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Abstract

The strongest empirical regularity about the exchange rate pass-through is that it is incomplete. We provide a new theoretical explanation based on the unwillingness of some firms to price discriminate between markets. These firms set a single price to all destinations and adjust it when the exchange rate shock occurs. But the adjustment is not necessarily proportional since the change in the single price affects revenues in all markets. The single price strategy also implies a "pass-around" effect: The exchange rate shock has repercussions of price changes to all export markets. The analysis of price changes operated by French exporters in different markets after the EUR/CHF shock of 2015 provides evidence in favour of our theoretical explanation.

Keywords: Exchange rate pass-through, International trade, Pricing-to-market

JEL Classification: F14, F31, F61, F62.

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1 Introduction

The most robust empirical evidence about the exchange rate pass-through (ERPT) is that it is incomplete: The price change at destination is less than proportional to the exchange rate change. Various explanations for the incompleteness have been proposed in the literature. Theoretically, variable markup (Krugman, 1987; Atkeson and Burstein, 2008; Berman et al., 2012) and marginal cost paid in the foreign currency (Corsetti and Dedola, 2005) are the two most prominent explanations. Empirical support for these mechanisms is strong along with the evidence that additional factors concur in mitigating the pass-through. Among these other factors there is the invoicing currency (Auer et al., 2019; Kaufmann and Renkin, 2019; Auer et al., 2021; Corsetti et al., 2022), incomplete information (Garetto, 2016), and product quality (Freitag and Lein, 2023). The magnitude of the pass-through is also found to vary with time after the shock (Bonadio et al., 2020).

One thing all these studies have in common is that they focus on bilateral price changes. That is, both theoretically and empirically, they only consider the effect that an exchange rate shock has on the prices of the two countries concerned. We propose instead an explanation of the incomplete pass-through based on the multilateral price strategy that exporters need to formulate. This multilateral price strategy may act as a constraint to a perfect price-to-market strategy. If the a firm is perfectly able to price discriminate between markets then the bilateral focus is justified because the firm will adjust only the price directly affected by the exchange rate shock. If the firm is unable or unwilling to perfectly price discriminate, all its prices will have to be adjusted to the exchange rate shock (including those in markets for which no exchange rate change has occurred). In such situation the exchange rate pass through may be incomplete. This mechanism is not related to price rigidity. Prices are flexible but some firms may be unable or unwilling to price discriminate between markets. These firms would (optimally) set a single price to all destinations and such price will react to the exchange rate change. But since a change of this price will change profits in all export markets, it will not react proportionally to the exchange rate shock. Furthermore, and this is what reveals it, the single price strategy implies that the exchange rate shock has repercussions of price changes to all export markets. We name this repercussion the *Exchange Rate Pass-Around* (ERPA).

To subject such hypothesis to empirical scrutiny the ideal situation would be one in which exporters face an exchange rate shock vis-à-vis one country and zero exchange rate repercussions on at least one other currency used for exporting. The Eurozone provides and excellent situation because any exchange rate shock that affects the Euro does not affect - by definition - the currency used for trade within the zone. As per the exchange rate shock, the Swiss National Bank kindly provided a big one on January 15, 2015 when unexpectedly abandoned the ceiling 0.833 Euro (EUR) per Swiss Franc (CHF). Within seconds, the Swiss currency reached a record level of less than one Swiss Franc to the Euro before stabilizing at around 0.96 Euro to the Franc in June 2015 and then at about 0.92 by the end of 2015. Figure 1 shows that the shock was substantial, sudden (see the jump of the spot rate), unanticipated (the forward rates the day before the shock were absolutely flat), and expected to be irreversible (the forward rates after the shock track very closely the spot rate). This is an ideal condition to explore empirically the relevance of multilateral price strategy as a possible source of incomplete pass-through. The first

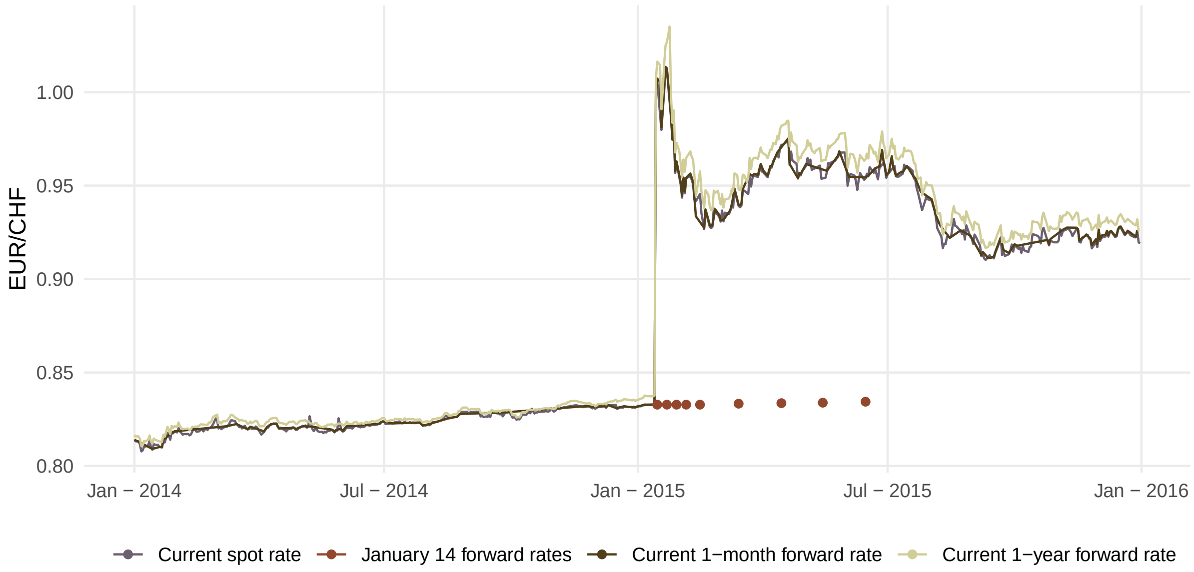


Figure 1: Spot and forward rates: EUR/CHF

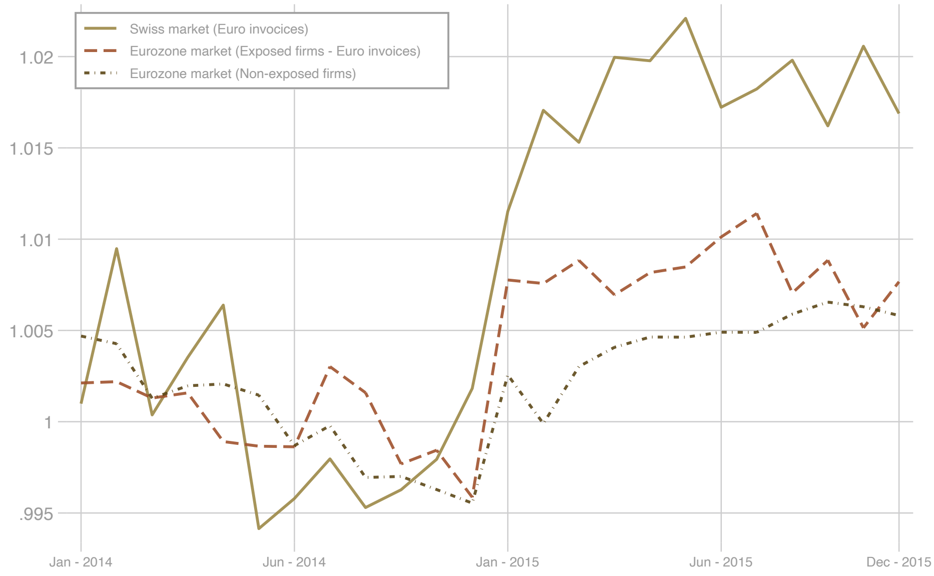
step of our empirical investigation is to ascertain that there is indeed some repercussion on the price of exporters on the Eurozone in the aftermath of the EUR/CHF shock. *Prima facie* evidence of the ERPA is provided by Figure 2.

The figure shows the adjustment of French export prices to Switzerland and to the Eurozone in the months before and after the appreciation of the Swiss Franc.[1] Some exporters set prices in Euro to every destination while some other exporters set prices in the currency of destination. Figure 2 is constructed using data for firms exporting in Euro to all destination. In this group of firms there are firms that export to Switzerland and to the Eurozone (the exposed firms) and firms that export to the Eurozone but not to Switzerland (non-exposed firms). Figure 2 shows that exposed firms have increased their export prices to Switzerland *and* to the Eurozone relative to non-exposed firms (solid and dashed lines relative to dash-dotted line). This is the exchange rate pass-around: The price adjustment does not only concern the export price *vis-à-vis* the country whose exchange rate has changed but also *vis-à-vis* third countries. This fact points at some inability or unwillingness to price discriminate between markets. Not all firms behave the same, however. Figure 3 shows the price reaction of firms that invoice in Swiss Francs. The pass-around is zero for these firms, as revealed by the fact that the price to the Eurozone of these firms is essentially indistinguishable from that of non-exposed firms. The dotted and the solid lines track the changes to, respectively, the price paid by Swiss consumers and its re-conversion to Euro operated by French Customs.

This preliminary analysis of the repercussions of the exchange rate shock gives ground to the hypothesis that the inability to price discriminate between markets is a possible source of

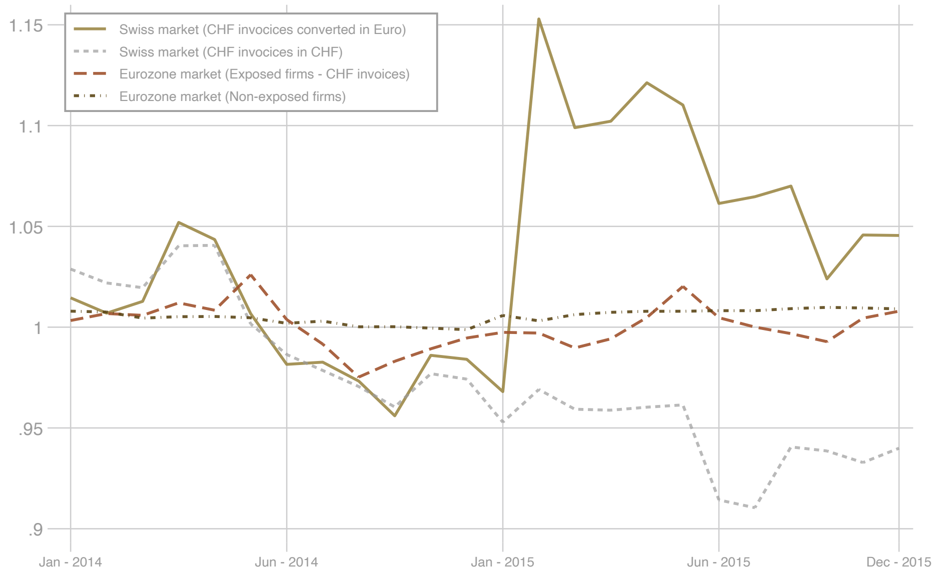
[1]The graph shows the median of the standardized prices. The latter are the residuals of a regression of the log of prices on firm-product, product-month and country-month fixed effects.

Figure 2: Exchange rate pass-around



* Exporters to Switzerland and exposed firms are firms invoicing their exports to Switzerland in Euro. Median export prices normalized (2014 average = 1)

Figure 3: Exchange rate pass-through



* Exporters to Switzerland and exposed firms are firms invoicing their exports to Switzerland in CHF. Median export prices normalized (2014 average = 1)

incomplete pass through. We have seen in the figures that firms that export to Switzerland in Euro have increased their export prices (which implies a partial ERPT). If we had not checked for the ERPA we would tend to attribute the partial pass-through to bilateral aspects (e.g., variable markup or marginal costs paid partially in foreign currency). Awareness of the ERPA pushes instead towards a different rationalisation that takes into account the multilateral price strategy that firms have to formulate. The inability or unwillingness of some firms to price discriminate between countries makes that an exchange rate shock induces a change in the export price to all destinations which, necessarily, implies an incomplete pass-through.

