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How Multi-Destination Firms Shape the Effect of Exchange Rate Volatility on Trade: Micro Evidence and Aggregate Implications

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Highlights

- Using a French firm-level database that combines balance-sheet and export information over the period 1995-2009, we study how firms reallocate exports across destinations following RER volatility shocks.
- Firm-level bilateral exports to a considered destination also react to RER volatility on other markets that could be reached by the firm.
- Firms tend to reallocate exports away from destinations with unfavorable dynamics in terms of RER volatility, and are even more prone to do so when the scope of possible reallocations is extended.
- Our results provide an explanation to the small aggregate trade response to RER volatility.

Abstract

How can the lack of reaction of aggregate exports to Real Exchange Rate (RER) volatility be explained? Using a French firm-level database that combines balance-sheet and product-destination-specific export information over the period 1995-2009, we propose a micro-founded explanation to this macro puzzle, by investigating how firms reallocate exports across destinations following RER volatility shocks. We show that firm-level bilateral exports to a considered destination also react to external volatility, represented by several indicators we build. Firms tend to reallocate exports away from destinations with unfavorable dynamics in terms of RER volatility, and this effect grows with the scope of possible reallocations. Efficient diversification of destinations served appear therefore as another way to handle exchange rate risks, and provides an explanation to the small aggregate trade response to RER volatility: if big multi-destination firms, who account for the bulk of aggregate exports, can react to an adverse shock of RER volatility somewhere by transferring trade to other and less volatile destinations, this leaves exports mainly unchanged at the macro level.

Keywords

Real Exchange Rate Volatility, Multi-destination Exporters, Reallocation, Aggregation.

JEL

F14, F31, G32, L25.

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RESEARCH AND EXPERTISE ON THE WORLD ECONOMY

How Multi-Destination Firms Shape the Effect of Exchange Rate Volatility on Trade: Micro Evidence and Aggregate Implications[1]

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1. Introduction

The increasing volatility of real exchange rates after the fall of Bretton-Woods agreements has been a source of concern for both policymakers and academics. Exchange rate risk increases trade costs and reduces the gains from international trade (Ethier, 1973). Surprisingly, macroeconomic evidence on the effect of exchange rate volatility on trade has however been quite mixed, yielding either small or insignificant effect on aggregate outcomes (see among others Tenreyro, 2007, Greenaway and Kneller, 2007 and Byrne et al., 2008). Common explanations for this missing evidence refer to the existence of hedging instruments for exchange rate risks, which are precisely designed to dampen the effect of exchange rate volatility on trade. At the micro (firm) level, a couple of papers provided evidence of a trade-deterring effect of real exchange rate volatility (see Cheung and Sengupta, 2013 on a sample of a few thousand Indian non-financial sector firms, and Héricourt and Poncet, 2015 on the population of Chinese exporters). The present paper aims at bridging the gap between the two types of evidence. Why does not the documented microeconomic trade-deterring effect of exchange rate volatility translate into elastic aggregate trade outcomes?

The present paper investigates the firm-level export reallocation across destinations following Real Exchange Rate (RER) volatility[2] shocks and its aggregate implications. We examine the heterogeneous responses of exporters to RER volatility according to their productivity and the number of destinations served. Beyond their higher access to financial instruments to hedge against risk, we argue that multi-destination firms are able to reallocate exports across destinations so as to minimize the overall impact of exchange rate volatility on their total exports. In that case, a large (or non-zero) trade-deterring effect of RER volatility in the firm-destination dimension would be consistent with a small (or zero) trade elasticity to RER volatility at the macro level, independently from hedging strategies.

We investigate this hypothesis using a French yearly firm-level dataset containing country- and product-specific trade data from the French Customs and balance-sheet information over the period 1995-2009. In a standard firm-level gravity-style model known to be compatible with most of the existing theoretical frameworks, we start by assessing the impact of standard bilateral RER volatility on several definitions of export performance at the firm level, for both the intensive and extensive margins. We provide evidence of a significant non-linear, trade-deterring effect of bilateral RER volatility. Indeed, we find that a 10% increase in bilateral volatility reduces the value exported by 0.25%, and entry to a given export market by 0.15%, for the average firm.

However, we find that firm performance, measured in many dimensions, seems to amplify strongly this trade-deterring effect of bilateral RER volatility. Ranking firms according to their productivity, we find that a 10% increase in bilateral volatility has a net differential effect on the 90th percentile of the distribution relative to the 10th percentile equal to -0.9%. More importantly, the number of destinations exacerbates even more strongly this negative effect, independently from any other measure of firm performance. Ranking flows according to the

[2] Although the volatility of the real exchange rate differs conceptually from that of the nominal exchange rate, as shown by Clark et al. (2004), they do not differ much in reality. Beyond the fact that the literature delivers a strong preference for volatility indicators based on real exchange rates, our study includes Euro zone members with a fixed nominal exchange rate after 1999. Therefore, the choice for RER volatility was straightforward.

number of destinations served, our results show that a 10% increase in bilateral volatility decreases bilateral exports at the 90th percentile by 3.6% relatively to 10th percentile. Similar computation for the differential effect between the 99th and the 1st percentile gives a decrease by 6.2%. Qualitatively identical results are found for entry, with respectively net differential impacts equal to -0.4% (90th-10th percentile) and -0.6% (99th-1st).

Those effects are robust to various specifications and robustness checks. In particular, the trade-deterring effect is robust to the inclusion of variables related to potential hedging behavior of firms, through imports or proxys of access to financial markets. The effect is also robust to the inclusion of potential omitted variables such as quality of political governance, usually capturing country-specific risks.

Since high-performing firms account for a major part of aggregate exports[3], this is all the more at odd with macro evidence mentioned above, concluding to an absence of effect of RER volatility on trade. How can the strong negative impact on exports at the firm-destination level for the firms making up the bulk of aggregate exports translate into an absence of impact at the aggregate level? In this paper, we propose an explanation to this puzzle, coming from the possibilities of reallocation across several destinations for firms serving a high number of countries.

We further explore this reallocation behavior by investigating how this behavior depends upon "external" RER volatility, i.e. other markets than the considered one. For this purpose, we build a so-called multilateral RER volatility, which is a weighted average of the RER volatility in other countries. This variable measures the aggregate RER volatility of the potential countries the firm could serve conditionally to her sector. We thus investigate how much the reallocation behavior of the firm depends upon both the bilateral and multilateral RER volatility, the latter acting as a dis-opportunity cost. We find that the above-mentioned results we documented are conditional upon relative RER volatility: when bilateral volatility increases (decreases) relatively to multilateral volatility, exports towards the considered market are hampered (supported).

While providing an explicit theoretical framework underlying our finding is beyond the scope of our study, we discuss a possible rationalization of this behavior through the lens of Markowitz (1952, 1991) portfolio theory: for a given level of profitability on each market, firms will tend to reallocate exports away from destinations characterized by higher, relative RER volatility, in order to hold the average risk level of their destinations portfolio constant. This behavior is logically exacerbated when the number of destinations actually served increases, i.e. when the scope of possible reallocations is extended. More destination-diversified firms are therefore better able to handle exchange rate risks, with substantial implications for aggregate exports. We explicitly test this idea by estimating how firm-level exports react to the correlation between the log-level of bilateral RER and a multilateral index of (log) RER in other destinations, and find this reaction to be negative, as expected: when the correlation between RER of the destination served and the multilateral RER of all other potential destinations increases, the considered market loses interest in terms of risk diversification, and the firm chooses to

[3]In our sample, firms at the top 1% in terms of value exported represent 63% of aggregate exports, and firms at the top 10% represent 91% of aggregate exports - shares are averages over the 1995-2009 period. Those figures are very similar to those found by earlier studies on French firm-level exports, see in particular Mayer and Ottaviano (2007).

decrease exports towards this country. Once again, this effect grows with the scope of possible reallocations, i.e. with the number of destinations served.

Heterogeneity in the possibility to reallocate exports across countries is crucial since it determines noteworthy implications for the trade-deterring effect RER volatility at the aggregate level. In this respect, we find that the trade-deterring effect of RER volatility is all the more dampened that exports are concentrated at the sectoral level. Our results help to reconcile the small aggregate trade elasticity to RER volatility and the trade-deterring micro effect growing with the number of destinations served: aggregate exports are driven by a small group of large firms that are especially able to reallocate exports across countries, leaving total exports mainly unaffected by bilateral RER volatility.

The first contribution of the paper is to provide an alternative explanation for the muted response of aggregate trade flows to RER volatility. Existing literature emphasized the hedging strategies large firms tend to implement to cope with RER risk. On the contrary, we document that firm-destination exports flows are very sensitive to changes in RER volatility for large firms and we provide evidence that this result is driven by an efficient diversification through reallocation of exports across destinations. Our results also indicate that the latter seems to coexist with other hedging strategies.

Our second contribution consists in the identification of the reallocation behavior using various measures of multilateral and relative RER volatility. These composite indicators represent RER volatilities of all other destinations that could be served by the firm, and capture the external conditions upon which firms can reallocate exports. They appear to be determinant for correctly capturing how the trade-deterring effect of RER is shaped at the firm-destination level, which emphasizes that taking into account third-market effects at the firm-level is important to understand precisely how cost/demand shocks impact bilateral exports.

Third, the present paper contributes to the literature investigating how aggregation bias and non-linearities shape aggregate outcomes. Imbs and Mejean (2015) show that the aggregation of heterogenous firms or sectors can result into a bias in the estimation of the elasticity of aggregate outcomes. Also close to our paper are Berman et al. (2012) and Berthou et al. (2016) who focus on the heterogeneous responses of trade at the firm/sector/country-level to changes in RER level and their aggregate implications. The focus on the present paper is however different, since we focus on the volatility of the RER, and its implication in terms of reallocation of exports between destinations at the firm-level.[4]

The paper is structured as follows. In the next section, we survey the different theoretical mechanisms underlying our approach. Section 3 presents the data set, and discusses our empirical methodology. Section 4 analyzes the first set of results of the paper, with respect to both the intensive and the extensive margins of trade, focusing only on the effect of bilateral RER volatility. We then further investigate the reallocation of exports across markets taking into account third-market effects in Section 5, before providing complementary evidence and robustness checks in Section 6. We then assess the aggregate implications of our results in Section 7, and provide concluding remarks in Section 8.

[4]Somewhat related to our study is the paper by de Sousa et al. (2016). However, their focus is quite different since they study the impact of the volatility of foreign demand on bilateral exports, and do not study the possible interactions with the other markets served at the firm-level.

2. Real Exchange Rate Volatility, Firm Heterogeneity and Exports: Theoretical Background

2.1. How should the average firm react to bilateral RER volatility?

Several, complementary mechanisms lead to expect a negative impact of exchange rate volatility on bilateral trade. First, RER volatility may be seen as a specific form of uncertainty, which can be shown to harm real, firm-level variables in several theoretical context. In a firm-level framework with partial irreversibility, Bloom et al. (2007) find that higher uncertainty reduces the responsiveness of investment to a firm-level demand shock. Relying on a heterogenous-firms trade model with risk-averse managers, de Sousa et al. (2016) show that on average, firm-level exports decrease with uncertainty.

Following Ethier (1973), one may also think of exchange rate risk as creating an uncertainty for the exporter's earnings in her own currency, which is similar to an increase in variable costs. In a heterogenous-firms context, Bernard et al. (2011) show that higher variable trade costs (e.g., an increase in RER volatility) lead to a decrease in the share of multi-product firms that export as well as the number of destinations for each product, and the range of products firms export to each market. Exchange rate volatility may also increase the sunk costs of exports (see Greenaway and Kneller, 2007), which can be seen as a form of investment in intangible capital. When facing a real depreciation of its own currency, the current earnings of a firm rise. The firm may use this additional income to fund the sunk costs of entering new markets. However, in the case of an abrupt subsequent currency appreciation, once these investments are made, it is impossible to back out and recover what they cost. Consequently, firms may be reluctant to take the chance of engaging in exports to markets characterized by highly volatile exchange rates.

2.2. How should firm performance impact this relationship between bilateral RER volatility and exports?

Recent trade literature accounts for firm heterogeneity along various measures of firm performance, among which the number of destinations and the number of exported products. It is widely known that aggregate exports are concentrated in a small number of major players (Eaton et al., 2004) and these large exporters are involved in exporting more than one product to several destinations (Bernard et al., 2011; Eckel et al., 2011).

