Pricing-to-market and exchange rate expectations*

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Abstract

This paper contributes to the literature on pricing-to-market by assessing whether and to what extent firms take into account the expected future evolution of the exchange rate while setting their export prices. Using French micro-level trade data and exploiting the expectations of future bilateral exchange rates reported by a large pool of financial intermediaries and investors, the empirical analysis reveals that firms adjust their export prices, absorbing part of both the observed and the expected future variations. Estimations exploiting firm heterogeneity in terms of market power and intensity of imported inputs show that the elasticity of export prices to the expected exchange rate variations depends on the former, in accordance with theoretical dynamic demand-side models encompassing mechanisms creating an intertemporal relationship between current market shares and future profits. Moreover, the analysis shows that the strength of such expectation-related mechanism is considerably reduced when the uncertainty regarding future exchange rates is greater, in line with an interpretation of pricing-to-market as an investment decision under uncertainty.

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1 Introduction

A major puzzle in international macroeconomics is why movements of the prices of imported goods do not fully reflect the corresponding changes in the exchange rate. In the attempt to account for such an evidence, known as incomplete exchange rate pass-through (ERPT hereafter), the economic literature has proposed a number of possible explanations. These are based either on general features of the economic environment (such as the existence of nominal rigidities to price adjustment, of local trade and distribution costs, and the like) or on actual pricing decisions implemented at the firm level.[1] In particular, since the seminal work in Krugman (1986), it is known that exporting firms might well decide to adjust their markups so as to limit purposefully the transmission of exchange rate variations into consumer prices. This mechanism, known as pricing-to-market (PTM hereafter), has received a lot of attention as a possible explanation for incomplete ERPT.[2] Recently, a growing body of work has linked pricing-to-market decisions to firm-level characteristics, showing that pricing strategies are heterogeneous across exporters and depend on their level of productivity, market shares, import intensity, output quality and the like. A surprisingly neglected fact regarding firm-level pricing decisions is that, when adjusting their export prices, firms do not only take into account the currently observed exchange rate changes, but they also consider the expected evolution of the currency value in the future. Indeed, evidence from firm-level surveys suggests that most firms are forward-looking and consider all the available information about both the present and the future expected movements of their pricing determinants (e.g. exchange rate, demand, costs, competitors' prices, and the like).[3] This forward-looking dimension is particularly important when current pricing decisions exert sizeable effects on the performance of the firm also in the future.

By bringing into the literature on PTM the role played by the expected variations in the exchange rate, this paper provides new evidence on exporters' pricing behavior. More precisely, it contributes to the existing literature on export pricing and PTM decisions by exploring empirically whether and to what extent the expected changes in the exchange rate influence the changes in firms' current export prices. Our empirical analysis reveals three main findings.

First, we provide evidence that expectations about future exchange rate movements impact firms' current export pricing decisions. Indeed, prices set by exporters react not only to the observed changes in the exchange rate but also to the movements expected to happen in the near future. The elasticity of French firms' export prices to observed changes is around 0.33, a value in line with the existing evidence.[4] The price elasticity with respect to expected future exchange rate variations is about 0.37, a value very similar to that of current variations. Besides being in line with what generally stated by firms in the context of qualitative surveys, this finding is in accordance with different theoretical frameworks, that will be reviewed and discussed in Section 2, according to which forward-looking firms engage in dynamic price setting and consider both present and expected future variations in the main determinants of their pricing decisions (See Froot and Klemperer, 1989; Alessandria, 2009; Alessandria et al., 2010, among others).

Second, the estimates provided in this work add new evidence on the role of firm heterogeneity

[1] See Burstein and Gopinath (2013) for a comprehensive survey of this strand of the literature.

[2] Generally speaking, producers price to market when they choose a different markup for the same product in different markets. In the context of international markets, firms can adjust their markups across countries with a view to reacting to destination-specific exchange rate movements that would otherwise be entirely transmitted to consumers. This behavior is conducive to pricing-to-market strategies and incomplete ERPT.

[3] See for example Fabiani et al. (2006), Langbraaten et al. (2008) and Greenslade and Parker (2012).

[4] Using year transaction level data for French exporters, Berman et al. (2012) find an estimated elasticity of around 0.25, while Chatterjee et al. (2013) conclude that the producer price elasticity for Brazilian exporters is approximately 0.23.

in export pricing. Firms do not only respond differently to the observed exchange rate variations, but they also exhibit heterogeneous reactions to the expected changes in the future. Our results show that firms with larger market shares tend to react more to expected exchange rate changes, whereas heterogeneity in the extent to which firms import their inputs is not accompanied by diverse responses to future movements in the exchange rate. This provides *prima facie* evidence consistent with the idea that firms with diverse market shares differ in their responsiveness to expected variations (Froot and Klemperer, 1989).

Third, our empirical investigations show that the degree of uncertainty about future exchange rate fluctuations reduces the sensitivity of prices to expected exchange rate movements: when the disagreement among forecasters about future expected variations in the exchange rate is higher, expectations become relatively less important and companies mainly react to the observed changes in the exchange rate. This novel evidence, in line with the empirical results discussed in Bloom (2014) concerning macroeconomic uncertainty in general, supports the idea of state-contingent pricing decisions and, more precisely, indicates that exporters are more cautious to respond to future expected changes when these latter are more uncertain.

The ambition of this paper is to bridge and merge distinct branches of the literature typically left apart, while providing new empirical evidence on the determinants of firms' export pricing. First, and most importantly, this study contributes to the almost nonexistent literature that, using micro data, investigates the role of exchange rate expectations in shaping pricing-to-market strategies. To the best of our knowledge, the only paper tackling this issue is Li and Zhao (2016). While similar in spirit, this work differs from Li and Zhao (2016) along various dimensions. Our paper focuses on many exchange rates as it involves various destinations for French products: they are all market economies for which the exchange rate was free to float. On the contrary, Li and Zhao (2016) investigate trade transactions between China and the US between 2000 and 2008, a period when the exchange rate between the US Dollar and the Chinese Renminbi was not free to float as it was manipulated by the Chinese authorities in a rather predictable way within a regime of strict capital controls. Furthermore, by exploring firm-heterogeneity in PTM, our work provides evidence in favor of those theories of price-setting in which firms' decisions are affected by dynamic demand-side mechanisms, whereas Li and Zhao (2016) refer only to alleged price rigidities to motivate firms' forward-lookingness. Finally, by exploiting for the first time the uncertainty surrounding the expected developments of the exchange rate, this work explores whether this source of uncertainty affects firm-level state-contingent pricing behavior.[5] In improving over Li and Zhao (2016), our work also contributes to the empirical literature that, using small sample survey-based data, suggests that most firms adopt a forward-looking behavior and consider all the available information about both the present and the future expected movements of their pricing determinants.

Second, our work also relates to the theoretical literature trying to explain why firms' pricing decisions are affected by expected future changes of the exchange rate and of other macroeconomic factors. In case of nominal stickiness, when choosing the current export prices, firms have to take into account the implications of their current choices in the future for they might not be able to adjust prices anytime soon (Calvo, 1983; Chari et al., 2000). Dynamic demand-side mechanism may also matter: they revolve around the idea that when current prices alter both the current and the future position of the firm in the foreign market – for instance due to consumer search (Alessandria, 2009), customer accumulation (Froot and Klemperer, 1989), or inventory management (Alessandria et al., 2010) – optimal price setting entails a forward-looking approach.

Third, this paper is related to the empirical literature on incomplete exchange rate pass-through

[5]Li and Zhao (2016) cannot explore this aspect as they employ the prices of non-deliverable forward contracts to derive future exchange rates, thereby missing interesting distributional features of individual expectations.

and pricing-to-market and, in particular, to the very recent line of research that explores how the heterogeneity in firm-level determinants of export prices affect firm-specific PTM strategies. After the seminal work by Berman et al. (2012), several other contributions, including Chatterjee et al. (2013) Amiti et al. (2014) Caselli et al. (2014) Amiti et al. (2016) Auer and Schoenle (2016) Garetto (2016) Bernini and Tomasi (2015), have deeply investigated the issue.[6] According to this recent strand of the literature, firm heterogeneity in pricing behavior is essential to generate realistic aggregate price dynamics and to explain the observed limited response of aggregate variables to exchange rate movements.

Finally, this paper is a contribution to the line of research documenting that macroeconomic uncertainty affects microeconomic behavior. Indeed, it has been shown that, in presence of high levels of uncertainty, consumers and firms tend to react more cautiously to macroeconomic factors such as expected changes in interest rates or fiscal cuts. Moreover, there is evidence that higher levels of uncertainty are associated with firms' lower willingness to hire and invest.[7] Not surprisingly, uncertainty has also been shown to affect those firms that are more active in international markets. Indeed, following Ethier (1973), it is widely accepted that high volatility generates additional costs that are detrimental to international economic activity.[8] More recently, De Sousa et al. (2017) show that greater demand uncertainty in foreign markets reduces both firms' export sales and exporting probabilities, and also makes exports less sensitive to trade policy. Firms reallocate their exports across the destinations served following variations in the volatility of bilateral exchange rates, as shown by Héricourt and Nedoncelle (2018). None has looked at foreign pricing decisions till now. Moreover, while most contributions use past volatility to proxy for uncertainty, this work exploits the distribution of expectations held by several financial intermediaries, thereby using the extent of their disagreement to proxy for uncertainty.

The rest of the paper is structured as follows. Section 2 introduces the conceptual framework that links pricing-to-market strategies to exchange rate expectations. Section 3 describes the dataset and the construction of the variables that will be used in regressions. Section 4 outlines the empirical model and the identification strategy, and investigates how the expectations of exchange rate variations affect the pass-through. Section 5 concludes.

2 Conceptual framework

This section lays out the conceptual framework behind the empirical estimations carried out in Section 4 to investigate the role of expectations in shaping the relation between exchange rate movements and exporters' pricing strategies. The common general framework used in the literature on the exchange rate disconnect (i.e. the observation that exchange rate movements tend to have small effects on the prices of internationally traded goods) is a simple accounting identity where the (log of the) price set by a firm for its exported product in a destination equals the sum of the firm's (log) marginal cost and the (log) markup. This can be written as follows

$$\ln p_{fpd,t}(e_{d,t}) \equiv \ln \mu_{fpd,t}(e_{d,t}) + \ln mc_{fpd,t}(e_{d,t}) \quad , \tag{1}$$

where $p_{fpd,t}$ is the export prices that a firm f (say, in France) charges in destination d (say, the US) for product p measured in the producer own currency (that is, in Euro), $mc_{fpd,t}$ is the log marginal costs, and $\mu_{fpd,t}$ the gross markup.[9] Both the marginal costs and the gross markup depend, among

[6] These papers will be discussed more in details in Section 2.