The ERPA may also helps understand why the ERPT depends on the currency of invoice to the extent that firms that are unable or unwilling to price discriminate are also unable to invoice in different currencies. In such case - if we only analyse the bilateral effects - we would observe that the currency matters. But if we take into account the multilateral price strategy we might conclude that it is not currency *per se* that matters for the ERPT but, instead, is the ability or willingness to price discriminate between markets. The multilateral price strategy perspective also helps understand the well documented fact that the magnitude of the ERPT depends on firm size (Berman et al., 2012; Devereux et al., 2017). In the perspective of multilateral price strategy, the dependence on size may be explained by low ability of small firms to price discriminate between market. This hypothesis is corroborated by the empirical literature that finds a wide heterogeneity in price discrimination behaviors. For instance, Fontaine et al. (2020) study the cross-sectional dispersion of prices paid by EMU importers for French products. They find that price discrimination between markets is more pronounced among the largest firms and for more differentiated products. Our own empirical investigation in section 4.2 confirms this fact.

The incompleteness of ERPT depicted in Panel 2 and confirmed by our empirical analysis is in line with most of the literature; see, e.g., Goldberg and Knetter (1996), Campa and Goldberg (2005), Gopinath and Rigobon (2008), Gopinath et al. (2010), Fontagné et al. (2018), and Freitag and Lein (2023), or Burstein and Gopinath (2014) for a review. Some papers have found that the incompleteness of the ERPT may be attributed to flexible markup, see e.g., Atkeson and Burstein (2008), Berman et al. (2012), Garetto (2016), Amiti et al. (2019), Amiti et al. (2020), Mayer and Steingress (2020). Our empirical evidence is compatible with these results but we also find that a large part of the incomplete pass-through may be explained by the inability or unwillingness to price discrimination rather than by flexible markup mechanisms. Our explanation has the advantage of being consistent with partial exchange rate pass-through as well as with the exchange rate pass-around effect observed in the data and depicted in Figure 2 and 3. Flexible markup alone, instead, does not immediately explain the pass-around.

Our paper makes six main points. First, we provide a new explanation for the incomplete pass-through. While most of the existing literature tends to conclude that the pass-through is smaller the more firms have the ability to price-to-market, we show that it is also possible that incomplete pass-through results instead from firms being *less* able to price-to-market. Second, the single-pricing mechanism we propose in our model may be fruitfully employed to better understand price dynamics after a variety of shocks, such as cost shocks (e.g. surge of energy prices or fiscal stimuli) or trade shocks. Third, the price repercussions on third markets suggests a useful distinction between vertical and horizontal rigidity in empirical analysis. The partial price adjustment after a shock may not be the consequence of the inability to adjust prices *tout court* (vertical rigidity) but instead be the consequence of the inability or unwillingness to adjust them differently in different markets (horizontal rigidity). Fourth, we provide a reasonable explanation for the existence of negative pass-through (i.e. export prices can fall when the foreign currency appreciates). More generally, we show that the magnitude and sign of the exchange rate pass-through depends also on country characteristics, namely the size of the country whose exchange rate varies, distance of exporters from that country, price difference between the destination countries, and the proportion of firms that are unable or unwilling to price discriminate between markets. The theoretical model provides the rationale for the use of these variables in the empirical analysis. Fifth, in empirical studies, it may be essential to take the full measure of a firm's ability to price discriminate to limit estimation biases. This point does not only apply to the exchange rate shock but also to the estimation of trade elasticities or cost shocks. Indeed, the pass-through estimated using firm-time fixed effects may underestimate severely the actual pass-through if the share of firms that do not price discriminate between markets is large. Sixth, from a macroeconomic perspective, the fact that some firms do not price-discriminate between markets changes the pattern and magnitude of international monetary policy transmission.

The remainder of the paper is structured as follows. We develop a model in section 2 that exhibits the heterogeneous behavior of firms showcased above. In section 3 we take another look at the data, before estimating the differential effect of French exporters to the dramatic change in the exchange rate in section 4. Section 5 concludes.

2 A simple model of incomplete pass-through.

We develop a simple model which contains only necessary and sufficient elements. The world is made of three countries labeled F(rance), E(urozone), and S(witzerland). The first two have the same currency (Euro) while the latter has a different currency (CHF). The extensions to multiple countries is trivial. Our benchmark model structure, discussed in section 2.1, is the traditional Dixit-Stiglitz-Krugman monopolistic competition with an outside good. To this structure we add two elements. First, we introduce destination-specific marginal costs to capture a feature of the data. Second, and more importantly, we introduce a single-price constraint for some firms. The single-price constraint is the key element that gives rise to incomplete or more than complete pass-through and to the pass-around effect. Furthermore, single pricing makes that the magnitude of the pass-through (and of the pass-around) depends on market size and trade costs, two variables so far ignored by the literature. The underlying model structure is purposely simple to highlight the fact that incomplete pass-through may arise also in the absence of flexible markup when firms are unable or unwilling to price discriminate between markets. In section 2.2 we show that the results obtained in the benchmark model are robust to alternative plausible model structures. In that section we embed the single-price constraint first in a model that features a variable elasticity of demand, and, second, in a model that exhibits marginal costs depending on the exchange rate. These two alternative model structures capture two sources of incomplete pass-through very often identified in the literature. Single-pricing in these model alternatives produces qualitatively the same results as in the simple set up we discuss section 2.1.

2.1 A simple benchmark model

Consumers. The representative consumer has Cobb-Douglas preferences defined over two goods indexed by g, ($g = X, Y$) with expenditure shares $\gamma_g > 0$ and $\sum_g \gamma_g = 1$. Good Y is our outside good; it is homogeneous, its technology requires one unit of labor input per unit of output, it is freely traded, and will serve as numéraire. This, combined with incomplete specialization implies that the wage is equal to 1 in every country. Good X is assumed to be a CES aggregate with elasticity of substitution equal to σ. Let p_{ij} be the price in j expressed in the currency of j of any variety produced in i and sold in j. Let $A_i = P_i^{\sigma-1}\gamma_X I_i$ be the demand shifter for good X applicable to $i = F, E, S$; where I_i is national income and P_i is the local price index all expressed in local currency. To lighten notation we omit the subscript referring to good X in prices and price indices. This will not induce confusion since Y is our numéraire. Given preferences and the budget constraint, demand functions take the usual form. For instance, a firm located in F faces the following demand functions in each market: $d_{Fj} = p_{Fj}^{1-\sigma}A_j$, with $j = F, E, S$. Analogous demand functions apply to firms in the other countries. Since we focus on firms in F and since results for the other countries are analogous we drop the first subscript from prices and other variables.

Firms and pricing rules. Firms producing good X face a fixed production cost F and a constant marginal cost c_i specific to the destination. Trade across borders is costly, for any unit of good shipped to i only a fraction $\tau_i \in (0, 1)$ arrives at destination. To set a price specific to each market a firm has to pay a fixed cost F_t (t for pricing-to-market). Some firms will pay F_t and adopt the pricing-to-market policy while other firms will not pay F_t and adopt the alternative policy of a single price. The latter are bound to apply the same price to all destinations. The different policy adoptions across firms may be justified by having in mind firm heterogeneity à la Melitz (2003) whereby only the most productive firms generate enough revenues to be able to pay F_t. We leave this well known mechanism in the background. Let e be the units of Euro needed to buy one unit of CHF. The firm's profit is

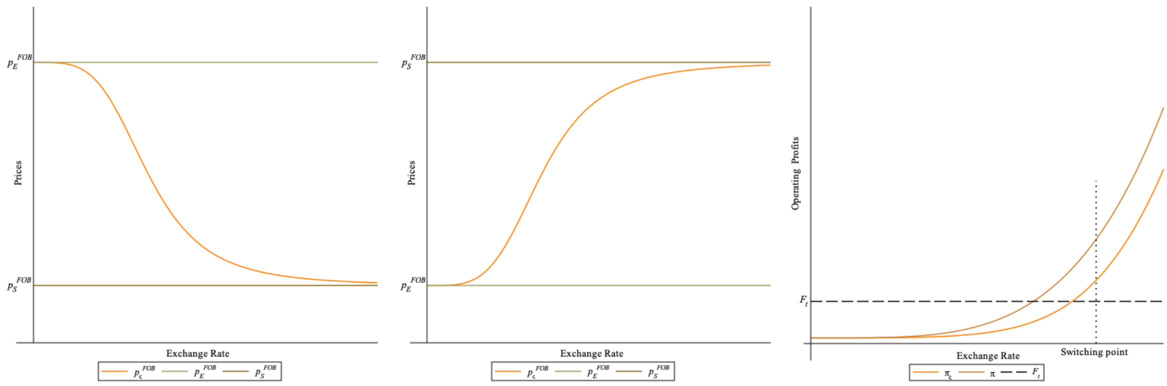
$$\pi = p_F^{1-\sigma}A_F + p_E^{1-\sigma}A_E + ep_S^{1-\sigma}A_S - c_F p_F^{-\sigma}A_F - c_E\frac{p_E^{-\sigma}A_E}{\tau_E} - c_S\frac{p_S^{-\sigma}A_S}{\tau_S} - (F + F_t). \tag{1}$$

with $F_t = 0$ for firms that opt for single-pricing. Since all the action is on the export prices, the domestic market may be neglected without loss of generality but with great gains in terms of length of mathematical expressions. We then set fictitiously $A_F = 0$ henceforth.

Pricing-to-market. We use the term pricing-to-market in the sense of Krugman (1987), that is, the ability of the firm to formulate independent profit-maximizing pricing rules in different markets. A firm that pays F_t maximizes π with respect to p_E and p_S obtaining the well known profit-maximizing prices $p_E = \frac{\sigma}{(\sigma-1)\tau_E}c_E$ and $p_S = \frac{\sigma}{(\sigma-1)\tau_S e}c_S$ to which correspond the Euro-denominated FOB prices

$$p_E^{FOB} = \frac{\sigma}{(\sigma-1)}c_E, \qquad p_S^{FOB} = \frac{\sigma}{(\sigma-1)}c_S. \tag{2}$$

Single-pricing. A firm that does not pay F_t maximizes profits by choosing a single FOB price.



(a) Price comparison $c_S < c_E$ **(b)** Price comparison $c_S > c_E$ **(c)** Operating Profits $(\forall c_S, c_E)$

Figure 4: FOB prices and Operating profits

We denote this single Euro-denominated FOB price as p_ς^{FOB}.[2] All other prices depend on this one in the following way:

$$p_E = p_\varsigma^{FOB}/\tau_E, \qquad p_S = p_\varsigma^{FOB}/(\tau_S e) \tag{3}$$

The profit of a single-price firm is the same as in expression (1) except that F_t is set to zero. Maximizing this profit subject to (3) gives

$$p_\varsigma^{FOB} = \frac{\sigma}{(\sigma-1)} \frac{A_S c_S \tau_S^{\sigma-1} e^\sigma + A_E c_E \tau_E^{\sigma-1}}{A_S \tau_S^{\sigma-1} e^\sigma + A_E \tau_E^{\sigma-1}}. \tag{4}$$

The single FOB price in equation (4) is between the two distinct FOB prices in equation (2). This is intuitive since the single price captures features of both markets. As the exchange rate goes from zero to infinity the single FOB price goes from p_E^{FOB} to p_S^{FOB} as revenues from the S market become more and more important. This convergence towards p_S^{FOB} implies a price increase or a price decrease depending on which of the two prices is the largest. Panels 4a and 4b of Figure 4 show these convergences.