Multi-destination firms straightforwardly face a larger risk, compared to firms serving less destinations, insofar as they are more exposed to changes in RER in many countries: each supplementary destination in the portfolio of markets served by the firm adds a new source of exchange rate uncertainty. However, multi-destination firms are simultaneously potentially more able to handle RER risks than smaller firms. These firms have a good access to hedging instruments, which is widely confirmed by survey data. Ito et al. (2015) investigate how firms cope with exchange rate risk using survey data on a sample of a few hundred Japanese firms listed on the Tokyo Stock Exchange. They find that firms extensively use financial and operational hedging (through imports) to reduce the risk associated to exchange rate fluctuations. Based on the results of a survey conducted on a sample of 3,013 exporting firms located in five Euro Area countries (Austria, France, Germany, Italy and Spain), Martin and

Mejean (2012) study the joint use of hedging instruments and the choice of invoicing currency. They find that firms using financial hedging are more likely to price in foreign currency, and conclude that the two strategies can be considered as complementary, and both strategies are correlated with the size of the firm: large firms are more likely to invoice exports in local currency and to hedge against exchange rate risk.

To sum up, it appears that big, multi-destination firms are simultaneously exposed to a larger aggregate RER risk and have a better access to tools for managing the latter. If firm performance mirrors primarily this ability to hedge, firm size and the number of destinations should therefore *dampen* the impact of RER volatility on exporting behavior of these firms on a given market. However, it appears form Martin and Mejean (2012)'s study that big firms are more exposed to RER volatility because they choose to do so. This may be because either they have a better access to hedging instruments, or because they serve more destinations and have increased diversification possibilities. In that case, big, multi-destination firms will have the possibility to be more reactive to increased RER volatility, by reallocating exports away from more volatile destinations. In other words, firm-destination exports' elasticity to bilateral RER volatility may be *magnified* by firm's size and the number of destinations served because of optimal reallocation across destinations.

At the other end of the distribution, what impact of bilateral RER volatility should we expect for small firms, serving only one or a few destinations? If our hypothesis of a magnifying influence of firm performance on bilateral volatility is correct, bilateral exports from low-performing firms could react positively to RER volatility shock. Let us consider a RER volatility shock on a given export market. Following our hypothesis, big firms decrease proportionally more their export to this market. Since they account for the bulk of aggregate exports, the decrease of the market shares of these big firms have significant general equilibrium effects: in a standard Melitz (2003) model, this implies a decrease in the productivity threshold for exporting profitably to the considered market, allowing smaller, less performing firms to enter, or to export more. In that context, exports from low performing firms may react positively to a negative RER volatility, especially as they tend to price their exports in their on currency, as shown by Martin and Mejean (2012): that way, they do not bear a significant part of RER volatility, related to fluctuations of the nominal exchange rate.[5]

We will bring this hypothesis of a strong non-linearity of RER volatility along firms' performance distribution to the data, along with an explicit way to take into account the RER volatility on other markets served.

2.3. External RER volatility and Reallocation

Several theoretical mechanisms can induce a reallocation behavior away from high to low RER volatility destinations by multi-destination firms. We propose to highlight the latter by investigating the effect of external RER volatility on firm-level bilateral exports. The underlying intuition is to have a measure of relative RER volatility affecting exports towards a considered destination, and not only the bilateral RER volatility of the considered market itself.

[5] This intuition is also supported by Quian and Varangis (1994), who show on macro data for advanced countries that exports invoiced in the exporter's currency are positively affected by exchange rate volatility.

Relative RER volatility. The measure we have in mind relies on a weighted average of RER volatilities on all other relevant markets outside the considered destination. The expected impact of this external volatility indicator on bilateral exports towards a considered destination depends on the underlying hypothesis regarding the way firms' sales interact across markets. In a recent paper, Berman et al. (2015) show that sales on different markets tended to be complementary in case of exogenous shocks: when sales on some markets vary because of an exogenous shock, sales on the other markets served tend to move in the same sense, possibly due to liquidity constraints. In our case, we would expect therefore a negative impact of the multilateral volatility on bilateral exports towards a considered destination.

However, our primary focus is more to assess how the connection between the two measures of RER volatility (bilateral and multilateral) impacts bilateral exports towards a considered destination. Consistently with the various theories exposed previously, RER volatility appears as a (both variable and sunk) trade cost, that firms will try to minimize (for a given level of profits) by reallocating exports away from destinations that are subject to higher relative volatility. A first natural test is therefore to assess the impact of a ratio of bilateral RER volatility over its multilateral counterpart, on bilateral exports towards a given destination, with a negative sign expected. Consistently with our intuition exposed above, we expect this negative impact to be magnified with the number of destinations.

Correlation of bilateral and multilateral RER. A second approach is possible within the frame of financial theory, in which diversification is a natural way to handle risks. Therefore, it makes sense to rationalize the export allocation decision of the firm within the frame of Markowitz (1952, 1991) portfolio theory. Markowitz portfolio theory attempts to maximize portfolio expected return for a given amount of portfolio risk, or equivalently minimize risk for a given level of expected return, by carefully allocating the various assets that may or may not enter the portfolio. In our context, for a given level of profit, firms will tend to reallocate exports to destinations in which the level of RER is less correlated to the composite level of the other destinations served, i.e., the rest of destinations portfolio. As a second natural test, we expect the time correlation between the RER in level in a considered destination and multilateral RER to have a negative impact on bilateral exports, once again magnified with the number of destinations.

2.4. Key testable relationships

Four testable relationships can be derived from these various theoretical approaches for export performance on both the intensive (export value) and the extensive trade margins (entry).

Testable Relationship 1: Export performance decreases with bilateral exchange rate volatility. We therefore expect the link between bilateral volatility, on the one hand, and the exported value and the entry decision, on the other hand, to be negative.

Testable Relationship 2: Firm performance (size and number of destinations) is expected to magnify the negative impact of bilateral RER volatility, if diversification dominates conventional (natural/financial) hedging behavior.

Testable Relationship 3: Export performance decreases with relative exchange rate volatility. We therefore expect the link between the latter, on the one hand, and the exported value and the entry decision, on the other hand, to be increasingly negative with the number of destinations served.

Testable Relationship 4: Export performance decreases when the considered destination loses interest in terms of risk diversification, i.e., when the correlation between bilateral and multilateral level of RER increases. We expect therefore that this correlation has a negative impact on bilateral export performance, and this impact to be magnified with the number of destinations served.

3. Empirics

3.1. Data

RER Volatility Indicators. We compute two types of RER volatility for a given firm-destination-year observation, a bilateral and several multilateral/relative ones.

The bilateral real exchange rate volatility towards destination j, $Bil\_volat_{j,t}$, is computed as the yearly standard deviation of monthly log differences in the real exchange rate. Because we rely on an indirect quotation (that is, one unit of foreign currency equals e units of euros), we compute the real exchange rate as follows: $\text{RER}_{j,m,t} = e_{j,m,t} \times \frac{p_{j,t}}{p_{\text{dom},t}}$, where $e_{j,m,t}$ is the nominal exchange rate of the domestic currency with respect to the destination j's currency at the end of month m of year t, $p_{j,t}$ is the CPI of country j in year t and $p_{dom,t}$ is the French CPI in year t. Nominal exchange rate data are monthly averages, and come from the IMF's IFS dataset.

We also compute various multilateral RER volatility indicators. The choice for weights in the computation of the latter is not a trivial issue. We first use sectoral weight structure, based on the share of each country in the Harmonised System (HS) 2-digit sector in which the firm exports:

$$Multi\_volat_{sjt} = \sum_{c \neq j} \omega_{sct} Bil\_volat_{c,t}$$

where $Bil\_volat_{c,t}$ is the above defined destination-year specific RER volatility. $Multi\_volat_{sjt}$ is the multilateral volatility associated to country j at time t in HS2 sector s, and the weighting scheme ω_{sct} stands for the share of country c in total exports of sector s at time t. Therefore, all destinations with exports from sector s are considered as potential alternative destinations for the firm belonging to the considered sector, even if this firm does not effectively exports towards the current country.

Alternatively, we use a macro weighting scheme, based on the share of each country in French aggregate exports ω_{ct}, thus defining multilateral volatility at the destination-year level.

Therefore, ω_{ct} stands for the share of country c in total French exports at time t:

$$Multi\_volat_{jt} = \sum_{c \neq j} \omega_{ct} Bil\_volat_{c,t}$$

This second weighting scheme should be understood as a robustness check of the first one. Both derived measures of multilateral volatility are likely to be exogenous in the sense that they measure a composite, external volatility shock, independently of the actual structure of exports destination of the firm, and consequently, independently of its allocation decision. It embodies a pure exogenously driven cost shock on the firm, and does not take into account the reallocation decisions of the firm.

However, it is also possible and relevant to build a third measure of external volatility, that accounts explicitly for the endogenous, effective and observable relocation behaviour of the firm. This is done by imposing a weight structure reflecting the true portfolio of destinations of each firm, i.e., destinations shares in the firm total exports. Therefore, this measure should reflect a more firm-level multilateral volatility, and consequently, should be less exogenous than the two other measures. More precisely, we use the one-year lagged shares of all destinations (but j) served by the firm in its total exports:

$$Multi\_volat_{ijt} = \sum_{c \neq j} \omega_{ic,t-1} Bil\_volat_{c,t}.$$

Third, we build three measures of relative RER volatility as follows:

$$Rel\_volat_{xjt} = \frac{Bil\_volat_{j,t}}{Multi\_volat_{xjt}}.$$

where $Multi\_volat_{xjt}$ is alternatively one of the three indicators of multilateral volatility presented above.[6] All three measures (bilateral, multilateral and relative) of RER volatility are taken in natural logarithms in the empirical exercise. Finally, other macroeconomic variables come from the Penn World Tables and the IMF's International Financial Statistics.

Firm-level data We use firm-level trade data from the French customs over the period 1995-2009. This database reports exports for each firm, by destination and year over our sample period. It reports the volume (in tons) and value (in euros) of exports for each CN8 product (European Union Combined Nomenclature at 8 digits) and destination, for each firm located on the French metropolitan territory. Some shipments are excluded from this data collection. Inside the European Union, firms are required to report their shipments by

[6] We report results with two alternative weighting schemes in Tables D.1 (intensive margin) and D.2 (extensive margin) in the online appendix. A first one is based on the shares of each sector in total French exports over the whole period, and are therefore time-invariant, limiting the potential impact of self-selection in some specific markets; a second one is based on weights that are inversely related to distance between France and the importer country, the purpose being once again to strengthen exogeneity. Results based on these measures are very close to those presented hereafter.

product and destination country only if their annual trade value exceeds the threshold of 150,000 euros. For exports outside the EU all flows are recorded, unless their value is smaller than 1,000 euros or one ton. Those thresholds only eliminate a very small proportion of total exports. We exclude from our sample intermediate goods using the Broad Economics Categories classification. The underlying intuition is that exports of intermediates should not react to RER volatility in their destination of exports, but to greater RER volatility in destinations' exports of the products for which these imports are used to produce.

We also use firm-level data contained in the dataset called "BRN" ("Bénéfices Réels Normaux"), which provides balance-sheet data i.e. value added, total sales, employment, capital stock and other variables. The period for which we have the data is from 1995 to 2009. The BRN database is constructed from reports of French firms to the tax administration, which are transmitted to INSEE (the French Statistical Institute). The BRN dataset contains between 650,000 and 750,000 firms per year over the period (around 60% of the total number of French firms). Importantly, this dataset is composed of both small and large firms, since no threshold applies on the number of employees. A more detailed description of the database is provided by Eaton et al. (2004, 2011). Depending on the year, these firms represent between 90% and 95% of French exports contained in the customs data. As it is standard in the literature, we restrict the observations to firms belonging to manufacturing which excludes wholesalers. Balance-sheet and customs data can be merged using the firm identifier (SIREN number) and the year. The dataset finally contains between 17,000 and 35,000 exporting firms per year, and between 137 and 151 destinations served per year.

3.2. Descriptive Statistics

Summary statistics of key variables are given in Tables 1 and 2. They are consistent with previous evidence about French firms: exporting firms are highly heterogeneous in their performance and size, implying a large variance in our dataset. The average firm-country exported value is slightly above 520,000 thousand euros, whereas the average number of employees and value of assets are also quite small: the average exporter is a small firm, with modest values of exports. Performance indicators distributions, that are reported in Table 2, deliver a similar message: only a small number of highly performing firms, exporting towards a significant number of destinations. Half of the French firms export towards at most 2 destinations, which is consistent with previous studies on the subject (Eaton et al., 2011 or Mayer and Ottaviano, 2007) and supports the representativeness of the sample.

