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Export Prices, Markups, and Currency Choice after a Large Appreciation*

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Abstract: We analyze export price adjustment of Swiss manufacturing firms using a novel data set of matched export, import, and domestic prices. After a large, unexpected, and permanent appreciation of the Swiss franc, export prices set in domestic currency fell less than export prices set in foreign currency. This difference prevails if we control for variation in firms' marginal cost. Through the lens of a structural model, this difference can be traced back to strategic complementarity in price setting for firms pricing in foreign currency. Meanwhile, firms setting prices in domestic currency exhibit no strategic complementarity and follow a constant markup-pricing rule.

JEL classification: E3, E5, F3, F4

Keywords: Nominal exchange rate, border prices, currency choice, variable markups, pricing-to-market, price rigidity, exchange rate pass through, exchange rate sensitive factor costs

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1 Introduction

A central question in international macroeconomics is why large exchange rate movements have a small effects on tradeable goods' prices. Understanding this exchange rate disconnect is key to understand the transmission of nominal shocks in open economies. The existing literature documents that the response of prices to exchange rate movements depends on the currency of pricing (see Gopinath et al. 2010). If a price is set in producers' domestic currency, customers abroad bear most of the variation in the exchange rate and vice versa. This implies that the optimal decision to set prices in domestic or foreign currency depends on the desired exchange rate pass-through.

In this paper, we shed light on the determinants of desired exchange rate pass-through using data of Swiss import, export, and domestic prices. The novel feature of the data is that we can match these prices to particular firms, which allows us to decompose desired pass-through into the exchange rate sensitivity of marginal cost, and strategic complementarity in price setting. To identify exchange rate elasticities, we rely on a comparison before and after the Swiss National Bank (SNB) surprisingly abandoned an exchange rate floor in January 2015. This episode provides a rare case of an unexpected, large, and permanent appreciation in a small open economy.

The matched data set allows to control for firm-level variation in marginal costs using two alternative approaches. First, we control for changes in the cost of imported inputs using firms' import prices, similar to Amiti et al. (2014). Second, we estimate the exchange rate elasticity of export prices relative to the same firm's domestic prices. While the first strategy only absorbs variation in marginal cost for imported inputs, the second strategy absorbs all variation in marginal cost common across products within a firm.

Our main results may be summarized as follows. We find large and persistent differences in exchange rate pass-through to export prices invoiced in domestic and foreign currency. The exchange rate elasticity of export prices (0.5) is larger than that of domestic prices (0.3). While almost all domestic prices are set in domestic currency, the elasticity depends on the invoicing currency for export prices. The elasticity is high for prices set in foreign currency (0.9), but small for prices set in domestic currency (0.3). We then show that differences in the exchange rate sensitivity of marginal cost cannot fully explain this gap. In particular, the gap prevails after controlling for changes in import prices, as

well as, after controlling for within-firm variation in marginal cost. This suggests that firms setting prices in foreign currency face strong strategic complementarity and accept a variable markup. By contrast, firms setting prices in domestic currency follow a constant markup-pricing rule.

To support and quantify this interpretation, we relate the reduced-form estimates to a structural model. In the model, the response to an exchange rate shock is determined by the exchange rate sensitivity of marginal cost and strategic complementarity of firms' export prices with the destination price level (see Gopinath et al. 2010). We find that marginal cost is more sensitive to variation in import prices for products priced in foreign currency than for products priced in domestic currency. Moreover, exporters invoicing in domestic currency exhibit no strategic complementarity in their price setting, confirming that they charge a constant markup over marginal cost. By contrast, exporters pricing in foreign currency exhibit substantial strategic complementarity and variable markups. Because the influence of strategic complementarity and sensitivity of marginal cost is non-linear, we examine the role of each parameter using counterfactuals. The absence of strategic complementarity for export prices set in foreign currency explains 81% of the gap between the exchange rate elasticity of prices set in domestic and foreign currency.

Our paper contributes to several strands of the price-setting literature. First, we analyze exchange rate pass-through and currency choice using border prices.[1] Devereux et al. (2004), Engel (2006) and Gopinath et al. (2010) discuss factors that affect currency choice if prices are rigid. Desired pass-through to export prices is low for firms with high market power, high strategic complementarity in pricing, and a high exchange rate elasticity of marginal cost. Therefore, these firms are more likely to set prices in foreign currency. Gopinath and Itskhoki (2010) show for US import prices that there is indeed a large gap between the exchange rate elasticity of prices set in domestic and foreign currency. The large gap of of pass-through between invoicing currencies we document is consistent with the theoretical predictions and confirms the empirical results for US import prices. We additionally show, however, that the high desired pass-through of firms pricing in foreign currency can mostly be traced back to strategic complementarity rather than exchange rate sensitive marginal cost.

[1]For two surveys of the literature see Goldberg and Knetter (1997) and Burstein and Gopinath (2014). An early contribution by Krugman (1986) emphasizes that market power allows firms to price-discriminate across export destination ("pricing-to-market"). Moreover, Engel (2003) surveys the literature on nominal price rigidities in the currency of the destination market.

Second, our paper is related to studies measuring the role of strategic complementarity in pricing decisions. Nakamura and Zerom (2010) analyse markup adjustment and incomplete cost pass-through in the US coffee industry. Amiti et al. (2016) provide empirical evidence on the importance of strategic complementarity in price-setting using data for Belgian manufacturing firms. Amiti et al. (2014) provide evidence that variation in import prices can explain a large share of the heterogeneity in the exchange rate elasticity across firms, but also find evidence for variable markups. Berman et al. (2012) show that the exchange rate elasticity of markups is higher for French high-performance firms. We add to this literature in two ways. First, apart from Amiti et al. (2014, 2016), it is one of the first to match manufacturing prices with information on firm level changes in factor costs. We observe actual transaction prices as well as the currency of pricing, however. Thus, we can investigate the role of currency choice in export price adjustments. Second, because we can match export, import, and domestic prices, the data allow us to identify the elasticity of markups for exporters. As a consequence, we are able to provide structural estimates of the importance of strategic complementarity in price setting and relate these estimates to currency choice.

Finally, we provide evidence on the exchange rate pass-through to Swiss border and domestic prices. In line with our findings, Campa and Goldberg (2005) and Fauceglia et al. (2014) show that Swiss import prices respond strongly to exchange rate fluctuations. Bonadio et al. (2019), Auer et al. (2018, 2019) also study the consequences of the January 2015 Swiss franc appreciation. Bonadio et al. (2019) focus on the speed of the response of Swiss import unit values in the immediate aftermath of the shock; Auer et al. (2018) analyze exchange rate pass-through of prices of consumer goods at the border, and in the Swiss retail sector; and Auer et al. (2019) show that export sectors with a high share of Swiss franc denominated prices experienced a stronger decline in export values.[2] We differ from these existing studies because we focus on export prices, measure markup adjustment, and provide empirical evidence on the role of strategic complementarity in price setting.

The paper is structured as follows We first describe the macroeconomic environment and the data. Then, we provide reduced-form estimates of the exchange rate elasticity of export prices and markups, which we then interpret through the lens of a structural model. The last section concludes.

[2] In Kaufmann and Renkin (2017) we provide additional evidence on rigidities in export, import, and domestic prices, as well as, employment adjustment.

2 The Swiss franc shock

For identifying the exchange rate elasticity of export prices, we rely on a large, unexpected and permanent appreciation of the Swiss franc against the Euro (see also Efing et al. 2015; Bonadio et al. 2019; Auer et al. 2018, 2019, for other applications). On 15 January 2015, the SNB abolished an exchange rate floor vis-à-vis the Euro that had been in place for more than three years.[3] As a consequence, the Swiss franc appreciated by more than 10% against the Euro (see Figure 1, panel a). Although the SNB also lowered its reference interest rate to negative territory, and introduced negative interest rates on reserves, the CHF/EUR exchange rate remained close to CHF/EUR 1.1 two years after. In what follows, we discuss the economic environment before and after the shock.

The removal of the exchange rate floor surprised analysts and the public alike. Panel (a) of Figure 1 shows the 12-month forecasts of a panel of 20 economists participating in the KOF Consensus Forecast, a survey of professional forecasters. In December 2014, one month before abolition of the exchange rate floor, all survey participants predicted the exchange rate to remain above CHF/EUR 1.20 over the next 12 months. The survey evidence is consistent with the high credibility of the floor found in financial market data (see Bonadio et al. 2019).

