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Exchange rate volatility, financial constraints and trade: empirical evidence from Chinese firms

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EXCHANGE RATE VOLATILITY, FINANCIAL CONSTRAINTS AND TRADE: EMPIRICAL EVIDENCE FROM CHINESE FIRMS

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NON-TECHNICAL SUMMARY

The increasing volatility of exchange rates after the fall of Bretton Woods agreements has been a source of concerns for both policymakers and academics. An increasing number of countries, both emerging (e.g., China) and developed (e.g., euro area members) have chosen more or less fixed exchange rate systems as a way to protect themselves from the effects of an excessive volatility, especially on trade. Surprisingly, macroeconomic evidence of the effect of exchange rate volatility on trade has been quite mixed, either small or insignificant. However, both an aggregation bias and an excessive focus on richer countries with highly developed financial markets could explain this counterintuitive outcome, since much more substantial negative effects of the exchange rate volatility on trade are found for developing countries. There is still a strong lack of firm-level evidence on both the impact of exchange rate volatility on exporting behavior, and the way this relationship may be influenced by financial constraints, likely to be much stronger and more binding in developing countries.

In this paper, we investigate both the impact of real exchange rate volatility on the exporting behavior and the way financial constraints, together with financial development, shape this relationship at the firm level. Our empirical estimations rely on export data for more than 100,000 Chinese exporters over the period 2000-2006. China is a highly relevant case for several reasons. First, the exchange rate volatility is expected to rise substantially in the future, along with a greater flexibility of the yuan. Second, the export rate is particularly high related to the size of China, leading to substantial exposure to exchange rate fluctuations. Finally, China is interesting because it is characterized by low financial development but rather high regional heterogeneity on that ground.

More specifically, we assess whether firms reallocate their export away from partners characterized by higher exchange rate volatility, and more important, we investigate the presence of a non-linear effect of exchange rate volatility on performance depending on the level of financial constraints, in the Chinese context. The latter is apprehended through two complementary dimensions. First, we infer firm-level financial vulnerability from the financial dependence of their activities. This approach has been shown to be a robust methodology to detect credit constraints and assess their evolution. Second, we exploit Chinese cross-provincial heterogeneity to study how financial development may mitigate both credit constraints and exchange rate volatility. Doing so, we build on a recent macroeconomic literature emphasizing that financial development tends to reduce the impact of exchange rate volatility on economic performance. Our first contribution is to provide a microfounded investigation of this effect, and propose a potential channel for it (through exports). Second, our methodology allows circumventing

a number of endogeneity problems which may have flawed some of the related studies. Third, we use the relevant firm-level data to test if exchange rate volatility is especially harmful to firms that have high liquidity needs when local financial development is low.

We show that firms tend to export less and fewer products to destinations with higher exchange rate volatility. It also appears that the magnitude of this export-deterring effect depends on the extent of firms financial vulnerability. As expected, financial development does seem to dampen this negative impact, especially on the intensive margin of export. These results suggest that the development of credit markets would help firms to overcome the additional export sunk cost related to RER volatility. It would support the expansion of firms' exports particularly to those destinations characterized by RER-related uncertainty.

ABSTRACT

This paper studies how firm-level export performance is affected by RER volatility and investigates whether this effect depends on existing financial constraints. Our empirical analysis relies on export data for more than 100,000 Chinese exporters over the period 2000-2006. We confirm a trade-deterring effect of RER volatility. We find that firms tend to export less and fewer products to destinations with higher exchange rate volatility and that this effect is magnified for financially vulnerable firms. As expected, financial development does seem to dampen this negative impact, especially on the intensive margin of export.

JEL Classification: F1, R12, L25.

Keywords: Exchange rate volatility; financial development, exports

VOLATILITÉ DU TAUX DE CHANGE, CONTRAINTES FINANCIÈRES ET COMMERCE : UNE ÉTUDE EMPIRIQUE SUR DONNÉES DE FIRMES CHINOISES

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RÉSUME NON TECHNIQUE

Depuis la disparition du système de changes fixes de Bretton woods, la volatilité du taux de change et son impact sur les échanges internationaux ont été un sujet de préoccupation majeure pour les pouvoirs publics. De nombreux pays tentent de se prémunir des effets de la volatilité et peu laissent leur monnaie flotter librement. Pourtant, les études macroéconomiques des effets de la volatilité du taux de change sur le commerce ne sont pas parvenues à des résultats tranchés et concluent généralement à un effet modeste ou non significatif. Ces résultats pourraient toutefois souffrir d'un biais d'agrégation et d'une focalisation excessive sur les pays riches, dotés de marchés financiers très développés ; d'autres analyses rapportent en effet un impact de la volatilité du taux de change plus nettement négatif sur les pays émergents. Quant aux études microéconomiques de l'impact de la volatilité du change sur le comportement à l'exportation des entreprises, elles sont quasi-absentes. Dans cet article, nous étudions l'impact de la volatilité du taux de change réel sur le comportement à l'exportation et la façon dont les contraintes financières et le niveau de développement financier façonnent cette relation au niveau de l'entreprise. L'analyse empirique s'appuie sur des données d'exportation portant sur plus de 100 000 entreprises exportatrices chinoises sur la période 2000-2006. La Chine apparaît comme un excellent objet d'étude à plusieurs titres. Tout d'abord, la volatilité du taux de change devrait s'accroître significativement avec l'assouplissement de la politique de change vers un yuan "plus flexible". De plus, le pays affiche un taux d'exportation très élevé pour une économie de cette taille, l'exposant massivement aux fluctuations du taux de change. Enfin, la Chine est caractérisée par un développement financier globalement faible mais présentant une grande hétérogénéité régionale. Plus précisément, nous évaluons dans quelle mesure les entreprises détournent leurs exportations des partenaires caractérisés par une volatilité élevée du taux de change, et nous recherchons la présence d'un effet non linéaire de cette volatilité sur la performance à l'exportation, dû à l'intensité des contraintes financières. Celle-ci est appréhendée à travers deux dimensions complémentaires. Tout d'abord, la vulnérabilité financière de l'entreprise est déduite du niveau de dépendance financière du secteur d'activité auquel elle appartient ; devenue standard, cette approche apparaît comme une méthodologie robuste d'évaluation des contraintes financières et de leur évolution. Ensuite, nous utilisons l'hétérogénéité entre provinces afin d'étudier la façon dont le développement financier peut à la fois réduire l'impact des contraintes financières et celui de la volatilité du taux de change ; nous nous inscrivons ici dans la continuité d'une littérature macroéconomique récente, qui met en avant un impact réduit de la volatilité du taux de change sur la performance économique lorsque le développement financier est élevé. Notre première contribution consiste ainsi à réaliser une étude microfondée de cet effet, tout en proposant un canal de transmission (par le biais des exportations) susceptible

de l'expliquer. En outre, notre méthodologie permet d'échapper aux problèmes d'endogénéité qui ont pu concerner certaines études voisines. Enfin, l'utilisation de données d'entreprises permet de montrer que la volatilité du taux de change a un impact particulièrement négatif pour les entreprises manquant de liquidités lorsque le développement financier régional est faible. Nos résultats montrent que les entreprises exportent moins, à la fois en valeur et en nombre de produits, vers les destinations caractérisées par une forte volatilité du taux de change. L'ampleur de cet effet négatif sur les exportations dépend du niveau de vulnérabilité financière des entreprises. Comme anticipé, le développement financier atténue cet impact, particulièrement sur la marge intensive de commerce. Ces résultats suggèrent que le développement des marchés de crédit pourrait aider les entreprises à faire face aux coûts d'entrée supplémentaires induits par la volatilité du taux de change. Ce faisant, le développement des exportations des entreprises vers les destinations caractérisées par une forte incertitude sur le taux de change s'en trouverait favorisé.

RÉSUMÉ COURT

Cet article analyse l'impact de la volatilité du taux de change réel sur la performance à l'exportation des entreprises et évalue dans quelle mesure cet effet est sensible à l'existence de contraintes financières. L'analyse empirique s'appuie sur des données portant sur plus de 100 000 entreprises exportatrices chinoises sur la période 2000-2006. Nos résultats confirment un impact négatif de la volatilité du taux de change réel sur leurs exportations. Les entreprises exportent moins, en valeur comme en nombre de produits exportés, vers les destinations caractérisées par une volatilité du taux de change plus élevée. L'ampleur de cet effet est liée au niveau de vulnérabilité financière des entreprises. Logiquement, le développement financier atténue cet impact, particulièrement sur la marge intensive de commerce.