[7] See Bloom (2014) for a discussion about the origins and the consequences of macroeconomic uncertainty.

[8] See **??**, among some of the earlier evidence of the negative impact of exchange rate volatility on trade.

[9] For the sake of simplicity, a single-product firm is used to illustrate this conceptual framework.

other factors that are neglected here for the sake of simplicity,[10] on nominal exchange rate, denoted with $e_{d,t}$. This latter is expressed as units of the consumer currency for one unit of the producer currency so that an upward (downward) movement of the exchange rate represents an appreciation (depreciation) of the producer currency.

Starting from this simple accounting identity, it is possible to detect several channels through which firms' export prices change in the aftermath of exchange rate movements, leading to incomplete exchange rate pass-through.

A first mechanism that has been put forward in the literature to explain the exchange rate disconnect is the pricing-to-market strategy, according to which firms adjust their markups to accommodate local market conditions. In one of his seminal paper, Paul Krugman suggested that, when market segmentation is combined with imperfect competition and importer currency price setting, firms' pricing power ends up inevitably into pricing-to-market behavior and, thus, incomplete ERPT (Krugman, 1986). Since then, many alternative theoretical models have been advanced to account for such a phenomenon. While differing in the precise mechanisms at work, these theories are all able to generate markups that vary both across destination markets d and across firms f.[11] A first group of models, including Melitz and Ottaviano (2008), Berman et al. (2012), Chatterjee et al. (2013) and Auer et al. (2018), adopt a preference framework with a linear demand system where the demand elasticity increases with the price of the product. In these models, exchange rate movements modify the elasticity of demand perceived by the exporters, who react by adjusting their markups across countries. Atkeson and Burstein (2008), Amiti et al. (2016), Garetto (2016), among others, propose an alternative modeling strategy featuring imperfect competition coupled with non-linear demand systems and strategic interactions in price setting. Pricing-to-market strategies have also been explained through models encompassing consumer search (Alessandria, 2009), customer accumulation (Froot and Klemperer, 1989), and inventories due to delivery lags and transaction-level economies of scale (Alessandria et al., 2010). In this last group of models, not only firms' interactions play a role in generating variable markups, but firms' pricing decisions reflect also dynamic (intertemporal) considerations.

Second, although pricing-to-market strategies related to markup movements represent a large part of the story, clearly they are not the only possible determinant of the observed variations in prices caused by fluctuations in the exchange rate. As captured in identity (1), a second relevant channel is represented by firms' costs: marginal costs might indeed influence pricing strategies as long as they are sensitive to exchange rate movements. Several papers show that marginal cost mechanisms, generated by the presence of local distributional costs and/or imported inputs priced in local currency, play a role in explaining the degree of ERPT (see Burstein et al., 2003; Corsetti and Dedola, 2005; Goldberg and Hellerstein, 2008; Nakamura and Zerom, 2010; Goldberg and Hellerstein, 2013; Amiti et al., 2014, among others).

Third, the sensitivity of export prices to exchange rate changes has been shown to depend on the degree of price stickiness and on the currency in which prices are set by the exporters (Chari et al., 2000; Fitzgerald and Haller, 2014). Under price stickiness in the currency of the destination market, if the exporters set their prices in the local currency, any movement in the exchange rate is offset by a corresponding change in the price expressed in producer currency (ERPT is null). If, on the contrary, producer prices are rigid and exporters set their prices in their own currency,

[10] Markups $\mu_{fpd,t}$ depend also on a set of market-specific factors associated with the level of competition such as the number of competitors, regulations, and trade agreements. Similarly, marginal costs mc_{fpd} are typically a function of the corresponding quantity sold by firm f in destination d. While these factors are omitted in the identity (1), they are included in the empirical section.

[11] See Burstein and Gopinath (2013) for a discussion of the different theoretical setting yielding variable markups and pricing-to-market strategies.

exchange rate movements are fully translated into changes in consumer prices (ERPT is perfect).

By manipulating the identity (1), it is possible to derive a specification to estimate. This reads

$$\Delta \ln p_{fpd,t} = \beta \Delta \ln e_{d,t} + \epsilon_{fpd,t} \quad , \tag{2}$$

where $\Delta \ln e_{d,t}$ is the (log) change in the exchange rate with destination d between time $t-1$ and t and $\Delta \ln p_{fpd,t}$ the corresponding (log) change in price in producer currency. In this specification, β captures the elasticity of a firm's export price to movements in the exchange rate. Hence, the transmission of exchange rate variations into import (consumer) prices can be computed as $1-|\beta|$. When exporters do not adjust export prices in response to fluctuations of the exchange rate, β is expected to be equal to 0. On the contrary, the closer $|\beta|$ is to 1, the larger is the change in export prices that firms implement to limit the exchange rate pass-through into import (consumer) prices. At the extreme, when $|\beta| = 1$, a firm adjusts its export price to absorb all the exchange rate variation and the ERPT is null.[12]

Equation (2) represents an extreme reduced-form specification where the coefficient β reflects the three possible mechanisms relating prices to exchange rate movements mentioned above, namely markup channel, cost mechanisms, and price stickiness.[13] As to the first channel, it is worth noticing that the coefficient β captures any of the many mechanisms able to generate variable markups. In the context of theoretical models with linear demand, for instance, an appreciation of the producer currency (i.e., an increase in $e_{d,t}$) increases the elasticity of the demand perceived by exporters who choose, by trading off changes in consumer prices and in expected sales, to decrease their markups and thus their export prices to safeguard sales. As to what cost mechanism is concerned, β captures any change in prices associated with an increase in $e_{d,t}$ due to the presence of either local distribution costs or of imported inputs used in the production process that are priced in the foreign currency. The relevance of the cost mechanism depends on the relative importance of marginal costs and distribution costs priced in foreign currency. To the extent that marginal costs are identical across markets and products within a firm (as assumed for instance in Fitzgerald and Haller, 2014), this channel can be captured (and thus distinguished from other mechanisms) by using a more sophisticated specification where a firm-level proxy of changes in marginal costs (Δ $\text{mc}_{f,t}$) is added to equation (2). Finally, the sensitivity of export prices to exchange rate changes may also depend on the currency in which prices are set by the exporters and on the degree of stickiness of the currency of pricing. With respect to the choice of the currency of invoice, Gopinath et al. (2010) have shown that this decision is driven by the same factors affecting the elasticity of markups to the exchange rate movements: firms with a low desired degree of ERPT tend to price more in the currency of the country that, given its relative stickiness, reduces more the ERPT. This entails that the first two channels suffice to account for the third channel as well.[14] With respect to price stickiness, while potentially relevant in theory, this channel seems unlikely to play a major role when the empirical analysis is based on biannual or annual data as the relevance of the price stickiness channel decreases with the increase in the time span over which price changes are considered. Considering that previous works showed that firms tend to change their prices

[12]The use of the results from PTM specifications to discuss the degree of ERPT is common in the literature. However, as pointed out by Goldberg and Knetter (1997), the contributions focusing on the ERPT and those looking at PTM behaviour employ different specifications to estimate the relationship between exchange rate and prices. While the PTM literature employs export prices, the ERPT literature uses the import price for a given product p from a source country o. The pass-through is therefore complete when the estimated coefficient on the exchange rate is equal to zero in the PTM specification and equal to one in the ERPT specification.

[13]The error term contains the variations in prices that are unrelated to the movements in the exchange rate.

[14]Moreover, its relevance cannot be directly identified with modifications in the specification, and it can be only indirectly gauged by distinguishing among goods with different degrees of price stickiness.

approximately every six months,[15] we posit that price variations over 6-12 months can be treated, at least to a first approximation, as changes in a quasi-flexible price environment.

Exchange rate expectations. As discussed in the Introduction, there exists some circumstantial evidence based on micro-surveys that firms, in setting their prices, tend to be forward-looking and consider also the expected future developments of relevant micro- and macro-economic variables, such as exchange rate, demand, costs, competitors' prices, and the like.[16]

Several mechanisms can explain why newly set prices are a function of both the current exchange rate movements and the expected changes in the future. Typically, these mechanisms are at the core of dynamic demand-side models where customer accumulation, consumer search or inventories due to delivery lags and transaction-level economies of scale generate an incentive to adopt a forward-looking approach.[17] For example, Froot and Klemperer (1989), extended in Gross and Schmitt (2000), propose a two-period oligopolistic model where firms' future demand depends on current market shares. Such intertemporal dependence between today's market share and tomorrow's profits can arise, for instance, because of the existence of consumer switching costs between brands of a product even when they are functionally identical (Klemperer, 1987; Farrell and Shapiro, 1988). In general, any demand rigidity associated with lock-in effects creates incentives for firms to maintain market shares as large as possible in the short term to extract higher profits in the future. These considerations make firms' pricing forward-looking and entail that expected developments in the future affect current prices. Because of this intertemporal dependence, the sale price set in the first period of the model does not reflect only the current competitive pressure, but also a firm's investment to achieve a larger market share and, accordingly, greater profits in the future period. As a consequence, the expected exchange rates affect the discounted value of future profits and alter the intertemporal value of the current market share, thereby affecting the firm's current pricing strategies.

While remaining in a reduced-form, it is not difficult to extend the specification in (2) in order to capture the role played by exchange rate expectations. One can consider

$$\Delta \ln p_{fpd,t} = \beta \Delta \ln e_{d,t} + \gamma \text{Exp}_t \Delta \ln e_{d,t+1} + \epsilon_{fpd,t} \quad , \tag{3}$$

where $\text{Exp}_t \Delta \ln e_{d,t+1} = \ln \text{Exp}_t e_{d,t+1} - \ln e_{d,t}$, i.e. the difference between the (log) expectations at time t about the exchange rate level at time $t+1$ and the (log) value of the exchange rate at time t. The coefficient γ captures the effect on the export price of an expected appreciation of the exchange rate with respect to its current value.