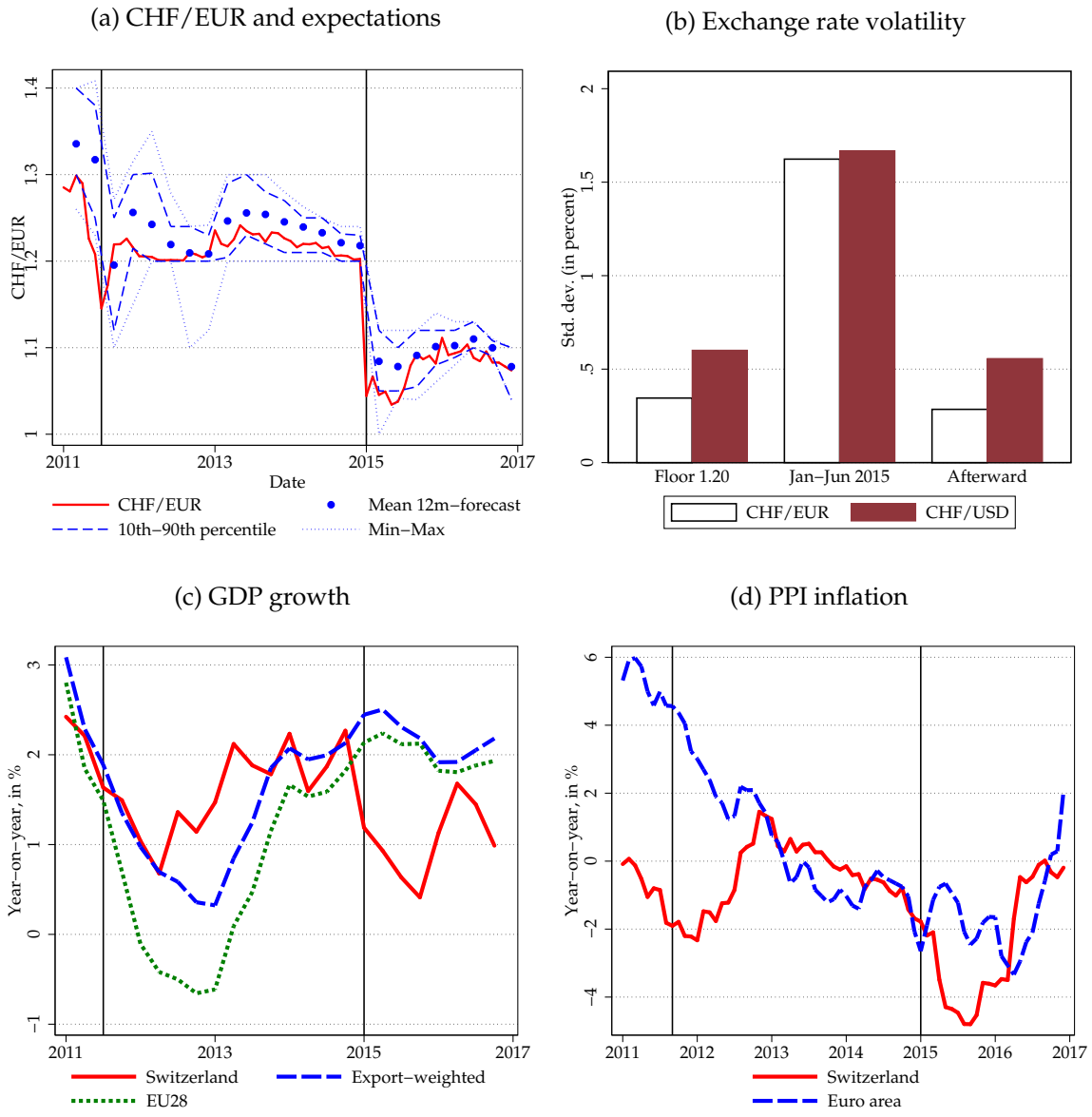
The removal of the floor did not mean that the Swiss franc was freely floating afterward. Rather, the SNB continued to intervene heavily in foreign exchange markets to stabilize the exchange rate over the following two years.[4] As a result, the volatility of the CHF/EUR exchange rate was low even after the floor was abandoned (panel b). After a short spike in the months immediately following the appreciation, volatility receded to levels even slightly lower than during the exchange rate floor regime.

Apart from the appreciation, the macroeconomic environment in Switzerland and its main trading

[3]The SNB introduced the floor in the wake of the global financial and Euro area debt crises. The SNB had already lowered its policy interest rate close to zero in early 2009. Because the dominant view at the time was that policy rates cannot fall below zero, conventional monetary policy was effectively out of ammunition (SNB 2009). The SNB thus promised on 6 September 2011 to buy unlimited foreign currency, if necessary, to defend a floor at CHF/EUR 1.20. Thereafter, the CHF/EUR exchange rate hovered just above the floor for the following years (see Figure 1, panel a).

[4]Foreign currency investments held by the SNB increased by 227 billion CHF during the floor at 1.20 CHF/EUR. For the shorter period between January 2015 and December 2016, foreign currency investments increased by 188 billion. See https://data.snb.ch/en/topics/snb#!/cube/snbbipo (accessed on 11 October 2019).

Figure 1 — The Swiss franc shock



Notes: Panel (a): CHF/EUR with expectations from the KOF Consensus Forecast, a survey of professional forecasters. Panel (b): Volatility of CHF/EUR and CHF/USD exchange rate during and after the exchange rate floor. Panel (c): GDP growth in Switzerland, its main trading partners (export-weighted), and in the European Union. Panel (d): Producer price inflation in Switzerland and the Euro area. Vertical lines denote the introduction and removal of the exchange rate floor at CHF/EUR 1.20. Sources: Survey data and export-weighted GDP retrieved from KOF Swiss Economic Institute. Exchange rate data retrieved from the ECB. GDP and producer price data retrieved from the OECD.

partners was stable around the time of the appreciation (see panels c and d).[5] In Switzerland, economic growth had been steady at around 2% from 2013 on. The EU, and Switzerland's other important trading partners, had similar growth rates in 2014, and no substantial change around the appreciation.[6] Swiss PPI inflation quickly converged to Euro area levels after the floor was introduced, and remained close to Euro area inflation until the floor was abolished. After the appreciation, producer price inflation in Switzerland dropped substantially, while inflation remained higher in the Euro area. Therefore, we conclude that foreign demand remained largely stable before and after the appreciation.

It is still possible, however, that firms' marginal cost were not only affected by the exchange rate shock but also by other factors. Indeed, panel (d) shows that foreign producer prices declined before and after the exchange rate shock. Because Swiss manufacturing firms import a relevant fraction of their intermediate inputs prices of imported inputs probably declined independently of the exchange rate shock.[7] In what follows, we describe a novel data set allowing us to control for such changes in firms' marginal costs, and identify the exchange rate elasticity of markups.

3 Data

We analyse export price adjustment using a novel data set on product-level manufacturing prices from December 2010 to November 2016. The data stem from three monthly surveys for imported, exported and domestically sold products. The Swiss Federal Statistical Office (SFSO) collects the data to construct the Producer Price Index (PPI) and Import Price Index (IPI).[8] The PPI measures price developments of products of manufacturing firms operating in Switzerland. Firms report separate prices for the domestic market and the export market. The IPI measures price developments of

[5] Previous studies of large exchange rate shocks have focused on devaluations in troubled middle income economies, and the 1992 breakdown of the European Monetary System (see e.g. Burstein et al. 2005). Those devaluations tend to be associated with government defaults or financial crises, as well as large fluctuations in output, consumption and inflation. Moreover, due to the underlying structural causes of the devaluation, these variables are typically affected already before the actual shock.

[6] We thank Florian Eckert for providing export-weighted foreign GDP computed by the KOF Swiss Economic Institute.

[7] Figure 3 in the Appendix shows that in Europe, prices of intermediate goods declined. Meanwhile, Swiss wages were less affected by the Swiss franc shock.