Classification JEL : F1, R12, L25.

Mots clés : Volatilité du taux de change, développement financier, exportations.

EXCHANGE RATE VOLATILITY, FINANCIAL CONSTRAINTS AND TRADE: EMPIRICAL EVIDENCE FROM CHINESE FIRMS

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1. INTRODUCTION

The increasing volatility of exchange rates after the fall of Bretton Woods agreements has been a source of concerns for both policymakers and academics. An increasing number of countries, both emerging (e.g., China) and developed (e.g., euro area members) have chosen more or less fixed exchange rate systems as a way to protect themselves from the effects of an excessive volatility, especially on trade. In a context where firms are risk averse, exchange rate risk increases trade costs and reduces the gains to international trade (Ethier, 1973). Initial macroeconomic evidence on the effect of exchange rate volatility on trade has been however quite mixed, concluding to an effect either significant but small or insignificant (see Greenaway and Kneller, 2007, or Byrne et al., 2008, for a survey). Even Rose (2000), who finds a very large effect of currency union on international trade, concludes to a small effect of exchange rate volatility. However, more recent works have emphasized that these results could be due both to an aggregation bias (Byrne et al., 2008; Broda and Romalis[1], 2010) and an excessive focus on richer countries with highly developed financial markets since much more substantial negative effects of the exchange rate volatility on trade are found for developing countries (Grier and Smallwood, 2007).

There is still a strong lack of firm-level evidence on both the impact of exchange rate volatility on exporting behavior, and on how this relationship may be influenced by financial constraints, which are likely to be much stronger and more binding in developing countries. A careful firm-level study of these relationships may bring us some more clear-cut evidence regarding the role of exchange rate volatility as a sunk cost of exporting, and how financial development may help to alleviate this additional cost. This paper aims to fill these gaps. We study both the impact of RER volatility on the exporting behavior and the way financial constraints, together with financial development, shape this relationship at the firm level. Our empirical estimations rely on export data for more than 100,000 Chinese exporters over the period 2000-2006.

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[1]Broda and Romalis (2010) also focus on the issue on reverse causality between exchange rate volatility and trade. Once the problem is controlled for, they still find a negative impact of volatility on trade, though reduced.

China is an highly relevant case for several reasons. Firstly, the exchange rate volatility is expected to rise substantially in the future, following the change of exchange rate policy toward a "more flexible" yuan. Secondly, the country displays an especially high export rate given it size, leading to substantial exposure to exchange rate fluctuations. Finally, China is interesting because it is characterized by low financial development but rather high regional heterogeneity on that ground, which will be useful to identify a non-linear effect of exchange rate volatility depending on credit constraints.

We expect a negative impact of exchange rate volatility on trade because of the existence of sunk costs in exports, which can be seen as a form of investment in intangible capital. In practice, most investment expenditures are at least in part irreversible, i.e. made of sunk costs that cannot be recovered if market conditions turn out to be worse than expected. It is well-known since Pindyck (1988, 1991) that the possibility of delaying irreversible investments make them very sensitive to uncertainty over future payoffs. The combination of investment irreversibility and asymmetric adjustments costs[2] induce a negative relationship between price volatility and investment, especially in developing economies. On a panel of 29 emerging and developed countries, Pindyck and Solimano (1993) find a significantly negative relationship between volatility and investment that is magnified in the case of developing countries. In such a context, high volatility is consistently shown to reduce growth and investment, especially private investment (Ramey and Ramey, 1995; Aizenman and Marion, 1999; Schnabl, 2007). Bloom et al. (2007) find identical results within a firm-level framework with partial irreversibility, tested on 672 UK firms over the period 1972-1991: higher uncertainty reduces the responsiveness of investment to a firm-level demand shock. Aghion et al. (2009) go one step further and identify that local financial development plays a key role for the magnitude of the exchange rate volatility repercussions. Relying on a panel of 83 countries over the period 1960-2000, they show that the negative impact of the real exchange rate volatility on productivity growth decreases with the country's financial development. Within an identical framework, but focusing on foreign currency (dollar) liabilities, Benhima (2012) shows over a panel of 76 emerging and industrial countries between 1995 and 2004 that the higher the share of foreign currency in external debt, the more exchange rate volatility is detrimental to growth. This tends to support the idea that the effect of RER volatility depends critically on the existence of credit constraints.

The link between volatility and export performance has been mostly investigated using macro, and less frequently, disaggregated data at the sectoral level.[3] Some papers do look at the impact of the exchange rate on exporting firms (Berman et al., 2012, on France; Li et al., 2012, and Park et al., 2010, on China), but they focus on the impact of the level of the exchange rate instead of the volatility, and do not account for the role of financial constraints. Firm-level studies of the impact of exchange-rate volatility on economic performance for developing countries are scarce (see e.g. Carranza et al., 2003, who find a negative impact of volatility on a sample of 163 Peruvian firms), and almost nonexistent regarding the role of credit constraints in

[2] In our case, this simply means that the negative impact of an appreciation on exports cannot be exactly offset by the positive impact of a subsequent depreciation, because some of the sunk costs of exports are irreversible.

[3] Some of them look at the impact of exchange rate variations on Chinese trade, including: Marquez and Schindler (2007), Ahmed (2009), Freund et al. (2011) and Cheung et al. (2012).

modelling the impact of RER volatility, especially on export performance. To our knowledge, Caglayan and Demir (2012) is the only firm-level study connecting firm productivity, exchange rate movements and the issue of access to external finance. Based on a dataset of 1000 private Turkish firms, their results support a negative impact of exchange rate volatility on productivity growth which is downplayed by better access to external finance. We depart from these previous works by using a much wider dataset of firms, by looking at whether firms reallocate their export away from partners characterized by higher exchange rate volatility, and more importantly, by investigating the presence of a non-linear effect of exchange rate volatility on performance depending on the level of financial constraints, in the Chinese context. The latter is apprehended through two complementary dimensions. First, we infer firm-level financial vulnerability from the financial dependence of their activities. This approach pioneered by Rajan and Zingales (1998) has been shown to be a robust methodology to detect credit constraints and assess their evolution (Kroszner et al., 2006, and Manova et al., 2011). Second, we exploit Chinese cross-provincial heterogeneity to study how financial development may mitigate both credit constraints and exchange rate volatility.

This paper contributes to the existing literature at various levels. First, we provide a micro-founded investigation of Aghion et al. (2009)'s approach, and propose a potential channel for their results (through exports). Second, our methodology allows to circumvent a number of endogeneity problems which may have flawed some of the related studies. Indeed, the use of firm-level data mitigates the issue of reverse causality from trade to exchange rate volatility (cf. Broda and Romalis, 2010), and the well-known simultaneity bias between exporting behavior and financial proxies for credit constraints at the firm-level. It is very unlikely that a Chinese firm shock impacts exchange rate volatility or measures of financial dependence based on US firms data. Besides, using cross-regional data within a single country instead of cross-country data makes the risk of confusion between financial development and other macro characteristics less severe. Third, we use the relevant firm-level data to test Aghion et al. (2009)'s prediction that exchange rate volatility is specially harmful to firms that have high liquidity needs when local financial development is low.

Our results are consistent with the above-mentioned macro studies, especially Aghion et al. (2009) : firms tend to export less and fewer products to destinations with higher exchange rate volatility. This export-deterring effect is magnified for financially vulnerable firms. As expected, financial development does seem to dampen this negative impact, especially on the intensive margin of export.

In the next section, we survey different theoretical mechanisms underlying our approach, before discussing our general methodology and presenting our database in section 3. In section 4, we start by presenting our benchmark results, before studying how financial development may alter them. Section 5 provides some robustness checks, and section 6 concludes.

