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Article International trade and exchange rates

Journal of Applied Economics

Provided in Cooperation with: University of CEMA, Buenos Aires

Suggested Citation: Kang, Jong Woo; Dagli, Suzette (2018) : International trade and exchange rates, Journal of Applied Economics, ISSN 1667-6726, Taylor & Francis, Abingdon, Vol. 21, Iss. 1, pp. 84-105, https://doi.org/10.1080/15140326.2018.1526878

This Version is available at: https://hdl.handle.net/10419/314041

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Journal of Applied Economics

ISSN: 1514-0326 (Print) 1667-6726 (Online) Journal homepage: www.tandfonline.com/journals/recs20

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To cite this article: Jong Woo Kang & Suzette Dagli (2018) International trade and exchange rates, Journal of Applied Economics, 21:1, 84-105, DOI: 10.1080/15140326.2018.1526878

To link to this article: https://doi.org/10.1080/15140326.2018.1526878

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Published online: 17 Nov 2018.

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International trade and exchange rates

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ABSTRACT

This paper analyzes the link between international trade and exchange rate levels in the context of the global financial crisis (GFC) and the rise of global and regional value chains (GVCs). Using bilateral data for 72 economies over the 2001–2015 period, we find a positive relationship between the real exchange rate and export volume pre-GFC; but this relationship mostly disappears post-GFC. We also examine the impact of deepening GVCs on trade and on the exchange rate-trade link channel. The analysis confirms that increased participation in GVCs lowers the impact of the exchange rate on exports, and could be a contributing factor to weakening links between exchange rates and trade. Lastly, other structural factors, such as import composition and stock of short-term external debt of exporters and importers, seem to have a significant impact on trade performance but less impact on the exchange rate-trade link channel post-GFC.

ARTICLE HISTORY

Received 21 June 2017 Accepted 1 January 2018

KEYWORDS

Trade volume; real exchange rate; gravity model; global value chains

1. Introduction

In the past 15 years, global trade has changed tremendously. Trade growth has slowed significantly since the global financial crisis (GFC), and except for a quick rebound after the crisis, it only recovered slowly afterwards. Several studies investigate its main drivers and whether cyclical or structural factors underlie the phenomenon. In particular, the impact of exchange rates on trade and the effectiveness of exchange rate policies as a tool in calibrating a country's external position and domestic economic stability has been a popular topic in the literature.

The contribution of this paper to the existing literature is to examine the relationship between the level of real exchange rate and trade volume in the presence of structural changes in the trade growth pattern pre- and post-GFC using a gravity model. In addition, the paper investigates the potential factors that can explain the weakening link between exchange rate and trade, such as global and regional value (GVCs), changing import product structure and composition, and short-term external debt exposure of countries.

While much literature shows the significant impact of the exchange rate level and its volatility on trade, myriad research also points to ambiguous and counterintuitive results (Aristeriou, Masatci, & Pilbeam, 2016; Dell'Ariccia, 1999; Mukherjee & Pozo, 2011; Rose, 2000). Bacchetta and van Wincoop (2000) analyze the relationship and find

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This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/ by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. that the shocks causing changes in the exchange rate can lead to changes in other macroeconomic variables, which could offset the impact of exchange rate on trade, while Koren and Szeidl (2003) look at the covariance in the movement of exchange rates and key macroeconomic variables and find that what matters is not exchange rate volatility but rather how it magnifies or moderates the risks faced by firms or consumers. Aristotelous (2001) and IMF (2004) use a gravity equation specification to estimate the impact of exchange rate volatility on trade and their empirical findings suggest that exchange rate volatility has no effect on export volumes.

One criticism of empirical work using exchange rate volatility is that volatility itself is not a critical issue for international trade, because there are financial instruments that firms can use to hedge against this risk (Ethier, 1973); and the presence of fixed costs in exporting (Franke, 1991; Krugman, 1989) undermines the relevance of the volatility of exchange rates on trade. UNCTAD (2013) investigates this issue by comparing two models – using exchange rate volatility and exchange rate misalignment (i.e., the difference between the observed real effective exchange rate (REER) and that rate adjusted for the Balassa-Samuelson effect). Using simple panel analysis, their results confirm earlier findings of no effect of exchange rate volatility on trade but they do find a significant effect of currency misalignment. They find that undervaluation results in promotion of exports and restriction of imports. Huchet-Bourdon and Korinek (2011) find that exports are more sensitive to changes in RER levels than their volatility and the effect is more pronounced in the agriculture sector exports.

Gala (2008) reviews the role of competitive currencies in the economic growth of East and Southeast Asian economies. Marquez and Schindler (2006) investigates the real exchange rate effects on the People's Republic of China's (PRC) share in world trade, and the results suggest that appreciation of the renminbi lowers the PRC's share in aggregate exports and increases its share in aggregate imports with smaller impact. Appuhamilage and Senanayake (2010) study the bilateral exports of Sri Lanka and the PRC and conclude that the depreciation of Sri Lankan rupee against the Chinese renminbi has a significant positive effect on exports of Sri Lanka to the PRC, while the depreciation has negative effects on its imports from the PRC. Baek (2012) studies exports and imports of 71 products between the US and the Republic of Korea and concludes that exports and imports of the Republic of Korea from the US are affected by exchange rate levels. Hooy, Law, and Chan (2015) also uses sector-level data to assess the impact of the Chinese renminbi on the exports of the ASEAN - as major trade partners in the global supply chains of the PRC - and the results point to the significant positive impact of real exchange rate depreciation on exports of high-technology and medium-technology final and intermediate goods. Thorbecke (2006) finds that exchange rate appreciation in developed Asia – as a result of the depreciation of the US dollar – could possibly disrupt complimentary trade relationship with developing economies in Asia, especially in technology intensive goods. Thorbecke and Kato (2011) explore a particular segment of exports (i.e., consumption goods) and their estimates suggest that an appreciation of the Japanese yen leads to a reduction of consumption exports of Japan.

Another strand of research considers the relationship between exchange rate level and international trade volume, after taking out the volatile price factor. Since the GFC, academic and policy debates have revived and shifted from exchange rate volatility (nominal or real) to the real exchange rate level, with concerns about global external imbalances, slow recovery, and the impact of sustained currency misalignments (WTO, 2011). Depreciation would normally increase a country's exports and reduce imports due to changes in terms of trade and the effect of price elasticity of demand. However, new patterns of international trade, including the growth of GVC, for example, render the effect of exchange rates on trade more complex than before. Findings in Ollivaud, Rusticelli, and Schwellnus (2015) and Ahmed, Appendido, and Ruta (2015a) suggest that the rise of GVCs weakened the impact of exchange rates on trade; and the elasticity of manufacturing export volume to the real effective exchange rate has decreased over time (Ahmed, Appendido, & Ruta, 2015b). But literature on this issue is still on its infancy.

IMF (2015a) provides a comprehensive analysis of the effect of the real exchange rate level on prices of traded goods and on trade volume, and whether the relationship among these variables has been stable. Its findings support evidence in earlier literature. Results suggest that currency depreciation leads to lower export prices paid by foreigners and higher import prices, and these price changes in turn lead to a rise in exports and a fall in imports. They also find that the increase in exports is higher when the exporting economy has a weaker financial system, especially in cases of banking crises. While the IMF finds evidence to support the weakening relationship of exchange rate and trade due to global value chains for some economies, overall, little evidence is found of the hypothesized disconnect between trade and exchange rates.

Structural factors, other than deepening GVCs, could also affect the exchange rate impact on trade. Some factors found in the literature include the import composition and short-term external debt exposure of economies. Campa and Goldberg's (2005) empirical study finds that higher primary goods trade compared to processed goods could lead to a higher impact of exchange rates, and the shift to manufactured imports has contributed to the weakened link between the exchange rate and trade. The findings of Kearns and Patel (2016) suggest that high external debt could offset the effect on trade of exchange rate movements. Theoretically, changes in trade volume should capture this effect better than trade value – by looking at the pure elasticity effect, and excluding the short-term, terms-of-trade effect. The GFC is an important contributor to the structural changes in global trade patterns. Post-GFC, not only has the trade volume growth rate slumped, but the dynamics between the drivers of trade growth and how it responds to these drivers has changed significantly.

Against this background, this paper examines the impact of the real exchange rate level on the trade volume of 72 economies from 2001–2015, and whether structural changes have weakened the impact of exchange rates on trade. Using a gravity model, we test for the impact of exchange rate movements on trade volume. The empirical analysis confirms the positive and significant effect of the real exchange rate on exports volume, with significantly decreasing magnitude from the pre-GFC to the post-GFC period.

