

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

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Motivation

- Increasing volatility of exchange rates (EXR) after the fall of Bretton Woods agreements.
 - Fixed EXR regimes (e.g., China or euro area members)
 - Floating EXR regimes (e.g. South Africa, UK, Canada...)
- Theoretically, excessive volatility increases trade costs and reduces the gains to international trade (Ethier, 1973).
- But **macro** empirical evidence rather mixed, concluding to an effect either significant but small or insignificant (Greenaway and Kneller, 2007, or Byrne et al., 2008).
- Aggregation bias (Byrne et al., 2008 ; Broda and Romalis, 2010) and an excessive focus on richer countries with highly developed financial markets.

Our research question

Focus of the paper : joint impact of EXR volatility and financial constraints on exporting behavior at the firm-level

- Strong lack of **firm-level** evidence on
 - ① the impact of EXR volatility on exporting behavior
 - ② how this relationship may be influenced by financial constraints (much stronger and more binding in developing countries).
- Main purpose : provide a careful firm-level study of these relationships in order to analyze
 - ① the exacerbating role of EXR volatility on export costs ;
 - ② the role of financial development to alleviate these additional costs.

Summary of methodology and main result

- Chinese customs data for more than 100,000 Chinese exporters over the period 2000-2006 + sectoral financial dependence + financial development at the regional level.
- Why China ? 3 main reasons :
 - ① High export rate given country's size, leading to substantial exposure to EXR fluctuations.
 - ② Low financial development on average but rather high regional heterogeneity (useful to identify a non-linear effect of exchange rate volatility depending on credit constraints, cf. Aghion et al., 2009).
 - ③ Chinese yuan strongly pegged with the US dollar over practically all the considered period \Rightarrow volatility truly exogenous to Chinese economic developments.
- **Main results :**
 - ① **Both the average value exported and the probability of entering a new export market decrease for destinations with higher exchange rate volatility.**
 - ② **Effect is magnified for financially vulnerable firms.**
 - ③ **Financial development dampens this negative impact, especially on the intensive margin of export.**

Theoretical background

- Exchange rate risk \Rightarrow uncertainty for the exporter's earnings \Rightarrow uncertainty on variable trade costs.
 - Bernard et al. (2011), Berthou and Fontagné (2013) : potentially all trade margins are concerned.
 \Rightarrow well-developed financial markets : hedging \Leftrightarrow dampening or eliminating negative effects on trade.
- Sunk costs of exports \approx investments in intangible capital, like R&D + EXR movements *are* sunk costs (Greenaway and Kneller, 2007)
 \Rightarrow uncertainty over future payoffs \Leftrightarrow delay irreversible investments.
 \Rightarrow Aghion et al. (2009) : financial development \downarrow credit constraints $\Rightarrow \downarrow$ impact of volatility on the sunk cost activity.
- 3 testable predictions :
 - ① *Export performance (=value and proba of entry) decreases with EXR volatility : $\alpha < 0$.*
 - ② *Negative impact magnified for financially vulnerable firms : $\beta < 0$.*
 - ③ *Financial development decreases the impact of EXR volatility on export performance (γ), proportionally more for financially vulnerable firms (δ) : $\delta, \gamma > 0$.*

Related literature

① Behavior of multi-product/multi-destination firms

- Bernard et al. (2011) : proportion of multi-product firms that export, the number of destinations for each product, and the range of products exported to each market \uparrow when variable trade costs \downarrow .
- Berthou and Fontagné (2013) : impact of the introduction of the euro on French firms' export behavior ; trade creation effect concentrated on destinations with higher volatility.

② Impact of credit constraints on exporting behavior

- ... stronger for firms belonging to industries relying more on external finance (Minetti and Zhu, 2011), and when considering developing countries (Berman and Héricourt, 2010) rather than developed ones (Greenaway et al., 2007).
- Manova (2013) : one third = limited firm entry into exporting, two thirds = contractions in exporters' sales.