2. ER VOLATILITY, FINANCIAL CONSTRAINTS AND EXPORTS: THEORETICAL UNDERPINNINGS

Several mechanisms can generate a negative impact of exchange rate volatility on trade, proportionally stronger for financially vulnerable firms - and consequently weaker with high levels

of financial development. One can think of exchange rate risk, which creates uncertainty for the exporter's earnings. The existence of well-developed financial markets should allow agents to hedge exchange rate risk, thus dampening or eliminating its negative effects on trade. But this effect is not clearly established, either empirically (Dominguez and Tesar, 2001) or theoretically (Demers, 1991). In that sense, mitigation of exchange rate risk is unlikely to be the main sources of the growth-enhancing effect of financial development found in the literature (Levine, 2005). Keeping in mind that sunk costs of exports are similar to investments in intangible capital, like R&D (Berman and Héricourt, 2010) and that exchange rate movements give rise to sunk costs (Greenaway and Kneller, 2007), the negative impact of exchange rate volatility on exports can be rationalized through the asymmetry of adjustment costs leading to investment irreversibility. Fixed start-up costs for entering the export market include costs of gathering information on foreign markets, establishing a distribution system and more generally adapting products to foreign tastes and environments. 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. But once these investments are made, it will be very difficult, and most of the time impossible, to back out and recover the cost of those investments even in the case of an abrupt subsequent currency appreciation. If firms are credit constrained, they will face additional difficulties to fund new investments, and will be even more reluctant to take the chance of engaging in exports to markets characterized by highly volatile exchange rate. We present below two models that imply such a negative impact of volatility and a magnifying impact of credit constraints.

In Aizenman and Marion (1999), the introduction of credit rationing[4] leads to a nonlinearity into the intertemporal budget constraint. Suppose that the supply of credit facing a developing country is bounded by a credit ceiling S. Suppose also that the demand for investment fluctuates between a high-demand state and a low-demand state, while the credit ceiling remains unchanged. The credit ceiling hampers the expansion of investment in the high-demand state, without moderating the drop in investment in the low-demand state. Thus, this asymmetric pattern implies that higher volatility reduces the average rate of investment.[5] Credit constraints appear therefore as a key feature in their model: the stronger the credit constraints (i.e., the lower the credit ceiling), the stronger the reduction in average investment due to volatile investment demand.

A second mechanism is proposed in Aghion et al. (2009). Their open monetary economy model with wage stickiness combines two features. First, the growth of productivity is a result of innovation (driven by intangible investment in R&D) by firms with sufficient cash flows to face short-run liquidity shocks. Second, macroeconomic volatility is driven by nominal exchange rate movements in presence of wage stickiness. Exchange rate fluctuations in turn are caused by both real and financial aggregate shocks. Suppose an exporter faces fixed wage costs in local currency. When the bilateral exchange rate of the local currency with that of the exporting market fluctuates, the exporter is not able to completely pass through the cost change to the

[4]Moral hazard and adverse selection problems are commonly invoked as the main explanations to credit rationing since the riskiness of individual borrowers cannot be identified *a priori* (Stiglitz and Weiss, 1981).

[5]This pattern is made clear in Figures 4(b) and 4(c) in Aizenman and Marion (1999).

exporting market, because of competitive pressures, for example. Then, exchange rate volatility leads to fluctuations in profits, which can lower investment in an environment where external finance is more costly than internal one (i.e., in case of credit constraints). Then, following an exchange rate appreciation, firms' current earnings decline. This reduces their ability to borrow in order to survive idiosyncratic liquidity shocks and thereby invest in the longer term. Depreciations have the opposite effect. However, the existence of a credit constraint implies that in general the positive effects of a depreciation will not fully compensate the negative effect of an appreciation. By reducing the cost of external finance, financial development relaxes credit constraints and consequently should decrease the impact of volatility on the sunk cost activity, in our case exports.

We can summarize the testable predictions from these models for export performance (both the export value and the number of products exported):

Testable Prediction 1. *Export performance decreases with exchange rate volatility. Naming α the parameter of interest, we expect therefore the link between volatility on the one hand and the exported value and the number of products on the other hand, to be negative: $\alpha < 0$.*

Testable Prediction 2. *The negative impact of exchange rate volatility on export performance is magnified for financially vulnerable firms. The sign of the interaction - hereafter named β - between the volatility of the real exchange rate and the external finance dependence is expected to be negative: $\beta < 0$.*

Testable Prediction 3. *By relaxing credit constraints, financial development decreases the impact of exchange rate volatility on export performance, proportionally more for financially vulnerable firms. The expected signs on both interactions, between volatility and financial development on the one hand (parameter γ), and between volatility, financial development and financial vulnerability on the other hand (parameter δ), are positive: $\delta, \gamma > 0$.*

Note also that the relative size and significance of α in comparison with the other parameters will give us interesting insights about the respective roles of the two potential explanations previously invoked to justify the lack of impact of exchange rate volatility on exports in the macro literature, namely the aggregation bias and the heterogeneity in terms of financial development. More precisely, a smaller (or even non-significant) α compared to β, γ and δ will suggest that the impact of exchange rate volatility on exports is mainly due to firms' credit constraints and low financial development, rather than a direct impact on export performance.

3. DATA SOURCES AND EMPIRICAL METHODOLOGY

3.1. Exchange rate volatility

Exchange rate volatility is computed as the yearly standard deviation of monthly log differences in the real exchange rate. We compute real exchange rate as the ratio of nominal exchange rate of the yuan with respect to the partner's currency divided by the partner's price level. Monthly data on nominal exchange rates and prices are taken for the IFS. As a robustness check, we consider two alternative measures of volatility, the two-year standard deviation of monthly log

differences in the real exchange rate and the yearly standard deviation of monthly log differences from the HP detrended real exchange rate (Hodrick and Prescott, 1997).

3.2. Trade data

The main data source is a database collected by the Chinese Customs. It contains Chinese firm-level yearly export flows by year, HS6 product and destination country, over the 2000-2006 period. We cover 113,368 exporting firms and 158 destinations.

3.3. Financial vulnerability

We compute the firm-level financial vulnerability as the weighted average of the financial vulnerability of its activities, with the weights being the sector's share in the firm exports in 2000.[6]

$$FinVuln^F = \frac{Exports_s^F}{\sum_s Exports_s^F} \times FinVuln_s \quad (1)$$

We use three different measures of a sector's financial vulnerability $FinVuln_s$, in line with other studies on the same topic. These variables are meant to capture technological characteristics of each sector which are exogenous to firms' financial environment, and determine the degree of reliance of each sector's firms on external finance. While firms in all industries may face liquidity constraints, there are systematic differences across sectors in the relative importance of up-front costs and the lag between the time production expenses are incurred and revenues are realized. We capture these differences with a measure of sectors' external finance dependence (referred hereafter as "financial dependence"), constructed as the share of capital expenditures not financed out of cash flows from operations. For robustness, we also use an indicator of firms' assets intangibility. This measure is the ratio of intangible assets to fixed assets. It thus captures another dimension of a firm's dependence on access to external financing: the difficulty to use assets as collateral in obtaining financing. As a third indicator, we follow Manova et al. (2011) who use the share of R&D spending in total sales (R&D), based on the fact that as a long-term investment, research and development often implies greater reliance on external finance.

As is standard practice in the literature, these indicators are computed using data on all publicly traded U.S.-based companies from Compustat's annual industrial files; the value of the indicator in each sector is obtained as the median value among all firms in each sector. Indicators of sectors' financial vulnerability are available for 27 3-digit ISIC sectors.[7] We borrow the values computed from Kroszner et al. (2006). As explained in Manova et al. (2011), the use of US data is not only motivated by the lack of data for most other countries, including China, but it

[6] In unreported results available upon request we verify that our results hold when measuring the financial vulnerability of firms as the financial vulnerability of its main (ISIC rev 2) sector of activity, identified as the one with the greatest export share in 2000.

[7] We use a correspondence table between the international trade nomenclatures and the ISIC Rev. 2 categories, developed at the CEPII to match the Chinese HS 6-digit product codes with the ISIC 3-digit sector categories.

has several advantages. Rajan and Zingales (1998) have pointed out that the United States have one of the most advanced and sophisticated financial systems, so that the values for US firms reflect the technology-specific component of external finance needs, or what can be called the finance content of an industry. It is likely that measuring these indices in the Chinese context would lead to different values, reflecting the fact that firms organize production differently in a credit-constrained environment. Thus, such measures would be endogenous to financial development in China, whereas measures based on US firms' data can be seen as exogenous in this respect.