The results of the gravity model estimation also support the important role of GVCs for the growth of international trade, but also find evidence of the weakened effect of exchange rate depreciation on export volume, due to the progress of deepening GVCs. Other structural factors tested in the empirical analysis, such as import composition (i.e., the primary-to-processed (or manufactured) imported-goods ratio and the stock of short-term external debt of both importer and exporter) point to a weakened interaction effect with real exchange rate, especially after the GFC. While the recent slowdown in international trade growth has been persistent since the GFC, not many efforts have

been made to empirically delve into the underlying causes of this phenomenon. In this regard, this paper contributes to elucidating the diminishing role of real exchange rate depreciation in boosting real exports over time, in particular after the GFC, and expounding the underlying structural causes diluting exchange rate-trade linkages, such as deepening GVC, import product composition and financial conditions of exporters.

Section II discusses the theoretical framework, data, and empirical model specification, Section III shows the empirical results, and Section IV concludes.

2. Model specification and data

2.1. Model specification

This paper's theoretical framework is based on a pricing-to-market mechanism, which was also employed by Krugman (1989); Feenstra, Gagnon, and Knetter (1996); Campa and Goldberg (2005); Burstein and Gopinath (2014), and IMF (2015b).

The export price is an outcome of optimal pricing decisions of suppliers, such that

$$\frac{eP^*}{Px} = J\left(\frac{c}{P}, \frac{eP^*}{P}\right),$$

where *e* is the nominal exchange rate, P^* is the foreign price level, Px is the price of exports in exporter's currency, *P* is the domestic price level, *c*/*P* is the unit labor cost, and eP^*/P is the real effective exchange rate.

We aim to analyze the effect of the exchange rate through export and import prices, on trade volume. The export volume demand equation is

$$X=D\bigg(\frac{eP^*}{Px}, Y^*\bigg),$$

in which the bilateral exports volume X is a function of the export prices $eP^*/P x$ and foreign demand Y^* . On the other hand, the import volume demand equation is

$$M = D\bigg(\frac{Pm}{P}, Y\bigg),$$

where *M* is import volume, *Y* is the domestic demand, and Pm/P is the relative prices of imports.

In the empirical analysis, the paper looks at bilateral trade flows in an *n*-country world, in particular exports from country *i* to country *j*. For each country pair *i* and *j* at time *t*, the value of exports was divided by the exporter's Px_t to estimate the exports volume X_{ijt} . The producer price index (PPI), which represents the prices of goods produced at home by the exporter, was used to approximate Px_t and derive the export volume X_{ijt} .¹ Export price index (EPI) data is available only for a limited number of countries, and the model is also estimated using export prices to derive export volume *X* as robustness check. The real exchange rate, which was computed multiplying the

¹Bilateral export prices are generally not available; hence, the empirical analysis of this paper uses the price index of the exporter country *i*, assumed to be the same for all importer countries *j*.

nominal bilateral exchange rate between exporter country i and importer country j by the ratio of their PPIs, was used in the empirical analysis instead of the real effective exchange rate.

The PPI is used as Px_t in the model and also to compute the real exchange rate. It is important to note that this is done deliberately to capture the domestic manufacturer selling prices of intermediate and final goods and services. An advantage of using the PPI instead of the consumer price index (CPI) is that the former does not include imported goods prices, while the latter also comprises imports. In addition, CPI also includes the prices of non-traded goods and services. A study by the International Monetary Fund (2015a) stipulates that CPI-deflated trade volume is a biased measure of the true volume, and may lead to spurious results.

A gravity model, a staple of international trade analysis, is employed in this paper as a representation of the empirical relationship between the size of countries i and j, the distance between them, trade costs and trade flows (UNESCAP 2012). The rich literature on the theoretical foundation of the gravity model centers on how important are the specifications and variables used – drawn from economic theory. One notable contribution is the work of Anderson and van Wincoop (2003) on controlling for relative trade costs in a well-specified gravity model. They show that the bilateral trade between countries i and j is determined by country j's trade cost towards i, relative to the overall "resistance" to imports, and to the "resistance" of exporter i; and not just the absolute trade costs between them. They call this the "multilateral trade resistance" terms (MTR), which are essential for a well-specified and theoretically sound gravity equation (Anderson & van Wincoop, 2003). The MTR includes, but is not limited to, remoteness, trade restrictive policies, and other factors which add to the trade costs between i and j.

In our econometric model, we use the gravity model with exports volume (in natural logs) as a function of GDP of importer and exporter (in natural logs), importer fixed effects, exporter fixed effects, and time fixed effects along with other bilateral fixed effects as below,

$$\ln X_{ijt} = \beta_0 + \beta_1 \ln RER_{ijt} + \beta_2 \ln GDP_{it} + \beta_3 \ln GDP_{jt} + \beta_4 R_{ij} + \varphi_i + \omega_i + \tau_t + \mu_{iit}, \quad (1)$$

where GDP_{jt} is the GDP of importing countries, GDP_{it} is the GDP of exporting countries, φ_j denotes importer fixed effects, ω_i captures exporter fixed effects and τ_t denotes time fixed effects. We call this the fixed effects model. X is the annual bilateral export volume, calculated by deflating the export value by the PPI of the exporting country. *RER* is the bilateral real exchange rate, calculated by *nxrate* $*\frac{PPI_i}{PPI_i}$, where *nxrate* is the nominal exchange rate, and *PPI_i* and *PPI_j* are PPIs of exporting and importing countries, respectively. R_{ij} controls for the usual gravity variables including distance, colonial relationship, common language and geographical contiguity.

We further augment this fixed effects model into the dynamic gravity model specification to control for time-varying importer fixed effects as follows:

$$\ln X_{ijt} = \beta_0 + \beta_1 lnRER_{ijt} + \beta_2 lnGDP_{it} + \beta_3 R_{ij} + \gamma_{it} + \delta_i + \mu_{ijt}, \qquad (2)$$

(3)

(4)

(5.2)

where the subscript *i* and *j* denote the exporter and importer, respectively, and *t* denotes time. γ_{jt} and δ_i are time-varying importer fixed effects and exporter fixed effects, respectively. Finally, μ_{iit} is the error term.

These time-varying importer fixed effects are added to control for the time-varying effect of trade barriers imposed by the importers, such as tariffs, nontariff barriers, and other trade restrictive factors which affect trade costs between i and j, and can collectively be referred to as multilateral resistance terms. In this model, the GDP of importing countries is dropped as it is subsumed into the time-varying importer fixed effect.

Using the dynamic gravity model, we test for the possible channel of the weakening impact of exchange rate on trade by introducing an additional variable, and its interaction with the variable of interest which is $\ln RER_{ijt}$. The first possible channel is the effect of increasing GVC trade on the link between exchange rate and trade. The GVC indicator, DVA_{ijt} , is the share of domestic-value-added (DVA) exports of country *i* to country *j* in total exports of country *i* at time *t*.

$$\begin{aligned} \ln X_{ijt} &= \beta_0 + \beta_1 \ln RER_{ijt} + \beta_2 \ln GDP_{it} + \beta_3 R_{ij} + \beta_4 DVA_{ijt} + \beta_5 \left(DVA_{ijt} * \ln RER_{ijt} \right) + \gamma_{jt} \\ &+ \delta_i + \mu_{ijt}. \end{aligned}$$

The changing import structure could also explain the weakening effect of exchange rate on trade. Import structure is computed as the natural log of the ratio of commodity goods to manufactured goods imports of country *j* from exporter country *i* at time *t*, $\ln IMP_{ijt}$. This variable captures the potential impact of the relative share of commodity and manufactured goods at a given time, on the effect of exchange rate on exports.

$$\ln X_{ijt} = \beta_0 + \beta_1 \ln RER_{ijt} + \beta_2 \ln GDP_{it} + \beta_3 R_{ij} + \beta_4 \ln IMP_{ijt} + \beta_5 (\ln IMP_{ijt} * \ln RER_{ijt}) + \gamma_{jt} + \delta_i + \mu_{ijt}.$$