3.3. French Firms and RER Volatility: Some Facts

Using these datasets, we start to explore how French firms cope with RER volatility. We report in Figure 1 the cumulative distribution of exports with respect to the bilateral RER volatility. We represent on the vertical axis the share of total exports $P(x)$ that was exported subject to a RER volatility lower than x. We restrict our figure to RER volatility that is under .1 since more than 98% of French exports are concentrated under this value. A high share of total exports face a low RER volatility: around 60% of exports are directed towards destinations with a volatility equal or lower than 0.02. This should not be surprising since an important part of French exports are directed towards Euro Area countries, with a structurally close to zero RER volatility. At the other end of the spectrum, 10% of aggregate exports face a bilateral RER volatility equal or above 0.04. On the whole, there is an interesting heterogeneity for our analysis.

Finally, we represent in Figure 2 two types of mean RER volatility faced by firms when exporting to many markets. The line represents the simple average RER volatility across all destinations, while the points represent the exports-weighted average RER volatility faced by firms. We thus compare average RER volatility and effective aggregate RER volatility for each type of firm. The higher the number of destinations, the higher the average RER volatility is. Yet, once firm choices are taken into account, we find that the average RER volatility increases but less than if no reallocation choices were made by the firm. This is a first, descriptive evidence that, when firms can allocate their exports across destinations, they face lower aggregate RER volatility.

3.4. Empirical Strategy

Export Performance and Bilateral RER Volatility. We start by estimating the following specification:

$$\begin{aligned}\text{ExportPerf}_{ijt} &= \alpha \text{Bil\_volat}_{jt} + \delta \left(\text{Bil\_volat}_{jt} \times \text{LaborProd}_{it-1}\right) \\ &+ \tau \left(\text{Bil\_volat}_{jt} \times \text{NbDest}_{it-1}\right) + \phi \mathbf{Z_{jt}} + \lambda_{it} + \theta_j + \epsilon_{ijt}\end{aligned} \tag{1}$$

where ExportPerf_{ijt} is a measure of the export performance of firm i for export destination j in year t. We consider two alternative measures of export performance: the intensive margin of exports is captured with the log of the free-on-board export sales to country j in year t while the extensive margin is apprehended as entry. The latter is defined as $Pr(X_{ijt} > 0 \mid X_{ijt-1} = 0)$[7]. Bil_volat_{jt} is the standard bilateral RER volatility in destination j. Our empirical strategy presumes the exogeneity of real exchange rate volatility, since it is very unlikely that a firm shock translates into a change in country-level exchange rate variations. This is a very standard assumption in the related empirical literature, made among others by Berman et al. (2012), Cheung and Sengupta (2013) or Héricourt and Poncet (2015). Our conditioning set $\mathbf{Z_{jt}}$ consists of destination-year specific variables. In standard models of international trade, exports depend on the destination country's market size and price index. Therefore, $\mathbf{Z_{jt}}$ includes destination j's GDP and effective RER. As for measures of firms' performance, we will focus on (apparent) labor productivity[8] ($LaborProd_{it-1}$ defined as value added per employee), which we lag one year, normalized by the yearly average labor productivity in the sample, and the number of destinations served ($Nb.Dest_{it-1}$), also lagged one year. Finally, firm-year fixed effects, λ_{it}, and country dummies, θ_j, are also included, allowing us to examine variation in export allocations between destinations for a given year.

We first focus on the unconditional effect of bilateral RER volatility on export performance,

[7] In that set of regressions, our sample consists of a firm-country series of zeros followed by a decision to begin exporting. For a given firm-country, we can have several beginnings. For example, the subsequent export statuses 011001 becomes 010001 in our sample.

[8] We do not have the required information to build proper Total Factor Productivity for all years. Robustness checks based on TFP for the period 1995-2001 delivers almost identical results - see Tables A.6 and A.7 in the online appendix.

i.e., on a benchmark specification with δ and τ restricted to 0. Consistently with Testable Relationship 1 from section 2, we expect α to be negative. We then condition the impact of volatility first on labor productivity, then on the number of destinations served, by introducing the relevant interaction terms. Note that all unconditional firm-year variables, such as labor productivity or the number of served destinations, are by construction subsumed in the firm-year fixed effects. The key parameters of interest are then δ (interaction with the apparent labor productivity) and τ (interaction with the number of destinations): their signs and levels of significance tell whether the reallocation behavior mentioned in section 2 is at play. If multi-destination firms take advantage of reallocation possibilities, δ and τ should exhibit a negative sign, like α (see Testable Relationship 2).

External RER volatility and Reallocation In a second step, we further explore the reallocation behavior of multi-destination firms, by investigating the effect of RER volatility on external markets served on bilateral exports towards a considered destination. This is done by including either a multilateral or a relative RER volatility indicator in equation 1:

$$\text{ExportPerf}_{ijt} = \alpha \text{Bil\_volat}_{jt} + \beta \text{Multi\_volat}_{ijt} + \phi \mathbf{Z_{jt}} + \lambda_{it} + \theta_j + \epsilon_{ijt} \tag{2}$$

$$\begin{aligned} \text{ExportPerf}_{ijt} &= \zeta \text{Rel\_volat}_{ijt} + \kappa \left(\text{Rel\_volat}_{ijt} \times \text{Nb\_dest}_{it-1} \right) \\ &+ \phi \mathbf{Z_{jt}} + \lambda_{it} + \theta_j + \epsilon_{ijt} \end{aligned} \tag{3}$$

Following Testable Relationship 3, ζ and κ are expected to be negative: bilateral exports towards a considered destination should decrease when the relative RER volatility of this destination rises, and this should be increasingly true when the scope of possible reallocation expands.

Besides, we also estimate :

$$\begin{aligned} \text{ExportPerf}_{ij} &= \gamma \text{Corr\_RER}_{ij} + \eta \left(\text{Corr\_RER}_{ij} \times \text{Nb\_dest}_i \right) \\ &+ \theta_j + \lambda_i + \epsilon_{ij} \end{aligned} \tag{4}$$

where $Corr\_RER_{ij}$ is the coefficient of correlation between the level of RER in the considered destination, and a multilateral measure of levels of RER in other destinations.[9] To perform such an exercise, we need to compute correlations for a given firm-destination couple over time between bilateral RER and multilateral RER. This requires several alterations in the

[9]The latter is built identically to the multilateral volatility indicator: the weighting schemes do not change, only the RER substitutes to volatility.

data. First, the database has to be collapsed over the time dimension. In other words, we investigate how the correlation impacts the average firm-destination exports or participation. Second, computing firm-level time correlations is a highly computational task, which proved to be impossible on the whole database. We decided therefore to use a random draw of 20% of the observations at the firm-year-destination level and we restrict our sample to firm-destination couples that are present at least 2 years in the sample.[10] Third, the country-specific controls (GDP and Country Price Index) disappear, since they are now subsumed in the country dummies included in the specification to control for unobserved heterogeneity at the country level. Firm fixed effects are also included for similar, obvious reasons.

According to Testable Relationship 4, we expect both γ and η to be negative: when the correlation of RER increases, the considered destination loses relevance in terms of risk diversification, and the firm reallocates exports away from it ($\gamma < 0$), and this should be increasingly true when the scope of possible reallocation expands ($\eta < 0$). Note that, concerning the extensive margin, export performance is restricted to participation, since there is no time dimension in this estimation. Participation is thus the average of the firm-destination-year dummy of participation defined as $Pr(X_{ij} > 0$.

Finally, all regressions are performed with the linear within estimator for the intensive margin and the linear probability model[11] for the extensive margin. Finally, Moulton (1990) shows that regressions with more aggregate indicators on the right-hand side could induce a downward bias in the estimation of standard errors. All regressions are thus clustered at the destination-year level using the Froot (1989) correction.

4. Results: Export Performance and Bilateral RER Volatility

4.1. Baseline evidence

We study the joint effects of both bilateral RER volatility, firm performance and number of destinations on the two margins of trade separately: the size of export value per firm for the intensive margin, and the decisions to start exporting (entry) for the extensive margin.

4.1.1. Intensive margin of trade

We present baseline estimation results in Table 3. All regressions include firm-year fixed effects, and columns (2) to (5) include country dummies. This fixed effect structure allows us to investigate whether changes in bilateral RER volatility affect exports across destinations for a given firm-year. As for control variables, our two proxies for the destination countries' market size and price index display the expected positive sign. GDP is significant in all specifications, but not the price index which turns insignificant as soon as country dummies are included.[12]

[10] We repeated the exercise several times to check the reliability of our results; estimates based on alternative and randomly drawn samples are available upon request to the authors.

[11] The LPM makes easier the estimation of models with many observations, fixed effects and dummies. In our case, an estimation based on a non-linear estimator, such as the conditional logit proved to be impossible.

[12] This should not be considered as surprising: our firm-year fixed effect structure soaks up a great part of the time variability, while country dummies capture time-invariant heterogeneity at the country-level, including difference in price levels. This explains also that estimated parameters on GDP, while significant, are constantly below unity, despite the predictions of standard gravity frameworks.

Columns (1) and (2) report both the unconditional relationship between RER volatility and export performance. Comparing the two set of estimates show that the inclusion of country dummies (capturing time-invariant factors at the country-level, like distance) is highly required. Indeed, both confirm that RER volatility appears to be negatively associated with export performance: consistently with Testable Relationship 1, the parameter α of equation 1 is significant and negative. But, the elasticity is divided by 10 when country dummies are added: a 10% increase in the RER volatility generates lower exports by around 0.2%. While qualitatively consistent with previous firm-level studies, this estimate for the average firm seems quantitatively modest.

However, the subsequent columns shows that this average effect hides strong heterogeneity across firms. Columns (3) to (5) show that the magnitude of this effect actually depends on the performance of the firm regardless of the indicator used: labor productivity in column (3), the number of destinations served in column (4), both simultaneously in column (5). Firm's performance actually magnifies the impact of bilateral RER volatility on firm-destination exports: estimated parameters δ and τ in equation 1 are negative, clearly indicating that the diversification effect mentioned in Testable Relationship 2 dominates: more productive firms, or firms serving more destinations are more impacted by bilateral RER volatility.

We check the robustness of this negative relationship when volatility is computed from a GARCH estimation on the RER level, or based on the yearly standard deviation of monthly log differences of the nominal exchange rate. The results reported in Tables A.1, A2 and A.3 in the online appendix confirm that the unconditional impact of exchange rate volatility on the intensive margin is negative and significant (and quantitatively very close to our main definition of volatility) whether we consider 1/the volatility coming from a GARCH model, 2/ the HP (Hodrick and Prescott, 1997) detrended version of our benchmark RER, or 3/ the nominal exchange rate.[13]

To illustrate these results, we can provide quantitative assessments of the differential impact of RER volatility on the export performance for firms at the 10th and 90th percentiles of the distribution of firm's performance indicators. Table 2 above reports summary statistics on the distribution of the two indicators of firm-performance. Using coefficients from column (3) in Table 3 for the intensive margin, all things being equal, the effect of a 10 percent increase in RER volatility on export value is 0.1 $\times$ α +0.1 $\times$ δ $\times$ $LaborProd$. Therefore, we find that a 10% increase in bilateral volatility decreases exports at the 90th percentile of the distribution by -0.7%[0.1 $\times$ (-0.022) + 0.1 $\times$ (-0.066) $\times$ (ln(121.93/59.44))].[14] At the other end of the distribution, the same 10% shock of RER volatility actually increases bilateral exports by +0.2% [0.1 $\times$ (-0.022) + 0.1 $\times$ (-0.066) $\times$ (ln(29.16/59.44))]. The key point is that the net differential effect on the 90th percentile of the distribution (which accounts for more than 90% of aggregate exports) relative to the 10th percentile is equal to -0.9% [0.1 $\times$ (-0.066) $\times$ (ln(121.93/59.44)-ln(29.16/59.44))].

More importantly, the number of destinations exacerbates even more strongly this negative effect. Based on coefficients from column (4) in Table 3, all things being equal, the effect of

[13] In the last case, the sample is restricted to destinations outside the EA. The latter exhibit zero nominal exchange rate volatility after 1999, which may generate a bias in the estimation.