Finally, Descriptive statistics of key variables are given in Tables 1 and Tables 2 below.

Table 1 – Summary statistics: key variables

Variable	Mean	Std. Dev.	Min	Max
Nb of exported products	4.66	13.95	1	13299
Firm Export value (million US $)	0.75	11.9	0.1	7,440
RER volatility	0.02	0.02	.01	0.44
GDP (million US $)	1.54	2.98	0.1	13.7
Price index	234.4	309.8	0.003	3549
Country-sector imports (million US $)	14.0	28.8	0.01	271
External dependence	.37	.26	-0.45	1.14
Intangibility	0.08	0.05	0	0.43
R&D	0.02	0.02	0	0.09

Table 2 – Descriptive statistics for financial vulnerability indicators

Distribution	External dependence	Intangibility	R&D
5%	0.01	0.01	0.004
10%	0.061	0.019	0.009
50%	0.326	0.074	0.019
90%	0.770	0.149	0.065
95%	0.838	0.160	0.070

3.4. Empirical specification

We estimate the following specification:

$$\text{ExportPerf}^F_{ijt} = \alpha\ \text{RERVolatility}_{jt} + \beta\ \text{RERVolatility}_{jt} \times \text{FinVuln}^F + \phi Z_{jt} + \lambda^F_j + \theta_t + \varepsilon^F_{ijt} \quad (2)$$

where $\text{ExportPerf}^F_{ijt}$ is a measure of export performance of firm F for export destination j in year t for province i. We use two alternative measures of export performance capturing the intensive and extensive margin of exports respectively, the log of the total free-on-board export sales and the log of the number of exported products in year t. Our regressions include firm-country fixed effects λ^F_j and year dummies θ_t. Firm-fixed effects capture the impact of local endowments and of sector-specific characteristics (including the financial vulnerability). Our conditioning set Z is made of destination-year specific variables. In standard models of international trade, exports depend on the destination country's market size and price index.

We use the country j's GDP[8] and effective real exchange rate.[9] We also account for the partner j's demand for goods of the main sector of the firms (identified as the one with the highest export share in 2000, the initial year of our dataset). We use the log of total import value for the country-sector in the year taken from BACI.[10] 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 province level[11] using Froot (1989) correction.

4. RESULTS

4.1. Benchmark

Table 3 present the estimations of the impact of the exchange rate volatility on firm-level export performance. While columns (1) to (6) look at the impact of RER volatility on export value, columns (7) to (12) focus on the number of exported products. Columns (1) and (7) report the estimates of specifications based only on the two proxies for destination countries' market size and price index (which are significant and display the positive expected signs), and columns (2) and (8) investigate the unconditional relationship between RER volatility and export performance. Columns (3) and (9) include an alternative measure of market size, namely the country-sector imports, which appears positive and significant. The following columns add a variable interacting RER volatility with firm-level financial dependence. Columns (2) and (8) show that exchange rate volatility appears negatively associated with export performance (i.e., the α parameter of equation 2 is significant and negative). Checking the robustness of this negative relationship with variables measured using two-year windows, Table 4 confirms this result on both measures of export performance (see columns (1) and (5)). Table 5 follows the same logic but computes volatility using yearly standard deviation of monthly log differences from the HP detrended real exchange rate; column (1) and (5) confirm a negative impact of RER volatility, but significant only for the value exported. Overall, the unconditional impact of RER volatility on export performance is negative and significant in almost all cases.

[8] GDP data come from the World Development Indicators.

[9] The effective exchange rate is computed from CEPII and IFS data as an average of the real exchange rates of destination country j toward all its trade partners weighted by the share of each trade partner in the country j's total imports.

[10] This dataset, which is constructed using COMTRADE original data, provides bilateral trade flows at the product level (Gaulier and Zignago, 2010). BACI is downloadable from http://www.cepii.fr/anglaisgraph/bdd/baci.htm. Trade flows are aggregated up to the 27 3-digit ISIC sectors for which our indicators of sectors' financial vulnerability are available.

[11] Since the province level is the most aggregated one (ie, with the smallest number of clusters) in our case, it gives the most possible conservative standard errors. Therefore, it is the safest choice we could make to put our results on solid grounds.

Table 3 – Firm-country export performance and exchange rate volatility

Dependent variable	Log Export value						Log Nb of exported products					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Financial indicator				Ext dep	Intang.	R&D				Ext dep	Intang.	R&D
RER volatility (α)		-0.439^{a}	-0.305^{a}	0.402	0.123	0.153		-0.132^{b}	-0.106^{c}	0.098	0.029	-0.013
		(0.119)	(0.106)	(0.246)	(0.183)	(0.172)		(0.065)	(0.061)	(0.108)	(0.086)	(0.095)
Ln country GDP	0.321^{a}	0.312^{a}	0.061	0.061	0.060	0.061	0.136^{a}	0.133^{a}	0.086^{a}	0.086^{a}	0.086^{a}	0.086^{a}
	(0.068)	(0.066)	(0.068)	(0.068)	(0.068)	(0.068)	(0.028)	(0.027)	(0.021)	(0.021)	(0.021)	(0.021)
Ln country price index	0.027^{c}	0.027^{c}	0.050^{a}	0.050^{a}	0.050^{a}	0.050^{a}	0.022^{a}	0.022^{a}	0.026^{a}	0.026^{a}	0.026^{a}	0.026^{a}
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Ln country-sector imports			0.357^{a}	0.356^{a}	0.357^{a}	0.356^{a}			0.067^{a}	0.067^{a}	0.067^{a}	0.067^{a}
			(0.014)	(0.014)	(0.014)	(0.014)			(0.012)	(0.012)	(0.012)	(0.012)
RER Volatility $\times$				-1.900^{a}	-5.686^{a}	-18.574^{a}				-0.551^{a}	-1.795^{a}	-3.778^{b}
Fin. Vulnerability(β)				(0.478)	(1.466)	(4.379)				(0.162)	(0.611)	(1.754)
Fixed Effects	Firm-country fixed effect											
R-squared	0.03	0.03	0.03	0.03	0.03	0.03	0.01	0.01	0.01	0.01	0.01	0.01
Observations	3,731,351											
Nb of firm-country pairs	1,128,873											

Notes: Heteroskedasticity-robust standard errors are reported in parentheses. Standard errors are clustered at province level; ^{a}, ^{b} and ^{c} respectively denote significance at the 1%, 5% and 10% levels.

Anyway, subsequent results suggest that the magnitude of this effect depends on the extent of financial constraints. Indeed, columns (4) to (6) and (10) to (12) of Table 3 show that the interaction with the financial vulnerability enters with a negative and significant coefficient, whatever the indicator of financial dependence used: external dependence in columns (4) and (10), asset intangibility in columns (5) and (11) and R&D intensity in columns (6) and (12). Across our three indicators, we observe consistently that the negative impact of RER volatility on exports grows with financial vulnerability. These results give us a first insight that the negative impact of exchange rate volatility on export performance going through financial vulnerability may actually dominate the direct effect.

These results are robust to various robustness checks. First, Tables 4 and 5 also confirm an export deterring effect of RER volatility that rises with financial vulnerability when the aforementioned alternatives measures of RER volatility are used, yet with a lesser significance for the number of exported product in the case of the HP-filtered RER volatility. Second, Table 10 in the Appendix report the estimates of equation 2 including sector-year fixed effects. This check allows to verify that although a large component of the variance in exchange rate volatility may be year-specific, our results do not solely reflect the sector-specific trends.[12] Estimated parameters on the interaction between exchange rate volatility and financial vulnerability are a bit lower in absolute value than in our preferred specification, but otherwise, results are qualitatively identical. Third, Table 11 in the Appendix replicates Table 3 when excluding intermediary firms as we worry that our measure of financial constraints which is computed from information based on the production technology may be less relevant for those firms which do not produce the goods they sell. We follow Ahn et al.'s (2011) approach to identify them based on Chinese characters that have the English-equivalent meaning of "importer", "exporter", and/or "trading" in the firm's name.[13] Once again, the negative impact of exchange rate volatility appears magnified for financially vulnerable firms.