Lastly, the short-term external debt stock of the exporters and importers could be a possible channel given the exposure of the exporter or the importer to international debt markets may offset the impact of exchange rates on trade. For this, we add the natural log of exporter debt $\ln debt_{it}$ and importer debt $\ln debt_{jt}$. This relationship is tested for both the exporter and importer, with the appropriate fixed effects specifications. Equation 5.1 estimates the effect of exporter's external debt on trade along with the natural log of exporter's GDP, exporter fixed effects and time-varying importer fixed effects, while Equation 5.2 estimates the effect of importer's external debt on trade along with the natural log of importer's GDP, importer fixed effects, and time-varying exporter fixed effects:

$$\ln X_{ijt} = \beta_0 + \beta_1 \ln RER_{ijt} + \beta_2 \ln GDP_{it} + \beta_3 R_{ij} + \beta_4 \ln debt_{it} + \beta_5 (\ln debt_{it} * \ln RER_{ijt}) + \gamma_{jt} + \delta_i + \mu_{ijt},$$
(5.1)

$$\begin{aligned} \ln X_{ijt} &= \beta_0 + \beta_1 \ln RER_{ijt} + \beta_2 \ln GDP_{jt} + \beta_3 R_{ij} + \beta_4 \ln debt_{jt} + \beta_5 \left(\ln debt_{jt} * \ln RER_{ijt} \right) \\ &+ \gamma_j + \delta_{it} + \mu_{ijt}. \end{aligned}$$

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To further address a possible, remaining endogeneity problem, we also estimate the dynamic and fixed effects gravity models with lagged and twice lagged bilateral real exchange rate, $lnRER_{ijt-1}$ and $lnRER_{ijt-2}$, respectively, wherever possible. By including lagged terms, suspected reverse causality between exchange rate and trade is controlled in the model. In addition, lagged terms capture whether the effect of exchange rate on exports volume is most significant at the contemporaneous year *t* or if it dissipates in *t*-1 or in *t*-2, as commonly discussed in the literature.

2.2. Data

Global bilateral exports data covering 2001–2015 is from the United Nations Commodity Trade database, classified according to the Broad Economic Category. The PPI and the EPI are from the International Monetary Fund International Financial Statistics (IMF IFS) database. The base year of PPI and EPI data is 2010 and is available for 72 and 20 economies, respectively. Gross domestic product data are from the World Bank World Development Indicators. Gravity variables such as distance, common language, common colonizer and contiguity are from CEPII database. All in all, the data cover 64 exporters and 72 importers, generating more than 56,815 observations for 2001–2015. A list of countries included is in Table A1 in Appendix.

GVC indicators are computed using the gross export decomposition methodology of Wang, Wei, and Zhu (2014) and the Asian Development Bank Multi-Regional Input-Output Table. This paper uses 2000, 2005, 2008, and 2011 data for 45 countries. Shortterm external debt stock data is from the World Bank International Debt Statistics. Lastly, the IMF Commodity Price index and the World Trade Organization Manufactures Price index, with base year 2005, were also used.

A Fisher-type unit root test was employed to test for non-stationarity of variables, and the Augmented Dickey Fuller test was used to check for non-stationarity within each panel. Results for the panel indicate that, both for exporters and importers, the null hypothesis that the GDP variable has a unit root cannot be rejected. All other variables have no unit root problem. UNESCAP's (2012) gravity model user guide highlights that the aggregate GDP and not per capita GDP should be used. Gravity models of trade oftentimes include nonstationary variables such as GDP (as in our case), but including fixed effects estimators take into account the non-stationarity of the macroeconomic variables (Fidrmuc, 2009).

3. Empirical results

3.1. Weakening impact of exchange rate on trade

The estimation results of the dynamic gravity model using panel regression over 2001–2015 are presented in Table 1 and show that the influence of usual gravity factors, such as distance, colonial relationship, common language, and geographical contiguity on export volume, is significant and has the expected direction. Table 1 shows the robust effect of $\ln RER_{ijt}$ on exports volume. The coefficient of $\ln RER_{ijt}$ is positive and significant at the 1% level. This suggests that the weaker the exporter's currency, the larger the export volume to its trading partners, such that a 1% depreciation of an

(1)	(2)	(3)
0.430***	0.240**	0.130
-0.113	-0.109	-0.111
-1.536***	-1.602***	-1.628***
(0.0367)	(0.0339)	(0.0335)
0.257*	0.208	0.249*
(0.149)	(0.164)	(0.151)
0.779***	0.690***	0.680***
(0.0853)	(0.0771)	(0.0762)
0.420**	0.420**	0.452**
(0.178)	(0.184)	(0.178)
0.353***		
(0.0601)		
	0.161***	
	(0.0514)	
		0.0745
		(0.0461)
16.95***	22.50***	24.67***
(3.033)	(2.922)	(2.976)
56,815	55,827	54,982
4,418	5,509	5,706
0.78	0.78	0.78
	(1) 0.430^{***} -0.113 -1.536^{***} (0.0367) 0.257^{*} (0.149) 0.779^{***} (0.0853) 0.420^{**} (0.178) 0.353^{***} (0.0601) 16.95^{***} (3.033) 56.815 4.418 0.78	$\begin{array}{c c c c c c c c c c c c c c c c c c c $

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Note: Importer time-varying fixed effects and exporter fixed effects are estimated, but not shown for brevity. *p < 0.10, **p < 0.05, ***p < 0.01 Robust standard errors are in parentheses.

exporter's RER, on average, leads to a 0.35% increase in export volume for the same year. The lag variable $\ln RER_{ijt-1}$ has a lower, but still positive and significant effect on export volume compared to the level RER. The coefficient of $\ln RER_{ijt-1}$ is 0.16. However, the coefficient of $\ln RER_{ijt-2}$, while positive, is insignificant. The inclusion of time-varying importer fixed effects in the model allows us to account for the unobserved time-varying characteristics of the importers which could influence trade, otherwise not captured by GDP and variables as in the fixed effects model.

Table 2 presents estimation results of the dynamic gravity model but with disaggregated time periods to account for observed structural difference in trade patterns between 2001 and 2015. For this purpose, this paper considers three periods – 2003–2006 (pre-GFC), 2007–2010 (GFC), and 2012–2015 (post-GFC). The size of the RER coefficient shrinks from $\ln RER_{ijt}$ to $\ln RER_{ijt-1}$ and to $\ln RER_{ijt-2}$. It can also be observed in the results that the magnitude of RER's coefficient is larger for the pre-GFC period than during the post-GFC period, while it is amplified during the crisis. The exchange rate effect on export volume was significantly dampened after the crisis period. Lastly, it is important to note that the coefficient of $\ln RER_{ijt-2}$ was even negative in the post-GFC period, as compared to the GFC period, and both are statistically significant.

To illustrate, the coefficient of $\ln RER_{ijt}$ is 1.05 in the GFC period and it is -0.27 in the post-GFC period, though statistically insignificant, while on average, for the entire period, it is 0.35. The positive effect is mostly driven by the crisis period and the magnitude has been less post-crisis. A 1% depreciation of exporter's currency leads to 1.05% increase in exports volume in 2007-2010, but the impact is effectively nil in 2012-2015. When the effect of $\ln RER_{ijt-1}$ is examined, a 1% depreciation of exporter's currency leads to 0.15% increase in exports volume in 2007-2010, but the effect of the effect becomes insignificant post-GFC. These findings point to the weakened impact of