③ Negative relationship between volatility and investment, stronger for developing countries : Pindyck and Solimano (1993), Ramey and Ramey (1995), Aizenman and Marion, (1999), Bloom et al. (2007) : \Rightarrow Aghion et al. (2009) : negative impact of the EXR volatility on productivity growth decreases with financial development

Related literature (Cont'd)

- Link between volatility and export performance mostly investigated using macro, and sometimes, sectoral data.
- Cheung and Sengupta (2012) : impact of RER variations and volatility on the share of exports to sales ratio for a sample of a few thousands Indian non-financial sector firms.
- Caglayan and Demir (2012) : only firm-level study dealing with firm productivity, EXR movements AND access to external finance.
- **Contribution** : a much wider dataset of firms, how firms reallocate their exports, investigation of the presence of a non-linear effect of EXR volatility on performance depending on the level of financial constraints.

Data

- Sample period : 2000-2006
- EXR volatility = yearly standard deviation of monthly log differences in the real exchange rate (IFS data)
 - Robustness : two-year standard deviation of monthly log differences ; standard deviation of monthly log differences from the HP detrended real exchange rate
- Firm-level exports : Chinese customs
 - Chinese exports by firm-product-destination over the period. HS6 product and destination country ; 113,368 exporting firms and 158 destinations.
- Firm-level financial vulnerability : weighted average of the financial vulnerability of its activities, with the weights being the sector's share in the firm exports in 2000.
 - three different measures : the share of capital expenditures not financed out of cash flows from operations ; ratio of intangible assets to fixed assets ; the share of R&D spending in total sales.
 - Indicators are computed using data on all publicly traded U.S.-based companies (=truly exogenous).

Empirical specification

$$\begin{aligned}
 \text{ExportPerf}_{ijt}^F &= \alpha \text{RERVolatility}_{jt} + \beta \text{RERVolatility}_{jt} \times \text{FinVuln}^F \\
 &+ \delta \text{RERVolatility}_{jt} \times \text{FinVuln}^F \times \text{FinDev}_{it} + \gamma \text{RERVolat}_{jt} \times \text{FinDev}_{jt} \\
 &+ \tau \text{FinVuln}^F \times \text{FinDev}_{it} + \eta \text{FinDev}_{it} + \phi Z_{jt} + \lambda_j^F + \theta_t + \epsilon_{ijt}^F
 \end{aligned}$$

where :

- $\text{ExportPerf}_{ijt}^F$: export performance of firm F for export destination j in year t for province i .
 - intensive margin : log of the total FOB export sales (Within Estimator, firm-country FE)
 - extensive margin : proba of entering ($Pr(X_{jt} > 0 \mid X_{jt-1} = 0)$, conditional logit, firm-country FE)
- Z : destination-year specific variables.
 - destination country's market size (= GDP) and price index (= effective real EXR).
 - partner j 's demand for goods of the main sector of the firms : log of total import value for the country-sector taken from BACI.
- Clustering at the province level using Froot (1989) correction.

Results : intensive margin

TABLE : Intensive margin, exchange rate volatility and financial constraints

Dependent variable	Log Export value (firm-destination-year)					
	(1)	(2)	(3)	(4)	(5)	(6)
Financial indicator				Ext dep	Intang.	R&D
RER volatility (α)		-0.439 ^a (0.119)	-0.305 ^a (0.106)	0.402 (0.246)	0.123 (0.183)	0.153 (0.172)
Ln country GDP	0.321 ^a (0.068)	0.312 ^a (0.066)	0.061 (0.068)	0.061 (0.068)	0.060 (0.068)	0.061 (0.068)
Ln country price index	0.027 ^c (0.014)	0.027 ^c (0.014)	0.050 ^a (0.014)	0.050 ^a (0.014)	0.050 ^a (0.014)	0.050 ^a (0.014)
Ln country-sector imports			0.357 ^a (0.014)	0.356 ^a (0.014)	0.357 ^a (0.014)	0.356 ^a (0.014)
RER Volatility \times Fin. Vulnerability (β)				-1.900 ^a (0.478)	-5.686 ^a (1.466)	-18.574 ^a (4.379)
Fixed Effects	Firm-country fixed effect					
Observations	3,731,351					
Number of firm-country pairs	1,128,873					