To illustrate these results we can compare the reduction in the export performance due to RER volatility for firms at the 10^{th} and 90^{th} percentiles of the distribution of financial vulnerability. Table 2 above reports summary statistics on the distribution of the three indicators of financial vulnerability. Using coefficients from Column (4) in Table 3 for intensive margin, this means that, all things being equal, the negative effect of RER volatility on export value is -1.46 [=-1.90 $\times$ 0.770] at the 90^{th} percentile of financial dependence compared to -0.12 [=-1.90 $\times$ 0.061] at the 10^{th} percentile. Our results hence suggest that an additional 0.02 in yearly RER volatility (which corresponds to a standard deviation increase) would reduce the export value by 3 percent and 0.24 percent in the two respective cases.

When turning to the indicator of firms' extensive margin, the number of products that firms export bilaterally in columns (7) to (12), we also find a negative effect of the RER volatility that is growing in the firm-activities' financial vulnerability. Based on results in column (10), we compute that the negative effect of RER volatility on the number of exported products is

[12] In unreported results available upon request, we verified that our results hold when adding interactions between year dummies and our proxy of financial vulnerability.

[13] In pinyin (Romanized Chinese), these phrases are: "jin4chu1kou3", "jing1mao4', "mao4yi4", "ke1mao4" and "wai4jing1".

Table 4 – Firm-country export performance and exchange rate volatility, two-year sub-periods

Dependent variable	Log Export value				Log Nb of exported products			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Financial indicator		Ext dep	Intang.	R&D int		Ext dep	Intang.	R&D int
RER volatility (α)	-1.067^a	0.426	-0.672^b	0.231	-0.498^a	0.025	-0.274	-0.209
	(0.198)	(0.438)	(0.296)	(0.403)	(0.130)	(0.219)	(0.175)	(0.191)
Ln country GDP	0.042	0.040	0.043	0.040	0.091^a	0.090^a	0.091^a	0.090^a
	(0.060)	(0.061)	(0.060)	(0.060)	(0.021)	(0.021)	(0.021)	(0.021)
Ln country price index	0.047^a	0.047^a	0.047^a	0.048^a	0.021^a	0.021^a	0.021^a	0.021^a
	(0.011)	(0.011)	(0.011)	(0.011)	(0.003)	(0.003)	(0.003)	(0.003)
Ln country-sector imports	0.322^a	0.323^a	0.322^a	0.322^a	0.054^a	0.055^a	0.055^a	0.055^a
	(0.021)	(0.021)	(0.021)	(0.020)	(0.009)	(0.009)	(0.009)	(0.009)
RER Volatility $\times$		-4.007^a	-5.261^b	-52.263^a		-1.403^a	-2.985^a	-11.636^a
Fin. Vulnerability(β)		(0.817)	(2.438)	(11.001)		(0.299)	(1.061)	(3.013)
Fixed Effects	Firm-country fixed effect							
R-squared	0.05	0.05	0.05	0.05	0.02	0.02	0.02	0.02
Observations	1,813,099							
Number of firm-country pairs	774,367							

Notes: All variables are computed on two-year windows (2001-02, 2003-04, 2005-06). Volatility is computed as two-year standard deviation of monthly log differences in the real exchange rate. Heteroskedasticity-robust standard errors are reported in parentheses. Standard errors are clustered at province level; ^{a}, ^{b} and ^{c} respectively denote significance at the 1%, 5% and 10% levels.

Table 5 – Firm-country export performance and ER volatility (HP filtered)

Dependent variable	Log Export value				Log Nb of exported products			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Financial indicator		Ext dep	Intang.	R&D int		Ext dep	Intang.	R&D int
RER volatility (α)	-0.210^a	-0.001	-0.082	0.010	-0.010	0.012	0.110^a	-0.008
	(0.074)	(0.142)	(0.109)	(0.117)	(0.025)	(0.030)	(0.038)	(0.026)
Ln country GDP	0.131^b	0.063	0.063	0.063	0.124^a	0.088^a	0.088^a	0.088^a
	(0.056)	(0.070)	(0.070)	(0.070)	(0.021)	(0.021)	(0.021)	(0.021)
Ln country price index		0.049^a	0.049^a	0.049^a		0.026^a	0.026^a	0.026^a
		(0.014)	(0.014)	(0.014)		(0.004)	(0.004)	(0.004)
Ln country-sector imports	0.348^a	0.357^a	0.357^a	0.356^a	0.063^a	0.068^a	0.068^a	0.068^a
	(0.014)	(0.014)	(0.014)	(0.014)	(0.012)	(0.012)	(0.012)	(0.012)
RER Volatility $\times$		-0.553^b	-1.517^c	-9.162^a		-0.053	-1.462^b	0.041
Fin. Vulnerability(β)		(0.203)	(0.836)	(2.196)		(0.079)	(0.565)	(0.956)
Fixed Effects	Firm-country fixed effect							
R-squared	0.03	0.03	0.03	0.03	0.01	0.01	0.01	0.01
Observations	3,730,205							
Number of firm-country pairs	1,128,105							

Notes: Volatility is computed as yearly standard deviation of monthly log differences from the HP detrended real exchange rate. Heteroskedasticity-robust standard errors are reported in parentheses. Standard errors are clustered at province level; ^{a}, ^{b} and ^{c} respectively denote significance at the 1%, 5% and 10% levels.

-0.42 at the 90^{th} percentile of financial vulnerability compared to -0.03 at the 10^{th} percentile. An additional 0.02 in yearly RER volatility would hence cut the number of exported products by 0.85 percent and 0.07 percent in the two respective cases. Tough non-negligible, the effects appear therefore quantitatively less important for the extensive margin than for the intensive one.

In Tables 6 and 7 we check the robustness of our results to the inclusion of additional controls. Financial vulnerability is measured using external dependence. We rely on our benchmark specification from columns (4) and (10) in Table 3. In column (1), we add the level of RER to check that our measured impact of RER volatility is not simply capturing the level impact of RER. The log of RER enters positively but fails to be significant. In column (2) we add the interactive term between the level of RER and financial dependence. The interactive term attracts a positive and significant coefficient, which is expected. The reasoning is symmetrical to the one exposed concerning RER volatility: financially constrained firms disproportionately take advantage of a depreciating exchange rate.

Table 6 – Robustness checks: Including RER in level and income volatility

Dependent variable	Log Export value					
Financial indicator	External dependence					
	(1)	(2)	(3)	(4)	(5)	(6)
RER volatility (α)	0.399	0.223		-0.238^{b}	0.520^{c}	0.504^{c}
	(0.243)	(0.217)		(0.125)	(0.282)	(0.278)
Ln country GDP	0.054	0.057	0.066	0.064	0.063	0.063
	(0.075)	(0.075)	(0.078)	(0.077)	(0.077)	(0.077)
Ln country price index	0.048^{a}	0.048^{a}	0.037^{b}	0.037^{b}	0.037^{b}	0.037^{b}
	(0.013)	(0.013)	(0.017)	(0.017)	(0.017)	(0.017)
Ln country-sector imports	0.356^{a}	0.355^{a}	0.409^{a}	0.407^{a}	0.406^{a}	0.406^{a}
	(0.014)	(0.014)	(0.017)	(0.017)	(0.017)	(0.017)
RER Volatility $\times$ Fin. vulnerability (β)	-1.901^{a}	-1.427^{a}			-2.025^{a}	-1.981^{a}
	(0.479)	(0.400)			(0.537)	(0.523)
Ln RER $\times$ Fin. vulnerability		0.465^{a}				
		(0.141)				
Ln RER	0.014	-0.158^{a}				
	(0.020)	(0.046)				
GDP volatility			-1.740^{a}	-1.721^{a}	-1.721^{a}	-1.338^{a}
			(0.234)	(0.234)	(0.234)	(0.316)
GDP Volatility $\times$ Fin. vulnerability						-1.057^{c}
						(0.565)
Fixed Effects	Firm-country fixed effect					
R-squared	0.03	0.03	0.03	0.03	0.03	0.03
Observations	3,731,351			3,158,760		
Number of firm-country pairs	1,128,873			952,132		

Notes: Heteroskedasticity-robust standard errors are reported in parentheses. Standard errors are clustered at province level; ^{a}, ^{b} and ^{c} respectively denote significance at the 1%, 5% and 10% levels.