Comparing profits is also interesting. Operating profits under pricing-to-market are always larger than under single pricing. The reason is that single-price maximization is subject to the binding constraint (3) while pricing-to-market is not. However, for small e the S market matters very little and paying F_t does not give a great push to profits. The firm prefers to adopt a single price in this case. Conversely, for large e, paying F_t gives a push to profits larger than F_t and the firm prefers to adopt the pricing-to-market policy. The switching point between the two pricing rules is represented in Panel 4c of Figure 4 where the vertical distance between operating profits exactly equals F_t. Having in mind the heterogeneous firm model, the switching point will be different for different firms, which explains the coexistence of different price policies. As e increases, more and more firms will adopt pricing-to-market. This result will be useful in understanding the dynamics of mean price changes discussed below.

[2] The Free On Board (FOB) price is the price of the traded goods at the border of the exporting country, which does not include international transport costs. Export declarations are valued at FOB prices. It is therefore these prices that we approximate with the unit values of export flows recorded in the customs data we use in our empirical analysis.

Pass-through and pass-around. Let $\widehat{x} \equiv dx/x$ be the percentage change for any variable x.

Pricing-to-market. Using optimal prices in equations (2) we see that the FOB prices are independent of the exchange rate. Therefore, the exchange rate shock leaves them unchanged:

$$\widehat{p}_E^{FOB} = 0, \qquad \widehat{p}_S^{FOB} = 0. \tag{5}$$

As for the pass-through we have $\widehat{p}_S = -\widehat{e}$, which is complete exchange rate pass-through.[3]

Single-pricing. Consider now a firm that does not pay F_t. Using (4) we obtain the price change induced by the exchange rate shock $\widehat{e}$, which is

$$\widehat{p}_\varsigma^{FOB} = \frac{(c_S - c_E)\,\sigma e A_S A_E\,(\tau_E \tau_S)^{\sigma-1}\ \widehat{e}}{\left(\tau_E^{\sigma-1} c_E A_E + e^\sigma \tau_S^{\sigma-1} c_S A_S\right)\left(\tau_E^{\sigma-1} A_E + e^\sigma \tau_S^{\sigma-1} A_S\right)} \gtreqless 0. \tag{6}$$

The FOB price change can be positive, zero, or negative depending on whether $c_S \gtreqless c_E$. This is also shown in Figure 4 where we see that a depreciation (moving on the right on the abscissa) moves the single FOB price to approach the pricing-to-market FOB price to S. This means an increase or a decrease of the single FOB price depending on whether the marginal cost c_S is larger or smaller than c_E. The pass-through can be incomplete, complete, or more than complete depending on the same conditions. The important thing here is that the exchange rate shock brings about the same price change to all destinations, not only to market S. This is the pass-around effect and is due to single-pricing. An important implication of this finding in relation to the empirical literature is that single-pricing may be one of the causes of the incomplete pass-through. This possibility has so far remained unexplored in the literature, which may have led to overestimating the importance of other factors.

Sensitivity to market size and trade costs. Under pricing-to-market, the FOB price response to the exchange rate shock is zero and therefore it is independent of the market size and trade costs. Conversely, the single-price response in expression (6) is sensitive to the size of demand shifter and to trade costs. Proximity to market S (i.e., an increase in τ_S relative to τ_E) has ambiguous effects on $\widehat{p}_\varsigma^{FOB}$ shown in the following inequalities:

$$\frac{\partial \widehat{p}_\varsigma^{FOB}}{\partial \tau_S} > 0 \Leftrightarrow \left\{ \begin{array}{c} c_S > c_E \quad \wedge \quad \left(\frac{\tau_E}{\tau_S}\right)^{2(\sigma-1)} \left(\frac{A_E}{A_S}\right)^2 \frac{c_E}{c_S} e^{-2\sigma} > 1 \\ \textit{or} \\ c_S < c_E \quad \wedge \quad \left(\frac{\tau_E}{\tau_S}\right)^{2(\sigma-1)} \left(\frac{A_E}{A_S}\right)^2 \frac{c_E}{c_S} e^{-2\sigma} < 1 \end{array} \right\} \tag{7}$$

with analogous conditions holding for $\frac{\partial \widehat{p}_\varsigma^{FOB}}{\partial \tau_S} < 0$.

In our empirical analysis, based on French custom declarations, we find that proximity to Switzerland has a positive effect on the pass-around effect. It is interesting to check what this

[3]To keep the terminology clear we use the term pass-through as defined in Deardorff (2014); that is, the extent to which an exchange rate change is reflected in the prices of imported goods.

empirical finding implies for the parameters of our models. To this purpose we may perform a crude numerical example using plausible parameter values. Using World Bank data we may set A_S to be 5.8% of A_E, our own estimations suggest to set c_S to be 30% larger than c_E, the pre-shock level of the exchange rate is observed at 0.83 (Figure 1), as per the elasticity we take a customary $\sigma = 4$. With this numbers, the second set of inequalities in the first row of equation (7) becomes $\left(\frac{\tau_E}{\tau_S}\right)^6 \times 1089 > 1$. To satisfy this inequality and therefore have $\frac{\partial \widehat{p}_\varsigma^{FOB}}{\partial \tau_S} > 0$ the ratio τ_E/τ_S must be not too small. The ratio τ_E/τ_S is almost certainly smaller than one since, for French exporters, business destinations in Switzerland are — on average — closer than those in the Eurozone (remember that $\tau_i \in (0,1)$ is the fraction of the good evaporated in transit). For simplicity, we may assume overall trade costs to be proportional to distances d_j, so that $\tau_j = 1/(1+d_j)$. With the simulation values above, the condition $\frac{\partial \widehat{p}_\varsigma^{FOB}}{\partial \tau_S} > 0$ is met when the distance to the Eurozone is not larger than 5.3 times the distance to Switzerland. The road distance between Paris and Athens (which is the Eurozone capital furthest away from France) is only 4.8 times the distance between Paris and Zurich. Furthermore, Athens is not the center of the Eurozone market relative to France. If we take the center of gravity of the Eurozone relevant for France to be an average between Berlin, Madrid and Rome we have a road distance which is only twice the distance to Zurich. With these numbers, the theoretical prediction is consistent with the empirical finding that the pass-around effect is positive and that proximity to Switzerland amplifies the exchange rate pass-around. Obviously, the numerical example is sensitive to the value of σ, but with the Eurozone at twice the distance to Switzerland, it would take an unlikely $\sigma > 14$ for the model prediction to be inconsistent with the empirical finding. The effect of the market size on $\widehat{p}_\varsigma^{FOB}$ has a qualitatively similar effect to the effect of trade costs to S. Aside from the quantitative prediction, single-pricing makes the price response sensitive to trade costs and market size while pricing-to-market does not.

Dynamics of mean price changes. Our empirical analysis will describe the average change of exporters' prices over several months. We therefore need to track the mean price change theoretically. In doing so we take into account the possibility that some firms decide to change their pricing policy. We have seen above that the switching point is different for different firms. Thus, after the exchange rate depreciation some firms will switch to pricing-to-market. These firms will switch from p_ς^{FOB} to p_E^{FOB} and p_S^{FOB}. Presumably, the switch takes place some time after the shock as firms have to realize the switch is profitable and have to reorganize their pricing policy. Let λ_z be the percentage of firms that have switched from a single-price to a pricing-to-market strategy between the day of the shock and z days after the shock. Then, the mean price change on market $J = E, S$ observed between the day of the shock and z, denoted μ_z^J, is

$$\mu_z^E = (1-\lambda_z)\widehat{p}_\varsigma^{FOB} + \lambda_z(p_E^{FOB} - p_\varsigma^{FOB}), \quad (8)$$

$$\mu_z^S = (1-\lambda_z)\widehat{p}_\varsigma^{FOB} + \lambda_z(p_S^{FOB} - p_\varsigma^{FOB}). \quad (9)$$

As shown in Figure 4, p_ς^{FOB} lies between p_E^{FOB} and p_S^{FOB}. Therefore, the second terms of equations (8) and (9) have opposite sign. Since the optimal price changes of pricing-to-market firms are zero, μ_z^E and μ_z^S measure the average ERPA and ERPT, respectively. If $p_S^{FOB} > p_E^{FOB}$ we expect an attenuation of the ERPA and an increase of the ERPT as we measure the price change over longer time intervals (larger z). Vice-versa if $p_S^{FOB} < p_E^{FOB}$. This result will be useful in the interpretation of Figure 6.

2.2 Model extensions.

In addition to highlighting the pass-around effect, one of the contributions of the theoretical model above is to suggest an original mechanism generating the incomplete pass-through. This section discusses alternative arguments that also give rise to incomplete pass-through and which are now standard in the literature. These arguments are insufficient to explain the pass-around effect we have identified in the data. We want to show, however, that they are compatible with the mechanism through which single-pricing generates a pass-around effect.

Variable elasticity of demand. In models with a variable elasticity of demand the exchange rate pass-through is incomplete and its magnitude depends on the productivity of the firm. These two results arise from the first order conditions for profit maximization, $p_S^v = \frac{w}{\phi e \tau}\frac{\nu(x)}{\nu(x)-1}$, where x is firm output sold to S and $\nu(x) \equiv -\frac{dx}{dp}\frac{p}{x} > 1$ is the price elasticity of demand. The firm chooses the position on the demand curve and would obviously not choose a point in the demand curve where the elasticity is less than one. This explains why $\nu(x) > 1$. We have used the superscript ^{v} to refer to the *v*ariable markup model. The first order condition defines the pricing rule only implicitly because x is a function of p. The FOB price is $p_S^{FOB,v} = ep_S^v$ and its percentage change induced by a depreciation of the Euro is

$$\widehat{p}_S^{FOB,v} = e\frac{\partial \nu(x)/\partial e}{\nu(x)(\nu(x)-1)}\widehat{e} = -\frac{\eta(x)}{\nu(x)-1}\widehat{e}$$

where $\eta(x) \equiv -\frac{\partial \nu(x)}{\partial e}\frac{e}{\nu(x)} = \frac{\partial \nu(x)}{\partial p}\frac{p}{\nu(x)}$. The key assumption of this class of models is $\eta(x) < 0$ so that the FOB price increases after the exchange rate depreciation. Two seminal papers that incorporate this assumption (in more elaborate settings) are Melitz and Ottaviano (2008) and Zhelobodko et al. (2012). Since $\widehat{p}_S^v = (\widehat{p}_S^{FOB,v} - 1)\,\widehat{e}$, it follows that the pass-through is less than complete. The economic mechanism is that the exchange rate shock pushes the firm to reduce the consumer price. This induces an increase in consumption (x) and thereby a reduction in $\nu(x)$ thus giving rise to a positive feedback on the price. As a result, the consumer price declines, but less than proportionally with respect to the exchange rate. If the elasticity of demand were constant, then $\eta = 0$, $\widehat{p}_S^{FOB,v} = 0$, and $\widehat{p}_S^v = -\widehat{e}$ with perfect pass-through. Without a single-price mechanism the pass-around effect does not arise from this class of models. Inserting a single-price constraint in this class of models gives rise to results qualitatively identical to those shown in the previous section. This can be seen by sketching a simple model with linear (inverse) demand given by $p_i^v = (a - bq_i)A_i$ for $i = E, S$. Then the optimal prices are

$$p_E^{FOB,v} = \frac{aA_E\tau_E + c_E}{2} \qquad p_S^{FOB,v} = \frac{eaA_S\tau_S + c_S}{2}$$
$$p_\varsigma^{FOB,v} = \frac{A_E A_S ae\tau_E\tau_S(\tau_E + \tau_S) + c_E\tau_S^2 c_E eA_S + c_S A_E\tau_E^2}{2(\tau_S^2 c_E eA_S + A_E\tau_E^2)}$$

with price changes

$$\widehat{p}_E^{FOB,v} = 0, \qquad \widehat{p}_S^{FOB,v} = \frac{eaA_S\tau_S}{eaA_S\tau_S + c_S}\widehat{e} \in (0, \widehat{e})$$
$$\widehat{p}_\varsigma^{FOB,v} \gtreqless 0 \Leftrightarrow A_E \gtreqless \frac{\tau_S(c_S - c_E)}{a\tau_E(\tau_S + \tau_E)} \tag{10}$$

where inequality (10) can be verified by simple calculus. These results are qualitatively similar to those of the simple model of constant markup presented in the previous section, except that the ERPT for pricing-to-market firms is now incomplete.