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	Pre-GFC	GFC	Post-GFC	Pre-GFC	GFC	Post-GFC	Pre-GFC	GFC	Post-GFC
Log of exporter's GDP	-0.147	0.135	2.149***	-0.149	-0.0800	2.010***	-0.112	-0.190	1.838***
	(0.446)	(0.249)	(0.463)	(0.442)	(0.237)	(0.495)	(0.440)	(0.230)	(0.502)
Log of distance	-1.527***	-1.552***	-1.448***	-1.513***	-1.550***	-1.452***	-1.512***	-1.550***	-1.478***
	(0.0403)	(0.0411)	(0.0428)	(0.0401)	(0.0410)	(0.0429)	(0.0401)	(0.0409)	(0.0421)
Colonial relationship dummy	0.300*	0.208	0.0905	0.285*	0.182	0.0923	0.283*	0.182	0.151
	(0.165)	(0.161)	(0.170)	(0.164)	(0.168)	(0.170)	(0.164)	(0.169)	(0.165)
Common language dummy	0.770***	0.853***	0.778***	0.835***	0.854***	0.780***	0.840***	0.849***	0.749***
	(0.0963)	(0.0978)	(0.100)	(0.0957)	(0.0987)	(0.100)	(0.0958)	(0.0984)	(9660.0)
Contiguity	0.522***	0.379**	0.349*	0.528***	0.394**	0.343*	0.528***	0.397**	0.287
	(0.187)	(0.192)	(0.201)	(0.186)	(0.191)	(0.202)	(0.186)	(0.190)	(0.202)
Log of bilateral RER	0.0404	1.053***	-0.277						
	(0.213)	(0.184)	(0.211)						
Log of 1 period lag bilateral RER				-0.221	0.151**	-0.444			
				(0.145)	(0.0615)	(0.327)			
Log of 2 period lag bilateral RER							-0.137**	0.115**	-0.822**
							(0.0644)	(0.0470)	(0.383)
Constant	30.81***	20.81***		31.70***	31.69***		31.10***		-20.37
	(11.92)	(6.868)		(11.81)	(6.329)		(11.71)		(13.47)
Observations	15,229	14,662	12,137	15,205	14,907	12,346	15,260	14,971	12,567
Number of country-pairs	4,079	3,985	3,311	3,965	3,988	3,313	3,965	4,028	3,542
R-squared	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Note: Pre-global financial crisis cov fixed effects are estimated, but r	ers 2003–2006, g not shown for br	lobal financial cri evity. $* p < 0.10$	sis covers 2007–2 *** <i>p</i> < 0.05, **	010, and post-glo $*p < 0.01$ Robust	bal financial crisis standard errors a	covers 2012–2015 ire in parentheses.	. Importer time-v	arying fixed effect	s, and exporter

Table 2. Dynamic gravity model estimation results, 2003–2006 vs. 2007–2010 vs. 2012–2015.

exchange rate on trade, and the structural change post-GFC. Regression analysis on the possible channels of the weakened impact of exchange rate on trade follows.

The regression results of the fixed effects model which adds the GDP of the importing countries, and exporter, importer and time fixed effects are generally consistent with the results discussed above for the dynamic gravity model.² Alternative specifications of the models using export prices instead of producer prices – as a robustness check – confirms earlier findings on the weaker impact of exchange rate on trade between pre- and post-GFC period.

3.2. Impact of global value chains

One potential cause of the subdued impact of exchange rates on trade, post-GFC, could be a deepening of GVCs. As we have shown in the Tables 1 and 2, a depreciation of exporter's RER results in higher exports. However, this relationship could be dampened if the exported goods embed a large portion of imported intermediates, as these are affected by the depreciation, obscuring the net impact of exporter's currency depreciation.

To test this, the dynamic gravity model was modified to account for the GVC share in exports. Given the data availability of GVC indicators, this section uses the average export volume, GDP, and exchange rate variables over the years 2001–2003, 2006–2008, 2009–2011, and 2012–2014. Specifically, the GVC indicator used was the DVA share out of gross bilateral exports for 2000, 2005, 2008, and 2011. This approach also estimates the possible persistent effect of GVC participation spread over multiple years. A smaller share of DVA out of gross exports means more participation in GVC (i.e., deepening GVCs).³ The expected sign of the interaction between DVA share and exchange rate is negative, such that when an economy has lower DVA share – it participates more in GVCs – the impact of exchange rate on exports will be less.

Table 3 shows the share of DVA in gross exports from 2000 to 2015. In 2000, DVA accounted for 74% of gross exports, then fell to 72.2% in 2005, sliding further to 70.2% in 2008. The DVA share increased in 2011 to 72.2%, and to 79.4% in 2015. As discussed earlier, higher DVA share in general corresponds to less participation in GVCs.

Table 4 presents summary results under the dynamic gravity model with timevarying importer fixed-effects. Overall, a larger DVA share leads to less bilateral exports. This indicates that deepening GVCs induces larger exports, confirming the hypothesis that rapid expansion of GVCs has contributed to international trade growth. The impact of average real exchange rate, $\ln RER_{ijt}$ on exports becomes negative after considering the GVC impact, while $\ln RER_{ijt-1}$ still has positive coefficient. The interaction between DVA share and $\ln RER_{ijt}$ has a negative coefficient of -0.085 and its magnitude implies that deepening GVC, as represented by lowering the DVA share

²For the 2001–2015 period, log of bilateral real exchange rate, ln*RER_{ijt}*, has a positive and significant coefficient at the 1% confidence interval, suggesting that weaker exporter's currency results in larger export volume to its trading partners, holding other factors constant. The lagged bilateral RER in natural logs, ln*RER_{ijt-1}* is also statistically significant, while ln*RER_{ijt-2}* is statistically insignificant. These suggest that the impact of currency depreciation is greatest in the same year but dissipates over time. The estimation results are available upon request.

³The trend of DVA share out of gross exports follows the opposite direction of the GVC participation rate, and hence is a good proxy for the latter. According to the Asian Economic Integration Report 2016 (ADB 2016), the DVA share decreased between 2000 and 2011 and increased between 2011 and 2015: the DVA share (% of gross exports) was 74% in 2000, 72.2% in 2011, and 79.4% in 2015. Meanwhile, the GVC participation rate increased between 2000 and 2011 and decreased between 2011 and 2015: it rose from 63.2% to 65.5%, and then fell to 58.7% during the period.

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Table 3. Domestic value added (% of gross exports).

	2000	2005	2008	2011	2015
DVA (% of gross exports)	74.00	72.18	70.22	72.19	79.38

Note: DVA = domestic value added. Source: Authors' computation using ADB Multi-Regional Input Output Tables, and methodology from Wang et al. (2014).

Table 4. Global value chain effects.

	Dynamic gravity model		
	(1)	(2)	
DVA share	-1.237***	-0.943***	
	(0.191)	(0.210)	
Log of bilateral RER	-0.206***		
	(0.0567)		
Log of 1 period lag bilateral RER		0.0694*	
		(0.0376)	
Log of bilateral RER $ imes$ DVA share	-0.0854*		
	(0.0487)		
Log of 1 period lag bilateral RER $ imes$ DVA share		-0.112***	
		(0.0410)	

Note: *p < 0.10, **p < 0.05, **p < 0.01 Robust standard errors are in parentheses.

by 1%, decreases the exchange rate impact on exports by 0.09%. When the interaction with $\ln RER_{ijt-1}$ is considered, the effect becomes bigger: 0.11%. These suggest that the deepening GVCs could have dampened the traditional mechanism of exchange rate levels influencing trade. However, these results cannot isolate GVC as the only factor that might have induced the weakening impact of exchange rate on trade, they only indicate that it could be one of the structural factors. The full set of results of this model is in Table A2 in Appendix.

3.3. Impact of composition in imported goods

Another possible structural factor that can influence the relationship of exchange rates and trade is its composition, reflected in the ratio of primary to processed good of the imports of country *j* from exporter country *i* at time *t*. More primary goods trade compared to processed goods could lead to a higher impact of the exchange rate and the shift to manufactured goods imports could contribute to the decline in the effect of the exchange rate on trade (Campa & Goldberg, 2005). For example, economies which are exporting commodity goods are more sensitive to exchange rate fluctuations. However, if the import mix is more biased to processed goods, which are likely to have imported contents, it could also have an offsetting effect on the impact of currency depreciation on exports volume. We define a new variable, $\ln Prim_{ijt}$, which is the ratio of primary goods to processed goods imports volume. Data is from the UN Commodity Trade Database classified according to the Broad Economic Category, which enables us to separate primary goods from processed goods, including capital goods imports. Lastly, to control for the price effect, price deflators for primary goods and processed (or manufactured) goods were used.⁴

⁴Given the limitations of price deflator availability for each sector classification under the Broad Economic Category, the paper uses the IMF Commodity Price Index as price deflator for the primary goods and the WTO Manufactured Goods Price Index for the processed goods. We assumed that the importers are price takers, and there is a global price for these two types of goods. Both price deflators have 2005 as the base year and are only available for 2005–2015.

Dynamic gravity model

Similar to the approach in investigating the GVC channel, the dynamic gravity model was modified to include the new variable $\ln Prim_{ijt}$ and its interaction with $\ln RER_{ijt}$ to capture the shared effect of these two variables on export volume. The direction of the effect and statistical significance of other gravity variables are consistent with earlier results, as presented in Table 2. In addition, we tested if the impact of these variables would be different in pre-GFC, GFC, and post-GFC periods.