[14] As stated in the empirical strategy section, labor productivity is normalized by the yearly average labor productivity in the sample, which is 59,440 euros.

a 10% increase in RER volatility on export value is 0.1 $\times$ α +0.1 $\times$ τ $\times$ $NbDest$. Our results show that a 10% increase in bilateral volatility decreases bilateral exports by -1.6% [0.1$\times$ 0.361 + 0.1 $\times$ (-0.145) $\times$ ln(37)] for firms above the 90th percentile, but boosts exports for firms at the 10th percentile by +2% [0.1$\times$ 0.361 + 0.1 $\times$ (-0.145) $\times$ ln(3)]. This brings a net impact on the 90th relatively to 10th percentile of - 3.6% [0.1 $\times$ (-0.145) $\times$ (ln(37)-ln(3))]. Similar computation for the differential effect between the 99th and the 1st percentile gives a decrease by 6.2% [0.1 $\times$ (-0.145) $\times$ (ln(72)-ln(1))].

As expected from the theoretical discussion supporting Testable Relationship 2, the same bilateral RER volatility shock simultaneously decreases exports from high performing firms and increases those for low-performing firms. The key point is that the differential impact between top and bottom percentiles delivers substantial negative figures, confirming that big multi-destination firms, which account for the bulk of aggregate exports, react both negatively and disproportionately to a RER volatility shock. These results are robust to various sensitivity checks regarding the definition of performance at the firm-level. Table A.4 in the online appendix reproduces our baseline estimations using alternative measures of firm performance (employment, assets, capital intensity). All firm size proxies amplify the negative effect of RER volatility. More importantly, the specific, additional exacerbating impact of the number of destinations served is not altered even when the latter is included simultaneously with other proxies of firm performance. This supports our initial intuition that multi-destination firms have a specific behavior regarding volatility, that we are going to explore further in the next subsections.

4.1.2. Accounting for hedging behavior and invoicing currency

Hedging strategies have been advocated to be responsible for the muted response of trade flows following RER volatility. Previous results however suggest that RER volatility impacts large firms more than the average firm. In Table 4, we check whether the negative (micro-level) effect of RER volatility resists to the inclusion of variables embodying (or at least, indirectly related to) hedging or invoicing behavior by firms.

In columns (1), (2) and (3), we start by controlling for natural hedging strategy by accounting for firm-country imports. We compute a dummy variable ($Import_{ijt}$) equal to 1 if the exporting firm i is simultaneously an importer from country j in year t.[15] Since this variable is defined at the firm-country level, the unconditional variable is not subsumed in the firm-year fixed effects. We can then estimate the unconditional impact of being an importer and investigate the conditional impact of RER volatility upon this dimension. The estimated coefficient with respect to the import dummy in column (1) is significantly positive and its conditional effect is zero (column (2)). However, once the conditional impact of the number of destinations is accounted for, imports seem to dampen slightly the negative effect of RER volatility, enlightening the existence of natural hedging. But our main result remains unharmed: even taking into account imports from the same country, bilateral volatility still exerts a disproportional negative impact on exports for firms serving many destinations.

[15] We choose to use a dummy rather the continuous imports variable itself, because of the many zeros it contains. The log transformation would then cause a drastic reduction in sample. Using a dummy allows to spare observations.

The inclusion of financial hedging in the picture is less straightforward. Exhaustive information regarding the use of hedging instruments is not available - studies like Martin and Mejean (2012) or Ito et al. (2015) are based on survey data for a few thousand firms. However, we do know that, in a world of imperfect financial markets with information asymmetries, a larger firm will have also easier access to external finance since it has more collateral (see Beck et al., 2005, for cross-country-evidence). This means two things: bigger firms have simultaneously a better access to external finance and to hedging instruments; they have more finance to fund the use of hedging instruments, like forward contracts or options. Since the latter are mostly short-term contracts, we can presume that they will weigh primarily on firms short-term finance. Therefore, we decide to focus on the effect of two ratios to capture firm-level access to short-term finance and hedging instruments. We first compute a working-capital ratio (WC ratio), defined as working capital requirement over stable resources using BRN dataset. Results are presented in columns (4) and (5). We then compute a short-term debt ratio (STD ratio), equal to short-term debt over total debt. Results are presented in columns (6) and (7). Both firm-level measures dampen the negative effect of RER volatility on trade flows, consistently with the idea these two variables may correctly proxy financial coverage. However, these results coexist with the magnifying effect of the number of destinations on bilateral volatility. The reallocation behavior we suspect does not seem to be affected by financial factors.

Similarly, no information on invoice currency used by the exporter is available at the firm-level. The study from Martin and Mejean (2012) on a few thousands firms from several EMU countries (among which, France) highlights that 90% of firms declare using the euro for exports, but this proportion decreases once firms are weighted by their size. On the whole, 70% of the value of EMU aggregate exports are invoiced in euro. This emphasizes that bigger firms are more likely to invoice using the local currency of the destination country to price their exports. We already control extensively for firms size in the above-mentioned estimations, and our main result of magnified impact of bilateral RER volatility for bigger firms is fully consistent with the idea that bigger firms are voluntarily more exposed to exchange rate risk. Interestingly, it also appears that firms mainly exporting to developing countries are expected to price in home currency while exports to the US or other large industrialized countries are more likely to be priced in destination countries. We test directly this idea in columns (8) and (9) of Table 4 where is introduced a dummy variable taking the value 1 if the destination country belongs to the OECD, and its interaction with bilateral volatility. Coefficients are insignificant in all cases, but are correctly signed in column (9): exporting towards an OECD country tend to magnify the impact of bilateral volatility, consistently with what the literature on invoicing currency suggests. In any case, this does not change our main result of a negative impact of bilateral volatility, growing with the number of destinations served.

4.1.3. Potential omitted factors

In Table 5, we check the robustness of our results to the inclusion of potential omitted variables. We start by checking that the impact of RER volatility on trade does not capture country-specific risks. It is widely recognized that quality of institutions and governance is a strong determinant of trade at the aggregate level and at the firm level, insofar as trade is negatively associated to political and economic risks. We thus use the "Political Stability Estimate" variable from the Worldwide Governance Indicators dataset on institutional quality to control for country-specific risks in our specification (Kaufmann et al., 2010). This variable is an inverse measure of risks: an increase in the value of political stability is associated with a decrease in the risks associated with export activity in this country, and is therefore expected to impact positively firm-level bilateral trade. Columns (1) to (4) of Table 5 display the results. The quality of governance increases the average trade flows, and the effect is magnified for large and multi-destination firms. Both unconditional and conditional effects of quality of governance are thus consistent and perfectly in line with the one on RER volatility. Crucially, these effects do not soak up each other: including quality of governance and conditioning this variable upon firm performance leaves the main results about the trade-deterring effect of RER volatility unchanged. This supports that the effect we are highlighting is truly related to exchange rate volatility, and does not capture an effect related to political instability instead.

Columns (5) to (8) report the result of a similar exercise with the RER level. It could indeed be argued that the measured impact of RER volatility actually captures mainly a depreciation or appreciation trend in the exchange rate. Including the RER controls explicitly for this trend. Because we rely on an indirect quotation, an increase in the level of the exchange rate, implying a depreciation, is expected to have a positive impact on export performance. This intuition is confirmed: RER volatility and RER level enter with reverse signs, respectively negative and positive. Once again, the inclusion of RER in level does not affect the main message: the trade-deterring effect of RER volatility remains present and is magnified by firm size and the number of destinations. Only elasticities are slightly reduced. Additional checks of the robustness of our results to the inclusion of other potential omitted variables, such as the quality of economic governance and real market potential (Head and Mayer, 2004), are presented in the online appendix (see Table C.1). Results are not affected by the inclusion of these variables in the baseline estimation.

4.2. Extensive margin of trade

In this section, we assess the joint effect of bilateral RER volatility and indicators of firm performance on the extensive margin of trade at the firm-country level (i.e. how they affect entry decision). The explained variable is now the decision for a firm to begin exporting to market j. It is constructed as a change of export status at the firm-country level; it takes the value 1 when a firm exports to country j in year t but did not in year $t-1$. We start by estimating the impact of RER volatility on this variable, before checking that hedging behavior or potential omitted controls do not affect our results.

Columns (1) to (4) of Table 6 replicate columns (2) to (5) from Table 3. Evidence in column (1) suggests that RER volatility has a significant deterring impact on the entry decision. A 10 % increase in RER volatility is associated to a 0.12 % decrease in entry probability. Once again, this average figure seems to hide strong heterogeneity, at least regarding the number of destinations served. Indeed, columns (2) and (3) investigate the existence of non-linearities of this trade-deterring effect in firm productivity and in the number of destinations. Both dimensions seem to amplify the negative response of entry associated to RER volatility, but the elasticity associated to the interaction with productivity is very close to zero (column (2)). Conversely, the magnifying effect associated with the number of destinations is sizable (column (3)). Besides, this effect exists beyond the sole productivity impact (column (4)). These results are robust to the use of several alternative performance measures (Table A.5 in the online appendix). When productivity is proxied through TFP over the period 1995-2001 (Table A.7 in the online appendix), qualitatively similar outcomes are delivered, but elasticities are much smaller.

As we did previously for the intensive margin, we can compare the differential impact of RER volatility conditioning on the number of destinations served by contrasting effects for firms at the 10^{th} and 90^{th} percentile of the distribution of the number of destinations. Based on coefficients from column (3), this leads that, all things being equal, the net differential effect on the 90^{th} percentile relative to the 10^{th} percentile of an additional 10 percent in RER volatility on the probability of entering is equal to -0.4% [0.1 $\times$ (-0.013) $\times$ (ln(72)-ln(3))]. For the 99^{th} percentile relative to the 1^{st}, the net differential impact amounts to -0.6% [0.1 $\times$ (-0.013) $\times$ (ln(72)-ln(1))].

As we did before for the intensive margin, we check in Table 7 the robustness of our results to the inclusion of variables possibly related to natural (columns (1) to (3)) or financial (columns (4) to (7)) hedging at the firm-level, as well as invoice currency choice (columns (8) and (9)). If imports are associated to higher entry in the considered country (column (1)), they do not seem either to have any hedging impact on bilateral volatility (column (2)) or to compromise our main result in any manner (column (3)). The same conclusion prevails for the Working Capital Ratio (columns (4) and (5)) and the short-term debt ratio (column (6) and (7)). In columns (8) and (9), we introduce a dummy variable for destination countries belonging to the OECD, as we did before for the intensive margin. Interactions between this variable and bilateral RER volatility is negative in both cases: the negative impact of RER volatility on entry is magnified for these specific destination markets, which fits well with the idea that exporters tend to price more in destination currencies when they export to developed markets. But once again, this does not change anything to our main result: bilateral RER volatility hits disproportionately more bilateral exports from firms serving many destinations.

Table 8 presents results when taking into account additional macro variables: in the same vein as for the intensive margin, we include the "Quality of Political Governance" variable and the RER in level in our regressions. Quality of governance enters positively, as expected, but with weak elasticity and significance (column (1)). The parameters on interactive terms with labor productivity (columns (2) and (4)) are zero, but those on the number of destinations are strongly significant and consistently signed (columns (3) and (4)): firms serving many destinations enter disproportionately into markets with good governance. The RER level also enters positively and significantly (column (5)), and its interaction with labor productivity is zero (column (6)); however, its interaction with the number of destinations served is once again positive and significant (column (7) and (8)), but the impact is quantitatively modest. Table C.2 in the online appendix reports quasi-identical results when the "Quality of Economic Governance" and the real market potential are included.

In all cases, these additional estimates do not affect our benchmark result of a negative impact of RER volatility that grows modestly with the number of destinations served. In the online appendix (Table B.1), we report results of robustness checks using an alternative, more restrictive definition of entry for the extensive margin. We follow Poncet and Mayneris (2013) when defining our dependent variable, now the probability to start exporting to destination j, while not being an exporter to j at $t-1$ and still being an exporter at $t+1$. Formally, this variable is $\Pr(X_{ijt} > 0 \quad | X_{ijt-1} = 0, X_{ijt+1} > 0)$. This definition is more conservative than the previous one, insofar as it corresponds to a more definitive entry. Results reported in Table B.1 are qualitatively very similar to the ones presented previously. Quantitatively, they are smaller, elasticities decreasing by one third to one half. This constitutes further evidence that bilateral RER volatility does impact the entry decision of firms into a considered market, but to a more limited extent than the intensive margin.

5. Investigating Reallocation Behavior

The crucial point of our previous estimations consists in the magnified negative effect of RER volatility for multi-destination firms. We further explore the reallocation behavior of multi-destination firms, by investigating the effect of RER volatility in external markets on previous results.