[8] For a detailed description of the questionnaires for import, domestic and export prices, see SFSO (2012) and SFSO (2016).

imported goods at the border.[9] The survey explicitly asks for transaction prices (SFSO 2016, p. 15).[10] The data set has two advantages. First, all three surveys ask for the currency of pricing. Second, we can match part of the price series to particular firms across all three surveys. In what follows, we describe our sampling decisions, descriptive statistics, and some limitations of the data.

3.1 Sampling decisions

The survey frequency varies across sectors, depending on the SFSO's experience on how often prices change. For most sectors the survey takes place each month or quarter. Therefore, we aggregate the data to quarterly frequency, using the average price over a quarter.[11] We disregard all prices collected less than quarterly or irregularly.

Price series enter or exit the panel for two reasons. First, the SFSO may redraw the sample of firms. Although the largest firms within a sector usually remain in the sample, small and medium-sized firms are replaced from time to time. About 2% of all firms enter or exit the sample each quarter. Second, firms may report prices for new products, if a product is temporarily out of stock, generates little revenue, or is discontinued altogether. In this case, the SFSO asks for the prices of a qualitatively similar product in the current and previous period.[12] The price difference of the old and new product in the same period is then used as a measure of the difference in quality. We follow the SFSO linking the prices of old and new products after adjusting for quality. If the new product is too different, or if no price is available for the previous period, we start a new series. On average, less than 10% of new products appear in the sample per quarter. The first quarter of 2016 is an exception, however, because the goods basket and sample of firms changed in a benchmark revision (see SFSO 2016). To avoid that product entry and exit affects the results we focus on price series observed in Q4 2014, the quarter just before the Swiss franc shock, and disregard new price series introduced thereafter.

Some large price changes likely result from reporting errors. We fix obvious mistakes.[13] Otherwise,

[9] Domestic prices are measured ex-factory, export prices free on board (excluding transportation cost, insurance cost, VAT and other taxes), and import prices duties unpaid.

[10] Of course, it is possible that firms do not comply with this requirement. If the firm cannot report a transaction price, however, the SFSO aims to find a good approximation to the market price.

[11] Firms report the price of the first eight days of the corresponding month. Before aggregation, we convert prices reported in foreign currency into Swiss franc using the average daily exchange rate during the first eight days of the month (the period of data collection). Daily Swiss franc exchange rates are inferred from cross-rates available from the ECB retrieved in April 2017 (`www.ecb.europa.eu/stats/eurofxref/`).

[12] The SFSO ensures the appropriate treatment of such replacements through phone calls or on-site visits.

[13] For example, if prices increase or decrease by exactly 100% or 1000%, this usually indicates an unreported change in the number of products.

we treat price changes larger than 100% as unreported changes in product quality and start a new price series. Overall, about 0.8% of price series are subject to at least one such adjustment.

3.2 Descriptive statistics

Table 1 shows descriptive statistics at the firm level for the domestic and export market. These statistics are computed for the period before the Swiss franc shock, from 2012 to 2014. There are 1,218 firms reporting on average 3.6 domestic prices. 556 firms report export prices for on average 3.1 products. Almost all domestic products are invoiced in domestic currency. Therefore, we do not report separately the currency of pricing. For the export market, 453 of 556 firms (81%) report all of their exported products in just one currency, either Euro or Swiss franc. Only 76 firms report prices in other or more than one currencies.

Table 1 — Descriptive statistics at firm level

	Domestic market	Export market			
	All	All	EUR	CHF	Other/mixed
Number of products	3.62	3.06	2.50	3.38	3.63
Size available	0.71	0.81	0.83	0.82	0.86
<50 employees	0.39	0.31	0.36	0.29	0.26
51–250 employees	0.39	0.46	0.50	0.43	0.43
>250 employees	0.21	0.23	0.14	0.28	0.31
Reports import prices	0.38	0.52	0.57	0.45	0.58
Import prices in EUR	0.38	0.46	0.61	0.34	0.36
Import prices in CHF	0.37	0.27	0.16	0.46	0.16
Import prices in other/mixed	0.14	0.19	0.17	0.15	0.39
Frequency of price changes	0.24	0.25	0.23	0.30	0.18
Frequency of price increases	0.13	0.14	0.14	0.16	0.09
Frequency of price decreases	0.13	0.12	0.10	0.16	0.09
Observations	1218	556	219	244	76

Notes: All statistics except the number of products and observations denote shares in the corresponding sample. Calculated from Q1 2012–Q4 2014 at the firm level and then averaged across firms.

About half of all export prices are reported in Euro. The Federal Customs Adminstration (2015) finds that, in a more representative trade data set, 1/3 of total exports in 2014 were invoiced in Euro, 1/3 in Swiss franc, and 1/5 in US dollar. The share of prices set in Euro and Swiss franc is higher in our data set, probably because the SFSO asks firms to report prices for their most important export destination. For exporting Swiss manufacturing firms, this is usually an EU country (see Table 2).

We cannot directly verify whether the currency indicator is accurate, similar as other studies using

survey data on border prices (see Gopinath and Rigobon 2008; Gopinath et al. 2010; Gopinath and Itskhoki 2010). However, Table 1 shows that the frequency of price changes is similar for domestic and export prices, as well as, for prices set in Euro and Swiss franc. This is indirect evidence that the currency indicator is quite accurate. If firms would systematically convert their foreign currency prices to Swiss franc, we would observe more frequent price changes in domestic currency relative to price changes reported in foreign currency.

Table 2 — Manufacturing firm characteristics in population

	Main export destination in EU	Exports in revenue	Labor expenses in revenue	Intermediate expenses in revenue
< 50 employees	87.7	8.5	41.6	35.8
$51 - 250$ employees	85.3	16.4	36.3	42.1
> 250 employees	87.6	28.5	32.2	45.5

Notes: All statistics are shares measured in %. Own calculations based on the past three waves (2011, 2013, 2015) of the KOF Innovation Survey (see Arvanitis et al. 2017)

Firms reporting export prices almost always report domestic prices. The overlap is smaller for export and import prices (see Table 1). Only about 50% of firms report export as well as import prices. For firms invoicing in Euro, the overlap between the export and import price data is somewhat larger than for firms invoicing in Swiss franc.

3.3 Limitations

The survey asks for the export destination. Unfortunately, the information is often missing, inaccurate, or ambiguous. We can therefore determine the export destination only for a small number of products.[14] Therefore, in the main analysis, we assume that all export prices denominated in Euro or Swiss franc belong to goods exported to the Euro area, or another country with a currency linked to the Euro. This assumption implies that we may erroneously assume that some prices are affected by the appreciation although the corresponding products are not exported to the Euro area. The resulting measurement error is likely to be small, however, for two reasons. First, the SFSO asks for prices for the main export destination. For Swiss manufacturing firms, this is predominantly a country in the European Union (see Table 2). Second, the Swiss franc not only appreciated against the

[14] We use the export destination information only in a robustness test.

Euro, but also against other currencies closely linked to the Euro area (see Figure 4 in the Appendix).[15]

The data set is tilted towards large, export-oriented manufacturing firms.[16] Less than 40% of firms in our data set have less than 50 employees (see Table 1). However, small firms make up more than 95% of firms in the overall Swiss manufacturing sector.[17] The high share of large export-oriented firms may matter for our results. In population, large firms earn more of their revenue with exports and spend more of their revenues on intermediate inputs (Table 2). The large share of intermediate inputs in production suggests that the firms in our sample may exhibit a higher exchange rate sensitivity of marginal cost than in population. Although we do not have information on the share of imported intermediates, Amiti et al. (2014) find that import intensity is correlated with firm size. Moreover, Amiti et al. (2016) show that large firms face stronger strategic complementarity. Because the import intensity and strategic complementarity will affect desired pass-through and currency choice we might expect large firms to invoice their products in foreign currency. We find no clear pattern, however. In fact, for small and medium firms, the share of Euro invoicing is larger than for large firms (see Table 1).