Table 5 shows that the depreciation of the exporter's currency results in higher export volume, although the effect becomes negative post-GFC. The regression results also indicate that $\ln Prim_{ijt}$ for the estimation period 2005–2015 has a negative impact on exports volume. This means that for a given country-pair *i* and *j*, if the ratio of primary to processed goods is higher, there is less export volume between country *i* and *j*. The interaction term of $\ln Prim_{ijt}$ with $\ln RER_{ijt}$ has a negative and significant coefficient of -0.004 and -0.005 during the pre-GFC and GFC period. These results indicate that higher primary goods exports relative to processed goods exports leads to a smaller impact of exchange rates on exports volume, of which the impact has become dampened post-GFC.

To control for possible endogeneity, the model was also estimated with the lagged RER. The results are consistent with the model with level RER. The interaction term has a negative and significant coefficient only during the GFC period. The full set of results of this model is in Table A3 in Appendix.

Compared to pre-GFC and post-GFC periods, primary goods ratio out of total imports was higher during the GFC period, as Table 6 shows. Not only did this have a negative impact on trade, but it dampened the exchange rate impact on trade.

3.4. Impact of short-term external debt

3.4.1. Exporter's short-term external debt

Drawing from the findings of Kearns and Patel (2016) on the relationship among the level of external debt, movement of exchange rates, trade volume, and the role of the

Post-GFC
-0.00975
(0.0107)
-0.510**
(0.212)
0.00261
(0.00341)
-0.00864
(0.0105)
-0.649**
(0.320)
0.00220
(0.00333)

Table 5. Imports composition effects.

Note: p < 0.10, p < 0.05, p < 0.05, p < 0.01 Robust standard errors are in parentheses.

Table 6. Im	ports com	position ra	atio: primai	y to	processed	imports	volume	ratio.
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Period	'05	'06	Pre-GFC	'07	'08	'09	'10	GFC	'11	'12	'13	'14	'15	Post-GFC	Over-all
Ratio*	0.94	0.9	0.92	0.98	1	1.03	0.89	0.97	0.9	0.95	0.88	0.93	0.95	0.93	0.94

Note: *This pertains to interquartile range value. Source: UN Commodity Trade Database.

	Exporters	Importers
Pre-GFC	3.66	6.76
GFC	4.48	4.83
Post-GFC	4.62	4.16
2001–2015	4.16	5.14

Table 7. Average short-term external debt (% of GDP).

Source: World Bank. World Development Indicators.

GFC in changing the dynamics among these variables, this paper attempts to find more evidence on the implied structural changes on this relationship pre- and post-GFC.

As Table 7 shows, the average short-term external debt of exporters in our sample increased from 3.66% of GDP pre-GFC to 4.62% post-GFC, while on the contrary, the average short-term external debt of importers in our sample declined post-GFC. Note that the levels of short-term external debt as share of GDP of both exporters and importers have not returned to their pre-GFC levels. This points to the possibility that the effect of the crisis on external debt may not be temporary or cyclical, or it should have dissipated over time. This provides motivation to look at short-term external debt as one of the structural factors which can explain the weakening relationship between exchange rate and trade.

Running the regressions based on Equations (5.1) and (5.2), we further test if exporter's and importer's short-term external debt levels have any impact on trade and exchange rate pass-through on trade. Over the full sample period, 2001-2015, InRER_{iit} has a positive and significant effect on exports volume (Table 8, Panel A). A 1% depreciation of the currency leads to as much as 0.45% increase in exports, as also shown in previous models. But when the estimation period is limited to the post-GFC period, we were unable to find any impact on exports. This confirms earlier observations of the weakening impact of exchange rate on trade, especially after the GFC. Note that during the post-GFC period, the effect of the exporter's short-term external debt on its export's volume was negative and significant. Exporters with high short-term external debt have tended to export less since the GFC. The interaction of lnRER_{iit} and $\ln debt_{it}$ shows a negative and significant effect on exports volume for the full period. This means that the effect of lnRER_{ijt} on exports volume is lower in the presence of higher short-term external debt of exporter, although this effect is more prominent during the crisis and post-crisis periods than in the previous period. The coefficients of one period lag bilateral RER, short-term external debt of exporter and their interaction are consistent with the model with level RER, indicating a negative and significant effect of high short-term debt of exporters on export performance.

3.4.2. Importer's short-term external debt

Meanwhile, the importer's short-term external debt, $\ln debt_{jt}$, is found to have a positive effect on exports volume for the pre-GFC and GFC periods (Table 8, Panel B). Debt-laden

Full period Pre-GFC GFC Post-GFC A. Exporter's short-term external debt -0.00767 0.0462 0.0434 -0.162* Log of exporter's short-term external debt -0.00767 0.0462 0.0434 -0.162* Log of bilateral RER 0.450*** 0.503 1.774*** 0.482 Log of exporter's short-term external debt × Log of bilateral RER 0.00777* -0.000683 -0.0112** -0.0379*** Log of exporter's short-term external debt Log of of uperiod lag bilateral RER 0.00077* -0.000683 -0.0112** -0.0379*** Log of exporter's short-term external debt -0.00050 0.0240 0.130** -0.111* Log of a period lag bilateral RER 0.208 -0.0105 1.189*** -0.115 Log of 1 period lag bilateral RER 0.208 -0.0105 1.189*** -0.158 (0.137) (0.302) (0.280) (0.516) -0.031***
A. Exporter's short-term external debt -0.00767 0.0462 0.0434 -0.162* Log of exporter's short-term external debt (0.0190) (0.0604) (0.0320) (0.0927) Log of bilateral RER 0.450*** 0.503 1.774*** 0.482 Log of exporter's short-term external debt × Log of bilateral RER (0.138) (0.289) (0.361) Log of exporter's short-term external debt × Log of bilateral RER 0.00777* -0.00683 -0.0112** -0.0379*** Log of exporter's short-term external debt -0.000550 0.0240 0.130** -0.111 Log of apprind lag bilateral RER 0.208 -0.0105 1.89*** -0.158 Log of 1 period lag bilateral RER 0.208 -0.0105 1.89*** -0.158 Log of apprinter's short-term external debt × Log of 1 period lag 0.00631 0.00974 -0.0321***
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$ \begin{array}{c} (0.0190) \\ Log of bilateral RER \\ Log of exporter's short-term external debt \times Log of bilateral RER \\ Log of exporter's short-term external debt \times Log of bilateral RER \\ Log of exporter's short-term external debt \times Log of bilateral RER \\ Log of exporter's short-term external debt \\ Log of 1 period lag bilateral RER \\ Log of exporter's short-term external debt \\ Log of 1 period lag bilateral RER \\ $
Log of bilateral RER 0.450^{***} 0.503 1.774^{***} 0.482 Log of exporter's short-term external debt × Log of bilateral RER (0.368) (0.289) (0.361) Log of exporter's short-term external debt 0.00777^* -0.000683 -0.0112^{**} -0.0379^{***} Log of exporter's short-term external debt -0.00050 0.0240 0.130^{**} -0.111 Log of 1 period lag bilateral RER 0.208 -0.0105 1.89^{***} -0.158 Log of exporter's short-term external debt × Log of 1 period lag 0.00631 0.00974 -0.0321^{***}
$ \begin{array}{c} (0.138) \\ Log of exporter's short-term external debt \times Log of bilateral RER \\ Log of exporter's short-term external debt \\ Log of exporter's short-term external debt \\ Log of exporter's short-term external debt \\ Log of 1 period lag bilateral RER \\ Log of 1 period lag bilateral RER \\ Log of exporter's short-term external debt \\ Log of 1 period lag bilateral RER \\ Log of exporter's short-term external debt \\ Log of 1 period lag bilateral RER \\ Log of exporter's short-term external debt \\ Log of exporter'$
$ \begin{array}{llllllllllllllllllllllllllllllllllll$
$ \begin{array}{c} (0.00440) \\ Log of exporter's short-term external debt \\ Log of 1 period lag bilateral RER \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \times Log of 1 period lag \\ Log of exporter's short-term external debt \\ $
Log of exporter's short-term external debt -0.000550 0.0240 0.130** -0.111 (0.0215) (0.0629) (0.0628) (0.0937) Log of 1 period lag bilateral RER 0.208 -0.0105 1.189*** -0.158 (0.137) (0.302) (0.280) (0.516) Log of exporter's short-term external debt × Log of 1 period lag 0.00631 0.000974 -0.0121** -0.0331***
$ \begin{array}{c} (0.0215) \\ Log of 1 \ period \ lag \ bilateral \ RER \\ 0.208 \\ (0.137) \\ Log \ of \ exporter's \ short-term \ external \ debt \ \times \ Log \ of \ 1 \ period \ lag \\ 0.00631 \\ 0.00631 \\ 0.000974 \\ -0.0121^{**} \\ -0.031^{***} \end{array} $
Log of 1 period lag bilateral RER 0.208 -0.0105 1.189*** -0.158 0.00 of exporter's short-term external debt × Log of 1 period lag 0.00631 0.000974 -0.0121** -0.0331***
Log of exporter's short-term external debt × Log of 1 period lag (0.137) (0.302) (0.280) (0.516) 0.000974-0.0121**-0.0331***
Log of exporter's short-term external debt \times Log of 1 period lag 0.00631 0.000974 -0.0121** -0.0331***
bilateral RER
(0.00443) (0.00884) (0.00569) (0.0113)
B. Importer's short-term external debt
Log of importer's short-term external debt -0.00292 0.114** 0.0450* 0.124
(0.0145) (0.0492) (0.0241) (0.106)
Log of bilateral RER 0.521*** 0.986*** 0.395 0.229
(0.107) (0.332) (0.262) (0.316)
Log of importer's short-term external debt \times Log of bilateral RER -0.00806^{**} 0.00141 0.00464 -0.00818
(0.00324) (0.00745) (0.00603) (0.0114)
<i>Log of importer's short-term external debt</i> -0.0208 0.0811* 0.0668 0.138
(0.0175) (0.0424) (0.0648) (0.106)
<i>Log of 1 period lag bilateral RER</i> 0.0353 0.863*** -0.0738 0.329
(0.0671) (0.282) (0.256) (0.376)
Log of importer's short-term external debt × Log of 1 period lag -0.000827 -0.00343 0.00270 -0.00559 bilateral RER
(0.00319) (0.00746) (0.00602) (0.00907)