5.1. First Strategy: Investigating Relative RER Volatility

Table 9 presents estimation results of the intensive margin of trade accounting for multilateral and relative RER volatility, defined as the ratio of bilateral to multilateral RER volatility. Columns (1) to (3) are based on multilateral RER volatility with sectoral weights, columns (4) to (6) on multilateral volatility with macro weights, columns (7) to (9) on multilateral volatility with firm-level weights.

As expected, columns (1), (4) and (7) show that multilateral volatility is negatively associated to exports at the firm-destination level, independently of the weighting scheme: the β parameter in equation (2) is negative and significant in all cases. On average, a 10% increase in the composite RER volatility outside of country j decreases exports to country j by 3.1 to 9.3%. This result is consistent with previous evidence suggesting complementarity of exports across destinations when sales are hit by exogenous shocks (see Berman et al., 2015). Multilateral volatility is lowering trade flows at the intensive margin and comes in addition to the trade-deterring effect of bilateral RER volatility. Interestingly, the inclusion of the multilateral term also tends to increase the elasticity of firm-destination exports to bilateral RER volatility, now comprised between -0.03 and -0.08. This provides additional evidence that taking into account dynamics on other markets matters.

Evidence on relative RER volatility (defined as the ratio of bilateral to multilateral RER volatility, columns (2), (5) and (8)) is less clear: the average effect (ζ parameter in equation (3)) is either nil, negative or positive depending on the weighting scheme chosen for the multilateral volatility. However, columns (3), (6) and (9) show that the interaction with the number of destinations served (κ parameter in equation 3) is negative and significant, as expected, with elasticities quasi-identical from one specification to another (around -0.14). For a given bilateral RER volatility in country j, a larger multilateral RER volatility outside of country j is associated to increased trade flows to country j for firms serving many destinations. This effect is once again consistent with the idea that multi-destination firms reallocate more easily exports away from markets plagued with high RER volatility.

Replicating the same structure, Table 10 reports estimations with respect to the entry decision. Results are qualitatively similar to those related to the intensive margin. Columns (1) and (4) show that the external RER volatility exerts a negative impact on entry decision (β parameter is negative, independently of the weighting scheme chosen): a 10% increase in multilateral volatility decreases entry by 0.2 to 1.4%.[16] Results are also fully consistent for the relative RER volatility (columns (2), (5) and (8)): the ζ coefficient is negative and significant on average, ranging between -0.011 and -0.015. For a given bilateral (resp. multilateral) RER volatility in country j, a smaller multilateral (resp. larger bilateral) RER volatility outside of country j harms entry to country j for the average firm. This effect is once again magnified for firms serving many destinations, as shown by the interactions with the relative RER volatility in columns (3), (6) and (9): the κ parameter evolves around -0.01. Firms will give up all the more easily entry to a considered market with higher relative RER volatility that they have a large set of alternative markets to enter.

Taken together, results from Tables 9 and 10 suggest that reallocation and external RER volatility matter when investigating how firms cope with RER volatility. The average firm-destination exports and entry decision react negatively to bilateral RER volatility all the less that external volatility is high, while the effect is magnified for large firms that are able to reach a large set of markets. A corollary is that heterogeneity in the number of destinations translates into heterogeneous response of trade flows to RER volatility, that will be the focus of our next section.

5.2. Second Strategy: a Simple Portfolio Approach

Here we propose an alternative approach in order to test for a diversification behavior of firms regarding the destinations they serve. More precisely, we check how firm-destination exports react to a modification of the time correlation between RER in the considered destination and a composite, multilateral indicator of RER in other markets, computed based on sectoral shares. Following equation (4), we expect the parameters γ and η to be negative: for a given level of expected profit, firms minimizing risks will to reallocate exports to destinations in which the level of RER is less correlated to the composite level of the other destinations served, i.e., the rest of destinations portfolio, and this should be increasingly true when the possible scope of reallocations (the number of destinations) increases.

Table 11 reports estimates for the intensive (columns (1) to (3)) as well as extensive (columns (4) to (6)) margins. Column (1) and (4) restrict the estimation to the unconditional impact of the correlation of RER (η is restricted to zero). We do have the expected negative impact (the γ parameter is negative and significant) only on bilateral exports, but not on participation. A 10% increase in correlation in RER in levels decrease the intensive margin on average by 0.2%, but leaves unchanged the extensive margin. Columns (2) and (5) show that adding correlation of RER volatilities basically do not change anything to this result. Column (3) supports that, consistently with previous results, the negative impact highlighted in column (1) tends to be exacerbated by the number of destinations served; conversely, column (6) confirms that correlation of RER has no impact whatsoever on Participation.

On the whole, these results tend to show that, when the correlation between the RER of a considered destination and the external RER increases, the considered market loses interest in terms of diversification, and the firm tends to reallocate exports away from this market. This

[16] We cannot show results with the unconditional effect on multilateral volatility with firm-level weights. The latter includes many zeros, and its log-transformation leads to a drastic reduction in the sample, leaving insufficient variability for properly identifying the coefficient.

effect grows with the number of destinations served, i. e., with the possibilities in terms of diversification, which is consistent with previous results. However, those diversification effects are only present for the destinations already served (intensive margin), no similar impact can be supported for the participation to a given export market. In other words, firms will react to increased RER volatility in some destinations by relocating sales from concerned markets elsewhere, but will not change participation to those destinations.

6. Complementary Results and Analyses

6.1. The Product Margin of Trade

Up to now, we studied exports at the firm-destination level, focusing on the potential reallocation behavior of firms exclusively between destinations. In this section, we go another step further by using the variation across products (defined at the HS6 level) within firms. In other words, we now use the information on the exported products by each firm to study if and how the reallocation behavior in terms of destinations we provided evidence for also emerges in this dimension. There are many reasons to believe that the product-mix may be an additional margin for firm exports. Recently, many papers, such as Mayer et al. (2014), have investigated the product mix of exports and have for instance emphasized the prominent role of the best-product at the firm-destination level.

More specifically, we report in Table 12 estimates for the intensive margin now defined as the (log) export value of the firm for a given product-year pair in a country (columns (1) to (4)), and for the extensive margin, defined as the (log) number of HS6 products for a given product-year pair in a country (columns (5) to (8)). Otherwise identical to Equations 1 and 3, regressions for the intensive margin include firm-product-year fixed effects, so that coefficients are identified from variation within firm-product-year triplets across countries. Therefore, our estimates consider the way in which firms choose to allocate their exports for a given product and a given year, across countries. For the extensive margin, the usual firm-year fixed effects and country dummies are used, with similar interpretation.

RER volatility, whether bilateral or relative, seems to impact export performance at the product level only very slightly on average, but once again becomes disproportionately negative for firms serving many destinations. Facing increased relative RER volatility, multi-product firms reallocate sales across destinations, using both the intensive and the extensive margin: for a given destination, they tend to decrease the average exported value and the number of exported products all the more that they serve many destinations. Interestingly, the elasticities on interacted terms in columns (2)/(4) and (6)/(8) tend to show that the effect is twice stronger for the number of products exported compared to the value per product. In other words, when a firm decreases exports towards a given destination following a RER shock, roughly one third of the effect comes from the decrease of the average value exported per product, and two thirds from a cut in the number of exported products.

6.2. Alternative Extensive Margin Measures

As an alternative to the entry behavior we studied until now, we estimate the impact of RER volatilities on participation and results are presented in Table 13. As we did previously for the estimation of equation 4, the participation is defined as the unconditional probability to be exporting to destination j, $Pr(X_{ijt} > 0)$. Variation in this variable comes from the different exporting status of firm i at time t across destinations and we consistently include firm-year fixed effects and country dummies. Taken together, results reported in Table 13 confirm our previous findings : they are qualitatively identical and quantitatively slightly higher to those found for entry. RER volatility exerts a negative effect on participation, growing with the number of destinations served. Elasticities however remain modest compared to the intensive margin.

It may also make sense to check if RER volatility shocks can represent an incentive to exit from a giver export market. Exit is defined as the probability of not exporting to destination j at time t, while being an exporter to j at time $t-1$: $Pr(X_{ijt} = 0|X_{ijt-1} > 0)$. We regress the corresponding dummy variable on the same variables as above and results are presented in Table 14. Expected effects are not straightforward: whether we consider volatility as a sunk or variable cost, predictions relate to entering or staying into the export market, but are less clear for exiting. In any case, average effects are nil, and interactions are significant, but elasticities are quite small. This is all the more true when we consider a temporary exit (i.e., when the firm gets back to the considered market the year following the exit, see Table B.2 in the online appendix).

All these findings about the extensive margin are confirmed by additional results – see tables in section B of the online appendix. They all confirm that firms mainly use the intensive margin to reallocate exports away from destinations plagued with high volatility, the phenomenon being quantitatively much smaller for the extensive margin.

6.3. Alternative Subsample : Excluding Euro-Area Destinations

A very significant part of export flows in our sample is directed towards the Euro Area (EA), for which nominal exchange-rate volatility is zero from 1999. For these observations, the sole source of RER volatility comes from a variation in relative price levels, which is known to be much smaller than the one of the nominal exchange rate. Keeping these observations in the sample may generate a bias. Therefore, another robustness check consists in dropping these observations from our sample. We replicate our baseline estimations for the intensive and the entry margins and results are respectively presented in Tables 15 and 16. Results are qualitatively identical to the ones we presented in above: there is still a negative impact of bilateral RER volatility, growing with the number of destinations served. The marginal effects are however reduced by half, indicating that the extent of reallocation is reduced in this subsample. This should not be surprising: EA countries are major markets for French firms. Removing these destination from the sample excludes significant reallocation possibilities.

6.4. Additional Robustness Checks

We also tested the robustness of the growing effect of RER volatility with the number of destinations served to various alternative specifications and subsamples (all referred Tables are in the online appendix). Concerning specifications, we replicate the estimations substituting firm-country fixed effects and year dummies to the baseline firm-year fixed effects together with country dummies structure used in the baseline analysis. Doing so allows us to examine how firms allocate exports to a particular destination over time. Results are reported in Tables D.3 and D.4 in the online appendix for the intensive and extensive margins, respectively. Exchange rate volatility impacts export performance over time negatively on average on both margins, and disproportionately more for firms serving many destinations at the intensive margin. However, the size of this magnifying effect is very reduced compared to our preferred specification, especially at the extensive margin, where it is basically non-existent. This indicates that reallocation over time is less massive than between destinations, and confirms that the major part of our story goes through the intensive margin.

Tables E.1 to E.6 check that self-selection into specific markets is not biasing our results. Tables E.1 and E.2 present estimates on the intensive and the extensive margins from regressions we performed only on destinations belonging to the OECD. Consistently with evidence presented in columns (8) and (9) of Tables 4 and 7, estimates on this specific subsample do not change fundamentally the picture. We then check that self-selection into fast-growing markets is not biasing our results, by first excluding BRICS countries (Tables E.3 and E.4), then the top 25 % of GDP growth distribution observations (Tables E.5 and E.6). Our results remain qualitatively and quantitatively immune to these alternative samples: the negative impact of both bilateral and multilateral volatility remains identical on average, compared to our benchmark estimation. Besides, the amplifying effect number of destinations on both volatilities is also persistent across all samples for both margins of trade, in proportions very similar to our baseline results. Finally, Tables E.7 and E.8 check how our results are impacted by the exclusions of firms exporting to a single destination. In all cases, estimates remain very close to the benchmarks presented above.

7. Aggregate Implications

We provided evidence that heterogeneity in firm size, and in the number of destinations firms served, are associated to heterogeneous trade response following RER volatility shocks. Firm-destination exports are all the more negatively affected by RER volatility that the firm is large, because of reallocation possibilities offered by a higher number of destinations served. We now further investigate the aggregate implications of this heterogeneity.

Following Berman et al. (2012), our exercise consists in estimating how the trade-deterring effect of bilateral RER volatility is shaped by concentration of exports at the sector level. More precisely, we check that sectors for which exports are very concentrated on a few high performing firms (exporting to many destinations) are those for which total sector exports are the least sensitive to RER volatility. We estimate the following specification:

$$X_{sjt} = \alpha \text{Bil\_volat}_{jt} + \phi_1 \text{Herf}_{sjt} + \phi_2(\text{Bil\_volat}_{jt} \times \text{Herf}_{sjt}) + \lambda_{st} + \theta_j + \varepsilon_{sjt} \quad (5)$$

where X_{sjt} is the aggregated export value for sector s (defined at the HS2 or HS4 level) to destination j in year t and where Herf_{sjt} is the Herfindahl concentration index of exports at the sector-destination-year level, calculated using export values by firms for the computation of market shares. Consistently with previous specifications, we also include sector-year fixed effects and country dummies. Therefore, we capture the variation of exportations at the sectoral level, for a given year, between countries.