4 Export price adjustment and currency choice

This section provides reduced-form estimates of export price adjustment and currency choice after the Swiss franc shock. We estimate the average development of prices relative to the quarter before the shock:

$$p_{i,t} = \theta_i + \sum_{k \neq -1} \alpha^k D_t^k + \varepsilon_{i,t} \quad . \tag{1}$$

The dependent variable is the log-price of product i in quarter t converted to Swiss franc. We include a set of time dummies D_t^k, that are one k quarters after the shock in $t^* =$ Q1 2015 and zero otherwise. We saturate the model with dummy variables for the entire sample period, except for the quarter

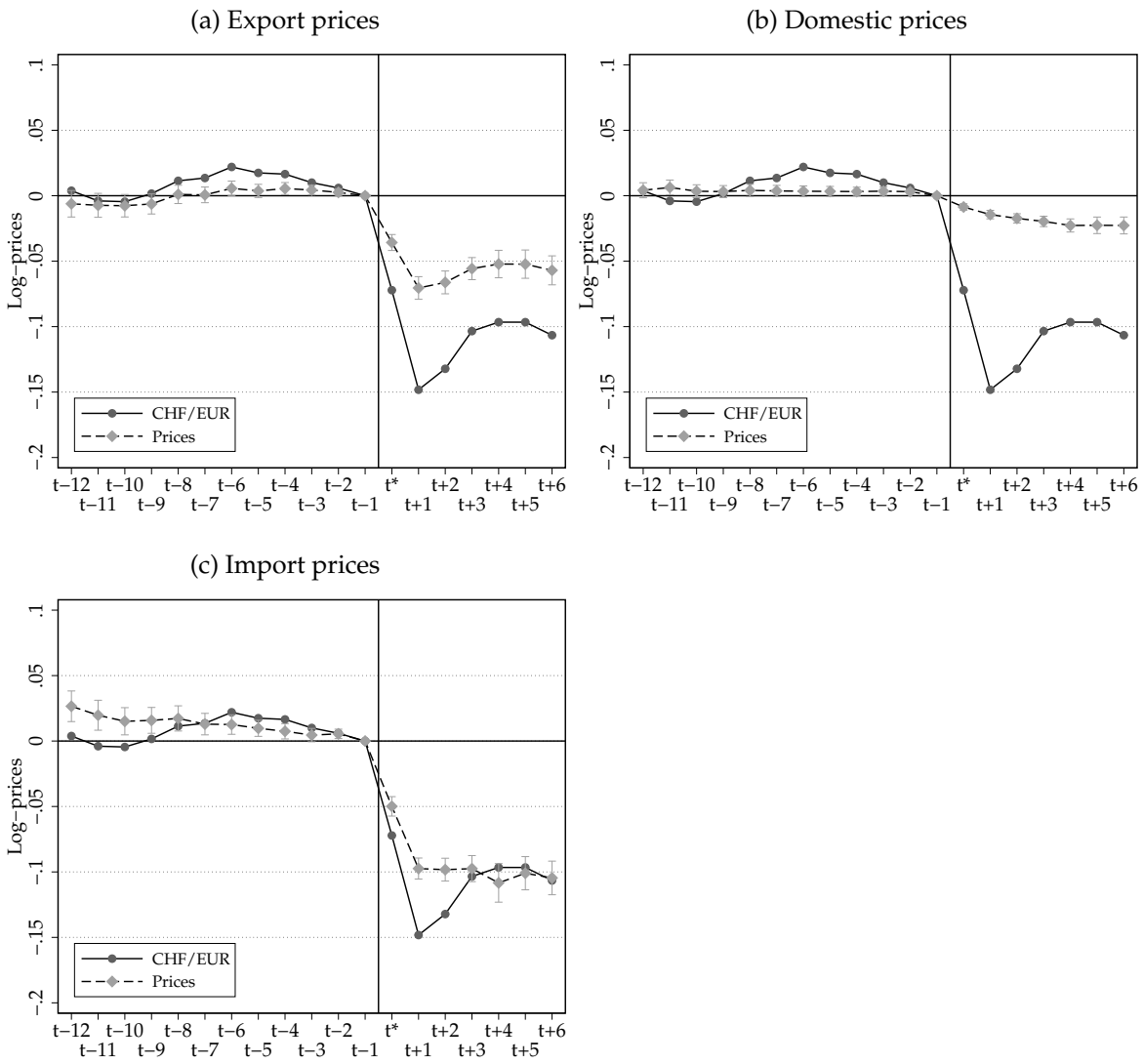
[15] The British pound is an exception. The UK is not a major export destination for Swiss manufacturing firms, however. In 2017, Swiss goods exports to the UK, excluding gold and jewellery, accounted for 5% of total exports. Meanwhile, this share is higher for the EU excluding the UK (48%) and the US (15%). See https://www.eda.admin.ch/dam/dea/de/documents/faq/schweiz-eu-in-zahlen_de.pdf, p. 11 (accessed on 11 October 2019).

[16] The firm size information is missing for a part of the sample because the firm size is used for index weights that are updated only every five years.

[17] This information stems from https://www.bfs.admin.ch/bfs/de/home/statistiken/industrie-dienstleistungen/unternehmen-beschaeftigte/wirtschaftsstruktur-unternehmen.html (accessed on 11 October 2019).

before the shock ($k = -1$). The coefficients α_k thus estimate the average change of prices relative to the last quarter before the shock.

Figure 2 — Exchange rate elasticity of export, domestic and import prices



Notes: Estimates of the average response of log-prices transformed to Swiss franc after the removal of the exchange rate floor in $t^* =$ Q1 2015. The solid line denotes the normalized evolution of the log-CHF/EUR exchange rate, the dashed line the response of prices. Vertical bars denote 95% confidence intervals based on standard errors clustered at the firm-level. The vertical line marks the removal of the exchange rate floor.

Figure 2 shows the response of export, domestic and import prices before and after the Swiss franc shock. The response of the exchange rate is an average of monthly observations weighted by the number of price quotes in each month.[18]

[18]We use a weighted average exchange rate that reflects the distribution of survey responses over a quarter. We first calculate the average exchange rate during the first eight days of each month, the period when the price data are collected. We then average the exchange rate over a quarter weighing each month by the number of reported prices. Because some prices are collected in the first week of January 2015–before the appreciation–the Swiss franc shock is spread over two quarters.

The estimated responses can be interpreted as causal effects of the appreciation on prices under two assumptions. First, we assume that the appreciation came unexpected. If prices are sticky, firms may already adjust prices before an anticipated shock. In this case, we would underestimate the causal effect. However, we can convincingly rule out this concern. As discussed in Section 2, there is little evidence that an appreciation was expected by professional forecasters or financial market participants. Moreover, Figure 2 shows no significant price movements before the appreciation. Second, our estimates rely on a "single difference" before-after comparison, and as a result, a causal interpretation rests on the assumption that there are no other confounding aggregate shocks. As discussed in Section 2, and in contrast to the previous literature studying episodes of large exchange rate movements, the Swiss franc shock indeed occurred in a period of relative stability.

The figure shows that export prices stabilize 5% below the level before the shock after three quarters. Thus, export price pass-through is incomplete. Meanwhile, import prices respond quickly and pass-through is complete. The fast and substantial pass-through to import prices is qualitatively in line with the findings by Bonadio et al. (2019) using trade unit values, as well as, Campa and Goldberg (2005), and Fauceglia et al. (2014) using aggregate data. Domestic producer prices decline by less than 3% and thus also exhibit incomplete pass-through. As marginal cost should move in parallel for products produced for the domestic and export market within a firm, this suggests either a large difference in the composition of firms between the two markets, or a role for demand-side factors.

To examine the role of currency choice, we interact all time dummies in specification (1) with an indicator for the export currency in the last quarter of 2014. To estimate exchange rate elasticities, we divide the coefficients by the log change in the weighted CHF/EUR exchange rate over the same period. Table 3, panel (a) shows that the elasticity of Swiss franc prices amounts to 0.14 on impact and 0.24 after six quarters.[19] In contrast, export prices set in Euro fall immediately by almost the full amount of the appreciation. This is what we would expect if export prices set in Euro are somewhat sticky. Prices increase slightly after that, but the exchange rate elasticity still amounts to 0.86 after six quarters. The lower panel provides p-values for the hypotheses that the elasticity is equal to one, and that the elasticity for prices set in different currencies is equal. At all horizons, we reject that the

[19] This is close to the exchange rate elasticity of domestic prices, which are almost exclusively set in Swiss franc.

exchange rate elasticity for Euro and Swiss franc prices is equal.