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TABLE : Robustness checks : Including RER in level and income volatility

Dependent variable	Log Export value (firm-destination-year)					
Financial indicator	External dependence					
	(1)	(2)	(3)	(4)	(5)	(6)
RER volatility (α)	-0.308 ^a (0.103)	0.399 (0.243)	0.223 (0.217)	-0.238 ^c (0.125)	0.520 ^c (0.282)	0.504 ^c (0.278)
Ln country GDP	0.054 (0.075)	0.054 (0.075)	0.057 (0.075)	0.064 (0.077)	0.063 (0.077)	0.063 (0.077)
Ln country price index	0.048 ^a (0.013)	0.048 ^a (0.013)	0.048 ^a (0.013)	0.037 ^b (0.017)	0.037 ^b (0.017)	0.037 ^b (0.017)
Ln country-sector imports	0.357 ^a (0.014)	0.356 ^a (0.014)	0.355 ^a (0.014)	0.407 ^a (0.017)	0.406 ^a (0.017)	0.406 ^a (0.017)
RER Volatility \times Fin. vulnerability (β)		-1.901 ^a (0.479)	-1.427 ^a (0.400)		-2.025 ^a (0.537)	-1.981 ^a (0.523)
Ln RER \times Fin. vulnerability			0.465 ^a (0.141)			
Ln RER	0.013 (0.020)	0.014 (0.020)	-0.158 ^a (0.046)			
GDP volatility				-1.721 ^a (0.234)	-1.721 ^a (0.234)	-1.338 ^a (0.316)
GDP Volatility \times Fin. vulnerability						-1.057 ^c (0.565)
Fixed Effects	Firm-country fixed effect					
Observations	3,731,351					
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TABLE : Controls for various subsamples

Dependent variable	Log Export Value (firm-destination-year)						
Financial indicator	External dependence						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Country Nb>1	Product Nb>1	No HK or Macao	High Nb products	Low Nb products	High Nb prod-dest	Low Nb prod-dest
RER volatility (α)	0.384 (0.244)	0.359 (0.270)	0.435 ^c (0.228)	0.799 ^c (0.394)	0.179 (0.204)	0.507 (0.336)	0.391 (0.250)
Ln country GDP	0.051 (0.064)	0.101 ^c (0.058)	0.031 (0.079)	0.170 ^b (0.066)	0.004 (0.085)	0.201 ^a (0.071)	0.057 (0.068)
Ln country price index	0.048 ^a (0.015)	0.035 ^b (0.014)	0.032 ^b (0.013)	0.040 ^b (0.017)	0.056 ^a (0.014)	0.043 ^b (0.018)	0.048 ^a (0.015)
Ln country-sector imports	0.355 ^a (0.013)	0.333 ^a (0.013)	0.342 ^a (0.015)	0.312 ^a (0.013)	0.409 ^a (0.020)	0.313 ^a (0.012)	0.355 ^a (0.014)
RER Volatility \times Fin. Vulnerability (β)	-1.866 ^a (0.467)	-1.722 ^a (0.602)	-1.921 ^a (0.466)	-3.314 ^a (0.927)	-0.968 ^b (0.382)	-2.545 ^a (0.722)	-1.892 ^a (0.478)
Fixed Effects	Firm-country fixed effects						
Observations	3,659,052	2,019,033	3,472,215	1,836,309	1,895,042	1,862,175	3,719,937
Number of firm-country pairs	1,106,403	781,138	1,059,036	532,927	595,946	527,3	1,128,139

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TABLE : The role of financial development