This empirical model can be extended further with a view to investigating whether there exist forms of heterogeneity, associated with firms' characteristics, in how export prices respond to expected future exchange rate movements. Indeed, we already know that this is the case for the observed variations in the exchange rate: the pricing-to-market literature has convincingly shown that pricing strategies are heterogeneous across exporters. According to this recent strand of the

[15] According to Baudry et al. (2007), the median price duration for French products is 6.2 months, and Irish exports in Fitzgerald and Haller (2014) report an average price duration of 6.25 months.

[16] A promising line of research has recently started on the basis of rich quantitative surveys containing firms' expectations about both firm-specific and aggregate variables, such as future demand growth and profits (Dickstein and Morales, 2018), earnings growth (Gennaioli et al., 2015), and future inflation (Coibion et al., 2018b). Unfortunately, firm-level expectations about the exchange rate have not been collected and analyzed yet.

[17] In theory, price rigidities may also play a role. In settings where producers know that they may not reset their prices in every period, it is rational to assume that the expected future developments of the exchange rate affect current pricing decisions (see for example Devereux and Yetman, 2010; Fitzgerald and Haller, 2014). Yet, as mentioned, to the extent that the variations cover a sufficiently long time span as is the case in our investigations, this is likely to be a second order effect.

literature, the price elasticity with respect to observed exchange rate movements (here captured by the parameter β) varies with firms' level of productivity, market shares, import intensity, output quality, complementarities and information about the competitors. Berman et al. (2012) represents the seminal article in this strand of the literature and the authors show that larger and more productive exporters tend to absorb exchange rate variations in their markups to a greater extent than relatively low productive ones do.[18] Chatterjee et al. (2013) extend the analysis of Berman et al. (2012) to the case of multi-product exporters, with more pronounced price variations following exchange rate movements for products with greater productivity, while Caselli et al. (2014) investigate adjustments in the markups within firms across products in response to exchange rate fluctuations. In addition to the presence of heterogeneous markups, as mentioned, Amiti et al. (2014) emphasize the role of imported inputs in affecting firms' pricing decisions. They show that firms with higher import intensity and larger market shares exhibit a more incomplete pass-through.[19] Bernini and Tomasi (2015) extend this line of analysis further and show that the degree of ERPT is also influenced by the quality of both the imported inputs and the exported product. Auer and Schoenle (2016) contribute to the literature on variable markups by showing that firms' pricing responses are heterogeneous along two important dimensions: market shares and price complementarities among importers. Finally, Garetto (2016) shows that, controlling for the impact of firms' market shares on their export pricing decisions, firms operating with less information about their competitors exhibit a lower exchange rate pass-through.

Uncertainty. Recent research has documented that uncertainty about macroeconomic variables affects microeconomic behavior along several dimensions. As discussed by Bloom (2014), in presence of high uncertainty, firms may become more cautious in their investment decisions, and this is typically the case when they face irreversible costs due to "real option" effects, when they become more risk averse and credit markets tighten up. Uncertainty, however, may also work in the opposite direction. For instance, when future economic conditions are unclear the potential gains associated with current investment increase and, consequently, firms may be pushed to invest more. This last channel has been shown to be important for R&D investments (Bloom, 2014).[20] Although the sign of the impact of uncertainty on export pricing in not known a priori, we posit that the uncertainty regarding future exchange rate movements may affect the PTM strategies, in particular when the intertemporal mechanisms discussed above are at work. Our empirical model is once again suitable to investigate this dimension of the issue through the introduction of a proxy variable for uncertainty in the empirical setting. As we shall explain in what follows, we measure the disagreement among financial intermediaries about the expected exchange rates in the future to capture the degree of uncertainty faced by exporters and other economic operators. Although used by central banks, the adoption of a disagreement-related measure of uncertainty is novel in the trade literature.

[18] As discussed in Berman et al. (2012), such heterogeneity can be generated starting from a linear demand system as in Melitz and Ottaviano (2008); in such a setting, firms with higher productivity set lower prices, have larger market shares, face a lower demand elasticity, and price more to the market. Facing a variation of the exchange rate, high-productivity firms change relatively more their markups and thus absorb exchange rate movements to a greater extent. Alternatively, heterogeneity may emerge in the theoretical setting developed by Atkeson and Burstein (2008), who provide for Cournot competitors and a nested CES demand system, or it may be explained in a model with local additive distribution costs paid in local currency as in Corsetti and Dedola (2005).

[19] Amiti et al. (2014) propose a theoretical model where the use of imported inputs affects export prices both directly, through a cost mechanism, and indirectly, through a selection-related markup mechanism. Because of selection into importing, firms with larger shares of imports are also larger, face greater markup elasticity and adjust more easily their markups to exchange rate variations.

[20] Coibion et al. (2018a) show that strategic complementarity is positively associated with uncertainty, as firms tend to wait that others make decisions before changing their prices.

A detailed description of our data sources and of the variables used in the empirical investigation is provided in the next section.

3 Data and Variables

The empirical analysis in this work requires to combine data from different sources and at diverse levels of aggregation.

French micro data. We exploit two sets of data collected by the French Statistical Office: the Foreign Trade Statistics and a firm level accounting dataset.[21] The foreign-trade statistics consist of all cross-border transactions performed monthly by French firms during the period 2000-2007. For all export flows defined at the firm-product-destination level we observe both monthly values and quantities expressed respectively in euros and in kilograms.[22] Product categories are classified according to the Harmonized System classification of traded goods and they are reported at the 6-digit level (HS6). Because some product categories are assigned different HS6 product codes at different points in time, we use concordance tables provided by Eurostat to harmonize the classifications to the 1996 version.

The main source of firm level data, from which we extract the information on firms' size and industry in which they operate, is the BRN data-set maintained by the French fiscal administration. The BRN covers the universe of manufacturing firms with more than 763,000 Euros sales.[23]

By merging these two datasets, we obtain a representative sample of French manufacturing exporters. Because we are interested in firms' reactions to exchange rate fluctuations, we further restrict the sample to firms exporting to non-Eurozone countries, leaving with an unbalanced panel of about 24,000 manufacturing exporters each year, as shown in column (1) of Table 1. The total exports of these firms are around 100 billions (in Euros) each year (column (2)). Given our interest in the response of export prices to current and expected exchange rate movements, the empirical analysis focuses on those destination countries for which we have information on exchange rate expectations (see below for details), namely the United States, Japan, United Kingdom and Switzerland. We extend the sample size by adding those destinations whose imports are mostly invoiced in US dollars: Indonesia, South Korea, Brazil and Canada.[24] As shown in column (3) of Table 1, by further restricting the sample we end up with an unbalanced panel of around 18,000 firms each year. Exchanges with these selected countries account for almost 75% of non-Eurozone exporters and 50% of the total exports (column (4)). Because most manufacturing exporters engage in some international transactions in most of these destinations, the exclusion of trade flows occurring with other areas does not reduce greatly the overall number of firms observed in the dataset.

[21] Both data sources were accessed via the Secure Access Data Center (CASD).

[22] Trade data are collected based on transactions. The European Union sets a common framework of rules but leaves some flexibility to member states.

[23] BRN stands for Bénéfice Réel Normal, the normal tax regime for French firms. This dataset contains annual balance-sheet information collected from the firms' tax forms, along with detailed information on the firms' balance sheets. The fact that the information come from tax authorities, then, ensures an overall very high quality of the data.

[24] As reported by Kamps (2006), the US dollar is used as invoicing currency for more than 80% of imports of both Indonesia and South Korea. Goldberg and Tille (2008) find evidence for a strong role of the US dollar as vehicle currency, especially in Korea and Thailand. Reiss (2014) reports that Brazil depends highly on the US dollar on both trade sides: around 95% of exports and 85% of imports are invoiced in this currency. Devereux et al. (2015) report similar statistics for Canada.

Table 1: Data coverage

Year	Exporters	Exports (EUR billions)	Exporters	Exports (EUR billions)
	All Non-Euro Countries		Selected countries	
	(1)	(2)	(3)	(4)
2001	25,428	95.4	19,558	51.8
2003	24,042	85.4	18,230	44.5
2005	23,410	101.6	17,825	49.0
2007	22,823	121.1	17,245	52.6

Note. The table reports the number of manufacturing firms that export outside the Euro-Zone, and their total value of exports in the database Foreign Trade Statistics-BRN (columns 1 and 2), and for those firms trading with US, Japan, UK, Switzerland, Indonesia, South Korea, Brazil and Canada (columns 3 and 4).

Transaction-level data are used to obtain some of the variables that will be used in the empirical analysis. After aggregating monthly information at semester level, we calculate the unit-values of the exported varieties $\text{uvx}_{fpd,t}$ as the simple averages across six months of the ratio between export values and export quantities, where the subscripts f, p, d, and t identify firms, HS6 product classes, destinations and semester-year, respectively.[25] We then compute the price change, $\Delta \ln \text{uvx}_{fpd,t}$ which is our main variable of interest, as the log difference of export prices between two consecutive semesters for a variety of product p exported by a firm f to destination d.

Similarly, we construct the unit values of the imported varieties $\text{uvm}_{fpo,t}$, where the subscript o refers now to the country of origin. Foreign trade data are also used to build our proxy of the change in marginal costs (Δ $\text{mc}_{f,t}$) defined, following Amiti et al. (2014), as the log change in unit values of a firm's imports from all source countries weighted by the respective expenditure shares

$$\Delta \text{mc}_{f,t} = \sum_{po,t} \ln \Delta \text{uvm}_{fpo,t} \bar{w}_{fpo,t} \tag{4}$$

where $\text{uvm}_{fpo,t}$ is the euro unit value of firm f's imports of product p from country of origin o at semester t and $\bar{w}_{fpo,t}$ are the averages of the share of respective import values in the firm's total imports in periods t and $t-1$.[26]

Exchange rates data. Micro-level variables are complemented by data on exchange rates. We collect from the Thomson Reuters Eikon database monthly information on the observed bilateral nominal exchange rates ($e_{d,t}$) between the European Euro (EUR) and the US Dollar (USD), the Japanese Yen (YEN), the British Pound (GBP) and the Swiss Franc (CHF) over the period 2000-2007. Exchange rates are expressed as the number of foreign currency (consumer) units per one unit of the Euro (producer currency). Data on actual exchange rates are complemented with information on their expected values at 6 and 12 months. Future values of the exchange rate are known to be hard to forecast (Rossi, 2013) and this appears to be true also for professional forecasters that often disagree on their expectations even in the near future.[27] Our proxy of expectations ($\text{Exp}_t e_{d,t+1}$) refers to the median value of the expected bilateral exchange rates forecasted by a large pool of

[25] Results do not change if we instead consider the weighted average of monthly unit values across a semester, using as weights the export share of each transaction.