Table 3 — Exchange rate elasticity export prices

	(a) All prices			(b) ≥1 price change post-2014		
Quarter	0	4	6	0	4	6
CHF export prices	0.14***	0.26***	0.24***	0.25***	0.46***	0.40***
	(0.03)	(0.08)	(0.08)	(0.06)	(0.13)	(0.13)
EUR export prices	0.93***	0.85***	0.86***	0.89***	0.78***	0.80***
	(0.03)	(0.08)	(0.08)	(0.04)	(0.11)	(0.11)
H0: CHF = 1	0.00	0.00	0.00	0.00	0.00	0.00
H0: EUR = 1	0.01	0.07	0.08	0.01	0.05	0.08
H0: CHF = EUR	0.00	0.00	0.00	0.00	0.07	0.02
Firms	501	459	303	342	329	218
Products	1618	1440	879	920	877	566

Notes: The left panel shows exchange rate elasticity of all export prices. The right panel limits the sample to prices that have been adjusted. The exchange rate elasticities are calculated as the response of prices divided by the log-change in the CHF/EUR exchange rate $\alpha^k/(e_{t^*+k} - e_{t^*-1})$. Standard errors in parentheses are clustered at the firm-level. Coefficients with superscript ***/**/* are statistically significant at the 1%, 5% and 10% level. The lower panel shows *p*-values for tests of an elasticity of unity and equal elasticities among currencies.

One reason for the difference in exchange rate elasticity is that prices are sticky in the currency of pricing. Panel (b) shows the elasticities conditional on observing at least one price adjustment after the shock. The number of observations drops considerably, leading to less precise estimates. The pattern remains similar, however. The elasticity for export prices in Euro is large on impact but falls to 0.8 after six quarters. Meanwhile, the elasticity for export prices denominated in domestic currency is small on impact and rises to 0.4 after four quarters. Even when conditioning on a price change, an economically relevant difference in adjustment remains after six quarters. At all horizons, the elasticities are also statistically significantly different, at least at the 10% level. This suggests that there are differences in desired pass-through between invoicing currency.

One potential source for differences in desired exchange rate pass-through is heterogeneity in the exchange rate sensitivity of marginal costs. As discussed in Gopinath and Itskhoki (2010), if input costs correlate with the exchange rate more strongly, firms are more likely to set their prices in foreign currency. Table 4 reports the exchange rate elasticity of import and domestic prices, separately for firms predominantly exporting in Euro and Swiss franc. For firms with Swiss franc export prices, import prices adjust more slowly and by less (panel a). Import currency plays a role in this, because firms with Swiss franc export prices more likely report Swiss franc import prices and

vice versa. Thus, differences in the exchange rate elasticity of import prices is one explanation for the difference in pass-through to export prices set in different currencies. In addition, firms setting export prices in Swiss franc lower their domestic prices by less than those setting export prices in Euro. Assuming that firms sell the same products domestically and abroad, this provides additional suggestive evidence that marginal cost decline more strongly for firms setting prices in Euro.

Table 4 — Exchange rate elasticity of import and domestic prices by export currency

	(a) Import prices			(b) Domestic prices		
Quarter	0	4	6	0	4	6
CHF export prices	0.66***	0.79***	0.71***	0.04**	0.13**	0.13**
	(0.08)	(0.11)	(0.13)	(0.02)	(0.05)	(0.05)
EUR export prices	0.95***	1.03***	1.08***	0.11***	0.32***	0.29***
	(0.05)	(0.10)	(0.10)	(0.04)	(0.08)	(0.07)
H0: CHF = 1	0.00	0.06	0.02	0.00	0.00	0.00
H0: EUR = 1	0.32	0.73	0.45	0.00	0.00	0.00
H0: CHF = EUR	0.00	0.10	0.02	0.07	0.04	0.06
Firms	187	176	153	338	316	253
Products	468	429	361	1242	1126	887

Notes: The left panel shows exchange rate elasticity of import prices. The right panel shows exchange rate elasticity of domestic prices. Both elasticities are estimated separately for firms with predominantly Swiss franc and Euro denominated exports. The exchange rate elasticity is calculated as the response of prices divided by the log-change in the CHF/EUR exchange rate $\alpha^k/(e_{t^*+k} - e_{t^*-1})$. Standard errors in parentheses are clustered at the firm-level. Coefficients with superscript ***/**/* are statistically significant at the 1%, 5% and 10% level. The lower panel shows p-values for tests of an elasticity of unity and equal elasticities among currencies.

To isolate the impact of the exchange rate shock on the markup of firms, we use two different strategies to partial out changes in marginal cost. First, we estimate the elasticity of export prices relative to domestic prices of the same firm. To do so, we include price series for both domestic and export prices in the estimation sample. We then estimate a difference-in-differences model including a firm-time fixed effect that should absorb changes in marginal cost at firm j ($\eta_{t,j}$). In addition, we interact all time dummies with an export price dummy ($D^e_{i,j}$), as well as, invoicing currency dummies ($D^{chf}_{i,j}$, $D^{eur}_{i,j}$):[20]

$$p^{e,d}_{i,j,t} = \theta_{i,j} + \eta_{t,j} + \sum_{k \neq -1} D^k_t D^e_{i,j} (\alpha^{k,chf} D^{chf}_{i,j} + \alpha^{k,eur} D^{eur}_{i,j}) + \varepsilon_{i,j,t} \ . \tag{2}$$

The coefficient $\alpha^{k,chf}$ ($\alpha^{k,eur}$) measures the average log-difference between export prices and domestic prices denominated in Swiss franc (Euro) relative to Q4 2014. Under the assumption that

[20]The dummies measure the invoicing currency in Q4 2014.

firms use the same technology to produce goods for different markets, this is equivalent to the change in export markups relative to domestic markups.

Second, we estimate the exchange rate elasticity controlling for firm-level import prices, assuming that the observed import price is a good proxy for all changes in marginal cost. We first construct a firm-specific import price index by computing the cumulative average of firm-level import price changes ($P^M_{j,t}$). We then estimate the following specification:

$$p^e_{i,j,t} = \theta_j + \sum_{k \neq K} D^k_t(\alpha^{k,chf} D^{chf}_j + \alpha^{k,eur} D^{eur}_j) + \sum_{l=0}^{4}(\gamma^{chf}_l D^{chf}_j + \gamma^{eur}_l D^{eur}_j) p^M_{j,t-l} + \varepsilon_{j,t} \ , \qquad (3)$$

where $K = \{-1, -11-, 10, -9, -8\}$. Because specification (1) is already fully saturated, we need to drop one event-study dummy for each coefficient estimated on import prices. The coefficients thus measure the effect relative to a composite of all omitted quarters. We include 4 lags of import prices omitting dummies for the year 2012 in addition to Q4 2014. Because of the lack of trends in prices, the choice of the omitted quarters is inconsequential for our results. Since this regression includes interactions of time and currency dummies, the coefficient on import prices is identified from variation in import prices across firms with the same export currency.

Table 5 shows that the exchange rate elasticities conditional on marginal cost differ substantially between export prices in Swiss franc and Euro. For prices denominated in Euro, the elasticity after six quarters amounts to 0.53 (compared to domestic prices) and 0.7 (controlling for import prices). Meanwhile, the elasticity is close to zero and not statistically significant for prices in Swiss franc. For both identification strategies and at all horizons, we can reject the null hypothesis that the elasticities are equal for Euro and Swiss franc prices. The results suggest that differences in the exchange rate sensitivity of marginal costs can only partly explain the differences in the exchange rate sensitivity between invoicing currencies.