Financial indicator	External dependence				
Dependent variable	Log Export value (firm-destination-year)				
	(1)	(2)	(3)	(4)	(5)
RER volatility (α)	0.450 ^c (0.224)	0.450 ^c (0.224)	0.312 (0.248)	0.292 (0.238)	0.299 (0.228)
⋮	⋮	⋮	⋮	⋮	⋮
RER Volatility × Fin. vulnerability (β)	-2.813 ^a (0.314)	-2.840 ^a (0.329)	-1.718 ^a (0.611)	-1.622 ^a (0.475)	-1.614 ^a (0.462)
RER Volatility × Financial vulnerability × High Fin. Devt (above median)	2.034 ^b (0.802)				
RER Volatility × Financial vulnerability × High Fin. Devt (above mean)		2.087 ^b (0.778)			
RER Volatility × Financial vulnerability × Fin. Devt (δ)			7.069 ^a (1.981)	3.034 ^b (1.234)	2.878 ^b (1.160)
Financial Development			0.087 (0.061)	-0.016 (0.056)	
Financial vulnerability × Fin. Devt				0.263 ^c (0.146)	0.260 ^c (0.138)
RER Volatility × Fin. Devt (γ)			-2.170 ^a (0.658)	-0.666 (0.457)	-0.770 (0.572)
Province-year Fixed Effects	no	no	no	no	yes
Fixed Effects	Firm-country fixed effect				
Observations	3,731,351				
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Fixed Effects	Firm-country fixed effect				
Observations	3,731,351				
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Results : extensive margin

TABLE : Extensive margin, exchange rate volatility and financial constraints

Dependent variable	$Pr(X_t > 0 X_{t-1} = 0)$									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Financial indicator				Ext dep	Intang.	R&D	External dependence			
RER volatility (α)		-0.864 ^a (0.099)	-0.735 ^a (0.080)	0.094 (0.226)	0.019 (0.190)	-0.454 ^a (0.153)	-0.779 ^a (0.079)	-0.197 (0.209)	-0.702 ^a (0.130)	0.024 (0.230)
Ln country GDP	0.072 (0.055)	0.051 (0.055)	-0.219 ^a (0.057)	-0.218 ^a (0.057)	-0.220 ^a (0.057)	-0.219 ^a (0.057)	-0.267 ^a (0.070)	-0.237 ^a (0.072)	-0.252 ^a (0.072)	-0.252 ^a (0.072)
Ln country price index	0.099 ^a (0.020)	0.102 ^a (0.020)	0.125 ^a (0.021)	0.124 ^a (0.021)	0.125 ^a (0.021)	0.124 ^a (0.021)	0.109 ^a (0.019)	0.108 ^a (0.019)	0.077 ^a (0.029)	0.077 ^a (0.029)
Ln country-sector imports			0.379 ^a (0.033)	0.378 ^a (0.033)	0.379 ^a (0.033)	0.379 ^a (0.033)	0.379 ^a (0.033)	0.372 ^a (0.033)	0.395 ^a (0.053)	0.394 ^a (0.053)
RER Volat. \times Fin. vuln. (β)				-2.233 ^a (0.431)	-9.852 ^a (1.973)	-11.731 ^a (3.612)		-1.462 ^a (0.374)		-1.923 ^a (0.370)
Ln RER \times Fin. vuln.								1.252 ^a (0.231)		
Ln RER							0.101 ^a (0.036)	-0.377 ^a (0.100)		
GDP volatility									0.076 (0.193)	0.950 ^c (0.574)
GDP Volat. \times Fin. vuln.										-2.433 ^b (1.178)
Fixed Effects	Firm-country fixed effects									
Observations	8,801,335						8,801,335		6,996,782	