In the remaining columns, we verify that RER volatility does not act as a mere proxy of economic fluctuations. We look at the repercussions of the volatility of the partner's GDP. It is computed as the standard deviation of year-to-year changes in quarterly GDP taken from the

Table 7 – Robustness checks: Including RER in level and income volatility

Dependent variable	Log Nb of exported products					
Financial indicator	External dependence					
	(1)	(2)	(3)	(4)	(5)	(6)
RER volatility (α)	0.090	0.057		-0.104	0.105	0.106
	(0.109)	(0.108)		(0.061)	(0.117)	(0.115)
Ln country GDP	0.069^a	0.070^a	0.105^a	0.104^a	0.104^a	0.104^a
	(0.022)	(0.022)	(0.022)	(0.021)	(0.021)	(0.021)
Ln country price index	0.022^a	0.022^a	0.021^a	0.021^a	0.022^a	0.022^a
	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
Ln country-sector imports	0.067^a	0.067^a	0.067^a	0.067^a	0.066^a	0.066^a
	(0.012)	(0.012)	(0.016)	(0.015)	(0.015)	(0.015)
RER Volatility $\times$ Fin. vulnerability (β)	-0.553^a	-0.465^a			-0.559^a	-0.560^a
	(0.161)	(0.153)			(0.181)	(0.177)
Ln RER $\times$ Fin. vulnerability		0.087^b				
		(0.042)				
Ln RER	0.031^c	-0.001				
	(0.018)	(0.025)				
GDP volatility			-0.344^a	-0.336^a	-0.336^a	-0.343^a
			(0.059)	(0.056)	(0.056)	(0.096)
GDP Volatility $\times$ Fin. vulnerability						0.020
						(0.155)
Fixed Effects	Firm-country fixed effect					
R-squared	0.01	0.01	0.02	0.02	0.02	0.02
Observations	3,731,351			3,158,760		
Number of firm-country pairs	1,128,873			952,132		

Notes: Heteroskedasticity-robust standard errors are reported in parentheses. Standard errors are clustered at province level; ^{a}, ^{b} and ^{c} respectively denote significance at the 1%, 5% and 10% levels.

Table 8 – Robustness checks: export performance and exchange rate volatility across various subsamples

Dependent variable	Log Export value			Log Nb of exported products		
Financial indicator	External dependence					
	(1)	(2)	(3)	(4)	(5)	(6)
	Country Nb>1	Product Nb>1	No HK or Macao	Country Nb>1	Product Nb>1	No HK or Macao
RER volatility (α)	0.384	0.359	0.435^{c}	0.102	0.136	0.116
	(0.244)	(0.270)	(0.228)	(0.108)	(0.152)	(0.103)
Ln country GDP	0.051	0.101^{c}	0.031	0.082^{a}	0.099^{a}	0.069^{a}
	(0.064)	(0.058)	(0.079)	(0.020)	(0.024)	(0.022)
Ln country price index	0.048^{a}	0.035^{b}	0.032^{b}	0.026^{a}	0.037^{a}	0.015^{a}
	(0.015)	(0.014)	(0.013)	(0.004)	(0.006)	(0.005)
Ln country-sector imports	0.355^{a}	0.333^{a}	0.342^{a}	0.067^{a}	0.073^{a}	0.060^{a}
	(0.013)	(0.013)	(0.015)	(0.012)	(0.014)	(0.010)
RER Volatility $\times$	-1.866^{a}	-1.722^{a}	-1.921^{a}	-0.558^{a}	-0.660^{b}	-0.571^{a}
Fin. Vulnerability(β)	(0.467)	(0.602)	(0.466)	(0.163)	(0.270)	(0.157)
Fixed Effects	Firm-country fixed effect					
R-squared	0.03	0.04	0.03	0.01	0.02	0.02
Observations	3,659,052	2,019,033	3,472,215	3,659,052	2,019,033	3,472,215
Number of firm-country pairs	1,106,403	781,138	1,059,036	1,106,403	781,138	1,059,036

Notes: Heteroskedasticity-robust standard errors are reported in parentheses. Standard errors are clustered at province level; ^{a}, ^{b} and ^{c} respectively denote significance at the 1%, 5% and 10% levels.

IFS. As argued by Baum et al. (2004) and Grier and Smallwood (2007), foreign income uncertainty may equally matter for trade. Consistently with their story, the GDP volatility enters with a negative sign: income volatility has a significant deterrent effect on both the value and the number of products exported. In columns (4) and (5) of both Tables 6 and 7, we see that this inclusion does not affect our benchmark result of a negative impact of RER volatility on both margins of exports that grows with financial vulnerability. In column (6) of both tables, we further include the interactive term between GDP volatility and financial dependence. It is insignificant at the 5% level in both cases (the negative impact of income volatility does not vary with firm's level of credit constraints), while our main message on the impact of RER volatility is not altered: the interaction between RER volatility and financial dependence remains negative and significant for both margins of trade.

Table 8 verifies that our results are robust to changes in the sample. Here again, financial vulnerability is measured using external dependence. Columns (1) to (3) use export value as the proxy for firm-level export performance while columns (4) to (6) replicate the specifications using the number of exported products. Column (1) and (4) restrict the sample to firms exporting to more than one country while column (2) and (5) concentrate on multi-product firms. The point estimates are virtually unaffected. In columns (3) and (6) we exclude observations for Macao and Hong Kong since we are concerned that RER volatility in the case of those two "Greater China" territories may have different implications than for other international partners. Once again, the negative coefficient on the interactive term between RER volatility and financial vulnerability remains.

In unreported results available upon request we verify that our results hold for exporters irrespective of their ownership structure (whether domestic or foreign). Also, when differentiating exports depending on their trade regime (ordinary or processing) type, we do not find evidence of systematic differences across firms. Another unreported robustness check consists in investigating whether our results pertain to a limited category of firms. We however find that our main findings apply to both low and high productivity firms when the productivity cut-off is computed based on the mean or median number of products, number of countries or number of product-country pairs that a firm exports.[14]

4.2. Role of financial development

We now ask if recent developments in China's financial system have helped to reduce the export losses from real exchange rate uncertainty. As previously mentioned, Aghion et al. (2009) suggest that the effect of RER volatility depends critically on the level of local financial development. We modify our empirical specification to allow β in Equation 2 to vary depending on the development of the local financial sector. Our main parameter of interest is that on the triple interaction between RER volatility, financial vulnerability and financial development (also denominated δ in the following table). We thus adapt the methodology first used in Rajan and Zingales (1998), which consists in filtering the impact of financial liberalization by the financial vulnerability, in order to isolate its direct finance-related causal effect. We measure local financial development as the share of total credit over GDP in the province.[15]

We first split the provinces into two groups depending on whether their financial development is below or above the national median or the national mean in 2000 (the initial year of our sample). Corresponding results are reported in columns (1) and (2) of Table 9 when looking at the intensive margin or exports and columns (6) and (7) for the extensive margin. The positive coefficient attracted by the interactive terms between RER volatility and financial vulnerability in the case of high-financial developed provinces indicate that the negative effect of RER volatility on firms' export performance is less present when credit is abundant. In the following columns we use the time-varying proxy of financial development and interact it directly with RER volatility and financial dependence; the interaction between local financial development and financial dependence is also included. We also add the level of financial development and its interaction with RER volatility (the γ parameter) in columns (4), (5), (9) and (10). In columns (5) and (10) we include province-year fixed effects to account for time-varying characteristics of the local economy (including financial development that drops as a consequence). In this way, any variable correlated with financial development, which could impact firms export performance, will be captured by these fixed effects, but should not affect our coefficients of interest β, unless its effect runs through a financial channel.

Our results confirm our previously measured negative interaction between RER volatility and financial vulnerability but suggest that the losses are mitigated with high local financial development, at least for the total value exported.

[14] More details of these checks available upon request to the authors.

[15] In robustness checks we verify that our results were similar when using the ratio of deposits over GDP which is the only other finance-related indicator that is available over the period 2000-2006 for all Chinese provinces.