5 Structural interpretation

We established that a relevant gap persists in pass-through to export prices set in foreign and domestic currency. The difference in the exchange rate elasticity according to invoicing currency cannot be solely traced back to differences in changes in marginal cost. We now use a structural

Table 5 — Exchange rate elasticity relative to domestic and conditional on import prices

	(a) Control for import price				(b) Relative to domestic prices		
Quarter	0	4	6	$\sum \gamma_l$	0	4	6
CHF export prices	-0.03	-0.15	-0.16	0.21***	0.07**	0.05	0.05
	(0.08)	(0.15)	(0.14)	(0.07)	(0.04)	(0.08)	(0.09)
EUR export prices	0.74***	0.63***	0.70***	0.22***	0.78***	0.55***	0.53***
	(0.05)	(0.11)	(0.11)	(0.08)	(0.03)	(0.07)	(0.07)
H0: CHF = 1	0.00	0.00	0.00		0.00	0.00	0.00
H0: EUR = 1	0.00	0.00	0.01		0.00	0.00	0.00
H0: CHF = EUR	0.00	0.00	0.00		0.00	0.00	0.00
Firms	173	192	121	121	511	478	364
Products	531	572	314	314	3240	2915	1998

Notes: Markup elasticity relative to domestic price and conditional on the average import price. The elasticity is calculated as the response of markups divided by the change in the CHF/EUR exchange rate $\alpha^k/(e_{t^*+k} - e_{t^*-1})$. $\sum \gamma_l$ measures the import price elasticity. Standard errors clustered at the firm-level are given in parentheses. Coefficients with superscript ***/**/* are statistically significant at the 1%, 5% and 10% level. The lower panel shows *p*-values for tests of an elasticity of unity and equal elasticities across currencies.

model closely following Gopinath et al. (2010) to assess the importance of strategic complementarity.

We assume that exchange rate pass-through is determined by strategic complementarity in price setting, and the exchange rate elasticity of marginal cost. Our goal is to back out differences in these two dimensions between products invoiced in Euro and Swiss franc and quantify their importance for the observed differences in the response to the shock.

Firms operate with a Cobb-Douglas production function $Y = M^{\lambda}L^{1-\lambda}$, where M denotes imported intermediate inputs bought at price P_M, L denotes labor inputs hired at wage W, and marginal cost is given by $MC = \lambda^{-\lambda}(1-\lambda)^{-(1-\lambda)}P_M^{\lambda}W^{1-\lambda}$. Goods are sold in a foreign market at price P. The exchange rate of one unit of foreign (local) currency to domestic (producer) currency is E. Therefore, an increase in the exchange rate represents a depreciation of the domestic currency. Even though some variables may vary between firms, we will omit firm subscripts for clarity.

We denote logarithms with small letters. Market demand and market structure are characterized by a markup function μ that determines the frictionless desired markup. Desired export prices are given by $\tilde{p} = \mu(\tilde{p} - \overline{p} - e) + mc$, where $\overline{p} + e$ is the relevant price level in the foreign export market in producer currency. We denote the negative derivative of the markup function as $\Gamma = -\frac{\partial \mu(x)}{\partial x}$.

Firms face a Calvo (1983) friction; they can change their prices with probability $1 - \theta$ and discount

the future at rate δ. When firms adjust their price, they can also decide whether to set the new price in foreign or domestic currency. The optimal price is generally different from the frictionless desired price. If prices are set in domestic currency, then the optimal price at time t is equal to a weighted sum of expected future desired prices:

$$p_t^* = (1 - \delta\theta) \sum_{l=0}^{\infty} (\delta\theta)^l \mathbb{E}_t(\tilde{p}_{t+l}) \ . \tag{4}$$

If the firm chooses to set its price foreign currency, the optimal price set is equal to $p_t^* + e_t$.

With the context of the Swiss franc shock in mind, we assume that the exchange rate is fixed, but may change by an and $i.i.d.$ factor u_t with a small probability ρ. Furthermore, changes in import prices are determined by the exchange rate and in and $i.i.d.$ cost shock, $\Delta p_{M,t} = \phi \Delta e_t + \varepsilon_t$. Then, the expected future exchange rate is given by $\mathbb{E}_t e_{t+l} = e_t$ and expected future import prices by $\mathbb{E}_t p_{M,t+l} = p_{M,t}$. Therefore, the elasticity of the optimal export price to a permanent exchange rate shock is given by:

$$\frac{\partial p_t^*}{\partial e_t} = \Psi_t = (1 - \delta\theta) \sum_{l=0}^{\infty} (\delta\theta)^l \left(\frac{\lambda\phi}{1+\Gamma} + \frac{\Gamma}{1+\Gamma} \left(1 + \frac{cov_t(\overline{p}_{t+l}, \Delta e_t)}{var(\Delta e_t)} \right) \right) \ . \tag{5}$$

Gopinath et al. (2010) also show that this elasticity is a sufficient statistic for currency choice. If $\Psi > 1/2$, and the elasticity of the optimal price is high, firms set their prices in foreign currency, so that the response of a price converted to domestic currency is close to optimal without an adjustment. If the elasticity of the optimal price is low, firms set their prices in domestic currency. The predictions of the framework are thus qualitatively in line with our previous empirical results.

We need two additional assumptions to back out structural parameters from the reduced-form analysis. First, we assume that $cov_t(\overline{p}_{t+l}, \Delta e_t) = 0$ for all l. In a more standard context, the nominal exchange rate should move with the foreign price level. However, as shown in Figure 1, the exchange rate was expected to remain largely constant during and after the exchange rate floor. In addition, it is unlikely that firms expected the appreciation of the Swiss franc to have an impact on the Euro area price level. In the model, optimal prices therefore adjust instantaneously rather than gradually to the new exchange rate. Therefore, desired pass-through amounts to:

$$\Psi = \frac{\lambda\phi}{1+\Gamma} + \frac{\Gamma}{1+\Gamma}. \tag{6}$$

Second, we assume that prices in Q4 2014 and at the end of the sample are, on average across firms, equal to the optimal price. This assumption would be violated if there were confounding aggregate developments, or, if adjustment to the exchange rate shock would be incomplete at the end of our sample period. As before, we argue that these assumptions are not violated because of the overall stability of both, the Swiss economy and its main trading partners. In addition, we did not detect any aggregate pre-trends in price series, and prices converged quite quickly to a stable level after the Swiss franc shock (see Figure 2).

Under these assumptions, we can map export and import price adjustments in the data to structural parameters:

$$\mathbb{E}\left(\frac{p_{Q32016}-p_{Q42014}}{e_{Q32016}-e_{Q42014}}\right)=\Psi=\frac{\lambda\phi}{1+\Gamma}\left(p_{M,Q32016}-p_{M,Q42014}\right)+\frac{\Gamma}{1+\Gamma}\ . \tag{7}$$

We estimate the three parameters ϕ, λ and Γ separately for prices invoiced in Swiss franc and Euro. First, we take the exchange rate elasticity of import prices by export currency as shown in Table 4 for ϕ_{EUR} and ϕ_{CHF}. Second, equation (7) is equivalent to specification (3), which controls for import prices. Conditional on import prices, the elasticity of export prices to the exchange rate is equal to $\Gamma/(1+\Gamma)$. In addition, the elasticity of export prices to import prices conditional on the exchange rate is equal to $\lambda\phi/(1+\Gamma)$. Therefore, we can back out estimates of λ_{EUR}, λ_{CHF}, Γ_{EUR} and Γ_{CHF} from the coefficients of specification (3) reported in Table 5:

$$\hat{\Gamma}_l=\frac{\hat{\alpha}_l}{1-\hat{\alpha}_l} \qquad\qquad \hat{\lambda}_l=\frac{\hat{\gamma}}{1-\hat{\alpha}_l}\ , \tag{8}$$

where $\hat{\alpha}_l$ denotes the estimated conditional elasticity of export prices to the exchange rate l quarters after the shock, and $\hat{\gamma}=\sum_{n=0}^{4}\hat{\gamma}_n$ denotes the estimated conditional elasticity of export prices to import prices.

Table 6 shows estimates for $l=4$ and $l=6$ quarters after the shock.[21] The exchange rate elasticity of import prices (ϕ) is higher for firms with Euro export prices. However, this difference is small compared to the gap of the exchange rate elasticity of export prices. In addition, we find a higher import price elasticity of marginal cost (λ) for Euro export prices than for Swiss franc export prices.

[21] The estimates for the structural parameters are similar for any horizon between $l=4$ and $l=6$ quarters.