Table 8. Short-term external debt stocks effects.

Note: *p < 0.10, **p < 0.05, **p < 0.01 Robust standard errors are in parentheses.

importing countries tend to import more under constraints in domestic production capacity. A 1% increase in the short-term external debt stock of importer leads to a 0.11 and 0.045% increase in imports in the pre-GFC and GFC periods, respectively. However, this effect largely dissipates post-GFC. In the meantime, the coefficient of the interaction term between ln*debt_{jt}* and ln*RER_{ijt}* shows significant negative result in the full period estimation. Depreciation of the exporter's currency has less impact on exports during this period when importers had high short-term external debt. This is probably because larger short-term external debt value of importer is partially cancelled out by the depreciation of the exporter country currency. (Note that depreciation of the exporter country currency implies appreciation of importer country currency.) Kearns and Patel (2016) has similar findings, such that the external debt could offset the effect on trade of exchange rate impact on trade largely dissipates during the GFC and post-GFC periods. The estimation results of the model with a one period lag of bilateral RER are similar. The full set of regression results of this model is in Table A4 in Appendix.

Overall, the exporter's short-term external debt level forges a significantly negative impact on trade performance post-GFC, while importer's short-term external debt level, which increased trade pre-GFC and GFC, does not seem to boost trade post-GFC anymore. Both factors should have contributed to tepid trade growth post-GFC. Meanwhile, the importer's short-term external debt level does not seem to induce a similar dampening effect on the exchange rate impact channel post-GFC anymore.

As discussed earlier, the average short-term external debt of exporters (Table 7) in our sample increased which should have contributed to slower trade growth post-GFC as the significant negative coefficient of exporter's short-term external debt in the estimation indicates. On the contrary, the average short-term external debt of importers in our sample declined post-GFC, which could have led to an amplifying effect of exchange rate on trade if it had happened pre-GFC, but this effect in fact has largely dissipated over time, as discussed above.

4. Conclusions

This paper explored the impact of the real exchange rate level on the exports volume of 72 economies from 2001 to 2015 using a gravity model estimation. The results of the empirical analysis contribute to the literature by first confirming the weakened impact of exchange rate on exports volume post-GFC and, second, investigating structural factors as possible channels of this relationship. There is evidence of a positive effect of real exchange rates on exports volume, such that depreciation of the exporter's currency results in higher exports volume. However, the effect has significantly weakened over time, in particular after the GFC. The impact of currency depreciation on trade has become much smaller post-GFC (2012–2015) compared to pre-GFC (2003–2006), with the effect lasting for a much shorter time.

Further, the gravity model estimation results support the important role of GVCs for growth of international trade, but also find evidence of the weakened effect of exchange rate depreciation on exports volume, with the progress of GVC participation around the world. Other structural factors tested in the empirical analysis – such as import composition (i.e., primary to processed (or manufactured) imported goods ratio and the stock of short-term external debt of both importer and exporter) also point to the negative impact of these factors on international trade, with some variations in magnitude across different periods. The results also suggest that potential structural changes could happen post-GFC, which seemed to have weakened the impact of these factors on the exchange rate pass-through on trade.

Disclosure statement

No potential conflict of interest was reported by the authors.

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References

Ahmed, S., Appendido, M., & Ruta, M. (2015a). Global value chains and the exchange rate elasticity of exports. *International Monetary Fund Working Paper*. 15 (552). International Monetary Fund. Washington, D.C.

- Ahmed, S., Appendido, M., & Ruta, M. (2015b). Depreciation without exports? Global value chains and the exchange rate elasticity of exports. *World Bank Policy Research Working Paper*. 7390, World Bank, Washington, D.C.
- Anderson, J. E., & van Wincoop, E. (2003). Gravity with gravitas: A solution to the border puzzle. *American Economic Review*, 93, 170–192.
- Appuhamilage, A., & Senanayake, K. (2010). Exchange rate movements' effect on Sri Lanka-China trade. *Journal of Chinese Economy and Foreign Trade Studies*, 3(3), 254–267.
- Aristeriou, D., Masatci, K., & Pilbeam, K. (2016). Exchange rate volatility and international trade: International evidence. *Economic Modelling*, 58, 133–140.
- Aristotelous, K. (2001). Exchange-rate volatility, exchange-rate regime, and trade volume: Evidence from the UK-US export function (1989–1999). *Economic Letter*, 72, 87–89.
- Asian Development Bank (2016). Asian economic integration report 2016. ADB. Manila, Philippines.
- Bacchetta, P., & van Wincoop, E. (2000). Does exchange-rate stability increase trade and welfare? *The American Economic Review*, 90(5).
- Baek, J. (2012). Exchange rate sensitivity of Korea-US bilateral trade: Evidence from industrial trade data. *Journal of Korea Trade*, 16, 1–21.
- Burstein, A., & Gopinath, G. (2014). International prices and exchange rates. *Handbook of International Economics*, 4, 391–451.
- Campa, J. M., & Goldberg, L. S. (2005). Exchange rate pass-through into import prices: A macro or micro phenomenon? *NBER Working Paper* No. 8934. National Bureau of Economic Research, Cambridge, MA.
- Dell'Ariccia, G. (1999). Exchange rate fluctuations and trade flows: Evidence from the European Union. *IMF Staff Papers*, 46(3), 315–334.
- Ethier, W. (1973). International trade and the forward exchange market. *American Economic Review*, 63, 494–503.
- Feenstra, R., Gagnon, J., & Knetter, M. (1996). Market share and exchange rate pass-through in world automobile trade. *Journal of International Economics*, 40(1–2), 187–207.
- Fidrmuc, J. (2009). Gravity models in integrated panels. *Journal of Empirical Economy*, 37(2), 435–446.
- Franke, G. (1991). Exchange rate volatility and international trading strategy. *Journal of International Money and Finance*, 10, 292–307.
- Gala, P. (2008). Real exchange rate levels and economic development: Theoretical analysis and econometric evidence. *Cambridge Journal of Economics*, 32(2), 1243–1272.
- Hooy, C.-W., Law, S.-H., & Chan, T.-H. (2015). The impact of the Renminbi real exchange rate on ASEAN disaggregated exports to China. *Journal of Economic Modelling*, 4, 253–259.
- Huchet-Bourdon, M., & Korinek, J. (2011). To what extent do exchange rates and their volatility affect trade? *OECD Trade Policy Papers*. 119. Organisation for Economic Co-operation and Development, Paris.
- International Monetary Fund. International Financial Statistics database. http://data.imf.org/?sk= 5DABAFF2-C5AD-4D27-A175-1253419C02D1&ss=1409151240976
- International Monetary Fund. (2004). Exchange rate volatility and trade flows—Some new evidence. Washington, DC: IMF.
- International Monetary Fund. (2015a). World economic outlook: Adjusting to lower commodity prices. Washington, DC: IMF.
- International Monetary Fund (2015b). Exchange rates and trade: A disconnect. IMF Working Paper No. 2017-58. IMF. Washington, D.C.
- Kearns, J., & Patel, N. (2016). Does the financial channel of exchange rate offset the trade channel? *Bank of International Settlements Quarterly Review*. Bank for International Settlements, Basel, Switzerland.
- Koren, M., & Szeidl, A. (2003). *Exchange Rate Uncertainty and Export Prices*, mimeo. Harvard University.
- Krugman, P. (1989). The case for stabilizing exchange rates. Oxford Review of Economic Policy, Oxford University Press. 5(3), 61–72.