Exchange rate in the marginal cost. This class of models assumes that part of the marginal cost of production is paid in the destination currency. As a result, the exchange rate variation influences the FOB price and the pass-through is incomplete. The first model of this family is in Corsetti and Dedola (2005). To sketch this mechanism and keep the notation as simple as possible, let the marginal cost c_S of the previous section be a function of the exchange rate, say $c_S = e\mathfrak{c}_S$ with $\mathfrak{c}_S > 0$. Then, optimal FOB prices would be:

$$p_E^{FOB,mc} = \frac{\sigma c_E}{\sigma - 1}, \qquad p_S^{FOB,mc} = \frac{e\mathfrak{c}_S\sigma}{\sigma - 1},$$
$$p_\varsigma^{FOB,mc} = \frac{\sigma}{\sigma - 1}\frac{A_S\mathfrak{c}_s\tau_S^{\sigma-1}e^{1+\sigma} + A_E c_E\tau_E^{\sigma-1}}{A_S\tau_S^{\sigma-1}e^{\sigma} + A_E\tau_E^{\sigma-1}}.$$

where we have used the superscript ^{mc} to indicate that this is the model with the exchange rate in the marginal cost. The percentage price changes are

$$\widehat{p}_E^{FOB,mc} = 0, \qquad \widehat{p}_S^{FOB,mc} = \widehat{e},$$
$$\widehat{p}_\varsigma^{FOB,mc} > 0 \begin{cases} \frac{(1+\sigma)c_S}{\sigma c_E} > 1 \\ \text{or} \\ \frac{(1+\sigma)c_S}{\sigma c_E} < 1 \quad \wedge \quad \left(\frac{\tau_E}{\tau_S}\right)^{(\sigma-1)} \frac{A_E}{A_S}\frac{\sigma c_E - (1+\sigma)c_S}{e^\sigma c_S} < 1 \end{cases} \tag{11}$$

where the inequalities in (11) can be verified by simple calculus. In this simple example the pass-through for pricing-to-market firms is zero because the marginal cost is proportional to the exchange rate. Of course, the magnitude of the pass-through may be larger than zero if we assume a nonlinear relationship between the marginal cost and the exchange rate or, more plausibly, if only a fraction of the marginal cost is paid in foreign currency. For single-price firms the pass-around effect may be positive or negative and its magnitude depends on parameter values. Again, the exchange rate pass-around effect is the result of the single-price constraint.

3 Data and descriptive statistics.

We now turn to the empirical analysis which exploits data on French customs declarations. These provide the values and quantities exported each month, by each French exporter, for each product (8-digit of the combined classification), and each destination country. For flows to non-EU members we also know the invoicing currency. If, in a given month, a firm that exports a given good to a given destination uses different currencies, the transactions using each currency will be recorded as distinct flows. We use unit values (i.e. export value/quantity ratios) as a proxy for FOB prices. We limit our analysis to exports to the Eurozone countries and Switzerland, registered each month between January 2014 and December 2015.

For the econometric analysis, we consider each firm-product pair as an independent individual. From now on, the terms "firms" and "exporters" will refer to a firm-product pair. Unit values are imperfect proxies for prices and we need to trim the data to remove the most obvious misrepresentations of prices. The 8-digit classification is very detailed, but it is always possible that a firm exports different varieties of the same product with different quality levels. In order to limit the risk that our results are driven by composition effects, we exclude firm-product pairs that have too much variability in unit values, in space and/or time. We eliminate firms that have at least 10% of monthly flows with prices 10 times higher or 10 times lower than the average. We also exclude firm-product pairs whose ratio between the largest and smallest unit value is greater than thirty. Lastly, we exclude products entirely when the max/min ratio exceeding thirty is present for more than half of their exporting firms. In the customs declarations, the quantities declared are rounded to the nearest kilo. For products (especially those with a high price per kilo) for which the average shipment has a very low weight, this rounding can result in a large volatility of unit values. Therefore, we eliminate from the sample all products with an average weight of monthly shipments below 10 kilograms. As we are interested in the evolution of prices before and after the Swiss Franc exchange rate shock, the group of exporters to Switzerland is limited to firms that export to Switzerland in both 2014 and 2015.

Invoicing currency. As shown in Figure 3 above, the prices of exports invoiced in CHF (once converted into Euros) and in Euros react very differently to the appreciation of the franc. This confirms the necessity of distinguishing between flows according to the invoicing currency. We therefore allocate exporters to Switzerland into three groups according to their invoicing currency. We consider a firm-product pair as invoicing in Euros if at least 99% of the total value exported to Switzerland both in 2014 and 2015 is invoiced in this currency. Similarly, a firm-product pair is defined as invoicing in Swiss Franc if the invoices in CHF represent more than 99% of the total value exported to Switzerland in both years. The remaining group (called "Mixed") includes therefore firms that use both currencies simultaneously in significant proportions, and also those who use a vehicle currency. Table 1 shows how the choices in terms of invoicing currency are distributed among exporters to Switzerland. The population of firms is distributed between

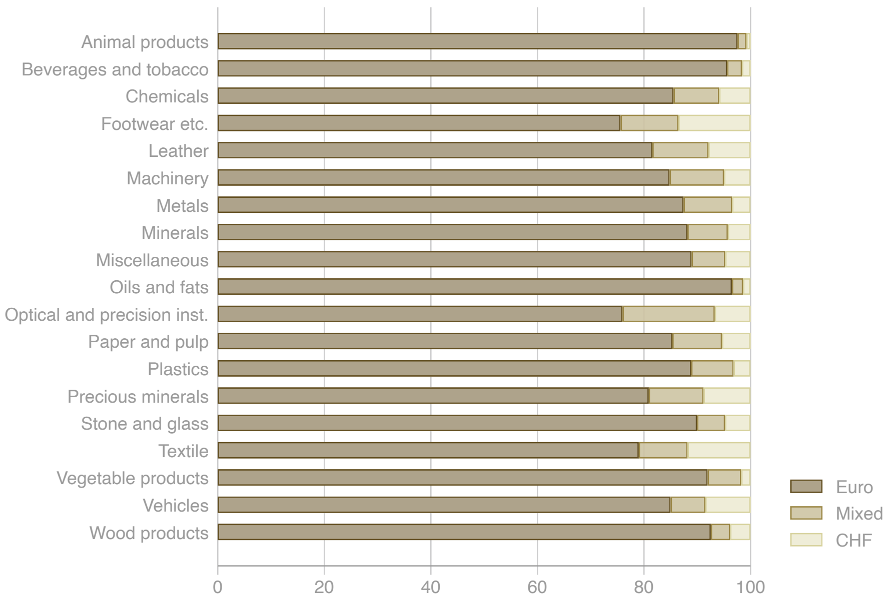
Table 1: % of exporters to Switzerland by bins of shares of Euro and CHF invoices

Share of exports invoiced in Euro	Share of exports invoiced in CHF							
	< 1%	1-10%	10-25%	25-50%	50-75%	75-90%	90-99%	> 99%
> 99%	89.653							
90-99%	0.077	0.371						
75-90%	0.04	0	0.377					
50-75%	0.04	0	0.006	0.604				
25-50%	0.04	0	0	0.004	0.451			
10-25%	0.04	0	0	0	0.01	0.336		
1-10%	0.024	0	0	0	0.002	0.002	0.485	
< 1%	0.509	0.004	0.004	0.004	0.008	0	0.004	6.903

bins combining the percentages of exports to Switzerland invoiced in Euros and the percentage invoiced in CHF. The top-left corner indicates that 89.65% of the exporters invoice at least 99% of their exports in Euros and — of course — less than 1% in CHF. Conversely, in the bottom-right corner, we have firms that form the group of Swiss Franc exporters. They account for 6.9% of all exporters to Switzerland. All other cells form the group of *Mixed* firms. All together these firms account for only 3.4% of exporters to Switzerland. Among the latter, only 0.5% use almost exclusively a vehicle currency (see bottom-left corner).

This strong dominance of the Euro in trade with Switzerland is confirmed by Figure 5, which shows its high share across the universe of tradable products.

Figure 5: Share Euro, CHF and Mixted invoicing exporters, by product category (2014)



After trimming, our main database contains more than 6 million observations, with 24 months, 19 countries (all Eurozone,[4] minus France, plus Switzerland), 34,405 firms, 8,010

[4]In 2014 and 2015, there were only 19 countries in the Eurozone. Croatia joined in 2023.

products and 38,1435 firm-product pairs. Among the latter, 39,567 firm-products pairs export to Switzerland both in 2014 and 2015. The empirical analysis that follows makes use of this large sample, but we focus mainly on exports of differentiated products and on firms that invoice their exports to Switzerland in euros and do not import from Switzerland (in order to eliminate a direct link between the CHF exchange rate and prices via firms' production costs). This reduced sample comprises 2,110,096 observations, 18,355 firms, 3,835 products and 145,962 firm-product pairs (among which 15,078 export to Switzerland in 2014 and 2015).

4 Econometric analysis.

We conduct two difference-in-differences analyses. The first one is a two-way fixed effects study comparable to the standard specification to estimate the exchange rate pass-through at the firm level (see e.g. Berman et al., 2012). In order to assess the impact of the exchange rate shock on exporters' prices, we estimate the change in export prices on the Swiss market, relative to the one on other European markets, for the same firm-product and date. Formally, this first model is:

$$\ln \mathit{Price}_{i,k,c,t} = \alpha \mathit{ERPT}_{c,t} + \Theta_{i,k,c} + \Theta_{i,k,t} + \varepsilon_{i,k,c,t}. \tag{12}$$

In equation (12), subscripts i, k, c, and t denote a firm, a product, a destination country and date (month-year), respectively. $\mathit{Price}_{i,k,c,t}$ is the unit value of the monthly exports of firm-product pair i,k in the European country c at date t. The treatment dummy, $\mathit{ERPT}_{c,t}$, takes the value of one for exports to Switzerland on months after the CHF appreciation (i.e. from February to December 2015). $\varepsilon_{i,k,c,t}$ is an error term. Fixed effects $\Theta_{i,k,c}$ and $\Theta_{i,k,t}$ control for all firm-product-destination and firm-product-time characteristics, respectively. By adding firm-products-time fixed effect, this specification eliminates all exogenous shocks that may have affected firms and modified their prices in all markets. The estimated α tells us to what extent firms have increased their prices in the Swiss market more than in other markets. For pricing-to-market firms, our theoretical framework predicts complete or incomplete (but not zero) exchange rate pass-through, with $\alpha = 0$ (i.e. complete ERPT) in the benchmark theoretical model, and $0 < \alpha \leq \hat{e}$ in any of the model extensions. For single-price firms, we unambiguously expect $\alpha = 0$. But in this case, it does not mean that these exporters do not change their prices in the Swiss market; they do. This is because they are expected to change their prices simultaneously – and to the same extent – in all their destination markets, so that these price changes will be absorbed by the firm's time fixed effects.