TABLE : Extensive margin, exchange rate volatility and financial constraints

Dependent variable	$Pr(X_t > 0 X_{t-1} = 0)$									
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Financial indicator				Ext dep	Intang.	R&D		External dependence		
RER volatility (α)		-0.864 ^a (0.099)	-0.735 ^a (0.080)	0.094 (0.226)	0.019 (0.190)	-0.454 ^a (0.153)	-0.779 ^a (0.079)	-0.197 (0.209)	-0.702 ^a (0.130)	0.024 (0.230)
Ln country GDP	0.072 (0.055)	0.051 (0.055)	-0.219 ^a (0.057)	-0.218 ^a (0.057)	-0.220 ^a (0.057)	-0.219 ^a (0.057)	-0.267 ^a (0.070)	-0.237 ^a (0.072)	-0.252 ^a (0.072)	-0.252 ^a (0.072)
Ln country price index	0.099 ^a (0.020)	0.102 ^a (0.020)	0.125 ^a (0.021)	0.124 ^a (0.021)	0.125 ^a (0.021)	0.124 ^a (0.021)	0.109 ^a (0.019)	0.108 ^a (0.019)	0.077 ^a (0.029)	0.077 ^a (0.029)
Ln country-sector imports			0.379 ^a (0.033)	0.378 ^a (0.033)	0.379 ^a (0.033)	0.379 ^a (0.033)	0.379 ^a (0.033)	0.372 ^a (0.033)	0.395 ^a (0.053)	0.394 ^a (0.053)
RER Volat. \times Fin. vuln. (β)				-2.233 ^a (0.431)	-9.852 ^a (1.973)	-11.731 ^a (3.612)		-1.462 ^a (0.374)		-1.923 ^a (0.370)
Ln RER \times Fin. vuln.								1.252 ^a (0.231)		
Ln RER							0.101 ^a (0.036)	-0.377 ^a (0.100)		
GDP volatility									0.076 (0.193)	0.950 ^c (0.574)
GDP Volat. \times Fin. vuln.										-2.433 ^b (1.178)
Fixed Effects	Firm-country fixed effects									
Observations	8,801,335						8,801,335		6,996,782	

TABLE : Extensive margin, exchange rate volatility and financial constraints

Dependent variable	$Pr(X_t > 0 X_{t-1} = 0)$									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Financial indicator				Ext dep	Intang.	R&D		External dependence		
RER volatility (α)		-0.864 ^a (0.099)	-0.735 ^a (0.080)	0.094 (0.226)	0.019 (0.190)	-0.454 ^a (0.153)	-0.779 ^a (0.079)	-0.197 (0.209)	-0.702 ^a (0.130)	0.024 (0.230)
Ln country GDP	0.072 (0.055)	0.051 (0.055)	-0.219 ^a (0.057)	-0.218 ^a (0.057)	-0.220 ^a (0.057)	-0.219 ^a (0.057)	-0.267 ^a (0.070)	-0.237 ^a (0.072)	-0.252 ^a (0.072)	-0.252 ^a (0.072)
Ln country price index	0.099 ^a (0.020)	0.102 ^a (0.020)	0.125 ^a (0.021)	0.124 ^a (0.021)	0.125 ^a (0.021)	0.124 ^a (0.021)	0.109 ^a (0.019)	0.108 ^a (0.019)	0.077 ^a (0.029)	0.077 ^a (0.029)
Ln country-sector imports			0.379 ^a (0.033)	0.378 ^a (0.033)	0.379 ^a (0.033)	0.379 ^a (0.033)	0.379 ^a (0.033)	0.372 ^a (0.033)	0.395 ^a (0.053)	0.394 ^a (0.053)
RER Volat. \times Fin. vuln. (β)				-2.233 ^a (0.431)	-9.852 ^a (1.973)	-11.731 ^a (3.612)		-1.462 ^a (0.374)		-1.923 ^a (0.370)
Ln RER \times Fin. vuln.								1.252 ^a (0.231)		
Ln RER							0.101 ^a (0.036)	-0.377 ^a (0.100)		
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Fixed Effects	Firm-country fixed effects									
Observations	8,801,335						8,801,335		6,996,782	