- Marquez, J., & Schindler, J. (2006). Exchange-rate effects on China's trade: An interim report. *Federal Reserve Bank of San Francisco Working Paper Series*, Working Paper No. 2006-41.
- Mukherjee, D., & Pozo, S. (2011). Exchange-rate volatility and trade: A semiparametric approach. *Journal of Applied Economics*, 43(13), 1617–1627.
- Ollivaud, P., Rusticelli, E., & Schwellnus, C. (2015). The changing role of the exchange rate for macroeconomic adjustment. OECD Economics Department Working Paper 1190, Organisation for Economic Co-operation and Development, Paris.
- Rose, A. (2000). One market, one money: Estimating the effect of common currencies on trade. *Economic Policy*, 30, 7–45.
- Thorbecke, W. (2006). The effect of exchange rate changes on trade in East Asia. Research Institute of Economy, Trade & Industry (RIETI) Discussion Paper Series. 05-E -009. RIETI, Tokyo.
- Thorbecke, W., & Kato, A. (2011). The effect of exchange rate changes on Japanese consumption exports. *Asian Development Bank Institute (ADBI) Working Paper Series*. ADBI Working Paper No. 298. ADBI, Tokyo.
- United Nations Conference on Trade and Development (UNCTAD) (2013). Exchange rates, international trade and trade policies. *Policy Issues in International Trade and Commodities Studies Study* Series No. 56.
- United Nations Economic and Social Commission for Asia and the Pacific. (2012). *The gravity model of international trade: A user guide*. Prepared by B. Shepherd. Bangkok, Thailand: UNESCAP.
- Wang, Z., Wei, S.-J., & Zhu, K. (2014). Quantifying international production sharing at the bilateral and sectoral levels. *NBER Working Paper*. No. 19677, National Bureau of Economic Research, Cambridge, Massachusetts.

World Trade Organization. (2011). World trade report. Geneva: Author.

Appendix

	Exporters		Importers
1.	Algeria	1.	Algeria
2	Argentina	2.	Argentina
3.	Armenia	3.	Armenia
4.	Australia*	4.	Australia*
5.	Brazil*	5.	Austria*
6	Bulgaria*	6	Brazil*
0. 7	Canada*	7	Bulgaria*
8	Central African Ren	8	Canada*
9	Chile	9	Central African Ben
). 10	Colombia). 10	Chile
10.	Costa Rica	10.	Colombia
12	Croatia	12	Costa Bica
12.	Cuprus*	12.	Croatia
14	Czech Benublic*	13.	Cioatia Cyprus*
15	Denmark*	15	Czech Benublic*
15.	Equat	1J. 16	Denmark*
10.	El Salvador	10.	Equat
17.	Er Salvador	17.	El Salvador
10.	Estoria	10.	El Salvauol
19.	Etiliopia	19.	Estonia
20.	Georgia	20.	Ethopia Finland*
21.	Hong Kong, China	21.	Filialiu Franco*
22.		22.	Coordia
25.	Huligary" India*	23.	Georgia
24.	India" Indianasia*	24.	Germany"
25.	Indonesia"	25.	Greece"
20.	Iran	20.	Hong Kong, China
27.	Japan^	27.	Hungary^
28.	Jordan	28.	india^
29.	Kazaknstan	29.	Indonesia^
30.	Korea, Rep. of ^	30.	Iran Ing Ing Ita
31.	Kuwait Kuwait	31.	Ireland^
32.	Kyrgyz Republic	32.	Italy^
33.	Latvia^	33.	Japan^
34.	Litnuania^	34.	Jordan Kasa bikatan
35.	Malaysia^	35.	Kazaknstan
30.	Mexico*	36.	Korea, Rep. of
37.	MOROCCO	37.	Kuwait Kuwait
38.	Netherlands"	38.	Kyrgyz Republic
39.		39. 40	Latvia"
40.	Pakislan	40.	
41.	Panama	41.	Mariae*
42.	Paraguay	42.	Mexico
43.	Peru Dhilinginge*	43.	MOTOCCO
44. 45	Philippines"	44.	Netherlands"
45.	Poland" Saudi Arabia	45.	
40.		40.	Pakistan
47.	Senegal	47.	Panama
40. 40	Singapore Slovakia*	4ð. 40	Parayuay
49. 50	Slovenia*	49. 50	reiu Dhilippipos*
50. 51	South Africa	5U. 51	Polond*
וג. בי	South Anica Sri Lanka*	51. 52	PoidiiQ"
52. 52	Sri Lanka" Sweden*	52.	Portugal [*]
55. E4	Sweden"	JJ. ⊑₄	Sauci Arabia
54. 55	Switzeriana	54.	Senegal
55. 56	Syria Theiler d*	55. 56	Singapore
50. 57	Inaliana" Tripidad and Tabana	50.	Slovaria*
5/.	Trinidad and Tobago	5/.	Slovenia*
ა	i unisia	58.	South Africa

Table A1. List of countries covered.

(Continued)

Table A1. (Continued).

	Exporters		Importers
59.	Turkey*	59.	Spain*
60.	United States*	60.	Sri Lanka*
61.	Ukraine	61.	Sweden*
62.	United Kingdom	62.	Switzerland
63.	Uruguay	63.	Syria
64.	Venezuela	64.	Thailand*
		65.	Trinidad and Tobago
		66.	Tunisia
		67.	Turkey*
		68.	United States*
		69.	Ukraine
		70.	United Kingdom*
		71.	Uruguay
		72.	Venezuela*

Note: * GVC data available

	(=:: = :::= :::= 'j()]:	
	(1)	(2)
Log of exporter's GDP	0.932***	0.809***
	(0.153)	(0.153)
Log of bilateral RER	-0.206***	
	(0.0567)	
Log of 1 lag bilateral RER		0.0694*
		(0.0376)
DVA share	-1.237***	-0.943***
	(0.191)	(0.210)
DVA share $ imes$ Log of bilateral RER	-0.0854*	
	(0.0487)	
DVA share $ imes$ Log of 1 period lag bilateral RER		-0.112***
		(0.0410)
Log of distance	-1.481***	-1.486***
	(0.0481)	(0.0438)
Colonial relationship dummy	0.280	0.283
	(0.196)	(0.190)
Common language dummy	0.458**	0.419**
	(0.180)	(0.177)
Contiguity	0.345	0.311
	(0.233)	(0.228)
Constant	5.397	9.127**
	(4.244)	(4.241)
Observations	3,736	3,462
Number of Country-pairs	1,044	1,118
R-squared	0.89	0.89

Table A2. GVC effects. Dependent variable: Log(Exports volume_{ijt})].

Note: Exporter fixed effects and time-varying importer fixed effects are included, but not shown for brevity. *p < 0.10, **p < 0.05, ***p < 0.01 Robust standard errors are in parentheses.