The second specification estimates the magnitude of the exchange rate pass-around effect described in our model. Here, the empirical strategy is to compare the evolution of prices in the Eurozone of firms that export to Switzerland in 2014 and 2015 to the one of firms that do not. We thus estimate the second model as:

$$\ln \mathit{Price}_{i,k,c,t} = \beta \mathit{ERPA}_{i,k,t} + \Theta_{i,k,c} + \Theta_{k,c,t} + \varrho_{i,k,c,t}, \tag{13}$$

where $\varrho_{i,k,c,t}$ is the error term. The treatment dummy, $\mathit{ERPA}_{i,k,t}$, takes the value of one from

Table 2: Exchange rate pass-through (ERPT) and pass-around (ERPA) for firms invoicing in Euro

	Currency	Importers	Products	Destinations	Treatment period	Variable	Coefficient	Standard err.	Sample size
(1)	Euro	Yes	All	EZ	Feb-Apr	$\text{ERPT}_{c,t}$	0.015a	(0.004)	3,594,832
(2)	Euro	Yes	All	EZ	Feb-Apr	$\text{ERPA}_{i,k,t}$	0.007a	(0.002)	3,453,381
(3)	Euro	No	All	EZ	Feb-Apr	$\text{ERPT}_{c,t}$	0.014b	(0.006)	1,973,146
(4)	Euro	No	All	EZ	Feb-Apr	$\text{ERPA}_{i,k,t}$	0.010a	(0.004)	1,884,832
(5)	Euro	No	Diff	EZ	Feb-Apr	$\text{ERPT}_{c,t}$	0.019b	(0.009)	1,266,877
(6)	Euro	No	Diff	EZ	Feb-Apr	$\text{ERPA}_{i,k,t}$	0.015a	(0.005)	1,216,787
(7)	Euro	No	Diff	EZ	Feb-Jun	$\text{ERPT}_{c,t}$	0.026a	(0.008)	1,429,541
(8)	Euro	No	Diff	EZ	Feb-Jun	$\text{ERPA}_{i,k,t}$	0.010b	(0.005)	1,373,451
(9)	Euro	No	Diff	EZ	Feb-Dec	$\text{ERPT}_{c,t}$	0.030a	(0.007)	2,019,858
(10)	Euro	No	Diff	EZ	Feb-Dec	$\text{ERPA}_{i,k,t}$	0.004	(0.004)	1,926,206
(11)	Euro	No	Diff	Border	Feb-Apr	$\text{ERPT}_{c,t}$	0.027b	(0.011)	416,515
(12)	Euro	No	Diff	Border	Feb-Apr	$\text{ERPA}_{i,k,t}$	0.018b	(0.007)	366,425

Notes: Significance levels: c: p< 0.1, b: p < 0.05, a : p < 0.01. Pre-treatment period: Jan.-Dec. 2014. Standard errors are clustered by firm-product-year. The dependent variable is the log of export prices denominated in Euros. Lines 3-12 exclude all firms that import from Switzerland in 2015. Lines 5-12 retain differentiated products only (cf.Rauch's liberal product classification). Border countries (lines 11 and 12) are Germany, Italy and Austria.

February 2015 onward for firms that export to Switzerland in both 2014 and 2015. The specification includes firm-product-destination fixed effects, $\Theta_{i,k,c}$, along with product-country-time fixed effects, $\Theta_{k,c,t}$. A $\beta \gtrless 0$ is the ERPA[5] and is consistent with the single-price mechanism of the model, while an absence of the ERPA ($\beta = 0$) is not.

4.1 Pass-through and pass-around

Table 2 reports estimates for the two models obtained with different samples of firms, products and destinations. Odd rows show the pass-through estimates (model 1), while even rows show the pass-around (model 2).[6]

Lines (1) and (2) use the whole sample of firms that either do not export to Switzerland and those who export to Switzerland invoicing in Euros. The treatment period is limited to 3 months: February-April 2015. In lines (3) and (4) we exclude firms that import from Switzerland in 2015. This shuts down the channel between the exchange rate shock and the export price through a change in the inputs prices. Lines (5) and (6) further exclude homogeneous products (cf. Rauch, 1999). Rows (7) to (10) expand the treatment window to February-June and February-December, respectively. Finally, lines (11) and (12) reproduce lines (5) and (6), but restrict the list of export destinations to Eurozone countries geographically close to Switzerland (Germany, Austria and

[5] More precisely, we predict $\beta > 0$ if $c_S > c_E$, i.e., if, as is clearly the case in our data, the price of exports to Switzerland is higher on average than that of flows to the Eurozone.

[6] Appendix A shows the results with a treated group made of exporters invoicing in CHF, and appendix B shows robustness checks using alternative difference-in-differences settings and estimators.

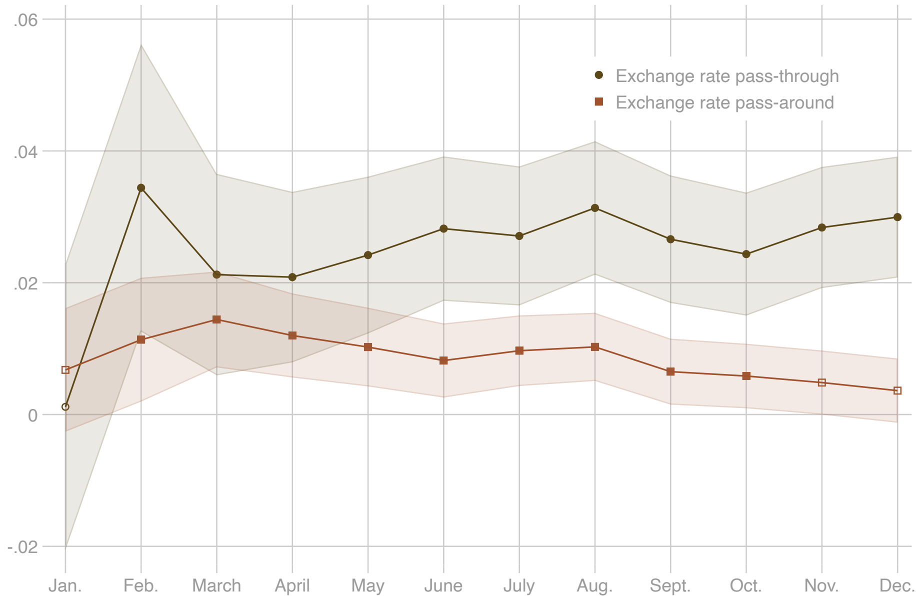


Figure 6: Exchange rate pass-through and pass-around: Euro invoices

Italy).

Across specifications for the first model, i.e. those reported in odd-numbered rows, the estimates reveal that French exporters reacted to the exchange rate shock by significantly increasing the price they set on the Swiss market (relatively to their price on Eurozone destinations). The exchange rate pass-through is therefore incomplete and the magnitude is comparable to that reported in the related literature. Using the same French customs data, Berman et al. (2012) report an exchange rate pass-through of 92% (i.e. the average French exporter increases its export price by 0.08% following a 1% real exchange rate depreciation, with the remainder $((1 - 0.08))$ passed on to the foreign consumer).[7] Fontagné et al. (2018), who also use the same data source, find an even larger exchange rate pass-through of about 97%. Our estimates, based on an exceptionally large exchange rate shock, suggest a slightly smaller pass-through (i.e. a larger coefficient α), but clearly in the same order of magnitude. In the quarter following the CHF appreciation, French exporters of differentiated products increased the FOB price charged on the Swiss market by 1.9% (i.e. $(e^{0.019} - 1)$, line 5). The increase rises gradually to 3% (i.e. $(e^{0.030} - 1)$, line 9). After a short period of overreaction in January 2015, the appreciation of the Swiss Franc stabilized at around 14% during the first half of 2015 (see Figure 1). All together, this suggests that the price response to a 1% CHF exchange rate shock lies between 0.13 and 0.21%, i.e., a pass-through between 86.4 and 78.6%. We also find a larger pass-through (i.e. a smaller α) on the entire sample of products, which includes non-differentiated ones.

More interestingly, the estimates reported in the even-numbered rows — the second model — confirm the presence of a significant pass-around effect. Compared to French exporters who do

[7]Berman et al. (2012) study a longer time horizon with a continuum of exchange rate changes.

not export to Switzerland, those who were directly exposed to the exchange rate shock because of their presence on the Swiss market increased their prices to *all* markets in the Eurozone. On average, during the first quarter following the Swiss Franc shock, exporters of differentiated products to Switzerland have increased their prices to the Eurozone by 1.51% (cf. line 6). This initial pass-around is very significant but fades away over the course of the year. The evolution is more clearly visible in Figure 6 which shows the dynamics of the pass-through and pass-around over the course of 2015.[8] The figure reports the estimates of our models 1 and 2 for a series of treatment periods expanded progressively from one to twelve months.

The pass-around effect revealed in Table 2 and Figure 6 is consistent with the theoretical predictions of our baseline model combined with any of the model extensions. The empirical results, through the lenses of our model, imply $p_S^{FOB} > p_E^{FOB}$ (see section 4.3 below for further discussion). In this case, an incomplete ERPT and a positive ERPA are expected, which is corroborated in Figure 6. Furthermore, from equations (8) and (9) we expect an increasing ERPT and a declining ERPA over time.

The following sections push the analysis further, by testing more specific theoretical predictions.

4.2 Pass-through and pass-around for single-price and pricing-to-market firms

Our model categorizes firms into two distinct types: Pricing-to-market firms and single-price firms. The pass-around effect is specific to single-price firms only. By contrast, pricing-to-market firms should not show any ERPA ($\beta = 0$), and specification (12) may reveal an incomplete EPRT ($\alpha > 0$) in the case of variable elasticity of demand. The estimates shown in the previous section only reflect the average impact of the exchange rate shock on these two types of firms, and depend strongly on the proportion of each group in the population at any given time. Ideally, we would like to assess the impact on each group separately.

The distinction between single-price and pricing-to-market firms defined theoretically is, of course, not directly observable in the data. In practice, this is made difficult by the high volatility of monthly transaction prices by destination, and by the fact that firms facing economic shock are likely to change their pricing strategy, as described in section 2.1.

We therefore build on a measure of the variance of firm prices to help identify those firms that most frequently price differently in different markets. However, it is necessary to distinguish between variance in time and in space in order to extract price differences between destinations from temporal fluctuations. To do so, we rely on an entropy index of inequality. Entropy indices measure the concentration of statistical distributions and, as such, they can be applied to a variety of situations, as noted by Brülhart and Traeger (2005). These indices have the double advantage of being simple and exactly decomposable into between and within sub-indices. Precisely, the overall dispersion of prices charged by a given firm in different markets over a given number of time periods can be decomposed into the sum of a within- and a between-country dispersion.

[8]The sample is similar to the one used for regressions shown in lines (9)-(10) of Table 2. It excludes firms importing from Switzerland and focuses on differentiated products.

For our purposes we retain the simplest entropy measure, the Theil index, defined as follows:

$$\textit{Theil}_i = \frac{1}{N_i} \sum \frac{p_{idt}}{\bar{\bar{p}}_i} \log \frac{p_{idt}}{\bar{\bar{p}}_i},$$

where p_{idt} is the price charged by firm i on market d at date t, N_i is the number of non-zero export flows for firm i and $\bar{\bar{p}}_i$ is the overall average of i's prices. The between index, $\textit{TheilB}_i$, captures the price heterogeneity across markets for firm i. The within index, $\textit{TheilW}_i$, measures the average price heterogeneity within each destination market. It is a weighted average of price heterogeneity within each market (i.e., across time) served by i. Obviously, $\textit{Theil}_i = \textit{TheilW}_i + \textit{TheilB}_i$. The within component of the Theil index is given by:

$$\textit{TheilW}_i = \sum_d \left(\frac{N_{id}}{N_i}\right) \left(\frac{\bar{p}_{id}}{\bar{\bar{p}}_i}\right) \textit{Theil}_{id},$$

where, $\textit{Theil}_{id}$ is the Theil index of prices of firm i in market d, N_{id} is the number of non-zero export flows to destination d, declared by firm i, and $\bar{p}_{id}$ is the average of the prices charged by firm i on market d.[9]

Figure 7 shows the decomposition of the 2014 export price variance measured by the Theil index by percentiles of firm size, measured by their total exports to the Eurozone and Switzerland. A few key features emerge. First, the price variance of French exporters, over the year 2014 and in the European neighborhood, is shared almost equally between the two margins. On average the between component represents 54% of the total Theil index.[10] Leaving aside the very small firms — which have very sporadic export flows with sometimes very erratic prices — we also observe a fairly clear relationship between firm size and the importance of the between dimension in the total variance of export prices. This supports the hypothesis that pricing-to-market behavior is more easily accessible to large firms, who are able to pay a fixed cost.