[26] As a robustness check, we replicate the analysis by focusing only on import of intermediate inputs. We select the intermediate input category by relying on the Broad Economic Categories (BEC) classification of HS6 products provided by the United Nations (UN). The BEC classification has been widely used in the literature of international trade to identify intermediate inputs (Amiti et al., 2014; Bas and Berthou, 2012; Brandt et al., 2012).

[27] Several works studied the dispersion of macroeconomic forecasts across professionals and the determinants of such

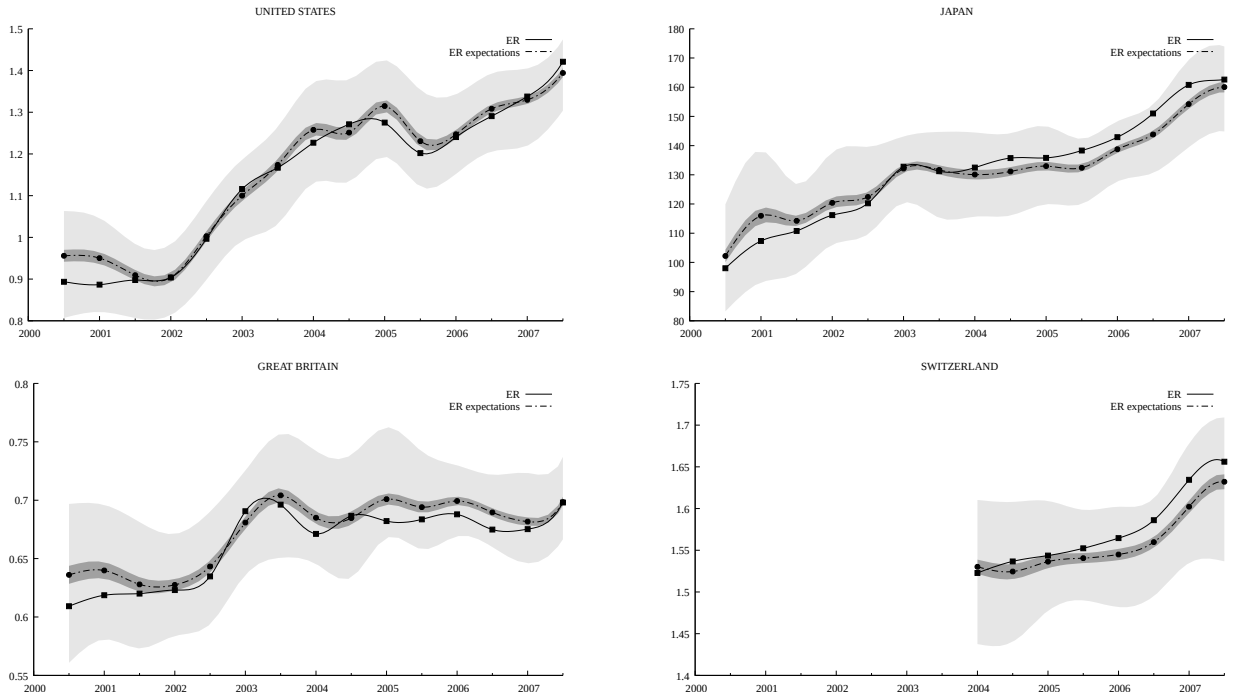

Figure 1: The figure reports the time evolution of the 4 exchange rates of Euro with respect to USD, YEN, GBP and CHF together with the 6-months ahead expectation. Dark and ligth gray bands represent a 2 standard deviation and a min-max confidence bands.

financial intermediaries and investors. Solid and dotted lines in Figure 1 reports the time evolution of the current and expected exchange rates, respectively, for the four currencies over the time period considered in our investigations. Our sample period covers an interval during which the Euro has appreciated substantially against the foreign currencies. Figure 1 shows the semester by semester variations both in the current and in the expected exchange rate.

An interesting feature of this data is that it provides information also on the dispersion of expected exchange rate forecasts. We exploit this information to measure the level of uncertainty regarding the exchange rate expectations. This measure of uncertainty exploits the distribution of expectations across financial intermediaries and is close in spirit to that employed by central banks to assess macroeconomic uncertainty. This measure is different from proxies of uncertainty based on the past volatility of the observed exchange rate (Campa and Goldberg, 2005; Donnenfeld and Zilcha, 1991; Devereux et al., 2004; Hooper and Kohlhagen, 1978).[28] The use of the latter would entail two strong assumptions: first, firms have the same information regarding what measure of past volatility to consider; second, past volatility is a good proxy of current uncertainty about the future. Still, our measure of uncertainty has a limitation, that is it is not able to capture any firm-specific form of subjective uncertainty (as done by Engelberg et al., 2009; Glas and Hartmann,

phenomenon (Jongen et al., 2012; Beckmann and Czudaj, 2017), and concluded that differences reside in heterogeneous information sets and in different weights attached by the agents to fundamental, technical, and carry trade forecast techniques.

[28]The empirical literature showing that decisions about foreign prices are time-varying and state-contingent is even larger. Among the others, see Amiti et al. (2014); Cheikh and Rault (2017); Devereux and Yetman (2010); Gopinath et al. (2010); Nogueira and Leon-Ledesma (2011).

2016; Lahiri and Sheng, 2010, for professional forecasters' beliefs on future inflation). To provide a visual impression of the extent of the disagreement among forecasters, Figure 1 displays the 2 standard deviation (dark-gray area) and the min-max (light-gray area) confidence bands for the expected values of the corresponding exchange rate (dotted line).

Country data. Quarterly data on observed changes in the level of GDP, current and expected changes in inflation (where inflation is measured in terms of the consumer price index (CPI)) are obtained from the OECD.[29] We then create the variables $\text{GDP}_{d,t}$, $\text{Inflation}_{d,t}$, and $\text{Exp}_t\ \text{Inflation}_{d,t}$, where t indicates the semester-year, by taking the simple average between two consecutive quarters.[30] Furthermore, we construct a measure of product import demand in the destination country using trade data from BACI, a dataset containing year-product level information on imports and exports for a very large set of countries.[31] Our demand measure is defined as

$$\text{Demand}_{pd,t_y} = \sum_{c \in \mathcal{C}_{pd,t_y}} \text{IMP}_{pcd,t_y} \quad , \tag{5}$$

where IMP_{pcd,t_y} is the total imports of product p by destination d in the year t_y. Here $\mathcal{C}_{pd}$ is the set of countries, excluding France, exporting product p to destination d. Similarly, to account for market concentration, we measure the level of import concentration in the destination country as

$$\text{HHI}_{pd,t_y} = \sum_{c \in \mathcal{C}_{pd,t_y}} \left(\frac{\text{IMP}_{pcd,t_y}}{\text{Demand}_{pd,t_y}} \right)^2 \quad , \tag{6}$$

that is the Herfindhal-Hirschman index for product p in destination d, again excluding imports from France. Finally, we create a proxy for the prices of competitors in the destination country by using the information on the unit value of product p in the destination d imported from all other countries. We calculate

$$\text{UV}_{pd,t_y} = \sum_{c \in \mathcal{C}_{pd,t_y}} \left(\frac{\text{IMP}_{pcd,t_y}}{\text{Demand}_{pd,t_y}} \right) \text{UV}_{pcd} \quad , \tag{7}$$

as the weighted average of the unit values of product p in destination d.

Summary statistics. After merging the information coming from the different sources, we end up with an unbalanced panel of around 18,000 firms exporting to eight different destinations. Summary statistics are provided in Table 2, for each single destination country. The first row reports the percentage share of firms exporting to each destination, while the second one shows the relative importance of each market in terms of total exports. Within the eight countries, the majority of firms sell to UK, US, Switzerland and Japan. The two first markets, UK and US, cover almost 80% of the total exports towards these eight destinations. On average bigger and more diversified firms are exporting towards the UK and the US, as shown by the average export value (Avg. Exp. Value) and by the average number of products exported (Avg. Num. Products).

Given our focus on price adjustments, some facts about the variability of prices are of particular note. Because in our empirical analysis we exploit the variability of price changes across semesters

[29] See for more details the website https://data.oecd.org/price/inflation-cpi.

[30] Alternatively, we could use the current and expected changes in the producer price index defined as the rate of change in prices of products sold as they leave the producer, excluding any taxes, transport and trade margins that the purchaser may have to pay.

[31] The BACI dataset reconciles trade declarations from importers and exporters as they appear in the COMTRADE database (Gaulier and Zignago, 2010).