TABLE : Controls for various subsamples

Dependent variable	$Pr(X_t > 0 \mid X_{t-1} = 0)$						
Financial indicator	External dependence						
	(1) Country Nb>1	(2) Product Nb>1	(3) No HK or Macao	(4) High Nb products	(5) Low Nb products	(6) High Nb prod-dest	(7) Low Nb prod-dest
RER volatility (α)	-0.295 (0.198)	-0.067 (0.317)	-0.274 (0.194)	-0.145 (0.287)	-0.616 ^b (0.278)	-0.137 (0.295)	-0.570 ^b (0.226)
Ln country GDP	0.297 ^a (0.052)	0.308 ^a (0.049)	0.305 ^a (0.077)	0.352 ^a (0.070)	0.475 ^a (0.053)	0.444 ^a (0.076)	0.413 ^a (0.040)
Ln country price index	0.064 ^a (0.014)	0.063 ^a (0.016)	0.056 ^a (0.012)	0.054 ^a (0.016)	0.020 (0.019)	0.043 ^a (0.012)	0.028 (0.020)
Ln country-sector imports	0.417 ^a (0.036)	0.356 ^a (0.041)	0.403 ^a (0.036)	0.335 ^a (0.040)	0.491 ^a (0.026)	0.384 ^a (0.039)	0.451 ^a (0.033)
RER Volatility \times Fin. Vulnerability (β)	-1.622 ^a (0.378)	-2.086 ^b (0.814)	-1.607 ^a (0.384)	-1.904 ^a (0.594)	-1.067 ^a (0.367)	-2.041 ^a (0.578)	-1.167 ^a (0.410)
Fixed Effects	Firm-country fixed effects						
Observations	4,617,726	1,684,176	4,496,413	2,276,599	2,341,127	2,304,527	2,313,199

TABLE : Controls for various subsamples

Dependent variable	$Pr(X_t > 0 \mid X_{t-1} = 0)$						
Financial indicator	External dependence						
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TABLE : The role of financial development

Financial indicator	External dependence			
Dependent variable	$Pr(X_t > 0 \mid X_{t-1} = 0)$			
	(1)	(2)	(3)	(4)
RER volatility (α)	0.246 (0.267)	0.245 (0.265)	0.029 (0.232)	-0.067 (0.215)
⋮	⋮	⋮	⋮	⋮
RER Volatility \times Fin. vulnerability (β)	-6.294 ^a (1.904)	-6.560 ^a (1.930)	-2.137 ^a (0.724)	-1.777 ^a (0.360)
RER Volatility \times Financial vulnerability \times High Fin. Devt (above median)	7.394 ^b (3.654)			
RER Volatility \times Financial vulnerability \times High Fin. Devt (above mean)		7.651 ^b (3.583)		
RER Volatility \times Financial vulnerability \times Fin. Devt (δ)			6.503 ^b (3.000)	-0.072 (1.679)
Financial Development			0.358 (0.230)	0.127 (0.186)
Financial vulnerability \times Fin. Devt				0.590 (0.383)
RER Volatility \times Fin. Devt (γ)			-0.866 (0.981)	1.552 ^c (0.813)
Fixed Effects	Firm-country fixed effect			
Observations	8,801,335			

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Financial indicator	External dependence			
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Fixed Effects	Firm-country fixed effect			
Observations	8,801,335			

Additional robustness

Export deterring effect of RER volatility, rising with financial vulnerability, confirmed with :

- alternatives measures of RER volatility.
- inclusion of sector-year fixed effects (= our results do not reflect sector-specific trends).
- exclusion of intermediary firms.
- differentiation of ownership (foreign/domestic) structure.
- alternative definitions of LHS variables (average value exported ; being exporter or not).

The trade-deterring effect of EXR volatility proportional to financial constraints and relaxed by financial development appear fully robust to :

- the addition of interactive terms with three proxies of geographical trade advantages (coastal location, western location and distance to partner country).

⇒ **Our results do not capture a correlation between financial development and trade costs.**

Conclusions

Estimations confirm a trade-deterring effect of EXR volatility but suggest that its magnitude depends mainly on the extent of financial constraints.

- Negative estimates of the α and β coefficient, positive estimates of δ (especially for the intensive margin)
- Robust to a number of checks, subsamples, additional controls etc.
- Development of credit markets would help firms to overcome the additional sunk costs related to EXR volatility
- Emerging countries should be careful when relaxing their exchange rate regime

Conclusions (Cont'd)

Insights on what could be the main sources of the lack of macro impact of exchange rate volatility.

- $\beta, \delta > (\text{quantitatively and qualitatively}) \alpha$.
⇒ **level of financial constraints and financial development clearly dominate the aggregation bias hypothesis.**
- microfounded evidence to the macro literature pointing at financial constraints and financial development as key determinants in determining the impact of RER volatility on real outcomes.