Results are presented in Table 17. We are more specifically interested in the ϕ_2 coefficient since it captures non-linearities in the trade-deterring effect of bilateral RER volatility. Identification comes from the variation in export concentration across sectors and destinations that is directly related to presence of large and multi-destination firms. Columns (1) and (2) present results when estimations are conducted at the HS2 sectoral level, while columns (3) and (4) are estimation results conducted at the more disaggregated HS4 level.

Results confirm that export concentration on big, multi-destination firms tends to dampen the trade-deterring effect of RER volatility. The coefficient ϕ_2 associated to the interaction term with concentration of exports is positive in both columns (2) and (4). The aggregate sectoral trade elasticity to bilateral RER volatility is smaller all the more that exports are concentrated at the sectoral level. We attribute this result to the presence of multi-destinations firms in sectors that can use their portfolio of destinations to perform optimal reallocations of exports when facing increased RER volatility.

8. Conclusion

Relying on a large French firm-level database combining balance-sheet and export information over the period 1995-2009, this paper proposes a new, micro-founded explanation to the macro puzzle of the muted reaction of aggregate exports to RER volatility. We start by showing that the number of destinations magnifies the trade-deterring effect of RER volatility on firm-destination exports. We support that this result is driven by reallocation strategies: multi-destination firms reallocate optimally their exports across destinations, generating higher bilateral trade elasticities. To identify this feature in the data, we build a multilateral RER volatility which is a weighted average of RER volatilities of all other destinations that could be served by the firm. The latter captures the external conditions upon which firms can reallocate exports. We show that multi-destination firms tend to reallocate exports away from destinations with unfavorable dynamics in terms of RER volatility, i.e., bilateral relatively to multilateral RER volatility. This may be interpreted as an efficient diversification behavior, as the one suggested by the portfolio theory: firms seek to hold the average risk level of their destinations portfolio constant, and this is easier to do as the scope of possible reallocations expands with the number of destinations served. An additional test based on the correlation between bilateral and multilateral RER provides additional support to this idea. Our results are robust to various checks, including potential omitted variables that are related to country-specific risks and the possibility that firms set hedging strategies. In any case, the diversification behavior we highlight seems to coexist with the latter.

More destination-diversified firms are therefore better able to handle exchange rate risks, with substantial implications for aggregate exports. If big multi-destination firms, who account for the bulk of aggregate exports, can react to an adverse shock of RER volatility somewhere by transferring trade to other and less volatile destinations, this leaves mainly unchanged exports at the macro level. The small aggregate trade response to RER volatility is thus rationalized by the diversification behavior of multi-destination firms and their prominent share in total exports.

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Figures and Tables

Table 1 – Summary Statistics of the Key Variables

Variable	Mean	Std. Dev.	Min	Max
Firm-level variables				
Firm Export value (millions of Euros)	14.11	139.62	0.00	11,163.93
Firm-country Export value (millions of Euros)	0.52	11.09	0.00	4,322.94
Start Dummy	0.16	0.37	0	1
Participation Dummy	0.25	0.44	0	1
Assets (Thousands of Euros)	189.75	5403.34	0.00	1,266,499
Employment (# Employees)	332.96	3262.39	0	298,487
Multilateral Volatility (sector-level sh.)	0.01	0.005	0.00	0.023
Multilateral Volatility (macro level sh.)	0.02	0.004	0.006	0.038
Multilateral Volatility (firm-level sh.)	0.01	0.010	0.00	1.318
Macro variables				
Bilateral RER Volatility	0.018	0.023	0.001	1.318
GDP (Billions of US dollars)	1,043.066	2,173.799	0.174	13,122.22
Price Index (Real Effective Exchange Rate)	0.693	0.451	0.000	3.33

Note: The summary statistics are computed on the 2,150,351 firm-country-year observations that make up our final regression sample used in Table 3 to study the intensive margin. The only exception are the statistics for the start and participation dummies which are computed, respectively, on the 6,533,922 firm-country-year observations used in Table 6, and on 7,695,707 firm-country-year used in Table 13. Source: authors' computations from BRN, French Customs and IFS data.

Table 2 – Distribution of Performance Indicators

Sample	Firm-Dest-Year		Firm-Year	
Variable	Productivity	# Dest.	Productivity	# Dest
1%	11.35	1	9.64	1
10%	29.16	3	27	1
50%	55	12	50.25	2
90%	121.93	37	110.24	12
99%	385.29	72	329	36

Note: Productivity = Value Added per employee, in thousands of euros. For the first two columns, the summary statistics are computed on the 2,150,351 firm-country-year observations that make up our final regression sample used in Table 3 to study the intensive margin. For the last two columns, the summary statistics are computed on the 425,741 firm-year dyads corresponding to our final regression sample.
Source: authors' computations from BRN and French Customs.

Table 3 – Intensive Margin: Baseline Estimations

Dep. Variable	Ln(X_{ijt})				
	(1)	(2)	(3)	(4)	(5)
Ln Bilateral RER volatility (α)	-0.261[a]	-0.024[a]	-0.022[b]	0.361[a]	0.352[a]
	(0.019)	(0.009)	(0.009)	(0.022)	(0.022)
Ln Country price index	0.032[a]	0.015	0.018	0.003	0.005
	(0.005)	(0.013)	(0.013)	(0.013)	(0.013)
Ln GDP	0.317[a]	0.543[a]	0.531[a]	0.561[a]	0.552[a]
	(0.007)	(0.044)	(0.044)	(0.043)	(0.043)
Ln Bil. RER Volatility × Ln LaborProd$_{t-1}$ (δ)			-0.066[a]		-0.047[a]
			(0.004)		(0.004)
Ln Bil. RER Volatility × Ln Nb. dest$_{t-1}$ (τ)				-0.145[a]	-0.141[a]
				(0.008)	(0.007)
Observations	2150351	2150351	2150351	2150351	2150351
R^2	0.102	0.153	0.153	0.156	0.156
Firm-year dyads	425741	425741	425741	425741	425741

Note: Robust standard errors clustered by destination-year in parentheses with [a], [b] and [c] respectively denoting significance at the 1%, 5% and 10% levels. All specifications include firm-year fixed effects. Country dummies are also included in columns (2), (3), (4), and (5).

Table 4 – Intensive Margin: Hedging Strategies

Dep. Variable	Ln(X_{ijt})								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ln Bilateral RER volatility (α)	-0.026^a	-0.028^a	0.335^a	0.001	0.386^a	-0.026^b	0.527^a	-0.029^a	0.372^a
	(0.009)	(0.009)	(0.021)	(0.009)	(0.024)	(0.011)	(0.036)	(0.011)	(0.024)
Ln Country price index	0.020	0.020	0.009	0.010	0.001	0.035^c	0.025	0.015	0.002
	(0.013)	(0.013)	(0.013)	(0.014)	(0.013)	(0.020)	(0.019)	(0.013)	(0.013)
Ln GDP	0.484^a	0.482^a	0.497^a	0.651^a	0.652^a	0.804^a	0.777^a	0.543^a	0.564^a
	(0.043)	(0.043)	(0.043)	(0.049)	(0.049)	(0.066)	(0.066)	(0.044)	(0.043)
Import	0.603^a	0.645^a	0.727^a						
	(0.010)	(0.036)	(0.037)						
Ln Bil. RER Volatility × Import		0.009	0.029^a						
		(0.007)	(0.007)						
Ln Bil. RER Volatility × Ln Nb. dest$_{t-1}$ (τ)			-0.138^a		-0.146^a		-0.186^a		-0.145^a
			(0.007)		(0.008)		(0.011)		(0.008)
Ln Bil. RER Volatility × WC ratio$_{t-1}$				0.038^a	0.035^a				
				(0.002)	(0.002)				
Ln Bil. RER Volatility × STD ratio$_{t-1}$						-0.003	0.008^a		
						(0.003)	(0.003)		
Ln Bil. RER Volatility × OECD								0.009	-0.018
								(0.015)	(0.016)
OECD								0.008	-0.106
								(0.088)	(0.085)
Observations	2150351	2150351	2150351	1749732	1749732	1022132	1022132	2150351	2150351
Firm-year dyads	425741	425741	425741	340893	340893	258334	258334	425741	425741
R^2	0.164	0.164	0.167	0.156	0.160	0.164	0.167	0.153	0.156

Note: Import stands for the importer dummy. WC ratio stands for Working Capital Ratio and is defined as working-capital requirement to stable resources. STD ratio stands for short-term debt ratio and is defined as the ratio of short-term debt to total debt, i.e. short- and long-term debt. OECD takes the value 1 if the destination country belongs to the OECD, 0 otherwise. Robust standard errors clustered by destination-year in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. All specifications include firm-year fixed effects and country dummies.

Table 5 – Intensive Margin: Omitted Factors - Quality of Political Governance and RER level

Dep. Variable	Ln(X_{ijt})							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln Bilateral RER volatility (α)	-0.026^b	-0.026^b	0.275^a	0.268^a	-0.020^b	-0.019^b	0.240^a	0.235^a
	(0.011)	(0.011)	(0.030)	(0.030)	(0.009)	(0.009)	(0.019)	(0.019)
Ln Country price index	0.019	0.024	0.003	0.007	-0.048^a	-0.045^a	-0.056^a	-0.053^a
	(0.015)	(0.015)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Ln GDP	0.501^a	0.488^a	0.527^a	0.517^a	0.491^a	0.476^a	0.521^a	0.509^a
	(0.053)	(0.053)	(0.052)	(0.052)	(0.044)	(0.044)	(0.042)	(0.042)
QoG Pol.	0.031^b	0.028^b	-0.189^a	-0.183^a				
	(0.013)	(0.013)	(0.025)	(0.025)				
Ln Bil. RER Volatility × ln LaborProd$_{t-1}$ (δ)		-0.048^a		-0.035^a		-0.040^a		-0.031^a
		(0.005)		(0.005)		(0.004)		(0.003)
QoG Pol. × LaborProd$_{t-1}$		0.045^a		0.030^a				
		(0.005)		(0.004)				
Ln Bil. RER Volatility × Ln Nb. dest$_{t-1}$ (τ)			-0.112^a	-0.110^a			-0.097^a	-0.095^a
			(0.011)	(0.010)			(0.007)	(0.007)
QoG Pol. × Ln Nb. dest$_{t-1}$			0.084^a	0.081^a				
			(0.009)	(0.009)				
Ln RER					0.220^a	0.221^a	0.031	0.038
					(0.030)	(0.030)	(0.030)	(0.030)
Ln RER × Ln LaborProd$_{t-1}$						0.031^a		0.021^a
						(0.002)		(0.001)
Ln RER × Ln Nb. dest$_{t-1}$							0.061^a	0.059^a
							(0.003)	(0.002)
Observations	1631978	1631978	1631978	1631978	2150351	2150351	2150351	2150351
R^2	0.156	0.157	0.160	0.161	0.153	0.154	0.160	0.161
Firm-year dyads	759917	759917	759917	759917	425741	425741	425741	425741

Note: "QoG Pol" is the quality of governance variable from the Worldwide Governance Indicators dataset on institutional quality (Kaufmann et al., 2010). Ln RER is the log of the yearly Real Exchange Rate, defined as the nominal exchange rate of the domestic currency with respect to the destination j's currency multiplied by the ratio of foreign CPI$_j$ over domestic CPI. Robust standard errors clustered by destination-year in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. All specifications include firm-year fixed effects and country dummies.

Table 6 – Extensive Margin: Baseline Estimations

Dep. Variable	Entry - $Pr(X_{ijt} > 0 \mid X_{ijt-1} = 0)$			
	(1)	(2)	(3)	(4)
Ln Bilateral RER volatility (α)	-0.012^a	-0.013^a	0.025^a	0.026^a
	(0.004)	(0.004)	(0.007)	(0.007)
Ln Country price index	0.005^b	0.005^b	0.005^c	0.005^c
	(0.002)	(0.002)	(0.002)	(0.002)
Ln GDP	0.108^a	0.108^a	0.108^a	0.108^a
	(0.012)	(0.012)	(0.012)	(0.012)
Ln. Bil. RER Volatility $\times$ LaborProd$_{t-1}$ (δ)		-0.001^b		0.001^a
		(0.000)		(0.000)
Ln. Bil. RER Volatility $\times$ Nb. dest$_{t-1}$ (τ)			-0.013^a	-0.013^a
			(0.001)	(0.001)
Observations	6533922	6533922	6533922	6533922
Firm-year dyads	1190841	1190841	1190841	1190841
R^2	0.015	0.015	0.016	0.016

Note: Robust standard errors clustered by destination-year in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. All specifications include firm-year fixed effects and country dummies.