Table A3. Import composition effects. Depe-	indent variable:	Log(Exports v	'olume _{ijt}).					
	Full period	Pre-GFC	GFC	Post-GFC	Full period	Pre-GFC	GFC	Post-GFC
Log of exporter's GDP	0.308**	-2.663**	0.241	1.730***	0.265**	-2.829**	0.0223	1.551***
	(0.135)	(1.222)	(0.235)	(0.460)	(0.134)	(1.146)	(0.224)	(0.481)
Log of bilateral RER	0.388***	0.775	1.035***	-0.510**				
	(0.0703)	(0.557)	(0.172)	(0.212)				
Log of 1 period lag bilateral RER					0.430***	0.621	0.124**	-0.649**
					(0.0702)	(0.434)	(0.0527)	(0.320)
Log of Prim _{itt}	-0.0129**	-0.00818	-0.000937	-0.00975	-0.0114**	-0.0100	0.000398	-0.00864
•	(0.00547)	(0.0109)	(0.00796)	(0.0107)	(0.00541)	(0.0109)	(0.00792)	(0.0105)
Log of Prim $_{jt}$ $ imes$ Log of bilateral RER	-0.00185	-0.00431*	-0.00488**	0.00261				
	(0.00162)	(0.00249)	(0.00208)	(0.00341)				
Log of Prim $_{jt} imes$ Log of 1 period lag bilateral RER					-0.00228	-0.00379	-0.00525***	0.00220
					(0.00158)	(0.00247)	(0.00203)	(0.00333)
Log of Distance	-1.504***	-1.506^{***}	-1.509***	-1.408***	-1.499***	-1.489***	-1.508***	-1.406***
	(0.0385)	(0.0421)	(0.0413)	(0.0438)	(0.0383)	(0.0416)	(0.0411)	(0.0436)
Colonial relationship dummy	0.232	0.390**	0.370**	0.0917	0.222	0.376**	0.368**	0.0902
	(0.166)	(0.159)	(0.147)	(0.183)	(0.165)	(0.157)	(0.146)	(0.182)
Common language dummy	0.731***	0.592***	0.748***	0.682***	0.748***	0.648***	0.754***	0.690***
	(0.0911)	(0.102)	(0.0958)	(0.101)	(0.0902)	(0.0994)	(0.0964)	(0.100)
Contiguity	0.368*	0.480***	0.426**	0.350*	0.372**	0.491***	0.429**	0.354*
	(0.188)	(0.184)	(0.188)	(0.211)	(0.187)	(0.184)	(0.186)	(0.212)
Constant	18.99***	98.36***	17.76***		20.08***	102.6***		-18.51
	(3.627)	(32.49)	(6.478)		(3.595)	(30.49)		(11.88)
Observations	31,824	6,306	12,363	10,472	32,373	6,231	12,614	10,636
Number of Country-pairs	3,841	3,340	3,579	2,969	3,849	3,254	3,583	2,976
R-squared	0.77	0.78	0.77	0.78	0.77	0.78	0.77	0.78
Note: Pre-global financial crisis covers 2003–2006, glv fixed effects are estimated, but not shown for bre	obal financial crisis vity. $* p < 0.10, *$	s covers 2007–20 * <i>p</i> < 0.05, * * *	10, and post-glob $p < 0.01$ Robust s	al financial crisis standard errors a	covers 2012–201 re in parenthesis.	5. Importer time-	varying fixed effec	ts and exporter

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Table A4. Short-term external debt eff	fects. Dependent	t variable: Logi	Exports volume	e_{ijt}).				
	Full period	Pre-GFC	GFC	Post-GFC	Full period	Pre-GFC	GFC	Post-GFC
A. Exporters' short-term external debt Log of exporter's GDP	1.456*** (0.214)	-0.302 (0.774)	1.781*** (0.453)	2.683*** (0.506)	1.234*** (0.216)	-0.451 (0.781)	1.661*** (0.456)	2.552*** (0.551)
Log of importer's GDP Log of bilateral RER	0.450***	0.503	1.774*** 1.774***	0.482				
Log of 1 period lag bilateral RER	(001.0)	(000.0)	(607.0)	(1000)	0.208	-0.0105	1.189*** (0000)	-0.158
Log of exporter's short-term external debt	-0.00767 (0.0190)	0.0462 (0.0604)	0.0434 (0.0320)	-0.162* (0.0927)	-0.000550 -0.000550 (0.0215)	(2002.0) 0.0240 (0.0629)	(0.200) 0.130** (0.0628)	(010.0) -0.111 (0.0937)
Log of importer's short-term external debt Log of exporter's short-term external debt	0.00777*	-0.000683	-0.0112**	-0.0379***				
× Log of exporter's short-term external debt	(0.00440)	(0.00818)	(0.00539)	(0.0114)	0.00631	0.000974	-0.0121**	-0.0331***
imes Log of 1 period lag bilateral RER					(0.00443)	(0.00884)	(0.00569)	(0.0113)
Log of importer's short-term external debt × Log of bilateral RER Log of importer's short-term external debt × 1000 of 1 positod has bilateral BEB								
 Log of Distance 	-1.578***	-1.575***	-1.597***	-1.497***	-1.662***	-1.550***	-1.601***	-1.517***
Colonial relationship dummy	(2000) -0.0777 (2010)	(0.0648) 0.0429 (0.207)	(0.0045) -0.227 (0.231)	(c000.0) -0.351 (575 0)	(11 c0.0) -0.301 (830 0)	(c.0045) 0.0350 (707.0)	(0.0044) -0.245 (0.230)	(0.06/0) -0.347 (0.263)
Common language dummy	1.046*** 1.046***	1.036***	1.149***	1.020***	0.931***	(0.2007) 1.105*** (0.131)	1.159*** 1.135	(002.0) (0.997***
Contiguity	0.399	0.515**	0.332	0.291	0.415	0.539**	0.335	0.258
Constant	(0.240) -9.464* (5.522)	(202.0) 32.79 (15.05)	-8.143 -8.143	-42.66*** -42.66***	-3.166 -3.166 (5.580)	(0.202) 38.33* (70.20)	(002.0)	(667.0)
Observations Number of Country-pairs R ²	(coc.c) 30,228 2,375 0.74	7,822 2,159 0.76	2,153 0.75 0.75	(6,638 6,638 1,785 0.75	29,433 2,928 0.74	(20.02) 2,071 0.76	7,923 2,153 0.75	6,715 1,786 0.75
B. Importers' short-term external debt Log of exporter's GDP								
								(Continued)

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Log of importer's GDP 1.29 (0.18 Log of bilateral RER 0.52	period	Pre-GFC	GFC	Post-GFC	Full period	Pre-GFC	GFC	Post-GFC
0.10 Loa of bilateral RER 0.52	96***	(2020)	1.295***	1.723***	1.256***	1.079*	1.337***	1.653***
	02) 21*** 07)	(0.086*** 0.986***	(c.76.0) 0.395 (c.26.0)	0.229	(col.0)	(710.0)	(0.4.0)	(0.494)
00.10 Log of 1 period lag bilateral RER	(/)	(0.332)	(707.0)	(015.0)	0.0353	0.863*** (0.282)	-0.0738	0.329
Log of exporter's short-term external debt I on of immorter's short-term external debt — _000	7970	0 114**	0.0450*	0 124	0.0008	0.0811*	0002.0)	0.138
	145)	(0.0492)	(0.0241)	(0.106)	(0.0175)	(0.0424)	(0.0648)	(0.106)
Log of exporter's short-term external debt × Log of bilateral RER								
Log of exporter's short-term external debt × Loa of 1 period laa bilateral RER								
Log of importer's short-term external debt -0.00 × Loa of bilateral RER	0806**	0.00141	0.00464	-0.00818				
(0.0)	0324)	(0.00745)	(0.00603)	(0.0114)				
Log of importer's short-term external debt × Log of 1 period lag bilateral RER					-0.000827	-0.00343	0.00270	-0.00559
•					(0.00319)	(0.00746)	(0.00602)	(206000)
Log of Distance	.20***	-1.653***	-1.745***	-1.541***	-1.763***	-1.625***	-1.741***	-1.532***
(0.05) (0.05) (0.05)	1588) 00	(0.0656) 0.122	(0.0664)	(0.0722)	(0.0503)	(0.0662)	(0.0661)	(0.0722)
0.32 (0.32)	25)	(0.388)	(0.347)	(0.309)	(0.294)	(0.386)	(0.396)	(0.307)
Common language dummy	38***	0.734***	0.807***	0.897***	0.681***	0.817***	0.812***	0.918***
(0.12	28)	(0.143)	(0.148)	(0.152)	(0.106)	(0.148)	(0.150)	(0.152)
Contiguity 0.36	67	0.578**	0.196	0.208	0.373	0.604**	0.233	0.218
(0.24	49)	(0.269)	(0.271)	(0.303)	(0.241)	(0.270)	(0.270)	(0.302)
Constant –4.02	124	-1.475		-20.91	-1.805	-3.961	-10.89	-20.70
(4.73	33)	(16.48)		(13.04)	(4.790)	(16.12)	(12.68)	(12.96)
Observations 25,	5,177	6,736	6,642	5,155	25,045	6,749	6,705	5,289
Number of country-pairs 2,0	,097	1,873	1,860	1,421	2,927	1,794	1,864	1,455
R ² 0.76	9	0.75	0.76	0.77	0.76	0.75	0.76	0.77