackwaren)

Table A.13: *Continued: Product categories in the retail and border price data*

Retail product class	Retail product group	SFSO product categories
KNAECKEBROT	DAUERBACKWAREN	Dauerbackwaren
KOHLE ZINK	BATTERIEN	Batterien und Akkumulatoren
KONFITUERE	BROTAUFSTRICH	Sonstiges verarbeitetes Obst und Gemse
KOSMETIK	BABYPFLEGE	Krperpflegemittel und Duftstoffe
KOSMETIKTUECHER	ZZAA PAPIERHYGIENE	Haushalts-, Hygiene- und Toilettenartikel aus Zellstoff u
KRAEUTER/FRUECHTETEE	WARMGETRAENKE	Tee
KRAFTNAEHRMITTEL	WARMGETRAENKE	Homogenisierte und ditet. Nahrungsmittel
LACHS	FISCH	Fisch und Fischprodukte
LANG HALTBAR	BROT	Dauerbackwaren
LIPPENSCHUTZ	GESICHTSPFLEGE	Krperpflegemittel und Duftstoffe
LIPPENSTIFT	DEKO KOSMETIK	Krperpflegemittel und Duftstoffe
LIQUEUR	SPIRITUOSEN	Spirituosen
LITHIUM	BATTERIEN	Batterien und Akkumulatoren
LUFTERFRISCHER	REINIGUNGSMITTEL	Seifen, Wasch-, Reinigungsmittel
LW ROSE	WEIN	Rotwein
LW ROT	WEIN	Rotwein
LW WEISS	WEIN	Weisswein
M/CO2	MINERALWASSER	Mineralwasser
MAKE UP BODY	DEKO KOSMETIK	Krperpflegemittel und Duftstoffe
MAKE UP FACE	DEKO KOSMETIK	Krperpflegemittel und Duftstoffe
MARGARINE	MOLKEREIPROD	Sonstige Milchprodukte
MARINADEN	WUERZEN	Wrzen und Saucen
MASKEN	GESICHTSPFLEGE	Krperpflegemittel und Duftstoffe
MAYONNAISE	WUERZEN	Wrzen und Saucen
MEERESFRUECHTE	FISCH	Fisch und Fischprodukte
MEERRETTICH	WUERZEN	Wrzen und Saucen
MEHL	GRUNDNAHRUNGSMITTEL	Sonstige Mllereiprodukte
MELASSE	BROTAUFSTRICH	Homogenisierte und ditet. Nahrungsmittel
MILCH FRISCH	MOLKEREIPROD	Sonstige Milchprodukte
MILCH KONZ	MOLKEREIPROD	Sonstige Milchprodukte
MILCHGETRAENKE	MOLKEREIPROD	Sonstige Milchprodukte
MUESLI	CEREALIEN	Sonstige Mllereiprodukte
NAGELLACK	DEKO KOSMETIK	Krperpflegemittel und Duftstoffe
NAGELPFLEGE	DEKO KOSMETIK	Krperpflegemittel und Duftstoffe
NAHRUNGSERGAENZUNG	DIAET NAHRUNGSMITTEL	Homogenisierte und ditet. Nahrungsmittel
NASSSUPPEN UNGEK	SUPPEN/BOUILLON	Wrzen und Saucen
NEKTAR	SAEFTE	Frucht- und Gemsesfte
NUESSE	KONS NAHRUNGSMITTEL	Homogenisierte und ditet. Nahrungsmittel
O/CO2	MINERALWASSER	Mineralwasser
OLIVEN	KONS NAHRUNGSMITTEL	Sonstiges verarbeitetes Obst und Gemse
PFLASTER	VERBANDSMATERIAL	Haushalts-, Hygiene- und Toilettenartikel aus Zellstoff u
PFLEGE	GESICHTSPFLEGE	Krperpflegemittel und Duftstoffe
PIZZA	HEIMKONSUM	Fertiggerichte
POMMES CHIPS	SNACKS/APERO	Sonstiges verarbeitetes Obst und Gemse
PORTIONEN	WARMGETRAENKE	Tee
PORTWEIN/SHERRY	WEINSPEZ	Spirituosen
POULET CHARCUTERIE	CHARCUTERIE	Geflgelfleisch
POULET FLEISCH	GEFLUEGEL	Geflgelfleisch
POULET WURST	WURSTWAREN	Fleischprodukte
PRAESERVATIVE	FAMILIENPLANUNG	Haushalts-, Hygiene- und Toilettenartikel aus Zellstoff u
PULVER	SAEFTE	Homogenisierte und ditet. Nahrungsmittel
QUARK	MOLKEREIPROD	Sonstige Milchprodukte