Table 9 – The role of financial development

Financial indicator	External dependence									
Dependent variable	Log Export value					Log Nb of exported products				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
RER volatility (α)	0.450^{c}	0.450^{c}	0.312	0.292	0.299	0.121	0.121	0.075	0.071	0.046
	(0.224)	(0.224)	(0.248)	(0.238)	(0.228)	(0.097)	(0.098)	(0.100)	(0.103)	(0.093)
Ln country GDP	0.059	0.059	0.057	0.059	0.049	0.085^{a}	0.085^{a}	0.083^{a}	0.084^{a}	0.077^{a}
	(0.069)	(0.069)	(0.068)	(0.068)	(0.069)	(0.021)	(0.021)	(0.020)	(0.020)	(0.020)
Ln country price index	0.050^{a}	0.050^{a}	0.050^{a}	0.049^{a}	0.050^{a}	0.026^{a}	0.026^{a}	0.026^{a}	0.026^{a}	0.027^{a}
	(0.014)	(0.014)	(0.014)	(0.014)	(0.015)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Ln country-sector imports	0.357^{a}	0.357^{a}	0.356^{a}	0.354^{a}	0.358^{a}	0.067^{a}	0.067^{a}	0.067^{a}	0.067^{a}	0.071^{a}
	(0.014)	(0.014)	(0.014)	(0.014)	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)	(0.011)
RER Volatility × Fin. vulnerability (β)	-2.813^{a}	-2.840^{a}	-1.718^{a}	-1.622^{a}	-1.614^{a}	-0.977^{a}	-0.991^{a}	-0.503^{a}	-0.486^{a}	-0.401^{a}
	(0.314)	(0.329)	(0.611)	(0.475)	(0.462)	(0.219)	(0.218)	(0.164)	(0.153)	(0.122)
RER Volatility × Financial vulnerability ×	2.034^{b}					0.948				
High Fin. Devt (above median)	(0.802)					(0.845)				
RER Volatility × Financial vulnerability ×		2.087^{b}					0.978			
High Fin. Devt (above mean)		(0.778)					(0.829)			
RER Volatility × Financial vulnerability ×			7.069^{a}	3.034^{b}	2.878^{b}			1.008	0.291	0.192
Fin. Devt (δ)			(1.981)	(1.234)	(1.160)			(0.651)	(0.520)	(0.421)
Financial Development			0.087	-0.016				0.090^{c}	0.072	
			(0.061)	(0.056)				(0.045)	(0.050)	
RER Volatility × Fin. Devt (γ)				0.263^{c}	0.260^{c}				0.047	0.031
				(0.146)	(0.138)				(0.031)	(0.019)
Financial vulnerability × Fin. Devt			-2.170^{a}	-0.666	-0.770			-0.390	-0.123	-0.101
			(0.658)	(0.457)	(0.572)			(0.269)	(0.256)	(0.234)
Province-year Fixed Effects	no	no	no	no	yes	no	no	no	no	yes
Fixed Effects	Firm-country fixed effect									
R-squared	0.03	0.03	0.03	0.03	0.03	0.01	0.01	0.01	0.01	0.02
Observations	3,731,351									
Number of firm-country pairs	1,128,873									

Notes: Heteroskedasticity-robust standard errors are reported in parentheses. Standard errors are clustered at province level; ^{a}, ^{b} and ^{c} respectively denote significance at the 1%, 5% and 10% levels.

In columns (3) to (5), we find that the triple interaction between exchange rate volatility, financial dependence and financial development is positive and significant: the more financially developed the province is, the less adversely local firms' export value is affected by exchange rate volatility. This is in line with Aghion et al. (2009) observation that financial development reduces the magnitude of performance deterioration induced by RER volatility. The evidence is much weaker (δ parameter remains positive, but with low significance) when export performance is measured by the number of exported products (columns (8) to (10)). This could indicate that the benefits from financial development apply especially for the intensive margin and less so for the extensive margin. As an additional check we verified in Table 12 in the Appendix that our main results hold when measuring the intensive margin based on the average export value for the firm-country pair computed as the ratio of total export value over the number of exported products (expressed in natural logarithms). All our key results remain: the negative impact of RER volatility on the intensive margin increases with firm's credit constraints, whatever definition of financial vulnerability is used (columns (3) to (5)). This result still holds when taking into account income uncertainty (column (6)). Finally, the relaxing effect of financial development also persists (columns (7) to (11)).

Finally, we verified that the differentiated impact of RER volatility depending on financial development does not simply reflect a correlation between financial development and trade costs. We worry that provinces with a more developed financial system also benefit from easier and cheaper international access: in that case, our results would be rather identifying a story about uncertainty related to distance. In Table 13, we replicate our benchmark result looking at the double interaction between RER volatility and financial dependence (column (4) of Table 3) and the triple interaction depending on financial development (column (5) of Table 9) when adding interactive terms with three proxies of geographical trade advantages that are coastal location, western location and distance to partner country[16], respectively. Our findings of a trade-deterring effect of RER volatility that is proportional to financial constraints and that is relaxed by financial development appear fully robust to these controls for geography.

5. CONCLUSION

This paper relies on a firm-level database covering exporters from China to study how export performance is affected by RER volatility. Our results confirm a trade-deterring effect of RER volatility but suggest that its magnitude depends mainly on the extent of financial constraints. While firms tend to export less and fewer products to destinations with higher exchange rate volatility, this negative effect is even stronger for financially vulnerable firms. Also financial development appears to dampen this negative impact, especially on the intensive margin of export.

These results suggest that the development of credit markets would help firms to overcome the additional export sunk cost related to RER volatility. It would support the expansion of firms' exports particularly to those destinations characterized by RER-related uncertainty. More gen-

[16]We use GeoDist dataset (Mayer and Zignago, 2011), available at http://www.cepii.fr/francgraph/bdd/distances.htm.

erally, our study emphasizes that emerging countries should be careful when relaxing their exchange rate regime. Hard fixed pegs for developing countries are certainly not always a panacea, but moving to a fully floating regime without the adequate level of financial development could also prove to be very hazardous for trade performance.

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APPENDIX

Table 10 – Firm-country export performance and exchange rate volatility: controlling for sector-specific trends.

Dependent variable	Log Export value						Log Nb of exported products					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
RER volatility (α)		-0.422^a	-0.324^a	0.175	0.025	-0.036		-0.138^b	-0.110^c	0.007	0.000	-0.049
		(0.123)	(0.109)	(0.209)	(0.166)	(0.138)		(0.065)	(0.061)	(0.101)	(0.083)	(0.087)
Ln country GDP	0.316^a	0.307^a	0.111^c	0.110^c	0.111^c	0.111^c	0.131^a	0.128^a	0.071^a	0.071^a	0.071^a	0.071^a
	(0.067)	(0.065)	(0.062)	(0.062)	(0.062)	(0.062)	(0.029)	(0.028)	(0.025)	(0.025)	(0.025)	(0.025)
Ln country price index	0.029^c	0.030^c	0.047^a	0.047^a	0.047^a	0.047^a	0.024^a	0.024^a	0.029^a	0.029^a	0.029^a	0.029^a
	(0.015)	(0.015)	(0.014)	(0.014)	(0.014)	(0.014)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Ln country-sector imports			0.279^a	0.279^a	0.279^a	0.279^a			0.080^a	0.080^a	0.080^a	0.080^a
			(0.013)	(0.013)	(0.013)	(0.013)			(0.007)	(0.007)	(0.007)	(0.007)
RER Volatility $\times$				-1.342^a	-4.648^a	-11.671^a				-0.313^b	-1.460^b	-2.450^c
Fin. Vulnerability(β)				(0.360)	(1.331)	(3.247)				(0.138)	(0.679)	(1.298)
Fixed Effects	Firm-country fixed effect and sector-year											
R-squared	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02
Observations	3,731,351											
Number of firm-country pairs	1,128,873											

Notes: Heteroskedasticity-robust standard errors are reported in parentheses. Standard errors are clustered at province level; ^{a}, ^{b} and ^{c} respectively denote significance at the 1%, 5% and 10% levels.