Finally, we find relevant differences in the extent of strategic complementarity. For prices set in Swiss franc, Γ is statistically insignificant and close to 0. Therefore, the elasticity of Swiss franc export prices to competitor prices at constant marginal cost is negligible. As a consequence, firms set prices as a constant markup over marginal cost. For prices set in Euro, Γ amounts to 1.71 and 2.31, after four and six quarters, respectively. The elasticity of Euro prices to competitor price changes is about 2/3. Therefore, they vary their markup in response to exchange rate fluctuations.

Table 6 — Parameter estimates

	After 4 quarters		After 6 quarters	
	CHF	EUR	CHF	EUR
Import price elasticity of marginal cost (λ)	0.25	0.58	0.25	0.71
	(0.13)	(0.13)	(0.13)	(0.15)
Strategic complementarity (Γ)	-0.13	1.71	-0.14	2.31
	(0.11)	(0.80)	(0.11)	(1.19)
Exchange rate elasticity of import price (ϕ)	0.79	1.03	0.71	1.08
	(0.11)	(0.10)	(0.13)	(0.10)

Notes: Parameter estimates based on coefficients from Table 5 and 4, using equation (8). Parameters for price adjustment after 4 quarters ($l = 4$) and after 6 quarters ($l = 6$). Standard errors in parentheses are calculated using the delta method.

Equation (7) implies that the importance of ϕ and λ declines in Γ. Given this nonlinear relationship we examine the role of the different parameters using counterfactuals. We compute the implied exchange rate elasticity of export prices using equation (7). In each counterfactual, we set one parameter to the value estimated for the other invoicing currency. Throughout this counterfactual exercise, we take currency choice as given. In reality, the different pass-through to prices set in domestic and foreign currency is evidence of endogenous currency choice. These counterfactuals therefore solely illustrate the importance of various parameters.

The results are shown in Table 7. The most important determinant of the gap in adjustment is the low degree of strategic complementarity of Swiss franc export prices. 81% of the gap would be eliminated if Γ were equal to Γ_{EUR} for all exports. The absence of strategic complementarity for Swiss franc exports not only creates a gap in adjustment because of the strong extent in strategic complementarity for Euro exports, it also amplifies differences in the elasticity of marginal cost. Increasing the import price elasticity of marginal cost of Swiss franc exports λ_{CHF} from 0.25 to 0.58 also reduces the gap by 38%. In contrast, setting both Γ_{EUR} and Γ_{CHF} to zero does little to reduce the

gap, as differences in λ become more important in that case.[22] Setting λ_{EUR} to a lower value without adjusting Γ_{EUR} similarly does little to reduce the gap. Changing the value of ϕ is inconsequential because the differences are small to begin with. Overall, the low strategic complementarity parameter for prices set in Swiss franc is the main driver of differences in the response to the exchange rate shock; differences in the exchange rate sensitivity of marginal cost play a smaller role.

Table 7 — Counterfactuals

Counterfactual	Elasticity EUR	Elasticity CHF	% of baseline diff. closed
Baseline	0.85	0.08	–
Both $\Gamma = 0$	0.60	0.20	0.48
Both $\Gamma = \Gamma_{EUR}$	0.85	0.70	0.81
Both $\lambda = \lambda_{EUR}$	0.85	0.38	0.39
Both $\lambda = \lambda_{CHF}$	0.73	0.08	0.16
Both $\phi = \phi_{EUR}$	0.85	0.15	0.09
Both $\phi = \phi_{CHF}$	0.80	0.08	0.07

Notes: Elasticities are calculated as $\lambda\phi/(1+\Gamma) + \Gamma/(1+\Gamma)$. We use estimates presented in Table 6, and vary parameters one-by-one as described in column 1. The relative difference is calculated as $1 -$ (Elasticity EUR $-$ Elasticity CHF)/(Baseline elasticity EUR $-$ Baseline elasticity CHF).

6 Robustness tests

We conduct a range of robustness tests. The results are shown in the Appendix. These tests focus on the reduced-form estimates. The results are robust when we only use those domestic and export products that belong to the same type, NACE division, or have the identical product description. As an alternative control for variation in marginal cost, we use prices for products set in USD at the same firm as a counterfactual. Although the Swiss franc appreciated against the Euro, it did not appreciate against the USD.[23] Again, we find a large relative elasticity of Euro prices and a small elasticity of Swiss franc prices. Because the sample is much smaller, however, the estimates are less precise. Finally, we examine alternative samples: a balanced panel for prices we observe over the entire sample period; a restricted sample using prices with known export destination in the Euro area;[24] a sample excluding exports of intermediate and energy goods. Qualitatively, the results

[22] We disregard the insignificant negative estimated value for Γ_{CHF} and use zero instead.

[23] See Figure 4 in the Appendix.

[24] The destination information in our data is based on free-form text, and the classification is based on our best judgment of this information. We include exports with multiple destinations if at least one is an Euro area country. We exclude destinations that only specify that the destination is in the EU, because the Swiss franc did not appreciate against the British pound.

remain similar although the elasticities are less precisely estimated if we focus on Euro area exports.

7 Concluding remarks

The Swiss franc shock provides a unique natural experiment to investigate currency choice and the degree and speed of border price adjustments. This study exploits within-firm variation and information to control for possible changes in firms' marginal costs when estimating the exchange rate elasticity of export prices. Therefore, we are able to estimate the exchange rate sensitivity of markups, and whether this sensitivity is related to currency choice.

While export prices set in domestic currency generally respond more slowly and by a smaller amount, prices set in foreign currency exhibit a larger elasticity. This difference prevails if we control for price rigidity and variation in marginal cost. Therefore, our findings suggest that Swiss manufacturing firms facing strong strategic complementarities in their export destination, adjust their markups more strongly, and set their prices in foreign currency.

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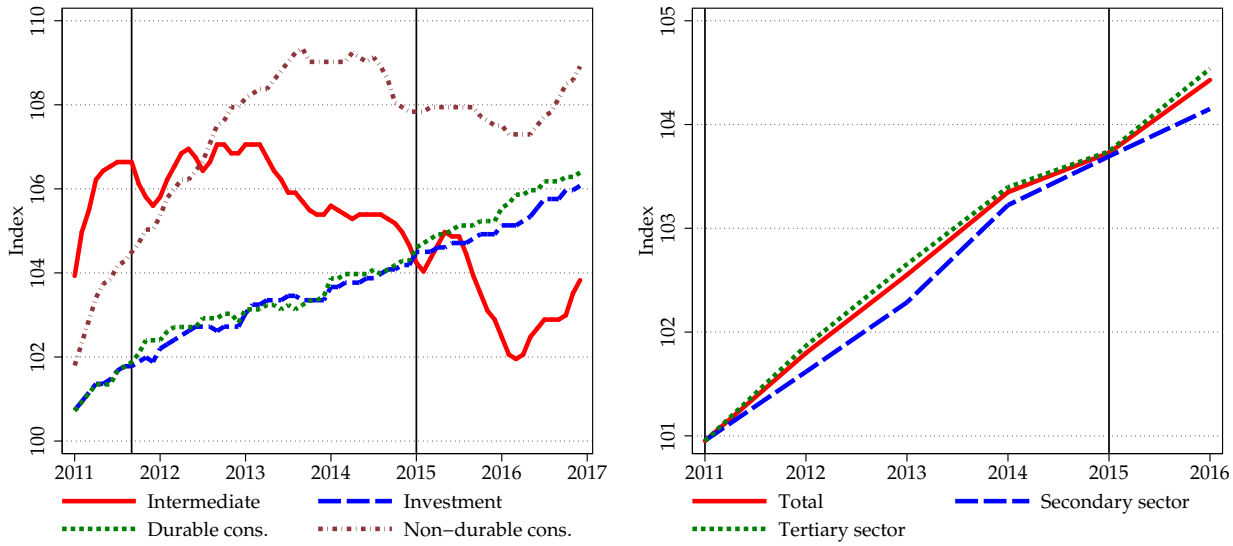
Appendix