Table A.14: *Continued: Product categories in the retail and border price data*

Retail product class	Retail product group	SFSO product categories
RAHM	MOLKEREIPROD	Sonstige Milchprodukte
RASIERAPPARATE	HERRENPFLEGE	Kleingerte
RAUCHERUNTENSILIEN	RAUCHERZUBEHOER	Tabakprodukte
REINIGUNG	GESICHTSPFLEGE	Krperpflegemittel und Duftstoffe
REINIGUNG HILFSMITTEL	HILFSMITTEL	Seifen, Wasch-, Reinigungsmittel
REINIGUNG REINIGUNGSMITTEL	REINIGUNGSMITTEL	Seifen, Wasch-, Reinigungsmittel
REIS	GRUNDNAHRUNGSMITTEL	Reis
RIND CHARCUTERIE	CHARCUTERIE	Fleischprodukte
RIND FLEISCH	FLEISCH	Anderes Fleisch
RIND WURST	WURSTWAREN	Fleischprodukte
RONDELLEN	WATTERPRODUKTE	Haushalts-, Hygiene- und Toilettenartikel aus Zells
RTEC	CEREALIEN	Sonstige Mllereiprodukte
SALATSAUCEN UNGEK	SAUCEN	Wrzen und Saucen
SALZ	WUERZEN	Wrzen und Saucen
SCHLANKH.MAHLZ/GETR	DIAET NAHRUNGSMITTEL	Homogenisierte und ditet. Nahrungsm
SCHMELZ	KAESE	Kse
SCHOKO BRANCHLI	SCHOKOLADE	Kakao- und Schokoladeerzeugnisse
SCHOKO DRAGEES	SCHOKOLADE	Kakao- und Schokoladeerzeugnisse
SCHOKO NAPOLITAINS	SCHOKOLADE	Kakao- und Schokoladeerzeugnisse
SCHOKO PRALINES	SCHOKOLADE	Kakao- und Schokoladeerzeugnisse
SCHOKO RIEGEL	SCHOKOLADE	Kakao- und Schokoladeerzeugnisse
SCHOKO SAISONARTIKEL	SCHOKOLADE	Kakao- und Schokoladeerzeugnisse
SCHOKO TAFELN	SCHOKOLADE	Kakao- und Schokoladeerzeugnisse
SCHOKO UEBRIGE	SCHOKOLADE	Kakao- und Schokoladeerzeugnisse
SCHOKO/KAKAOPULVER	WARMGETRAENKE	Kakao- und Schokoladeerzeugnisse
SCHOKOKOEPFE	SCHOKOLADE	Kakao- und Schokoladeerzeugnisse
SCHWARZTEE	WARMGETRAENKE	Tee
SCHWEDENBROT	DAUERBACKWAREN	Dauerbackwaren
SCHWEIN CHARCUTERIE	CHARCUTERIE	Schweinefleisch
SCHWEIN FLEISCH	FLEISCH	Schweinefleisch
SCHWEIN WURST	WURSTWAREN	Fleischprodukte
SEIFE	KOERPERREINIGUNG	Seifen, Wasch-, Reinigungsmittel
SEKT REIN	WEINSPEZ	Schaumwein
SENF	WUERZEN	Wrzen und Saucen
SENFFRUECHTE	KONS NAHRUNGSMITTEL	Sonstiges verarbeitetes Obst und Gen
SHAMPOO	HAARPFLEGE	Krperpflegemittel und Duftstoffe
SIRUP	KONZENTRATE	Erfrischungsgetrnke
SLIPEINLAGEN	DAMEN	Haushalts-, Hygiene- und Toilettenartikel aus Zells
SNACKS UEBRIGE	SNACKS/APERO	Sonstige Nahrungsmittel
SODA KONZENTRAT	KONZENTRATE	Erfrischungsgetrnke
SONNE	KOERPERPFLEGE	Krperpflegemittel und Duftstoffe
SPEISEESSIG	WUERZEN	Wrzen und Saucen
SPEISEFETT	GRUNDNAHRUNGSMITTEL	le und Fette (ohne Margarine)
SPEISEOEL	GRUNDNAHRUNGSMITTEL	le und Fette (ohne Margarine)
SPEZ PRODUKTE	TEXTIL/BEHANDLUNG	Seifen, Wasch-, Reinigungsmittel
SPEZIALITAETEN	ZUCKERCONFISERIE	Zuckerwaren
SPORT/ENERGIEDRINKS	SUESSGETRAENKE	Erfrischungsgetrnke
STAEBCHEN	WATTERPRODUKTE	Haushalts-, Hygiene- und Toilettenartikel aus Zells
STAERKEPRODUKTE	DIV. NAHRUNGSMITTEL	Strke und Strkeerzeugnisse
STAUBSAUGERSACK	BEUTEL/FOLIEN	Haushalts-, Hygiene- und Toilettenartikel aus Zells
STUECKARTIKEL	PATISSERIE	Backwaren (ohne Dauerbackwaren)
STYLING	HAARPFLEGE	Krperpflegemittel und Duftstoffe
SUESS STOFFE	DIAET NAHRUNGSMITTEL	Homogenisierte und ditet. Nahrungsm
SUESSWASSER	SUESSGETRAENKE	Erfrischungsgetrnke
SUESSWEINE	WEINSPEZ	Schaumwein
SULZ	WUERZEN	Wrzen und Saucen