In Table 3 we interact the *ERPT* and *ERPA* treatment variables with dummies indicating whether the treated firms has a *TheilB* above or below the median. As in Table 2, we expand the treatment window from three months (regressions 1-2 and 7-8) to 5 months (regressions 3-4 and 9-10) and 11 months (regressions 5-6 and 11-12). In regressions 7-12, we restrict the

[9]In their analysis of exporter prices heterogeneity, Fontaine et al. (2020) adopt an alternative approach, based on a heuristic measure of price variance and decomposition. They decompose the total variance of prices, $\textit{VarT}_i$, in a between-country component ($\textit{VarB}_i$) and a within-country one ($\textit{VarW}_i$), such that:

$$\begin{aligned}\textit{VarT}_i &= \frac{\sum_{d,t}(p_{idt} - \bar{\bar{p}}_i)^2}{N_i - 1} \\ &= \underbrace{\sum_d \left[\frac{N_{id} - 1}{N_i - 1}\right] \left[\frac{\sum_t (p_{idt} - \bar{p}_{id})^2}{N_{id} - 1}\right]}_{\textit{VarW}_i} + \underbrace{\sum_d \left[\frac{N_{id}}{N_i - 1}\right] [\bar{p}_{id} - \bar{\bar{p}}_i]^2}_{\textit{VarB}_i}.\end{aligned}$$

In our sample, the correlation between $\textit{Theil}_i$ and $\textit{VarT}_i$ is above 95%, so as the one between $\textit{TheilB}_i$ and $\textit{VarB}_i$. The advantage of the Theil index is its theoretically exact decomposition.

[10]Note that the share of the between dimension is significantly higher for firms that export to Switzerland (62%).

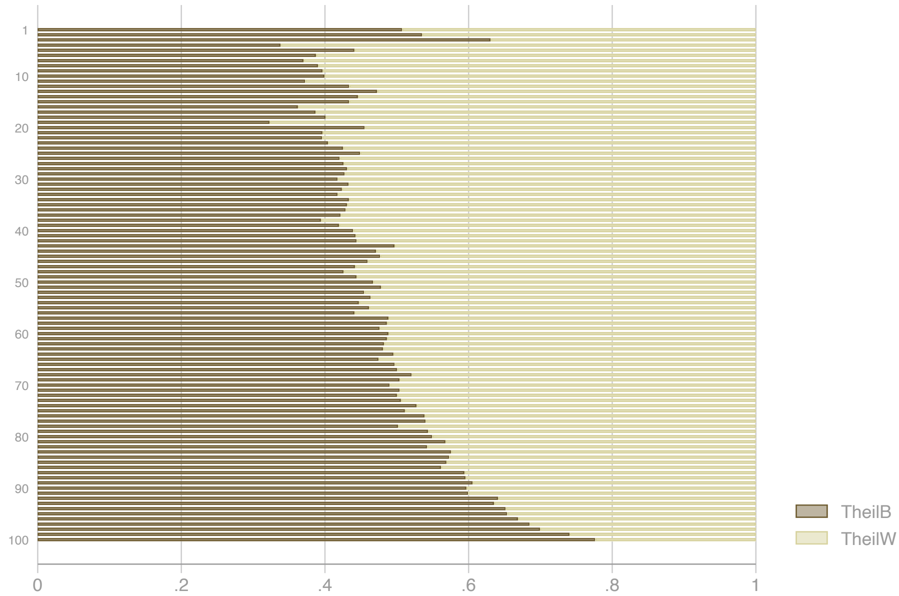


Figure 7: Decomposition of the Theil index - Medians by percentiles of firms' exports to Eurozone+CH

sample of destinations to Switzerland and its bordering countries.

We observe a clear difference in the behavior of firms depending on whether they have a large or low *TheilB*, which corroborates our theoretical predictions.

In the first quarter following the exchange rate shock, firms with a high *TheilB* – hence with a relatively higher ability set different prices to different markets – increased significantly their prices in the Swiss market relative to the ones in other markets (cf. regressions 1 and 7). The coefficient 0.027 obtained from regression (1) suggests an incomplete pass-though of 80.5%,[11] lower than the estimate obtained with the full sample in table 2. The pass-through is even smaller if we consider border countries only (70.8% – Cf. coefficient 0.04 in regression 7). Over time, this pass-through decreases slightly, with a coefficient α increasing from 0.027 in regression 1 to 0.041 in regression 5. Interestingly, these firms do not show a significant pass-around. The absence of a pass-around is the theoretical expectation for pricing-to-market firms. Note however that the incomplete pass-through we observe (α positive but small) is not a prediction of our simple model with constant markup and marginal cost. Rather, this result supports the model extensions proposed in section 2.2.

The contrast with the coefficients on treatment variables interacted with the dummy characterising firms with a low *TheilB* is striking. The coefficient α is very small and statistically insignificant on the short run (0.009 in regression 1 and 0.017 in regression 7). The absence of significance does not mean that these firms have not increased their prices on the Swiss market. In fact, as expected from firms with limited pricing-to-market behavior, they exhibit a large and significant pass-around. For this group of firms, the coefficient β is 0.024 (in regression

[11]This is computed, taking an appreciation of the Swiss Franc of 14%, as: $100 * \left[1 - (e^{0.027} - 1)/0.14\right] = 80.5$.

Table 3: Firm-level price heterogeneity, exchange rate pass-through (ERPT) and pass-around (ERPA) for High and Low *TheilB* firms

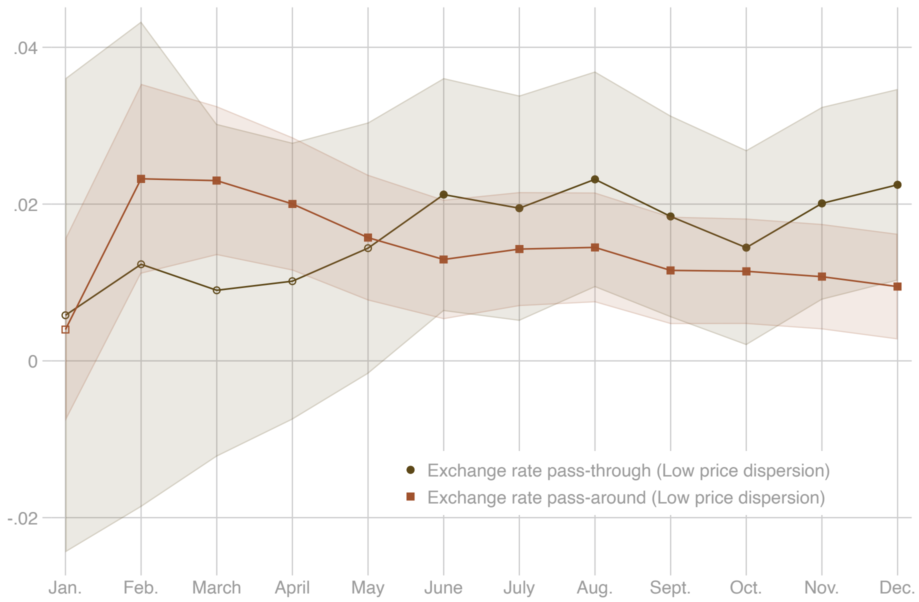
	Destinations	Treatment period	Variable	Coefficient	Standard err.	Sample size
(1)	Eurozone	Feb-Apr.	$\text{ERPT}_{c,t}$ × *TheilB*<p50	0.009	(0.011)	1,223,674
			$\text{ERPT}_{c,t}$ × *TheilB*>p50	0.027b	(0.012)	
(2)			$\text{ERPA}_{i,k,t}$ × *TheilB*<p50	0.024a	(0.006)	1,210,759
			$\text{ERPA}_{i,k,t}$ × *TheilB*>p50	0.008	(0.006)	
(3)	Eurozone	Feb-June	$\text{ERPT}_{i,k,t}$ × *TheilB*<p50	0.017c	(0.009)	1,380,809
			$\text{ERPT}_{i,k,t}$ × *TheilB*>p50	0.033a	(0.010)	
(4)			$\text{ERPA}_{i,k,t}$ × *TheilB*<p50	0.014a	(0.005)	1,366,254
			$\text{ERPA}_{i,k,t}$ × *TheilB*>p50	0.006	(0.006)	
(5)	Eurozone	Feb-Dec.	$\text{ERPT}_{i,k,t}$ × *TheilB*<p50	0.022a	(0.007)	1,931,232
			$\text{ERPT}_{i,k,t}$ × *TheilB*>p50	0.041a	(0.009)	
(6)			$\text{ERPA}_{i,k,t}$ × *TheilB*<p50	0.009b	(0.004)	1,908,636
			$\text{ERPA}_{i,k,t}$ × *TheilB*>p50	-0.001	(0.004)	
(7)	Border	Feb-Apr.	$\text{ERPT}_{c,t}$ × *TheilB*<p50	0.017	(0.012)	377,496
			$\text{ERPT}_{c,t}$ × *TheilB*>p50	0.040a	(0.014)	
(8)			$\text{ERPA}_{i,k,t}$ × *TheilB*<p50	0.028a	(0.008)	364,581
			$\text{ERPA}_{i,k,t}$ × *TheilB*>p50	0.003	(0.009)	
(9)	Border	Feb-June	$\text{ERPT}_{i,k,t}$ × *TheilB*<p50	0.022b	(0.010)	425,237
			$\text{ERPT}_{i,k,t}$ × *TheilB*>p50	0.042a	(0.012)	
(10)			$\text{ERPA}_{i,k,t}$ × *TheilB*<p50	0.014b	(0.007)	410,682
			$\text{ERPA}_{i,k,t}$ × *TheilB*>p50	0.002	(0.008)	
(11)	Border	Feb-Dec.	$\text{ERPT}_{i,k,t}$ × *TheilB*<p50	0.026a	(0.009)	594,881
			$\text{ERPT}_{i,k,t}$ × *TheilB*>p50	0.051a	(0.010)	
(12)			$\text{ERPA}_{i,k,t}$ × *TheilB*<p50	0.011b	(0.006)	572,285
			$\text{ERPA}_{i,k,t}$ × *TheilB*>p50	-0.001	(0.006)	

Notes: Significance levels: c: $p < 0.1$, b: $p < 0.05$, a : $p < 0.01$. Pre-treatment period: Jan.-Dec. 2014. Standard errors are clustered by firm-product-year. The dependent variable is the log of export prices denominated in Euros. Border countries are Germany, Italy and Austria. All regressions exclude firms that import from Switzerland in 2015 and homogeneous and referenced price products (cf.Rauch's liberal product classification).

1), which is slightly smaller than the α estimated for high *TheilB* firms (0.027 in regression 1). In other words, the estimates suggest that the low *TheilB* firms have certainly increased their prices on the Swiss market, but they simply raised them as much as they did in other Eurozone countries. The magnitude of the pass-around is quite large for this group of firms. We estimate a non-negligible price increase in the Eurozone countries of 2.4% (and 2.8% in Switzerland's neighboring countries). The behavior of the low *TheilB* firms evolved gradually throughout 2015: The coefficient β decreases while α increases. This dynamic can be seen more clearly in Figures 8.