Table 2: Summary statistics

Country	Brazil	Canada	Switzerland	Grain Britain	Indonesia	Japan	South Korea	U.S.
% Num. Firms	5.45	8.54	18.90	32.28	2.15	9.75	5.97	17.30
% Exp. Value	2.76	3.16	5.50	38.12	0.61	6.69	3.17	39.99
Avg. Exp. Value (million)	19.70	17.07	10.42	59.75	16.40	37.82	19.85	140.85
Avg. Num. Products	9.31	7.89	7.50	28.32	8.51	9.72	6.63	15.96
Transaction frequency[a]	8.5	8.3	5.2	9.3	8.4	8.5	8.5	8.6
$\ln \Delta$ uvx$_{fpd,t}$ (mean)	-0.004	0.004	0.007	0.004	-0.002	-0.003	-0.005	-0.006
$\ln \Delta$ uvx$_{fpd,t}$ (madev)	0.39	0.38	0.36	0.39	0.40	0.41	0.40	0.45
$\ln \Delta$ uvx$_{fpd,t} > 0$ (median)	0.19	0.19	0.17	0.18	0.18	0.21	0.20	0.22
$\ln \Delta$ uvx$_{fpd,t} < 0$ (median)	-0.18	-0.19	-0.17	-0.18	-0.16	-0.20	-0.18	-0.21

Note. The table reports summary statistics for the 8 destination countries in our sample pooled over the period 2000-2007. "madev" stands for mean absolute deviation.[a] Note that for all countries, except Switzerland, the upper bound of this frequency is 16, while for Switzerland is 9.

within the firm-product-country, we provide descriptive statistics about the frequency of price adjustments within this triple over time. First, in Table 2 we report information on the observed frequency of transactions (Frequency of Transaction), that is the average number of times a firm is exporting a product to a destination over the time horizon considered. We observe that, on average, for each firm-product-country, the transaction is reported 8 times (out of 16) and this number is quite stable across destinations. We also compute the frequency of price changes (not reported) and we observe that, within firm-product-destination, prices are adjusted each semester.[32] Average changes in unit values ($\ln \Delta$ uvx$_{fpd,t}$) are ranging across countries between -0.6% and 0.7%, which are reasonable values comparable with those provided by Berman et al. (2012). A large variability is detected for our dependent variable as shown by the mean absolute deviation provided in Table 2. Finally, we report some information for the positive and negative changes. Price increases have the same frequency than price decreases: on average, across countries, half of the price changes are reductions and half of them are increments. The size of price increases and decreases is roughly symmetric, with the median rise (fall) being around 18%. Cross-country differences in both the direction and the magnitude of price changes are small.

Finally, the variations exploited in our empirical investigations to identify the coefficients of interest are illustrated in Figure 2. It shows, for the estimated sample, the density distribution of the changes in export prices over the semester and the time changes in the actual and expected exchange rates. The size of the price changes from one period to another is higher than that observed for the actual and expected exchange rate variations, despite the patterns in the exchange rate over the course of the sample period observed in Figure 1.

4 Econometric model and identification strategy

Using the conceptual framework developed in Section 2, in the following we present a set of empirical exercises aimed at investigating whether and to what extent firms in setting their export prices use information about expected values of the future exchange rates.

[32]Looking at the producer prices in the euro area, Vermeulen et al. (2012) observe that 21% of producer prices are adjusted each month and they are changed more frequently than consumer prices. Similar statistics are provided by Fitzgerald and Haller (2014). Although our statistics are not comparable as we employ semester exporter prices rather than monthly producer prices, the stylized facts reported here suggest high frequency and variability in export price movements.

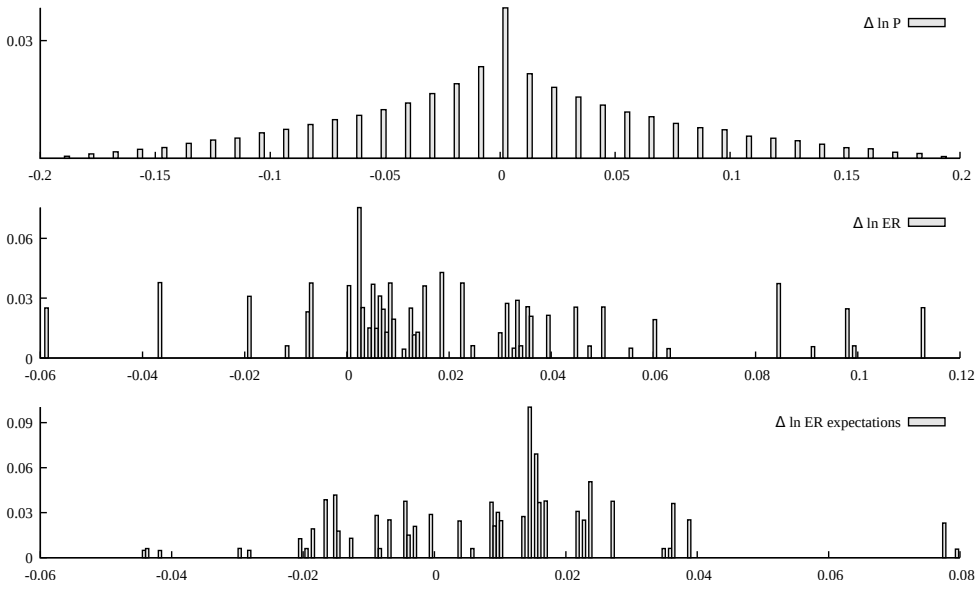

Figure 2: The figure plots the kernel density of the log changes in export prices and in the expected exchange rate variation.

We start by laying down an econometric model specified as the empirical counterpart of the reduced-form equation (3)

$$\Delta \ln \text{uvx}_{fpd,t} = \alpha + \beta \Delta \ln \text{e}_{d,t} + \gamma \text{Exp}_t \Delta \ln \text{e}_{d,t+1} + \delta_{fpd} + \delta_{sem} + \epsilon_{fpd,t} \quad , \tag{8}$$

where the dependent variable $\Delta \ln \text{uvx}_{fpd,t}$ is the log change of unit value between two consecutive semesters for a variety of product p exported by firm f to destination d at time t and proxies the log change of the export price. In our analysis t represents a year-semester time unit. The variable $\Delta \ln e_{d,t}$ measures time-to-time variations in the (log) bilateral exchange rate ($e_{d,t}$) between France and the destination country d, while $\text{Exp}_t \Delta \ln e_{d,t+1}$ is defined as the (log) difference between the nominal exchange rate expectation at time t for $t+1$ (i.e., $\text{Exp}_t e_{d,t+1}$) and the current nominal exchange rate at time t ($e_{d,t}$). To identify our parameter of interest, γ, we consider variables in (year-semester) first differences and we include highly demanding fixed effects, δ_{fpd}, to control for unobservable time-invariant differences across firm-product-destination triplets that may influence trends in export prices. They also control for time invariant characteristics of the triplets that might influence both the (actual and expected) exchange rate variations and export price changes. Consequently, γ is identified solely using the time variation of our independent variable and it identifies the average firms' price adjustments to expected exchange rate variations.[33] We also add a semester fixed effect, δ_{sem}, to capture possible differences in seasonal price patterns.

As discussed in Section 2, γ may capture market-specific markup adjustments (PTM), but also marginal costs variations due to local distributional costs and/or imported inputs.[34] To account

[33] A typical specification proposed in the empirical literature controls for product and country (or product-country) fixed effects capturing the time-invariant part of those characteristics that may affect firm pricing and that tend to vary by destination (e.g., size of importing country, trade costs from France, distribution costs, and the like) and by product (e.g. product differentiation, technological sophistication and complexity, quality level). With these fixed-effects, however, the determinants of firm-product-destination trends in export prices are poorly controlled for.

[34] As discussed above, nominal rigidities should play a minor role given the use of bi-annual data.

for the presence of local distributional costs and/or imported inputs priced in local currency, we include a firm-level control for marginal costs $\Delta \, \mathrm{mc}_{f,t}$, as defined in equation (4). This control also prevents that a possible correlation between exchange rate variations and other real shocks (i.e., productivity shocks) induces a bias in the OLS estimates.

To improve further the identification, our baseline specification is augmented to include a set of time varying controls capturing potential confounding factors at different levels. First, we add a proxy to capture within firm-product-destination quality adjustments, $\Delta \, \mathrm{Quality}_{fpd,t}$. This is important since it is likely that movements in the unit values might not properly reflect price changes because they are contaminated by quality shifts. To control for such quality-related effects, following a consolidated literature (Manova and Yu, 2017; Manova and Zhang, 2012), we build the control variable $\Delta \, \mathrm{Quality}_{fpd,t}$, that measures the variation in the quality of the product p exported by firm f to destination d. We measure export quality at the firm-product-destination level by applying the methodology implemented by Manova and Yu (2017), where quality is identified as a demand shifter.[35] Second, we include controls for time varying macroeconomic conditions (GDP, Inflation, Expected Inflation) and for product-destination specific changes in the characteristics of the competitive environment concerning demand ($\Delta \, \mathrm{Demand}_{pd,t_y}$), concentration ($\Delta \, \mathrm{HHI}_{pd,t_y}$) and strategic complementarities ($\Delta \, \mathrm{UV}_{pd,t_y}$) as defined in section 3.[36]

All regressions are estimated with OLS where, to control for serial correlation within firm-product-destination triplets, standard errors are clustered at the firm-product-destination level.

4.1 Pricing-to-market and exchange rate expectations

Table 3 reports the estimation results for the baseline specification. In column (1) we estimate a regression with the inclusion of only current and future movements in the exchange rate. This column reports the unconditional regression run on the sample including all the eight destinations for which we have information on exchange rate expectations: the United States, Japan, the United Kingdom, Switzerland, Indonesia, South Korea, Brazil and Canada. The average elasticity of export prices to exchange rate variations, β, is estimated to be approximately -0.3. This estimate is in line with the value observed for the Belgian firms by Amiti et al. (2014). More importantly, the negative estimated coefficient of the term $\mathrm{Exp}_t \Delta \ln e_{d,t+1}$ suggests that firms adjust their current export prices by taking into consideration also the expected future changes of the exchange rate. The estimated average elasticity of firms' export prices to expected exchange rate variations is about 0.2, which implies that firms adjust their export prices not only when they experience an appreciation of their currency but also when one is expected in the next semester. This result is consistent with the idea that firms are forward-looking and provides *prima facie* evidence in favor of theoretical models where firms set current prices by considering both current and future economic conditions (Froot and Klemperer, 1989; Alessandria, 2009; Alessandria et al., 2010).

The negative price elasticity with respect to expected exchange rate variations is robust to the inclusion of several control variables. In column (2) we include two time varying controls for marginal costs and quality adjustments. Results indicate that both a rise in a firm's marginal costs and an increase in the quality of its product imply a positive effect on the export prices. In column (3) we add variables that control for other general equilibrium effects that might be at work and that depend on competition intensity and market structure. As far as these variables are concerned, it is interesting to note that the coefficient of the variable reflecting the presence of

[35] Quality is obtained as the residual of a regression of $\ln q_{fpd,t} + \sigma \ln p_{fpd,t}$ on $\alpha_p + \alpha_{d,t} + \epsilon_{fpd,t}$, where elasticities of substitution σ are sector (3-digit) specific and taken from Imbs and Mejean (2017).