Table 7 – Extensive margin: Hedging Strategies

Dep. Variable	Entry - $Pr(X_{ijt} > 0 \mid X_{ijt-1} = 0)$								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ln Bilateral RER volatility (α)	-0.012^a	-0.012^a	0.026^a	-0.014^a	0.028^a	-0.013^a	0.030^a	-0.006^a	0.039^a
	(0.004)	(0.004)	(0.007)	(0.004)	(0.008)	(0.004)	(0.008)	(0.002)	(0.005)
Ln Country price index	0.004^c	0.004^c	0.004^c	0.005^c	0.005^c	0.005^c	0.005^c	0.003	0.003
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
Ln GDP	0.096^a	0.097^a	0.094^a	0.098^a	0.095^a	0.098^a	0.096^a	0.105^a	0.104^a
	(0.013)	(0.013)	(0.013)	(0.015)	(0.014)	(0.015)	(0.014)	(0.013)	(0.013)
Import	0.078^a	0.077^a	0.086^a						
	(0.004)	(0.013)	(0.015)						
Ln Bil. RER Volatility × Import		-0.000	0.002						
		(0.004)	(0.004)						
Ln Bil. RER Volatility × Ln Nb. dest$_{t-1}$ (τ)			-0.013^a		-0.014^a		-0.014^a		-0.014^a
			(0.002)		(0.002)		(0.002)		(0.002)
Ln Bil. RER Volatility × WC ratio $_{t-1}$				-0.001^a	-0.001^a				
				(0.000)	(0.000)				
Ln Bil. RER Volatility × STD ratio$_{t-1}$						0.000^c	0.002^a		
						(0.000)	(0.000)		
Ln Bil. RER Volatility × OECD								-0.019^c	-0.022^b
								(0.010)	(0.010)
OECD								-0.050	-0.065
								(0.040)	(0.040)
Observations	4792514	4792514	4792514	4792514	4792514	4758742	4758742	4792514	4792514
Firm-year dyads	425741	425741	425741	340893	340893	258334	258334	425741	425741
(R^2)	0.020	0.020	0.020	0.016	0.016	0.016	0.016	0.016	0.016

Note: "Import" stands for the importer dummy. WC ratio stands for Working Capital Ratio and is defined as working-capital requirement to stable resources. STD ratio stands for short-term debt ratio to and is defined as the ratio of short-term debt to total debt, i.e. short- and long-term debt. OECD takes the value 1 if the destination country belongs to the OECD, 0 otherwise. Robust standard errors clustered by destination-year in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. All specifications include firm-year fixed effects and country dummies.

Table 8 – Extensive Margin: Omitted Factors - Quality of Political Governance and RER Level

Dep. Variable	Entry - $Pr(X_{ijt} > 0 \mid X_{ijt-1} = 0)$							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln Bilateral RER volatility (α)	-0.010^b	-0.010^b	0.017^b	0.018^b	-0.012^a	-0.012^a	0.017^a	0.018^a
	(0.005)	(0.005)	(0.007)	(0.007)	(0.004)	(0.004)	(0.007)	(0.007)
Ln Country price index	0.006^b	0.006^b	0.006^b	0.006^b	-0.002	-0.002	-0.001	-0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Ln GDP	0.092^a	0.092^a	0.092^a	0.092^a	0.102^a	0.102^a	0.102^a	0.102^a
	(0.013)	(0.013)	(0.013)	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)
QoG. Pol.	0.005^c	0.005^c	-0.015^a	-0.015^a				
	(0.003)	(0.003)	(0.004)	(0.004)				
Ln. Bil. RER Volatility × LaborProd$_{t-1}$ (δ)		-0.000		0.001^a		-0.001^b		0.001^a
		(0.001)		(0.000)		(0.000)		(0.000)
QoG. Pol. × LaborProd$_{t-1}$		0.000		-0.000				
		(0.000)		(0.000)				
Ln. Bil. RER Volatility × Nb. dest$_{t-1}$ (τ)			-0.009^a	-0.009^a			-0.010^a	-0.010^a
			(0.001)	(0.001)			(0.001)	(0.001)
QoG. Pol. × Nb. dest$_{t-1}$			0.007^a	0.007^a				
			(0.001)	(0.001)				
Log RER					0.025^a	0.025^a	0.010^c	0.010^c
					(0.006)	(0.006)	(0.006)	(0.006)
Ln RER × LaborProd$_{t-1}$						0.000		-0.000
						(0.000)		(0.000)
Ln RER × Nb. dest$_{t-1}$							0.004^a	0.004^a
							(0.000)	(0.000)
Observations	4926925	4926925	4926925	4926925	6533922	6533922	6533922	6533922
Firm-year dyads	917639	917639	917639	917639	1190841	1190841	1190841	1190841
R^2	0.014	0.014	0.015	0.015	0.015	0.015	0.016	0.016

Note: "QoG Pol" is the quality of governance variable from the Worldwide Governance Indicators dataset on institutional quality (Kaufmann et al., 2010). Ln RER is the log of the yearly Real Exchange Rate, defined as the nominal exchange rate of the domestic currency with respect to the destination j's currency multiplied by the ratio of foreign CPI$_j$ over domestic CPI. Robust standard errors clustered by destination-year in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. All specifications include firm-year fixed effects and country dummies.

Table 9 – Reallocation Behavior - Intensive Margin

Dep. Variable	Ln (X_{ijt})								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ln Bilateral RER volatility (α)	-0.031^a			-0.042^a			-0.082^a		
	(0.009)			(0.010)			(0.010)		
Ln Country Price Index	0.015	0.016	0.004	0.019	0.019	0.009	0.009	0.027	0.012
	(0.013)	(0.013)	(0.013)	(0.013)	(0.014)	(0.013)	(0.014)	(0.021)	(0.018)
Ln GDP	0.543^a	0.546^a	0.563^a	0.568^a	0.594^a	0.596^a	0.556^a	0.639^a	0.638^a
	(0.044)	(0.044)	(0.044)	(0.047)	(0.047)	(0.047)	(0.045)	(0.070)	(0.062)
Ln Multi. RER Volatility (sect. w.) (β)	-0.361^a								
	(0.032)								
Ln Relat. RER Volatility (sect. w.) (ζ)		-0.010	0.350^a						
		(0.009)	(0.021)						
Ln Relat. volat. (sect. w.) $\times$ Nb dest$_{t-1}$(κ)			-0.137^a						
			(0.008)						
Ln Multi. RER Volatility (macro w.) (β)				-0.934^a					
				(0.272)					
Ln Relat. RER Volat (macro w.) (ζ)					-0.021^b	0.341^a			
					(0.009)	(0.024)			
Ln Relat. volat. (mac. w.) $\times$ Nb Dest$_{t-1}$(κ)						-0.137^a			
						(0.008)			
Ln Multi. RER Volatility (firm w.) (β)							-0.616^a		
							(0.025)		
Ln Relat. RER volatility (firm w.) (ζ)								0.249^a	0.577^a
								(0.017)	(0.017)
Ln Relat. volat. (firm w.)$\times$ Nb Dest$_{t-1}$(κ)									-0.141^a
									(0.009)
Observations	2150332	2150332	2150332	2042498	2042498	2042498	1804261	1804261	1804261
Firm-year dyads	408736	408736	408736	408736	408736	408736	408736	408736	408736
R^2	0.153	0.153	0.156	0.152	0.152	0.155	0.175	0.168	0.171

Note: The multilateral RER volatilities are computed using sectoral shares in the first four columns, and using aggregate national shares in the last four columns. Robust standard errors clustered by destination-year in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. All specifications include firm-year fixed effects and country dummies.

Table 10 – Reallocation Behavior - Extensive Margin

Dep. Variable	Entry - $Pr(X_{ijt} > 0 \mid X_{ijt-1} = 0)$								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ln Bilateral RER volatility	-0.013^a			-0.015^a			-0.015^a		
	(0.004)			(0.004)			(0.005)		
Ln Country price index	0.005^c	0.005^c	0.005^c	0.005^c	0.005^c	0.005^c	0.010^a	0.010^a	0.010^a
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Ln GDP	0.108^a	0.108^a	0.108^a	0.102^a	0.105^a	0.104^a	0.131^a	0.131^a	0.130^a
	(0.013)	(0.013)	(0.013)	(0.014)	(0.014)	(0.014)	(0.015)	(0.015)	(0.015)
Ln Multi. RER Volatility (sect. w.) (β)	-0.023^a								
	(0.005)								
Ln Relat. RER Volatility (sect. w.) (ζ)		-0.011^a	0.025^a						
		(0.004)	(0.007)						
Ln Relat. volat. (sect. w.) × Nb dest$_{t-1}$(κ)			-0.012^a						
			(0.001)						
Ln Multi. RER Volatility (macro w.) (β)				-0.142^c					
				(0.080)					
Ln Relat. RER Volatility (macro w.) (ζ)					-0.012^a	0.024^a			
					(0.004)	(0.008)			
Ln Relat. volat. (mac. w.) × Nb Dest$_{t-1}$(κ)						-0.012^a			
						(0.002)			
Ln Relat. RER Volatility (firm w.) (ζ)								-0.015^a	0.012
								(0.005)	(0.009)
Ln Relat. volat. (firm w.)× Nb Dest$_{t-1}$(κ)									-0.008^a
									(0.002)
Observations	6533922	6533922	6533922	6244007	6244007	6244007	3700811	3700811	3700811
Firm-year dyads	1190841	1190841	1190841	1190841	1148928	1148928	1148928	1148928	1148928
R^2	0.254	0.254	0.254	0.253	0.253	0.253	0.167	0.167	0.168

Note: The multilateral RER volatilities are computed using sectoral shares in the first four columns, and using aggregate national shares in the last four columns. Robust standard errors clustered by destination-year in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. All specifications include firm-year fixed effects and country dummies.

Table 11 – Reallocation - Correlation of RER

Dep. Variable	Ln (X_{ijt})			Participation - $Pr(X_{ijt} > 0)$		
	(1)	(2)	(3)	(4)	(5)	(6)
Corr(RER level) (γ)	-0.017^{b}	-0.017^{b}	0.058^{c}	0.001	0.001	-0.002
	(0.007)	(0.007)	(0.031)	(0.001)	(0.001)	(0.004)
Corr(RER Volat.)		0.004			-0.000	
		(0.007)			(0.001)	
Corr(RER level) × Nb. dest$_{t-1}$ (η)			-0.026^{b}			0.001
			(0.011)			(0.001)
Observations	55820	55820	55820	55820	55820	55820
# Firms	15523	15523	15523	15523	15523	15523
R^2	0.279	0.279	0.280	0.102	0.102	0.102

Note: Corr(RER level) refers to the correlation between the bilateral RER level and its aggregate counterpart. Corr(RER Volat.) refers to the correlation between bilateral and multilateral RER volatility. The aggregate values of RER volatility and RER level are computed using sectoral shares. The first three columns report results for the intensive margin, and the three last columns report results for participation. Robust standard errors clustered by destination-year in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. All specifications include firm fixed effects and country dummies.

Table 12 – Regressions at the firm-product level

Dep. Variable	ln X_{ijpt}				ln Nb Products			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln Bilateral RER volatility	-0.019	0.133^a			-0.017^a	0.211^a		
	(0.018)	(0.032)			(0.006)	(0.012)		
Ln Country Price Index	-0.066^b	-0.070^a	-0.065^b	-0.069^a	0.058^a	0.051^a	0.059^a	0.053^a
	(0.027)	(0.026)	(0.027)	(0.027)	(0.009)	(0.009)	(0.009)	(0.009)
Ln GDP	0.418^a	0.431^a	0.419^a	0.432^a	0.325^a	0.332^a	0.329^a	0.335^a
	(0.099)	(0.098)	(0.099)	(0.098)	(0.035)	(0.034)	(0.034)	(0.034)
Ln Bilateral RER volatility $\times$ Nb Dest$_{t-1}$		-0.049^a				-0.086^a		
		(0.009)				(0.004)		
Ln Relative RER volatility			-0.008	0.131^a			0.003	0.216^a
			(0.017)	(0.030)			(0.006)	(0.012)
Ln Relative RER volatility $\times$ Nb Dest$_{t-1}$				-0.045^a				-0.081^a
				(0.009)				(0.004)
Observations	9232368	9232368	9232368	9232368	2260130	2260130	2260130	2260130
R^2	0.756	0.756	0.756	0.756	0.590	0.593	0.590	0.593
Firm-year-product triads	3917863	3917863	3917863	3917863	x	x	x	x
Firm-year dyads	x	x	x	x	454805	454805	454805	454805

Note: Robust standard errors clustered by destination-year in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Specifications 1 to 4 include firm-year-product fixed effects and country dummies, while specifications 5 to 8 include firm-year fixed effects and country dummies.