Analogous to Figure 6, Figure 8 shows the dynamics of the pass-through and pass-around effect when we expand progressively the treatment window. The estimates underline the absence of a pass-around effect and a stable pass-through for high *TheilB* firms. For firms with a lower *TheilB*, the pass-around effect fades very slowly during 2015, while we observe a small increase

(a) Low price dispersion (*TheilB* $<$ median)



(b) High price dispersion (*TheilB* $>$ median)

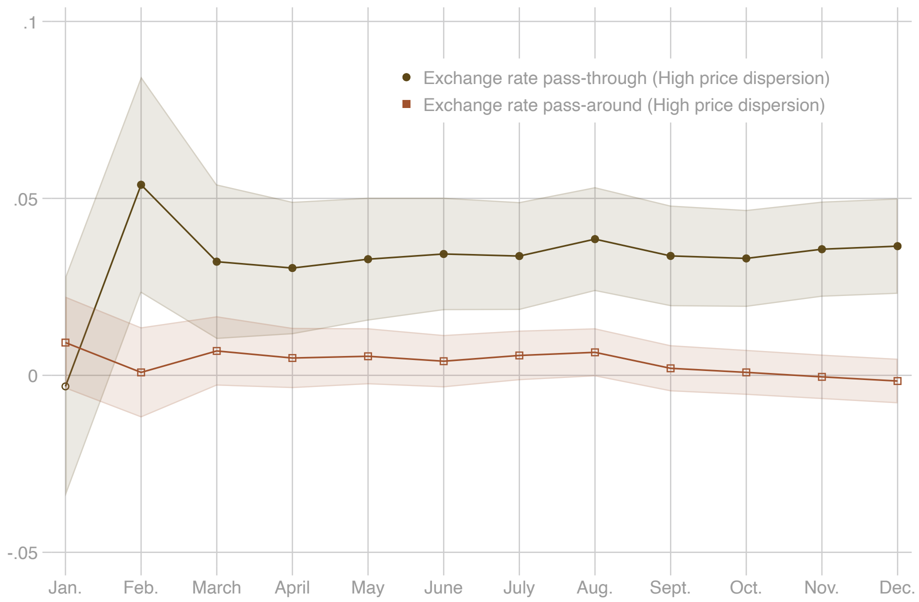


Figure 8: Exchange rate pass-through and pass-around for high and low firm-level price dispersion across destinations

of α over time. This is in line with the theoretical predictions about mean price changes as firms change their behavior progressively, as discussed in section 2.1 above.

4.3 ERPA and price differences between countries

The theoretical framework predicts a pass-around for single-price firms, which can be positive or negative. The magnitude and the sign of the pass-around depend on the difference between the destination-specific marginal costs, c_S and c_E. In the empirical analysis above we have

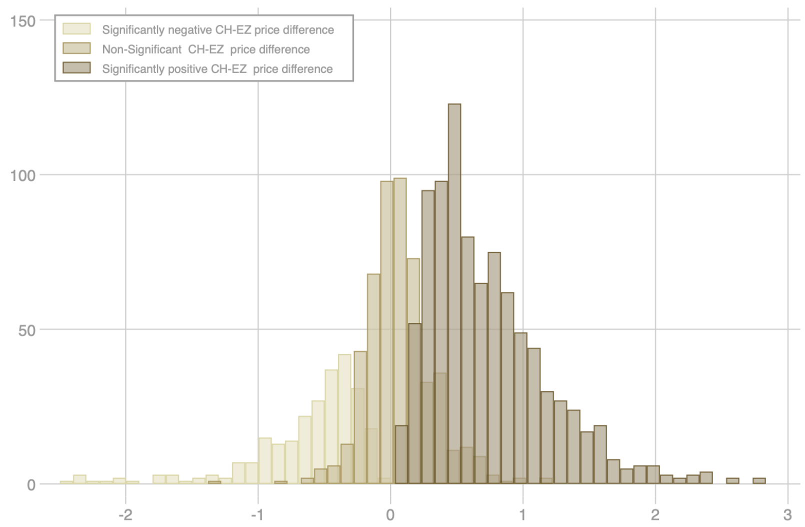


Figure 9: Eurozone - CH price difference (2014, by nc8 products)

found a positive exchange rate pass-around ($\beta > 0$), consistent with our model when $c_S > c_E$ or, equivalently, $p_S^{FOB} > p_E^{FOB}$. This section verifies that this condition holds and discusses the relationship between prices differences between the Swiss and the Eurozone markets and the magnitude of the the pass-around.

To achieve the first goal, we estimate the price difference between Switzerland and all Eurozone countries in 2014 for each NC8 product separately. For each product, we regress the log of firms' export prices, $\ln p_{i,k,c,t}$, on time fixed effects and a dummy variable that takes the value 1 for export flows to Switzerland. The coefficient on this dummy measures the price differential. Figure 9 below shows the frequency distribution of the coefficients on this dummy, estimated for 1,696 differentiated products. They vary widely (from -2.5 to 2.7), but they are clearly positive on average (both the average and median are about 0.32). There are 72.7% positive coefficients; 54.25% are significantly positive, only 15.21% are significantly negative and 30.54% are not statistically different from zero. This clear dominance of positive price differentials between Switzerland and the Eurozone is consistent with the observation of a positive pass-around. However, for the purpose of investigating how price differentials shape the size of the pass-around, these measures of price differentials are not ideal.

One difficulty is that we do not directly observe marginal costs (c_S and c_E), which are, in our model, the key determinants of the pass-around, but only price differences. This is not an issue in a discussion of the sign of the pass-around. Here the predictions are clear: A positive (negative) price difference should lead to a positive (negative) pass-around. However, positive price differences are a very imperfect measure for predicting the magnitude of possible positive pass-around. A moderate price difference for a given product may reflect a small difference in marginal costs and therefore a low expected pass-through. But it may also reflect the fact that a large proportion of exporters have a single price strategy, leading to a high pass-around for this product. Conversely, products that exhibit a large price differentials are inevitably exported mainly by pricing-to-market firms, which will not pass on the exchange rate shock to third

Table 4: Exchange rate pass-around for low and high price differences

	Price Diff.	Treatment period	Variable	Coefficient	Standard err.	Sample size
(1)		Feb-Apr	$\text{ERPA}_{i,k,t}$	0.011b	(0.005)	904,595
			$\text{ERPA}_{i,k,t}$ $\times\text{PriceDiff}_k$	0.031a	(0.011)	
(2)		Feb-June	$\text{ERPA}_{i,k,t}$	0.004	(0.005)	1,019,936
			$\text{ERPA}_{i,k,t}$ $\times\text{PriceDiff}_k$	0.034a	(0.010)	
(3)		Feb-Dec	$\text{ERPA}_{i,k,t}$	-0.000	(0.004)	1,438,487
			$\text{ERPA}_{i,k,t}$ $\times\text{PriceDiff}_k$	0.024a	(0.007)	
(4)	Signif. < 0	Feb-Apr	$\text{ERPA}_{i,k,t}$	0.007	(0.013)	166,866
(5)	Non Signif. $\neq 0$	Feb-Apr	$\text{ERPA}_{i,k,t}$	0.003	(0.008)	276,983
(6)	Signif. > 0	Feb-Apr	$\text{ERPA}_{i,k,t}$	0.028a	(0.006)	460,746
(7)	Signif. < 0	Feb-June	$\text{ERPA}_{i,k,t}$	0.002	(0.012)	166,866
(8)	Non Signif. $\neq 0$	Feb-June	$\text{ERPA}_{i,k,t}$	-0.006	(0.007)	276,983
(9)	Signif. > 0	Feb-June	$\text{ERPA}_{i,k,t}$	0.023a	(0.005)	460,746
(10)	Signif. < 0	Feb-Dec	$\text{ERPA}_{i,k,t}$	-0.002	(0.009)	187,696
(11)	Non Signif. $\neq 0$	Feb-Dec	$\text{ERPA}_{i,k,t}$	-0.002	(0.006)	311,520
(12)	Signif. > 0	Feb-Dec	$\text{ERPA}_{i,k,t}$	0.010a	(0.004)	520,720

Notes: Significance levels: c: p< 0.1, b: p < 0.05, a : p < 0.01. Pre-treatment period: Jan.-Dec. 2014. Standard errors are clustered by firm-product-year. The dependent variable is the log of export prices denominated in Euros. All regressions exclude firms that import from Switzerland in 2015 and homogeneous products (cf. Rauch's liberal product classification). The sample of exporters to Switerland includes low-$TheilB$ firms only.

countries. We therefore propose a slightly different strategy. As before, we use the observed prices of exports to Switzerland and the euro area in 2014 to estimate price differences. But now we do it on the sub-sample of exports to Switzerland by firms with a high level of *TheilB* (above the median). We then estimate the impact of the price difference on pass-through on the sample of exporters with a low level of *TheilB*. Hence, the two pieces of information are coming from two different samples of exporters to Switzerland: the price differences are estimated from flows of exporters that are more likely pricing-to-market firms, while the pass-arounds are estimated on the sample of firms that are more likely single-price.[12] Estimation results are shown in table 4.

Lines (1) to (3) report the estimates of equation 13 augmented with an interaction term between our treatment variable, $\text{ERPA}_{i,k,t}$, and the estimated product-level price gap between Switzerland and the Eurozone. In line with our theoretical predictions, the coefficient on this interaction term is positive and highly significant regardless of the size of the treatment window. Alternatively, lines (4)-(6), (7)-(9) and (10)-(12) estimate the specification 13 on three different groups of products: those with a negative price gap, those for which the gap is not statistically significant, and those for which the gap is strictly positive. Our model suggests that the pass-around should be negative for the first group, zero for the second and positive for the last. The

[12]This strategy requires that we observe both high-*TheilB*. and low-*TheilB*. firms for each product, which is a severe limitation. Therefore, to avoid reducing our sample too much, price differences are estimated here at the HS6 product level, which is more aggregated than the nc8 level.

first of these predictions is not supported by the data, which may be explained by the existence of downward price rigidity. Nevertheless, for these products, with prices in Switzerland lower than elsewhere, the coefficient on the ERPA variable is very low and far from the significance threshold. Conversely, our results corroborate the predictions for the other two product groups. We observe the expected absence of pass-through for products where the price difference is not significant. We also observe very strong, significant, and persistent pass-through when Swiss prices are significantly higher than those in other countries.[13]

4.4 Pass-around and trade costs to Switzerland

The ERPA in our model is sensitive to trade costs to the Swiss market and to its size as shown in equation (7). Since we focus on a single exchange rate shock, we cannot assess the role of the importer market size, as it is of course the same for all firms. Instead, we exploit the variance of distances between exporters to Switzerland to focus on the influence of trade costs on the magnitude of the pass-around. Simulations for the parameter values discussed above in relation to equation (7) predict a stronger ERPA for firms with smaller trade frictions to Switzerland.

To approximate trade costs for French firms to their Swiss consumers, we compute the road distance from each firm's municipality to Switzerland.[14] For firms with multiple establishments located in different cities, we retrain the shortest distance. Bilateral distances to Switzerland are computed as the weighted average of the closest road access between each French municipality to the geographical centroid of each the 26 Cantons of Switzerland.[15] Those distances are then weighted by the respective Cantons' share in total Swiss imports from France, similar to Hinz (2017).

Being equipped with a proxy for firm-specific trade costs to Switzerland, we run a series of estimates of equation (13), with different samples of firms defined by their maximum road time travel to Switzerland. We start with a set of firms located less than 1 hour and 15 minutes drive from the centre of Switzerland, then we enlarge the sample by steps of fifteen minutes, up to 11 hours (the few firms located in French municipalities that are more than 11 hours away from Switzerland are gathered in the last bin).

Estimates are shown graphically in Figure 10. We see clearly the expected negative relationship between the magnitude of the exchange rate pass-around and trade costs to reach the Swiss market. The closer the firms exposed to the exchange rate shock are to Switzerland, the more

[13] Note that a similar exercise, but based on the whole sample of firms both to measure price differences by product and to estimate the pass-around, also gives results in line with the predictions. But the pass-around appears more clearly for products whose price difference is positive, but not significant. This confirms the intuition that the measurement of price differences is tainted by the proportion of pricing-to-market firms (which, according to our model, reveal the price difference, but have no pass-around).