Figure 3 — Foreign prices and Swiss wages

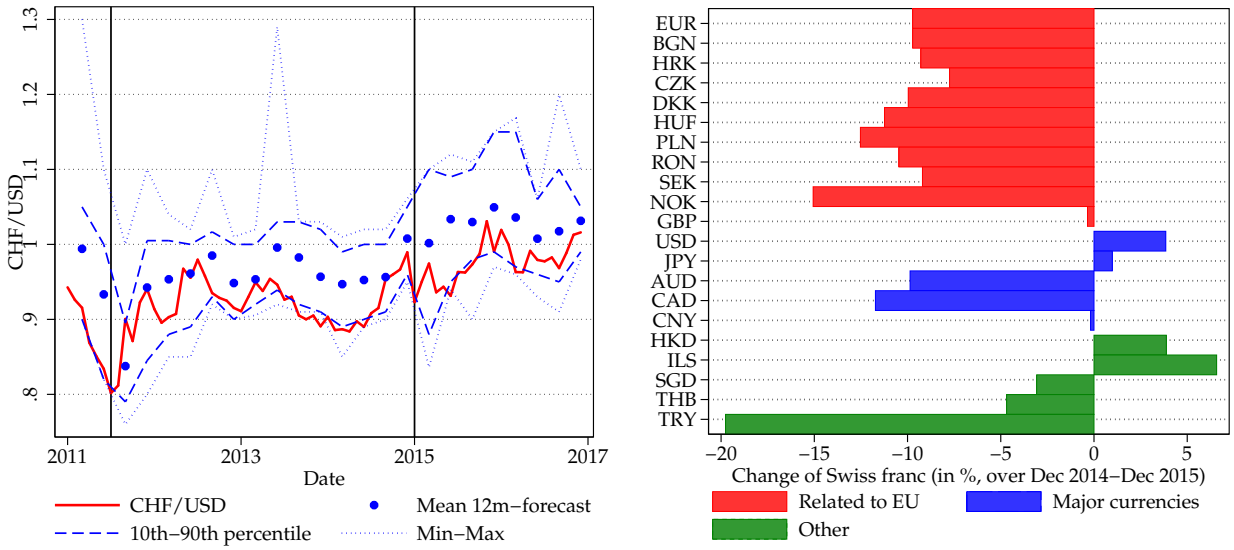


(a) Producer prices in the EU

(b) Nominal wages in Switzerland

Notes: Vertical lines denote the introduction and removal of the exchange rate floor at CHF/EUR 1.20.

Figure 4 — Appreciation against other currencies



(a) CHF/USD and expectations

(b) Swiss franc against other currencies

Notes: Panel (a): expectations based on the KOF Consensus Forecast survey, a survey of professional forecasters. Vertical lines mark the introduction and removal of the CHF/EUR exchange rate floor in September 2011 and January 2015. Panel (b): percentage change of the Swiss franc against various currencies. Sources: Producer price data retrieved from the Eurostat. Wage data retrieved from the SFSO.

Table 8 — Matched products

	Matched by type			Matched by division			Matched by description		
Quarter	0	2	4	0	2	4	0	2	4
CHF exports	0.02	0.10***	0.09	0.01	0.10**	0.09	0.03	0.12***	0.10
	(0.03)	(0.04)	(0.07)	(0.03)	(0.04)	(0.07)	(0.03)	(0.04)	(0.07)
EUR exports	0.91***	0.74***	0.60***	0.92***	0.74***	0.61***	0.94***	0.74***	0.59***
	(0.07)	(0.05)	(0.07)	(0.07)	(0.05)	(0.07)	(0.08)	(0.05)	(0.08)
H0: CHF = 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H0: EUR = 1	0.22	0.00	0.00	0.25	0.00	0.00	0.40	0.00	0.00
H0: CHF = EUR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Firms	424	418	400	424	418	400	403	396	377
Products	2897	2824	2642	2860	2806	2629	2603	2557	2392

Notes: Elasticity of export markup relative to domestic markup for matched product categories. The elasticity is calculated as the response of markups divided by the change in the CHF/EUR exchange rate $\alpha^k/(e_{t^*+k} - e_{t^*-1})$. Standard errors clustered at the firm-level are given in parentheses. Coefficients with superscript ***/**/* are statistically significant at the 1%, 5% and 10% level. The lower panel shows p-values for tests of an elasticity of unity and equal elasticities across currencies. Sources: Survey data retrieved from KOF Swiss Economic Institute. Exchange rate data retrieved from the ECB.

Table 9 — Elasticity of export markups relative to USD price

	Relative to US price		
Quarter	0	2	4
CHF exports	-0.33	0.03	-0.12
	(0.64)	(0.24)	(0.50)
EUR exports	1.21***	0.81***	1.37***
	(0.47)	(0.12)	(0.24)
H0: CHF = 1	0.04	0.00	0.02
H0: EUR = 1	0.65	0.11	0.12
H0: CHF = EUR	0.01	0.00	0.00
Firms	50	47	48
Products	201	189	191

Notes: Markup elasticity relative to USD price. The elasticity is calculated as the response of markups divided by the change in the CHF/EUR exchange rate $\alpha^k/(e_{t^*+k} - e_{t^*-1})$. Standard errors clustered at the firm-level are given in parentheses. Coefficients with superscript ***/**/* are statistically significant at the 1%, 5% and 10% level. The lower panel shows *p*-values for tests of an elasticity of unity and equal elasticities across currencies.

Table 10 — Alternative samples

(a) Balanced panel

	Desired pass-through			Relative to domestic price			Conditional on import price		
Quarter	0	2	4	0	2	4	0	2	4
CHF exports	0.05	0.21***	0.32***	0.04	0.08	0.12	-0.04	0.09	0.15
	(0.05)	(0.06)	(0.09)	(0.04)	(0.05)	(0.08)	(0.09)	(0.08)	(0.11)
EUR exports	0.83***	0.90***	0.87***	0.69***	0.78***	0.59***	0.54***	0.67***	0.62***
	(0.08)	(0.04)	(0.07)	(0.10)	(0.06)	(0.08)	(0.11)	(0.08)	(0.10)
H0: CHF = 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H0: EUR = 1	0.04	0.02	0.07	0.00	0.00	0.00	0.00	0.00	0.00
H0: CHF = EUR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Firms	314	314	314	234	234	234	118	118	118
Products	943	943	943	1496	1496	1496	317	317	317

(b) Known export destination Euro area

	Desired pass-through			Relative to domestic price			Conditional on import price		
Quarter	0	2	4	0	2	4	0	2	4
CHF exports	0.12	0.33**	0.44*	0.14	0.29*	0.35	-0.29***	-0.01	-0.09
	(0.13)	(0.14)	(0.27)	(0.15)	(0.15)	(0.35)	(0.08)	(0.20)	(0.44)
EUR exports	1.17***	0.96***	0.96***	0.93***	0.84***	0.67***	1.01***	0.73***	0.57***
	(0.16)	(0.05)	(0.10)	(0.16)	(0.09)	(0.16)	(0.21)	(0.13)	(0.18)
H0: CHF = 1	0.00	0.00	0.04	0.00	0.00	0.06	0.00	0.00	0.01
H0: EUR = 1	0.29	0.48	0.72	0.63	0.06	0.04	0.95	0.04	0.02
H0: CHF = EUR	0.00	0.00	0.07	0.00	0.00	0.39	0.00	0.00	0.17
Firms	78	95	92	923	987	956	31	32	53
Products	195	233	228	4362	4624	4426	70	72	125

(c) Excluding intermediate goods and energy related products

	Desired pass-through			Relative to domestic price			Conditional on import price		
Quarter	0	2	4	0	2	4	0	2	4
CHF exports	0.01	0.10**	0.18**	-0.03	0.02	-0.01	-0.01	0.06	0.10
	(0.04)	(0.04)	(0.09)	(0.03)	(0.05)	(0.08)	(0.04)	(0.06)	(0.12)
EUR exports	0.75***	0.86***	0.76***	0.71***	0.78***	0.57***	0.55***	0.72***	0.68***
	(0.09)	(0.05)	(0.10)	(0.09)	(0.06)	(0.10)	(0.12)	(0.08)	(0.11)
H0: CHF = 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H0: EUR = 1	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
H0: CHF = EUR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Firms	267	265	253	372	368	350	114	114	107
Products	963	947	890	2310	2272	2114	377	376	361

Notes: Main results based on a balanced panel of firms and products available over the entire period from 2014-2016 (a); based on a sample of products known to be exported to the Euro area (b) and to the EU (c).