[36] Note that the time variation of these product-destination controls, T, is across years and not across year-semester. This is due to the time coverage of the BACI data set.

Table 3: Exchange rate expectations: baseline results and robustness checks

Dep. Variable: $\Delta \ln uvx_{fpd,t}$	Baseline				Robustness checks			
	(1)	(2)	(3)	(4)	(5) Intermediate inputs	(6) Single-Product Firms	(7) Top Product	(8) No-Carry Along
$\Delta \ln e_{d,t}$	-0.330***	-0.337***	-0.328***	-0.323***	-0.328***	-0.308***	-0.303***	-0.289***
	(0.026)	(0.026)	(0.026)	(0.026)	(0.027)	(0.069)	(0.038)	(0.028)
$\text{Exp}_t \Delta \ln e_{d,t+1}$	-0.202***	-0.340***	-0.369***		-0.370***	-0.305***	-0.378***	-0.298***
	(0.068)	(0.050)	(0.050)		(0.051)	(0.126)	(0.069)	(0.052)
$\text{Exp}_t \Delta \ln e_{d,t+2}$				-0.276***				
				(0.036)				
Δ mc$_{f,t}$		0.022***	0.022***	0.022***	0.014***	0.024**	0.026***	0.015***
		(0.004)	(0.004)	(0.004)	(0.003)	(0.010)	(0.006)	(0.004)
Δ Quality$_{fpd,t}$		0.128***	0.128***	0.128***	0.129***	0.137***	0.126***	0.129***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.002)	(0.001)
Δ GDP$_{d,t}$			-0.010***	-0.010***	-0.010***	-0.0004	-0.005**	-0.009***
			(0.002)	(0.002)	(0.002)	(0.004)	(0.002)	(0.002)
Δ Inflation$_{d,t}$			-0.002	-0.001	-0.002	0.005	0.004	-0.003
			(0.002)	(0.002)	(0.002)	(0.005)	(0.003)	(0.002)
Δ Exp$_t$ Inflation$_{d,t}$			0.003	0.002	0.003	-0.005	-0.004	0.003
			(0.002)	(0.002)	(0.002)	(0.005)	(0.003)	(0.002)
$\Delta \ln$ Demand$_{pd,y}$			0.001	0.001	0.001	-0.007	-0.003	0.002
			(0.003)	(0.003)	(0.003)	(0.009)	(0.005)	(0.003)
$\Delta \ln$ HHI$_{pd,y}$			-0.004	-0.004	-0.004	0.006	-0.003	-0.002
			(0.004)	(0.004)	(0.004)	(0.011)	(0.006)	(0.004)
$\Delta \ln$ UV$_{pd,y}$			0.003**	0.002**	0.003**	-0.004	-0.00004	0.004**
			(0.001)	(0.001)	(0.001)	(0.004)	(0.002)	(0.002)
δ_{fpd}	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
δ_{sem}	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	510,507	510,507	510,507	510,507	497,979	66,670	181,002	418,054
R^2	0.078	0.498	0.498	0.498	0.497	0.488	0.439	0.511
adj.R^2	-0.102	0.400	0.400	0.400	0.399	0.350	0.315	0.406

Notes: Observations are at the firm-destination-product-time level. Δ corresponds to time changes between semesters. The coefficients appear together with standard errors clustered at firm-product-country level. *** significant at the 1% level, ** significant at the 5% level and * significant at the 10% level.

strategic complementarities, $\Delta \ln \text{UV}_{pd,t}$, is positive and the only one statistically significant. This result is in line with the recent empirical evidence suggesting that a firm's price changes depend on the price changes of its competitors (Amiti et al., 2016; Auer and Schoenle, 2016) and it opens an interesting line of empirical research.

In our favorite specification, reported in column (3), where we control for time varying micro and macro characteristics that might affect exporters' prices and where the coefficients β and γ should capture mainly pricing-to-market mechanisms, the two estimated coefficients remain negative and statistically significant. In particular, the elasticity to the expected exchange rate movements decreases to -0.37 and it comes closer to that of current variations, that is about -0.33. It is interesting to note that in a different specification (not reported) where we remove the exchange rate expectations term but we leave all the other controls the estimated β drops in absolute terms by more than 40%: this suggests that the realized pass-through of exchange rate movements is strengthened when controlling for the expected changes in the future. As a further exercise, in column (4) we show the results for the same regression using the expectations on the bilateral nominal exchange rates at 12 months ($\text{Exp}_t \Delta \ln e_{d,t+2}$), rather than at 6 months. We observe that the elasticity of export prices to longer-term expected appreciations is negative and statistically

significant, but exhibits a smaller magnitude with respect to the short-term one. Firms thus tend to adjust their prices relatively more to account for changes expected in the near future. Arguably, this can be due to three orders of reasons. First, even assuming that firms consider both short-term and long-term expectations, they might attribute greater weight to the former, as dynamic demand-driven mechanisms work more strongly in the short term. Second, firms may react less vigorously to expectations when uncertainty about the future is higher (we will investigate this point below) so that the longer is the horizon of the expectations, the lower is the estimated elasticity. Third, firms may look ahead to cover only the limited time span in which prices tend to be sticky.

Threats to identification. Our identification strategy is valid under the assumption that, conditional on firm-product-destination and semester fixed effects and controlling for observable time varying characteristics, the within firm-product-destination variations in the expected exchange rate is orthogonal to any other determinants of the export price dynamics.

A first threat to our identification strategy is related to measurement errors. Indeed, on the one hand, we are confident that our proxies of actual and expected exchange rate changes are, to a first extent, accurate: they concern nominal variations and come from official institutional sources. On the other hand, however, one might have doubts that our marginal costs and export price variables are not perfectly measured. To explore the possibility that these errors drive our results, we run two different exercises. First, we construct the change in marginal costs by using only those products classified as intermediate inputs, defined as those belonging the intermediate input category according to the Broad Economic Categories (BEC) classification of HS6 products provided by the United Nations (UN). Results reported in column (5) show that the estimated elasticity with respect to expected exchange rate movements remains unaltered. Second, we test the robustness of the results regarding the exporters' price responsiveness to expected exchange rate movements using alternative sub-samples chosen with the aim of exploring different sources of identification. As it is known that the adjustments to exchange rate movements are heterogeneous across products within a multiproduct firm (Chatterjee et al., 2013; Bernini and Tomasi, 2015), we address the possibility that price changes are affected by the product mix composition and the product range within the firm, and that these interfere with the identification strategy. To avoid that the results are confounded by composition-related effects, we provide two different exercises. First, we restrict the sample to firms that export only one product to one destination and, second, we keep for each multi-product exporter only the most relevant product, defined as the one with the highest exports to a given destination d at a given time t.[37] Estimates reported in columns (6) and (7) show that our findings remain unaffected when using these alternative samples, corroborating our original identification strategy. In column (8) we report results associated with another sensitivity check regarding the phenomenon known as "carry-along trade", that is the increasing propensity of manufacturing firms to export products that they do not produce (Bernard et al., forthcoming). As far as these products are imported and exported in the same foreign currency, they should be less sensitive to current and expected exchange rate variations and including them in the sample could bias the estimates. To identify carry-along products, we would need information on both production and exports at the product level. Since these data are not available, we exclude those

[37]Note that, as recently suggested by Fontagné et al. (2018), firms' core competences could not simply relate to export sales but could reflect richer forms of interdependence that can be captured by those goods that are more likely to be co-exported. Indeed, Fontagné et al. (2018) observe a significant departures from the theoretical benchmark of core competences following a rigid ordering in the product export sales across destinations. While our aim here is simply to check the robustness of our main results with respect to a different sample composition, the possible heterogeneous effects of pricing-to-market strategies across products within a firm taking into account such type of complementarities is an important area for future research.

products that are contemporaneously exported and imported by the same firm. Our main results remain to a large extent valid also in this case.

A second threat to our identification strategy comes from sample selection issues. Indeed, our empirical investigations so far have been carried out conditioning on the subset of exporting firms active in a destination market without modeling exit and selection into exports. This conditioning might be associated with a bias in the estimates of β and γ. Intuitively, in our conceptual framework firms hit by a negative cost/productivity shock are those that would like to increase their prices more. If firms dropping a destination market or exiting from the sample in face of an exchange rate appreciation ($\Delta \ln e_{d,t} > 0$) are also those more likely to be affected by such a negative shock, our estimates of β would be downward biased.[38] For our main parameter of interest, γ, this selection problem may however be different and the extension of the same reasoning is more subtle. In particular, it seems doubtful that (conditional on an actual exchange rate variation) there exists any correlation between the probability of exiting and the expected future exchange rate appreciation. Table A1 in Appendix A provides some evidence corroborating this intuition. First, consistently with the results in Amiti et al. (2014), the probability of remaining active in a market appears (barely) negatively correlated with an appreciation of the exchange rate. Second, we do not find any correlation between an expected variation of the exchange rate and the probability of staying in the export market. Taken together with the stability of our results using alternative sub-samples, it seems safe to say that this indirect evidence suggests that our estimates, in particular of the parameter of interest γ, should not be driven by a selection bias.

Last, a correlation between the error term and our main variable of interest might be generated by simultaneous causality. While possible, this potential source of bias and inconsistency for the OLS appears to us less problematic as it seems rather unlikely that individual French firms' behavior can systematically influence the exchange rate movements of the Euro.

4.2 Heterogeneous effects

Our findings provide evidence in favor of the conjecture that firms react to both observed and expected movements in the exchange rate when setting their export prices. As next task, we investigate whether these effects are heterogeneous across firms. Indeed, the PTM literature has convincingly shown the existence of heterogeneous pricing strategies across firms, in that export price elasticities differ across firms depending on their market power and on their input import intensity (Berman et al., 2012; Amiti et al., 2014). Following the approach used in these articles, we empirically explore whether the heterogeneity in firms' export price elasticity applies also with respect to the response of expected exchange rate movements.