Table 11 – Firm-country export performance and ER volatility (excluding intermediaries)

Dependent variable	Log Export value					Log Nb of exported products				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Financial indicator			Ext dep	Intang.	R&D int			Ext dep	Intang.	R&D int
RER volatility (α)	-0.457^a	-0.336^a	0.227	0.002	0.013	-0.112^c	-0.095	0.043	-0.021	-0.037
	(0.128)	(0.108)	(0.248)	(0.185)	(0.167)	(0.065)	(0.061)	(0.100)	(0.080)	(0.090)
Ln country GDP	0.291^a	0.037	0.036	0.036	0.036	0.075^b	0.039	0.039	0.039	0.039
	(0.068)	(0.071)	(0.071)	(0.071)	(0.071)	(0.030)	(0.023)	(0.023)	(0.023)	(0.023)
Ln country price index	0.032^b	0.056^a	0.056^a	0.056^a	0.056^a	0.025^a	0.028^a	0.028^a	0.028^a	0.028^a
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Ln country-sector imports		0.374^a	0.373^a	0.374^a	0.373^a		0.054^a	0.054^a	0.054^a	0.054^a
		(0.015)	(0.015)	(0.015)	(0.015)		(0.012)	(0.012)	(0.012)	(0.012)
RER Volatility $\times$			-1.438^a	-4.461^a	-13.300^a			-0.351^b	-0.973	-2.206
Fin. Vulnerability(β)			(0.448)	(1.545)	(4.205)			(0.133)	(0.653)	(1.481)
Fixed Effects	Firm-country fixed effect									
R-squared	0.04	0.04	0.04	0.04	0.04	0.02	0.02	0.02	0.02	0.02
Observations	3,176,864									
Number of firm-country pairs	988,612									

Notes:Heteroskedasticity-robust standard errors are reported in parentheses. Standard errors are clustered at province level; ^{a}, ^{b} and ^{c} respectively denote significance at the 1%, 5% and 10% levels.

Table 12 – Firm-country export performance and ER volatility : alternative indicator of intensive margin

Dependent variable	Log Average export value=total export value / Nb of exported products										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Financial indicator			Ext dep	Intang.	R&D int	External dependence					
RER volatility (α)	-0.194^a	-0.198^a	0.304^c	0.095	0.167	0.399^b	0.329^b	0.329^b	0.237	0.220	0.253^c
	(0.067)	(0.065)	(0.155)	(0.109)	(0.104)	(0.181)	(0.141)	(0.141)	(0.169)	(0.147)	(0.148)
Ln country GDP	0.007	-0.025	-0.025	-0.025	-0.025	-0.041	-0.026	-0.026	-0.026	-0.025	-0.028
	(0.038)	(0.052)	(0.052)	(0.052)	(0.052)	(0.064)	(0.053)	(0.053)	(0.052)	(0.052)	(0.053)
Ln country price index		0.023^c	0.023^c	0.023^c	0.023^c	0.016	0.023^c	0.023^c	0.023^c	0.023^c	0.023^c
		(0.012)	(0.012)	(0.012)	(0.012)	(0.016)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Ln country-sector imports	0.286^a	0.290^a	0.289^a	0.290^a	0.289^a	0.340^a	0.289^a	0.289^a	0.289^a	0.287^a	0.287^a
	(0.017)	(0.019)	(0.018)	(0.019)	(0.018)	(0.025)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
RER Volatility×Fin. vulnerability (β)			-1.349^a	-3.890^a	-14.796^a	-1.422^a	-1.837^a	-1.849^a	-1.215^b	-1.137^a	-1.213^a
			(0.346)	(1.094)	(3.571)	(0.380)	(0.356)	(0.362)	(0.472)	(0.341)	(0.354)
GDP volatility						-0.995^a					
						(0.243)					
GDP Volatility×Fin. vulnerability						-1.077^b					
						(0.475)					
RER Volatility×Fin. vulnerability × High Fin. Devt (above median)							1.086^a				
							(0.170)				
RER Volatility×Fin. vulnerability × High Fin. Devt (above mean)								1.109^a			
								(0.177)			
RER Volatility×Fin. vulnerability × Fin. Devt (δ)									6.061^a	2.743^a	2.686^a
									(1.695)	(0.827)	(0.824)
Financial Development									-0.004	-0.088^b	
									(0.023)	(0.035)	
RER Volatility× Fin. Devt (γ)									-1.780^a	-0.543^c	-0.669
									(0.639)	(0.311)	(0.407)
Financial vulnerability × Fin. Devt										0.216^c	0.229^c
										(0.125)	(0.132)
Fixed Effects	Firm-country fixed effect										
R-squared	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Observations	3,731,351										
Number of firm-country pairs	1,128,873										

Notes: Heteroskedasticity-robust standard errors are reported in parentheses. Standard errors are clustered at province level; ^{a}, ^{b} and ^{c} respectively denote significance at the 1%, 5% and 10% levels.

Table 13 – Firm-country export performance and ER volatility : robustness to trade costs proxies

Dependent variable	Log total export value								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Province-level geographical indicator	Coastal location			Western location			Distance to partner		
RER volatility (α)	0.702^a	0.790^b	0.807^b	0.378	0.265	0.280	18.340^a	19.028^a	18.426^a
	(0.246)	(0.330)	(0.337)	(0.249)	(0.239)	(0.233)	(5.786)	(5.710)	(5.445)
Ln country GDP	0.060	0.059	0.049	0.061	0.059	0.049	0.041	0.039	0.029
	(0.068)	(0.068)	(0.069)	(0.068)	(0.068)	(0.069)	(0.073)	(0.073)	(0.074)
Ln country price index	0.050^a	0.050^a	0.050^a	0.050^a	0.049^a	0.050^a	0.053^a	0.052^a	0.052^a
	(0.014)	(0.014)	(0.015)	(0.014)	(0.014)	(0.015)	(0.015)	(0.015)	(0.016)
Ln country-sector imports	0.356^a	0.354^a	0.358^a	0.356^a	0.354^a	0.358^a	0.353^a	0.351^a	0.354^a
	(0.014)	(0.014)	(0.013)	(0.014)	(0.014)	(0.013)	(0.014)	(0.014)	(0.013)
RER Volatility×Fin. vulnerability (β)	-2.026^a	-2.483^a	-2.262^a	-1.857^a	-1.567^a	-1.563^a	-23.007^b	-25.357^b	-22.903^b
	(0.644)	(0.754)	(0.691)	(0.482)	(0.479)	(0.467)	(9.573)	(9.739)	(9.445)
RER Volatility× Fin. Devt (γ)		-1.021^c	-1.157^c		-0.700	-0.793		-0.755^c	-0.853^c
		(0.537)	(0.617)		(0.453)	(0.575)		(0.375)	(0.493)
RER Volatility×Financial vulnerability ×		3.568^b	3.301^b		3.105^b	2.941^b		3.234^a	3.055^a
Fin. Devt (δ)		(1.397)	(1.312)		(1.235)	(1.161)		(1.111)	(1.051)
Financial Development		-0.009			-0.015			-0.015	
		(0.055)			(0.056)			(0.054)	
Financial vulnerability × Fin. Devt		0.252	0.252^c		0.262^c	0.259^c		0.262^c	0.259^c
		(0.149)	(0.141)		(0.145)	(0.137)		(0.144)	(0.136)
Financial vulnerability × geographical	0.219	1.139	0.899	-1.476	-2.066	-2.172^c	2.374^b	2.670^b	2.395^b
indicator	(0.872)	(0.914)	(0.893)	(1.439)	(1.320)	(1.228)	(1.029)	(1.068)	(1.038)
RER Volatility×geographical	-0.427	-0.681	-0.710	0.668	0.788	0.676	-2.023^a	-2.113^a	-2.045^a
indicator	(0.360)	(0.422)	(0.439)	(0.865)	(0.848)	(0.777)	(0.630)	(0.628)	(0.601)
Province-year Fixed Effects	no	no	yes	no	no	yes	no	no	yes
Fixed Effects	Firm-country fixed effect								
R-squared	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Observations	3,731,351								
Number of firm-country pairs	1,128,873								

Notes: Heteroskedasticity-robust standard errors are reported in parentheses. Standard errors are clustered at province level; ^{a}, ^{b} and ^{c} respectively denote significance at the 1%, 5% and 10% levels.

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