Table 13 – Alternative Extensive Margin - Participation - baseline estimations

Dep. Variable	Participation - $Pr(X_{ijt} > 0)$				
	(1)	(2)	(3)	(4)	(5)
Ln Bilateral RER volatility	-0.019^a	0.042^a	-0.021^a		
	(0.007)	(0.011)	(0.007)		
Ln country price index	0.012^a	0.012^a	0.012^a	0.012^a	0.012^a
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Ln GDP	0.154^a	0.154^a	0.154^a	0.155^a	0.155^a
	(0.019)	(0.019)	(0.019)	(0.018)	(0.019)
Ln. Bil. RER Volatility × Nb. Dest$_{t-1}$		-0.020^a			
		(0.002)			
Multilateral RER Volatility (sector weights)			-0.092^a		
			(0.009)		
Ln Relative volatility (sector weights)				-0.015^b	0.044^a
				(0.006)	(0.010)
Ln Relative volatility (sector weights) × Nb. Dest$_{t-1}$					-0.019^a
					(0.002)
Observations	7695707	7695707	7695707	7695707	7695707
R^2	0.325	0.325	0.325	0.325	0.325
Firm-year dyads	1213215	1213215	1213215	1213215	1213215

Note: Robust standard errors clustered by destination-year in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. All specifications include firm-year fixed effects and country dummies.

Table 14 – Alternative Extensive Margin - Exit - baseline estimations

Dep. Variable	Exit - $Pr(X_{ijt} = 0 \vert (X_{ijt-1} > 0)$			
	(1)	(2)	(3)	(4)
Ln Bilateral RER volatility	-0.006	0.029^{a}		
	(0.004)	(0.007)		
Ln country price index	0.005^{c}	0.005^{c}	0.005^{c}	0.005^{c}
	(0.003)	(0.003)	(0.003)	(0.003)
Ln GDP	0.076^{a}	0.075^{a}	0.076^{a}	0.076^{a}
	(0.011)	(0.012)	(0.011)	(0.012)
Ln. Bil. RER Volatility × Nb. dest$_{t-1}$		-0.012^{a}		
		(0.001)		
Ln Relative volatility (sector weights)			-0.004	0.029^{a}
			(0.004)	(0.006)
Ln Relative volatility (sector weights) × Nb. dest$_{t-1}$				-0.011^{a}
				(0.001)
Observations	6537564	6537564	6537564	6537564
R^2	0.261	0.262	0.261	0.262
Firm-year dyads	1194772	1194772	1194772	1194772

Note: Robust standard errors clustered by destination-year in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. All specifications include firm-year fixed effects and country dummies.

Table 15 – Subsample: EMU Countries Excluded - Intensive Margin

Dep. Variable	Ln (X_{ijt})				
	(1)	(2)	(3)	(4)	(5)
Ln Bilateral RER volatility	-0.027^a	0.180^a	-0.034^a		
	(0.010)	(0.033)	(0.010)		
Ln Country price index	0.006	0.004	0.005	0.006	0.004
	(0.015)	(0.014)	(0.015)	(0.015)	(0.015)
Ln GDP	0.525^a	0.522^a	0.512^a	0.520^a	0.517^a
	(0.044)	(0.044)	(0.045)	(0.045)	(0.045)
Ln. Bil. RER Volatility × Nb dest$_{t-1}$		-0.077^a			
		(0.012)			
Multilateral RER Volatility (sector weights)			-0.478^a		
			(0.040)		
Ln Relative volatility (sector weights)				-0.006	0.171^a
				(0.010)	(0.032)
Ln Relative volatility (sector weights) × Nb dest$_{t-1}$					-0.066^a
					(0.012)
Observations	1608712	1608712	1608712	1608712	1608712
R^2	0.545	0.545	0.542	0.542	0.542
Firm-year dyads	378984	378984	378984	378984	378984

Note: In this sample, we exclude European Monetary Union countries with respect to the baseline sample. We thus exclude from our sample countries for which nomninal exchange rate volatility is 0 due to the common Euro currency. Robust standard errors clustered by destination-year in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. All specifications include firm-year fixed effects and country dummies.

Table 16 – Subsample: EMU Countries Excluded - Extensive Margin: Entry

Dep. Variable	Entry - $Pr(X_{ijt} > 0 \mid X_{ijt-1} = 0)$				
	(1)	(2)	(3)	(4)	(5)
Ln Bilateral RER volatility	-0.006^a	0.019^a	-0.007^a		
	(0.002)	(0.004)	(0.002)		
Ln Country price index	0.004^c	0.004^c	0.004^c	0.004^c	0.004^c
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Ln GDP	0.118^a	0.117^a	0.119^a	0.120^a	0.119^a
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Ln. Bil. RER Volatility × Nb. dest$_{t-1}$		-0.008^a			
		(0.001)			
Multilateral RER Volatility (sector weights)			-0.029^a		
			(0.005)		
Ln Relative volatility (sector weights)				-0.005^a	0.019^a
				(0.001)	(0.004)
Ln Relative volatility (sector weights) × Nb. dest$_{t-1}$					-0.008^a
					(0.001)
Observations	5425809	5425809	5425809	5425809	5425809
R^2	0.279	0.279	0.269	0.269	0.269
Firm-year dyads	1116231	1116231	1116231	1116231	1116231

Note: In this sample, we exclude European Monetary Union countries with respect to the baseline sample. We thus exclude from our sample countries for which nomninal exchange rate volatility is 0 due to the common Euro currency. Robust standard errors clustered by destination-year in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. All specifications include firm-year fixed effects and country dummies.

Table 17 – Sector-Level Implications

Dep. Variable	Ln (X_{sjt})			
Sector Level	HS2		HS4	
	(1)	(2)	(3)	(4)
Ln Bilateral RER Volatility (α)	-0.077^a	-0.144^a	-0.051^a	-0.199^a
	(0.018)	(0.025)	(0.009)	(0.013)
Ln Country Price Index	0.046^c	0.045^c	0.019	0.016
	(0.025)	(0.025)	(0.013)	(0.013)
Ln GDP	1.032^a	1.038^a	0.783^a	0.799^a
	(0.081)	(0.080)	(0.042)	(0.041)
Herfindahl index (ϕ_1)	-0.873^a	-0.374^b	-1.657^a	-0.790^a
	(0.059)	(0.150)	(0.023)	(0.065)
Herfindahl index $\times$ Bil. RER Volatility (ϕ_2)		0.128^a		0.208^a
		(0.038)		(0.015)
Observations	76324	76324	376897	376897
R^2	0.623	0.623	0.428	0.428

Note: "Herfindahl index" measures exports concentration within a sector. Robust standard errors clustered by destination-year in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. All specifications include sector-year fixed effects and country dummies.

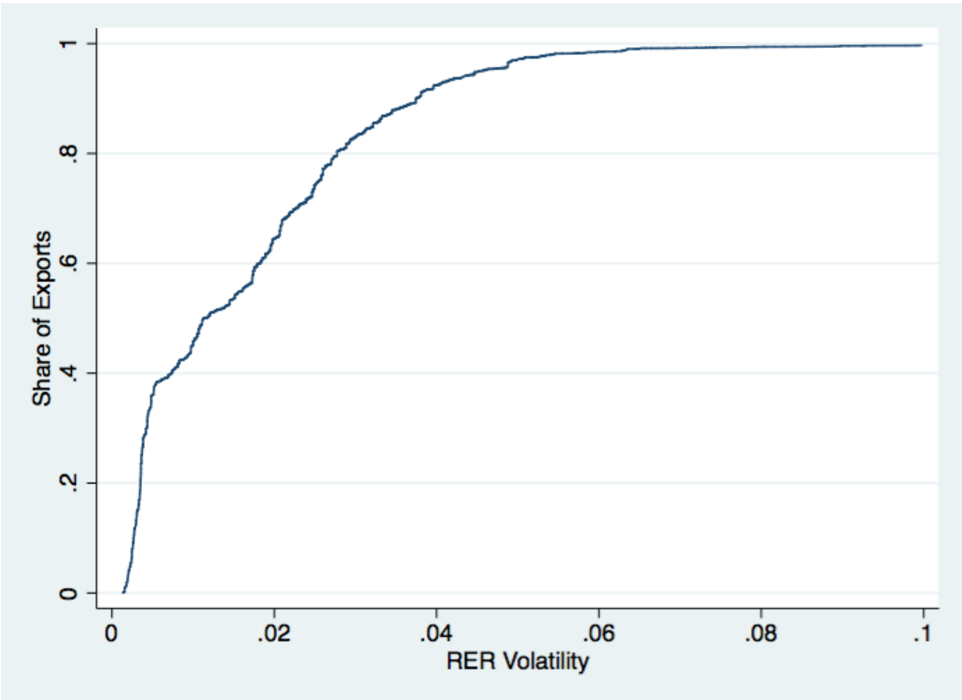

Figure 1 – Cumulative Distribution of Exports

Note: We restrict our sample to RER volatility, as defined in the text, that is lower that 0.1.

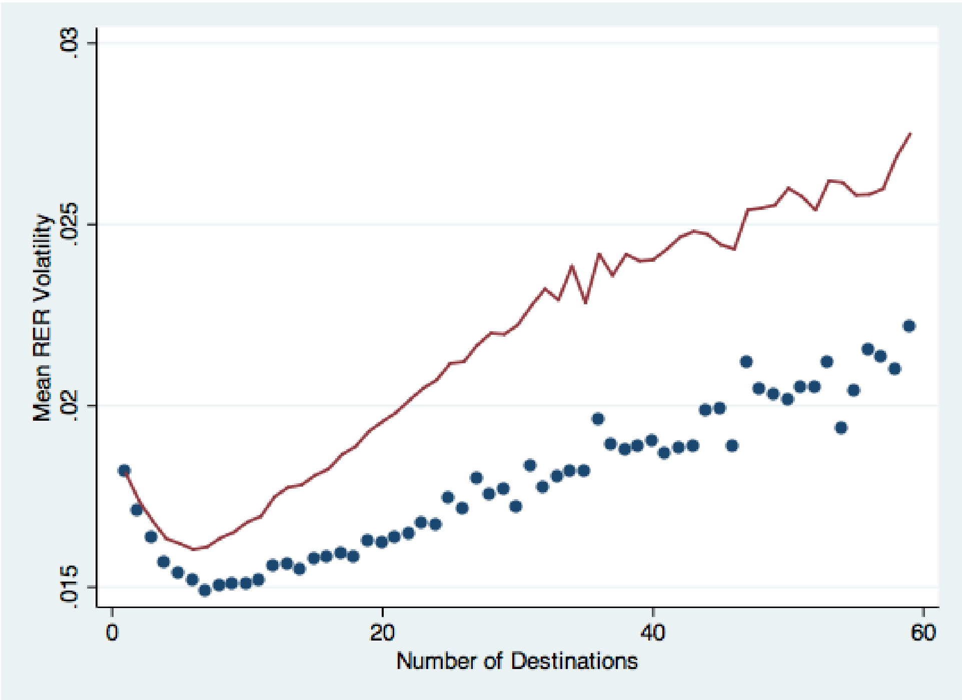

Figure 2 – Average RER Volatilities : Arithmetic Mean and Effective Mean.

Note: The full line represents, per number of destinations, the mean of the firm-level arithmetic mean RER volatility over all destinations. The dotted line represents, per number of destinations, the mean of the firm-level weighted mean RER volatility over all destinations.
Precisely, we compute for each firm two types of average RER volatility over all destinations she serves. We compute an arithmetic mean of the RER volatilities and second an average RER volatility weighted by the share of each destination in all firm-year exports. We then average it over all firms serving the same number of destinations.
Source: authors' computations from French Customs and IFS.