The first source of heterogeneity that we address is in terms of firms' market power: the hypothesis to test is that price adjustments to exchange rate movements reflect the differences in exporters' market power across products and destinations. To proxy for exporters' market power, we follow Amiti et al. (2014) and use the individual firm's market share, defined as the ratio between a firm's exports in product p to destination d at time t over the total exports from the same country in that same product-destination-time:

$$S_{fpd,t} = \frac{\text{Exports}_{fpd,t}}{\sum_{f \in \mathcal{F}_{pd,t}} \text{Exports}_{fpd,t}} \quad ,$$

where $\text{Exports}_{fpd,t}$ is the export value of each transaction and $\mathcal{F}_{pd,t}$ is the set of French firms exporting product p to destination d at time t. To investigate this issue we modify our baseline

[38] This argument mimics Amiti et al. (2014) where the same type of bias might emerge.

Table 4: Exchange rate expectations: heterogeneous effects

Dep. variable: $\Delta \ln uvx_{fpd,t}$	(1)	(2)
$\Delta \ln e_{d,t} \times S_{fpd,t}$	-0.329***	
	(0.115)	
$Exp_t \Delta \ln e_{d,t+1} \times S_{fpd,t}$	-0.575***	
	(0.187)	
$S_{fpd,t}$	-0.078***	
	(0.005)	
$\Delta \ln e_{d,t} \times II_f$		0.012
		(0.013)
$Exp_t \Delta \ln e_{d,t+1} \times II_f$		0.040*
		(0.022)
II_f		-0.0004
		(0.0004)
$\Delta mc_{f,t}$	0.017***	0.017***
	(0.004)	(0.004)
$\Delta Quality_{fpd,t}$	0.131***	0.131***
	(0.001)	(0.001)
$\delta_{pd,t}$	Yes	Yes
δ_f	No	No
N	473,970	473,970
R^2	0.557	0.557
adj. R^2	0.475	0.475

Notes: Observations are at the firm-destination-product-time level. Δ corresponds to time changes across semesters. The coefficients appear together with standard errors clustered at destination-product-time level. *** significant at the 1% level, ** significant at the 5% level and * significant at the 10% level.

specification to read

$$\Delta \ln \text{uvx}_{fpd,t} = \alpha + \beta_S \Delta \ln \text{e}_{d,t} \times \text{S}_{fpd,t} + \gamma_S \text{Exp}_t \Delta \ln \text{e}_{d,t+1} \times \text{S}_{fpd,t} + \mu \text{S}_{fpd,t} + \delta_{pd,t} + \epsilon_{fpd,t} \ , \quad (9)$$

where we interact both the current and the expected exchange rate changes with market shares at the firm-product-destination level. With respect to the baseline specification we replace firm-product-destination fixed effects with product-destination-time fixed effects since we are interested in identifying heterogeneity across firms. As in the baseline we control for marginal costs and quality adjustments. This specification controls for all time-varying and time-invariant product-destination characteristics that might affect firms' export prices and it captures the heterogeneity across firms in response to a common exchange rate variation. It follows that in this specification the two variables $\Delta \ln e_{d,t}$ and $\text{Exp}_t \Delta \ln e_{d,t+1}$, as well as the vector of macroeconomic controls, are absorbed by the fixed effects $\delta_{pd,t}$. Consequently, our coefficient of interest γ_S, is identified by exploiting the variability across firms within the same triplet product-destination-time. Regressions are estimated with OLS with standard errors clustered at the product-destination-time level.

Consistently with the empirical findings in previous works, the negative and highly significant estimate for the coefficient of β_S in column (1) of Table 4 confirms that firms with higher market shares insulate more the import price of their products from the observed exchange rage variations. More interestingly for the present paper, the elasticity of the export price to expected exchange rate changes increases with a firm's market power, as the coefficient associated with this interaction term γ_S is negative and statistically significant.

The second source of heterogeneity that we investigate regards differences in the extent to which firms import from abroad their inputs. Indeed, firm-level import intensity represents a good proxy for the sensitivity of marginal costs to the exchange rate variations and is associated with its ability to insulate the prices of its exported varieties from exchange rate variations (Amiti et al., 2014). We compute a firm's import intensity as the ratio of its total imports over its variable costs including the total wage bill and the total material costs

$$\text{II}_{f,t} = \frac{\text{Imports}_{f,t}}{\text{Variable Costs}_{f,t}} \quad .$$

To control for potential diversity in a firm's mix of imported inputs across time and/or country, we average $\text{II}_{f,t}$ over all available periods, from 2000 to 2007. We thus obtain a time-invariant imported input intensity, II_f, and we estimate

$$\Delta \ln \text{uvx}_{fpd,t} = \alpha + \beta_{II} \Delta \ln \text{e}_{d,t} \times \text{II}_f + \gamma_{II} \text{Exp}_t \Delta \ln \text{e}_{d,t+1} \times \text{II}_f + \mu \text{II}_f + \delta_{pd,t} + \epsilon_{fpd,t} \quad . \tag{10}$$

Results of this specification are reported in column (2) of Table 4. The two coefficients for actual and expected exchange rate variations turn out to be not statistically significant or barely significant, suggesting that the imported input intensity channel is not important to explain heterogeneous export prices elasticities.

Taken together, these results suggest the existence of significant heterogeneity across firms with different market power in their response to observed and expected exchange rate changes. The evidence that market power mechanisms generate a heterogeneous impact of expected exchange rate changes on current export prices supports those models where forward-looking firms consider both the observed and the expected changes of the variables affecting their profits and, in making decisions on current export prices, discount such inter-temporal effects by taking into account their current position in the market (Froot and Klemperer, 1989; Alessandria, 2009; Alessandria et al., 2010). This very same result provides novel empirical evidence on the importance that the structure of the market and the way firms interact among each other have in shaping export price strategies, as recently suggested by Auer et al. (2018) and Amiti et al. (2016). This strengthens the idea that the extent to which firms price-to-market is a very important determinant of the price-setting decisions in foreign markets and that the limited exchange rate pass-through observed in the majority of studies is not only the consequence of the presence of costs denominated in local currency and of imported intermediary inputs, but also of an intentional attempt by the firms to take into account the impact of observed and expected exchange rate variations on their market shares.

4.3 Expectations uncertainty

Taking the cue from the literature on the role of uncertainty discussed in Bloom (2009), we move on by investigating to what extent uncertainty affects the elasticity of firms' export prices to expected exchange rate movements. As explained, in this work we rely on information provided by the forecasts of the individual financial intermediaries and thus treat the disagreement among them as a proxy of uncertainty.[39]

While there might not be a monotone relationship between the strength of disagreement among intermediaries and the level of uncertainty (Glas and Hartmann, 2016; Lahiri and Sheng, 2010), stark disagreement is certainly more likely to emerge in situations of significant uncertainty. As

[39] As we have no access to either intermediaries' individual uncertainty or firm-specific forecasts, we can build proxies of uncertainty only by elaborating the individual point forecasts.

Table 5: Exchange rate expectations: uncertainty

Dep. variable: $\Delta \ln uvx_{fpd,t}$	(1)	(2)
$\Delta \ln e_{d,t}$	-0.374***	-0.369***
	(0.039)	(0.029)
$\text{Exp}_t \Delta \ln e_{d,t+1}$	-0.475***	-0.590***
	(0.106)	(0.077)
$\times D^{\text{UNC}}_{d,t}$	0.383***	0.351***
	(0.117)	(0.086)
$D^{\text{UNC}}_{d,t}$	0.0002	-0.004**
	(0.003)	(0.002)
Δ mc$_{f,t}$		0.022***
		(0.004)
Δ Quality$_{fpd,t}$		0.128***
		(0.001)
Δ GDP$_{d,t}$		-0.010***
		(0.002)
Δ Inflation$_{d,t}$		-0.003
		(0.002)
ΔExp Inflation$_{d,t}$		0.003
		(0.002)
$\Delta \ln$ Demand$_{pd,y}$		0.001
		(0.003)
$\Delta \ln$ HHI$_{pd,y}$		-0.004
		(0.004)
$\Delta \ln$ UV$_{pd,y}$		0.004**
		(0.001)
δ_{fpd}	Yes	Yes
δ_{sem}	Yes	Yes
N	510,507	510,507
R^2	0.078	0.498
adj. R^2	-0.101	0.400

Notes: Observations are at the firm-destination-product-time level. Δ corresponds to time changes across semesters. The coefficients appear together with standard errors clustered at firm-product-country level. *** significant at the 1% level, ** significant at the 5% level and * significant at the 10% level.

shown by Beckmann and Czudaj (2017), uncertainty is indeed an important determinant of individual forecasts.[40] For this reason, rather than using a continuous measure of disagreement among forecasters, we create a dummy variable that takes value one in the semesters in which disagreement among forecasters about the future bilateral exchange rate is relatively high, and zero otherwise. The classification of periods in terms of uncertainty requires, in turn, to set a threshold value for the extent of disagreement that characterises periods of high uncertainty.

Accordingly, we build the dummy variable $D^{UNC}_{d,t}$ as follows

$$\text{D}^{\text{UNC}}_{d,t} = \mathbb{1}[\text{cv}_{d,t} > \text{median-cv}_d + \varphi \text{ mad-cv}_d] \ , \tag{11}$$

where $\mathbb{1}$ is the indicator function, $\text{cv}_{d,t}$ is the coefficient of variation of expectations across financial intermediaries and investors at any point in time ($\text{Exp}_t\ e_{d,t+1}$) and median-cv$_d$ and mad-cv$_d$ its

[40]Stark disagreement could also indicate that only a number of intermediaries receive certain information and change their forecasts accordingly. This said, whether different individual beliefs come from heterogeneity in the information sets or from differences in the understanding of the economic fundamentals is immaterial here.

median and median absolute deviation.[41] The parameter φ will be initially set equal to 0.5, so that periods of high uncertainty are those when the observed coefficient of variation of bilateral exchange rate expectations is higher than the median coefficient of variation plus half of its median absolute deviation. We will subsequently vary φ to check the robustness of the results to alternative values for the disagreement-related threshold.