[14] We only know the municipality of firms, not their exact geolocation. Since French cities are small and numerous ($\approx$ 35,000), we expect the error induced by the use of the coordinates of the municipality instead of those of the firm to be fairly small. As a comparison there are only about 11,000 in Germany.

[15] Distances are computed using the Open Source Routing Machine (Luxen and Vetter, 2011).

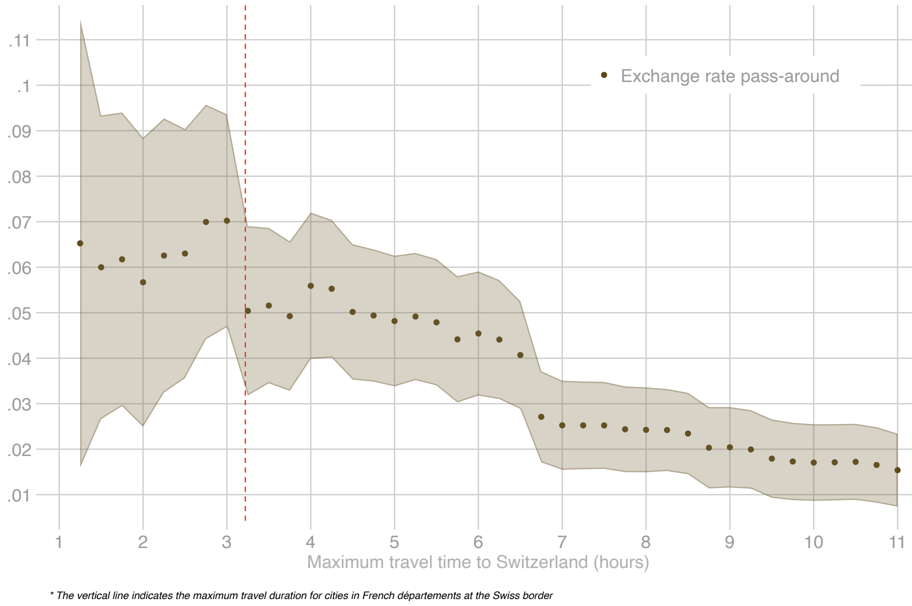


Figure 10: Exchange rate pass-around and travel time to Switzerland

they increase their prices on the Eurozone markets after the Swiss Franc appreciation. Interestingly, we observe also a form of border effect. The vertical dotted line shows the maximum travel time between Switzerland and French cities located in departments bordering Switzerland.[16] It is clear that firms in these departments react more strongly than others.

5 Conclusion

In this paper, we have proposed a new theoretical explanation for the incompleteness of the pass through. The novelty of the explanation is in that it takes into account the multilateral aspect of price setting. In our model, some firms opt for a multilateral strategy of pricing-to-market; some other firms opt for single-pricing. For the latter firms, an exchange rate shock affects prices to all destinations. We have named this repercussion the Exchange Rate Pass Around (ERPA) and we have documented it empirically. The proposed theoretical mechanism can explain both the ERPA and the incompleteness of the exchange rate pass-through. In our empirical analysis we have used monthly French firm-level customs data, confirming the existence of the exchange rate pass-around effect and quantifying its magnitude. French exporters, who were exposed to the sudden and unexpected appreciation of the Swiss Franc in January 2015 and had previously invoiced their exports to Switzerland in Euros, also saw a sudden change in export prices *to their Eurozone* customers. While the estimated impact of the pass-around effect is economically modest and fades away over the longer term, its driving mechanism — a single-pricing strategy — generates an incomplete pass-through that had so far remained unexplored in the literature.

[16]The French departments are administrative and geographical units corresponding to the NUTS3 of the European classification. The French continental territory is divided into 94 departments.

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A Appendix: The case of CHF invoices

In Table 5, we show estimates of our two models on the sample of treated firms made of those exporting to Switzerland in Swiss Franc. Comforting the stylized fact shown in Figure 3, the estimated pass-through is very large. During the first quarter following the exchange rate shock, exporters prices on the Swiss market, while converted in Euros, increased by 16.5%. This simply means that the pass-through is zero: French exporters invoicing in CHF did not change significantly their CHF prices and therefore absorbed all the currency shock. However, they gradually adjusted their prices over the course of 2015. From a zero pass-through during the first quarter, they moved to a roughly 50% pass-through by the end of 2015 (cf coefficient 0.072 on line 5 of Table 3. Contrasting with firms invoicing in Euros, there is no significant pass-around, in the short run, in the Eurozone for exporters invoicing in CHF. However, as the exporters adjust their prices on the Swiss market, we observe a rise of the pass-around, especially on the markets close to Switzerland (see lines 10 and 12).

Table 5: Exchange rate pass-through (ERPT) and pass-around (ERPA) for firms invoicing in CHF

	Currency	Importers	Homog. goods	Destinations	Treatment period	Variable	Coefficient	Standard err.	Nb. Obs.
(1)	CHF	No	No	EZ	Feb-Apr	$\text{ERPT}_{c,t}$	0.165a	(0.021)	1,471,358
(2)	CHF	No	No	EZ	Feb-Apr	$\text{ERPA}_{i,k,t}$	0.013	(0.033)	1,471,358
(3)	CHF	No	No	EZ	Feb-Jun	$\text{ERPT}_{c,t}$	0.134a	(0.018)	1,665,090
(4)	CHF	No	No	EZ	Feb-Jun	$\text{ERPA}_{i,k,t}$	0.016	(0.011)	1,665,090
(5)	CHF	No	No	EZ	Feb-Dec	$\text{ERPT}_{c,t}$	0.072a	(0.019)	2,265,268
(6)	CHF	No	No	EZ	Feb-Dec	$\text{ERPA}_{i,k,t}$	0.045c	(0.027)	2,265,268
(7)	CHF	No	No	Border	Feb-Apr	$\text{ERPT}_{c,t}$	0.160a	(0.033)	445,749
(8)	CHF	No	No	Border	Feb-Apr	$\text{ERPA}_{i,k,t}$	0.016	(0.019)	445,749
(9)	CHF	No	No	Border	Feb-Jun	$\text{ERPT}_{c,t}$	0.112a	(0.030)	503,867
(10)	CHF	No	No	Border	Feb-Jun	$\text{ERPA}_{i,k,t}$	0.030c	(0.017)	503,867
(11)	CHF	No	No	Border	Feb-Dec	$\text{ERPT}_{c,t}$	0.008	(0.033)	683,417
(12)	CHF	No	No	Border	Feb-Dec	$\text{ERPA}_{i,k,t}$	0.053b	(0.025)	683,417

v *Notes:* Significance levels: c: p< 0.1, b: $p < 0.05$, a : $p < 0.01$. Pre-treatment period: Jan.-Dec. 2014. Standard errors are clustered by firm-product-year. The dependent variable is the log of export prices denominated in Euros. Border countries are Germany, Italy and Austria. All regressions exclude firms that import from Switzerland in 2015 and homogeneous products (cf.Rauch's liberal product classification.

B Appendix: Robustness check

Our econometric specification for estimating the exchange rate pass-through and pass-around is a typical difference-in-differences study, based on a two-way fixed effects (TWFE) estimator. This estimator has been proved to produce misleading results, if the treatment is fuzzy or heterogeneous between groups and/or time.

At first glance, the setting of our difference-in-differences analysis is free of these concerns. The increase of the exchange rate is obviously the same for all firms; The intensity of treatment is homogeneous for all firms and (given the relative stability of the EUR-CHF exchange rate during 2015) does not vary much over time. We are not either in the case of a staggered treatment where different groups of units receive the treatment at different times (Goodman-Bacon, 2021). However, in practice, the treatment does not really apply simultaneously to all firm-destination pairs because firms do not export continuously to each destination. Firms' shipments are sporadic, and treated firms only effectively perceive the treatment in those months of 2015 in which they export. The severely unbalanced nature of our panel makes our design more complicated than it might seem, and a legitimate concern is that our two-way fixed effect estimators is not equivalent to a difference-in-differences and leads to non-robust conclusions (De Chaisemartin and D'Haultfoeuille, 2023).

It turns out, however, that the threat to our estimates is limited. Using the *twowayfeweights* command (De Chaisemartin and D'Haultfoeuille, 2020) to estimate the weights attached to our benchmark estimates of pass-through and pass-around effects (cf. rows 5 and 6 of Table 2), we find that the proportion of negative weights is very low. It is 0.42% for the pass-through estimate and 0.7% for the pass-around (with sum of negative weight of -1.335×10^{-6} and -1.161×10^{-5} respectively).

Nevertheless, we perform a simple robustness check to address this potential concern. We construct a balanced panel allowing to conduct an event study with a design that ensures the equivalence between the two-way fixed effects and the difference-in-difference estimator. We aggregate our monthly data by consecutive periods of three months: January-March 2014, April-June 2014, July-September 2014, October-December 2014, February-April 2015 and May-July 2015 (note that we therefore exclude January 2015). Then, we retain firm-product-country triads that are active both during the pre-treatment period and the first post-treatment period (February-April 2015). We obtain a balanced panel with a perfectly uniform treatment over the whole treated group. Table 6 confirms the results reported in section 4. The table reports the TWFE estimates on this balanced panel, along with results provided by the *did multiplet* and the *csdid* estimators (cf. De Chaisemartin and D'Haultfoeuille (2020) and Callaway and Sant'Anna (2021), respectively). The results are consistent with those presented in the main text.

Table 6: Robustness check - Balanced sample with aggregate data by quarters

	Estimator	Treatment period	Variable	Coefficient	Standard err.	Sample size
(1)	TWFE	Feb-Apr	$\text{ERPT}_{c,t}$	0.011	(0.008)	930,400
(2)	did multiplegt	Feb-Apr	$\text{ERPT}_{c,t}$	0.016	(0.010)	930,400
(3)	csdid	Feb-Apr	$\text{ERPT}_{c,t}$	0.004	(0.010)	930,400
(4)	TWFE	Feb-Apr May-Jul	$\text{ERPT}_{c,t}$	0.011c	(0.006)	1,079,648
(5)	did multiplegt	Feb-Apr May-Jul	$\text{ERPT}_{c,t}$	0.016b	(0.009)	1,079,648
(6)	csdid	Feb-Apr May-Jul	$\text{ERPT}_{c,t}$	0.014b	(0.006)	1,079,648
(7)	TWFE	Feb-Apr	$\text{ERPA}_{i,k,t}$	0.010a	(0.003)	870,265
(8)	did multiplegt	Feb-Apr	$\text{ERPA}_{i,k,t}$	0.008b	(0.003)	870,265
(9)	csdid	Feb-Apr	$\text{ERPA}_{i,k,t}$	0.013a	(0.004)	870,265
(10)	TWFE	Feb-Apr May-Jul	$\text{ERPA}_{i,k,t}$	0.005c	(0.003)	1,007,881
(11)	did multiplegt	Feb-Apr May-Jul	$\text{ERPA}_{i,k,t}$	0.012a	(0.004)	1,007,881
(12)	csdid	Feb-Apr May-Jul	$\text{ERPA}_{i,k,t}$	0.007b	(0.003)	1,007,881
(13)	TWFE	Feb-Apr	$\text{ERPA}_{i,k,t} \times$ TheilB<p75	0.014a	(0.003)	870,265
			$\text{ERPA}_{i,k,t} \times$ TheilB>p75	0.002	(0.006)	
(14)	TWFE	Feb-Apr May-Jul	$\text{ERPA}_{i,k,t} \times$ TheilB<p75	0.005c	(0.003)	1,007,881
			$\text{ERPA}_{i,k,t} \times$ TheilB>p75	0.005	(0.005)	

Notes: Significance levels: c: p< 0.1, b: p < 0.05, a : p < 0.01. Pre-treatment period: Four quarters of 2014. Standard errors are clustered by firm-product-year. The dependent variable is the log of export prices denominated in Euros. Monthly data are aggregated by quarters. The sample excludes importers from Switzerland, homogeneous products, firms that do not invoice their shipments to Switzerland in Euros.