Table A.15: *Continued: Product categories in the retail and border price data*

Retail product class	Retail product group	SFSO product categories
TABAK	TABAKWAREN	Tabakprodukte
TAFEL	SAEFTE	Frucht- und Gemsesfte
TAMPONS	DAMEN	Haushalts-, Hygiene- und Toilettenartikel aus Zells
TEIGPRODUKTE	DIV.BAECKEREI	Teigwaren
TEIGWAREN	HEIMKONSUM	Teigwaren
TEIGWARENKONSERVEN	KONS NAHRUNGSMITTEL	Teigwaren
TISCHDEKO	PAPIERWAREN	Haushalts-, Hygiene- und Toilettenartikel aus Zells
TK BACKWAREN	TK CONVENIENCE	Fertiggerichte
TK DESSERT	TK DESSERT	Fertiggerichte
TK FERTIGGERICHTE	TK CONVENIENCE	Fertiggerichte
TK FISCH	TK TRADITIONELL	Fertiggerichte
TK FLEISCH	TK TRADITIONELL	Fertiggerichte
TK FRUECHTE	TK TRADITIONELL	Fertiggerichte
TK GEFLUEGEL	TK TRADITIONELL	Fertiggerichte
TK GEMUESE/PILZE	TK TRADITIONELL	Fertiggerichte
TK GLACEN	TK DESSERT	Fertiggerichte
TK KARTOFFELN	TK TRADITIONELL	Fertiggerichte
TK MEERESFRUECHTE	TK TRADITIONELL	Fertiggerichte
TK PIZZA	TK CONVENIENCE	Fertiggerichte
TK REST	TK TRADITIONELL	Fertiggerichte
TK TEIGWAREN	TK CONVENIENCE	Fertiggerichte
TOFU/SOJA	TOFU/SOJA	Sonstige Nahrungsmittel
TOMATENPUREE	WUERZEN	Wrzen und Saucen
TORTEN/KUCHEN/CAKE	PATISSERIE	Backwaren (ohne Dauerbackwaren)
TORTILLAS/TACOS	HALTB.CONVENIENCE	Dauerbackwaren
TROCKEN	TOILETTENPAPIER	Haushalts-, Hygiene- und Toilettenartikel aus Zells
TROCKEN TEIGWAREN	GRUNDNAHRUNGSMITTEL	Teigwaren
TROCKENSUPPEN	SUPPEN/BOUILLON	Wrzen und Saucen
UNGESUESST	BROTAUFSTRICH	Homogenisierte und ditet. Nahrungsmi
VITAMINE	SELBSTMEDIKATION	Homogenisierte und ditet. Nahrungsmi
VOLLKORNCRACKER	DAUERBACKWAREN	Dauerbackwaren
WAEHEN	DIV.BAECKEREI	Backwaren (ohne Dauerbackwaren)
WARM UNGEK	SAUCEN	Wrzen und Saucen
WASCHMITTEL	TEXTIL/BEHANDLUNG	Seifen, Wasch-, Reinigungsmittel
WATTE	WATTERPRODUKTE	Haushalts-, Hygiene- und Toilettenartikel aus Zells
WC STEINE	REINIGUNGSMITTEL	Seifen, Wasch-, Reinigungsmittel
WEICH	KAESE	Kse
WEIN/SEKT MIX	WEINSPEZ	Schaumwein
WEINBRAND	SPIRITUOSEN	Spirituosen
WEISSTEE	WARMGETRAENKE	Tee
WHISKY	SPIRITUOSEN	Spirituosen
WHITE SPIRITS	SPIRITUOSEN	Spirituosen
WINDELN EINWEG	BABY	Haushalts-, Hygiene- und Toilettenartikel aus Zells
Z.SAFT/KONZENTRAT	DESS/BACKZUTATEN	Frucht- und Gemsesfte
ZAHNBUERSTEN	MUNDPFLEGE	Krperpflegemittel und Duftstoffe
ZAHNPASTA	MUNDPFLEGE	Krperpflegemittel und Duftstoffe
ZIGAR/ZIGARIL/STUMP	TABAKWAREN	Tabakprodukte
ZIGARETTEN	TABAKWAREN	Tabakprodukte
ZUBEHOER GETR.ZUBEREITUNG	GETR.ZUBEREITUNG	Sonstige Mllereiprodukte
ZUCKER	GRUNDNAHRUNGSMITTEL	Zucker
ZUSATZMITTEL	GESCHIRRSPUELER	Seifen, Wasch-, Reinigungsmittel
ZWIEBACK	DAUERBACKWAREN	Dauerbackwaren
ZZAA DAUERBACKWAREN	DAUERBACKWAREN	Dauerbackwaren
ZZAA GES.PFLEGE	SELBSTMEDIKATION	Homogenisierte und ditet. Nahrungsmi
ZZAA MUNDPFLEGE	MUNDPFLEGE	Krperpflegemittel und Duftstoffe
ZZAA TIERE TIERNAHRUNG	TIERNAHRUNG	Futtermittel fr Haustiere
ZZAA TOILETTENPAPIER	TOILETTENPAPIER	Haushalts-, Hygiene- und Toilettenartikel aus Zells
ZZAA Z.CONFISERIE	ZUCKERCONFISERIE	Zuckerwaren