In order to allow for the possibility that exporter price responsiveness varies according to the level of uncertainty about future exchange rates, we estimate the following equation

$$\begin{aligned}\Delta \ln \mathrm{uvx}_{fpd,t} = \alpha + \beta \Delta \ln \mathrm{e}_{d,t} + \gamma \mathrm{Exp}_t \Delta \ln \mathrm{e}_{d,t+1} + \delta_{fpd} + \delta_{sem} + \\ + \zeta \mathrm{Exp}_t \Delta \ln \mathrm{e}_{d,t+1} \times \mathrm{D}^{\mathrm{UNC}}_{d,t} + \lambda \mathrm{D}^{\mathrm{UNC}}_{d,t} + \epsilon_{fpd,t} \ ,\end{aligned} \tag{12}$$

where we interact $\mathrm{Exp}_t \Delta \ln e_{d,t+1}$ with a dummy variable $\mathrm{D}^{UNC}_{d,t}$ taking value 1 in periods of relatively high uncertainty regarding future exchange rates. A positive sign for the coefficient ζ, associated to the interaction term, would indicate that the response of export prices to expected exchange rate variations is lower when the level of uncertainty is higher. Situations where individual forecasts differ substantially are thus associated with greater caution by firms and by lower average responses to expectations. Regressions are estimated with OLS with standard errors clustered at the firm-product-destination level.

Table 5 reports the estimation results of equation (12) for the baseline specification, in column (1), and those for the specification that includes micro- and macro-economic controls, in column (2). Our tests detect significant heterogeneity and state-contingency in the impact of exchange rate expectations on export prices and indicate that it depends on the level of uncertainty. Considering the magnitude of this effect, we find that the export price elasticity to expected exchange rate changes decreases by more that 50% when moving from a low to high level of uncertainty (column 2). While the threshold φ is unobservable, we can test the sensitivity of our results by modifying the values of φ that activates the dummy capturing a high level of uncertainty. We run a battery of tests by exploring the interval of values of φ between 0.5 (the most conservative benchmark) and 1.1. In a nutshell, we find that the precise value of φ is immaterial to our findings, at least to the extent that enough observations are left in each uncertainty-related regime. Indeed, the results are robust across the specifications and the coefficients of interest, γ and ζ, remain remarkably stable, as can be seen in Figure 3 where we plot the point estimates and the confidence intervals for these parameters estimated by imputing different values of φ between 0.5 and 1.1.[42] As we are interested in the overall impact of expected variations in the exchange rate on export prices, we also run a test on the statistical significance of the sum of the parameters γ and ζ, that is the null hypothesis $\gamma + \zeta = 0$. The data always reject the null hypothesis. This implies that, for meaningful values of φ, greater uncertainty does reduce, but never entirely cancels, the role that expected variations of the exchange rate play on current pricing decisions.

Our results indicate that firms respond more cautiously to an expected exchange rate variation when the level of uncertainty is higher. In line with the mechanisms discussed in Bloom (2014), this suggests that channels associated with the existence of irreversible costs, with the presence of risk averse firms or with a deterioration of the credit market conditions appear to be stronger than those working in the opposite direction. Again this evidence goes well with a dynamic demand-side mechanism whereby, due to the intertemporal relationship between current market shares

[41] If instead of the median and the median absolute deviation we use the mean and the mean absolute deviation results remain qualitatively similar.

[42] For values of φ larger (smaller) than 1.1 (0.5), very few observations are included in the high (low) uncertainty regime, and this prevents the identification of the parameters of interest. Accordingly, we focus on meaningful values of the threshold φ that are consistent with the actual presence of both uncertanty-related regimes across the destinations and over time.

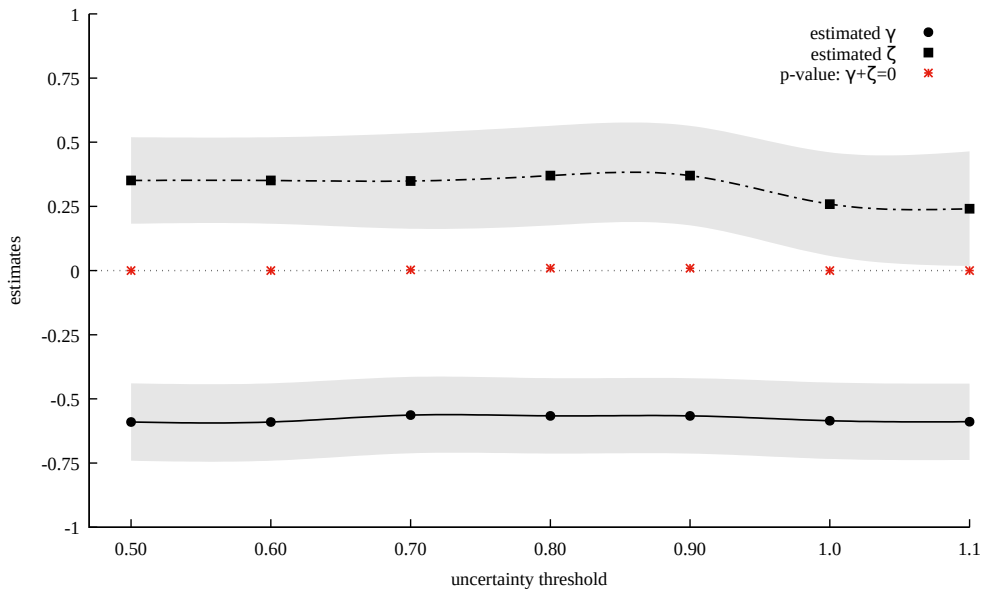

Figure 3: The figure reports the estimates of γ (circle-dotted line) and ζ (square-dotted line) for the values of the threshold φ, distinguishing high and low uncertainty regimes, between 0.5 and 1.1. Ligth gray bands represent a 2 standard deviation bands. The red asterisks stands for the p-value associated with the test of the null hypothesis $\gamma + \zeta = 0$.

and future profits, a pricing-to-market strategy incorporates also investment decisions in current market shares. Similarly to what happens for any other investment decisions, uncertainty has a non-negligible impact and, more precisely, reduces firms' incentives to gain market shares today so as to increase expected profits in the future.

5 Conclusions

On the basis of a rich dataset of French firm-product-destination international transactions, this paper investigates empirically the impact of expectations about future exchange rate variations on the individual firms' export pricing. It shows that expectations affect price decisions as the exporting firms consider both the observed and the expected exchange rate variations in setting their export prices.

Falling short of firm-specific subjective expectations (not available for French firms), the analysis relies on the forecasts offered by the main financial intermediaries to which internationalized French companies refer for financing and advice. This allows to produce novel evidence on the role of exchange rate expectations in export pricing, as well as on the impact of firm heterogeneity and uncertainty on the mechanisms relating expectations about the future to current pricing decisions.

By exploring the role of various features of firm heterogeneity, in particular, the analysis shows that the intensity of the impact of expectations on export prices depends on the firms' market power, in accordance with the theoretical hypothesis that, while maximizing their intertemporal profits, firms take into account the dynamic relationship between current market shares and future profits. Demand rigidities associated with mechanisms such as customer accumulation (Froot and Klemperer, 1989), consumer search (Alessandria, 2009) or inventory management (Alessandria et al., 2010) are credible candidates to explain this forward-looking behavior of firms, while price

stickiness is less likely to be relevant due to an empirical setting where biannual variations in prices are considered.

The work provides also novel evidence on the role of uncertainty about future bilateral exchange rates, showing that the strength of the impact of expectations about future exchange rate movements is considerably reduced in periods of relatively large uncertainty. Also this evidence goes well with the dynamic demand-side mechanism. Similarly to what happens for any other investment decisions, uncertainty has a non-negligible impact and, more precisely, reduces firms' incentives to gain market shares today so as to increase expected profits in the future.

Recently, Coibion et al. (2018a) analyze how firms develop their expectations and show that firms update their beliefs when presented with new information and that variations in their beliefs impact on firms' decisions. To the extent that internationalized companies tend to resort to financial intermediaries to finance their operations and receive advice, Coibion et al. (2018a)'s results support our working assumption that the exchange rate forecasts offered by financial intermediaries influence firms' beliefs and decisions. Unfortunately, we cannot test the extent to which intermediaries' and firms' expectations move together as no direct questions on expected future movements of the exchange rates are present in the available micro-surveys. To be sure, an approach based on firm-specific expectations (such as those used in Buchheim and Link, 2018; Coibion et al., 2018b,a; Dickstein and Morales, 2018; Gennaioli et al., 2015) would allow to exploit more dimensions of variation in the data, explore further interesting questions regarding firm heterogeneity in terms of expectations, and consider the subjective dimension of uncertainty. To address the impact of subjective expectations on export pricing decisions in the empirical framework proposed in this work, one would need to match firms' expectations, financial data and custom data. This is, at the moment, not possible for French companies.

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A Selection bias

The table here below reports the results of estimating a Linear Probability Model for a firm's f probability of remaining in a destination market d, that is for $\Pr(\mathbb{1}_{fd,t} = 1 | \mathbb{1}_{fd,t-1} = 1)$.

Table A1: Probability of staying in the sample - $\Pr(\mathbb{1}_{fd,t} = 1 | \mathbb{1}_{fd,t-1} = 1)$

Dep. variable: $\Pr(\mathbb{1}_{fd,t} = 1 \mid \mathbb{1}_{fd,t-1} = 1)$	(1)	(2)	(3)	(4)
$\Delta \ln e_{d,t}$	-0.664**	-0.086	-0.056	-0.068
	(0.251)	(0.060)	(0.047)	(0.060)
$\text{Exp}_t \Delta \ln e_{d,t+1}$	0.414	-0.100	-0.153	0.140
	(0.439)	(0.155)	(0.249)	(0.238)
Controls	Yes	Yes	Yes	Yes
δ_t	Yes	No	No	No
$\delta_t + \delta_d$	No	Yes	No	No
$\delta_t + \delta_d + \delta_f$	No	No	Yes	No
$\delta_t + \delta_{fd}$	No	No	No	Yes
N	441,030	441,030	435,630	421,006
R^2	0.232	0.239	0.419	0.559
adj. R^2	0.232	0.239	0.384	0.484

Notes: Observations are at the firm-destination-time level. Δ corresponds to time changes. The coefficients appear together with standard errors clustered at the same level of the fixed effects. *** significant at the 1% level, ** significant at the 5% level and * significant at the 10% level. The dependent variable is equal to 1 in 72% of the observations. Controls include: variation over time of GDP, current and expected inflation rates, demand, market concentration and competitors' prices as in our baseline specification.