Exchange Rates and Trade: A Disconnect?

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Abstract

We examine the relationship between exchange rates and trade and its stability over time using an analysis of large currency depreciations. We find that both exchange rate pass-through and the price elasticity of trade volumes are largely stable over time. Economic slack and financial conditions affect the relationship significantly, but there is limited evidence that participation in global value chains is so far a significant factor in the exchange rate–trade relationship. We find similar results using now-standard trade regressions, which suggests that the endogeneity bias is small.

Keywords: Exchange rate disconnect, global trade, exchange rates and trade

JEL Classification; F14, F31, F41

1. INTRODUCTION

Recent exchange rate movements have been unusually large. The global economic recovery since the 2008 financial crisis has been uneven and most of the world's economies remain vulnerable. This and the unconventional monetary policy response to the crisis have created large movements in the currencies of major economies. Between mid-2014 and mid-2015, for example, the U.S. dollar appreciated by more than 10 percent in real effective terms.[1] In turn, the euro depreciated by more than 10 percent between early 2014 till mid-2015, and the yen lost more than 30 percent of its value since mid-2012. The time paths of these currencies in the recent past and their historic ranges are shown in Figure 1. Such movements, although not unprecedented, are well outside the normal fluctuation ranges of these currencies.[2] The abrupt depreciation of the British pound following the United Kingdom's decision to leave the European Union added to this phenomenon.

Even for emerging market and developing economies (EMDEs), whose currencies typically fluctuate more than those of advanced economies (AEs), the recent movements have been unusually large. The yuan and the rupee have appreciated substantially while the Brazilian real and South African rand have depreciated significantly, by more than 50 percent since mid-2012 to the mid-2015. These currency movements have substantial impacts on trade competitiveness and the design of optimal policies. There is, however, no consensus on whether these changes imply large redistributions of trade flows in favor of depreciating currencies as they did in the past.[3]

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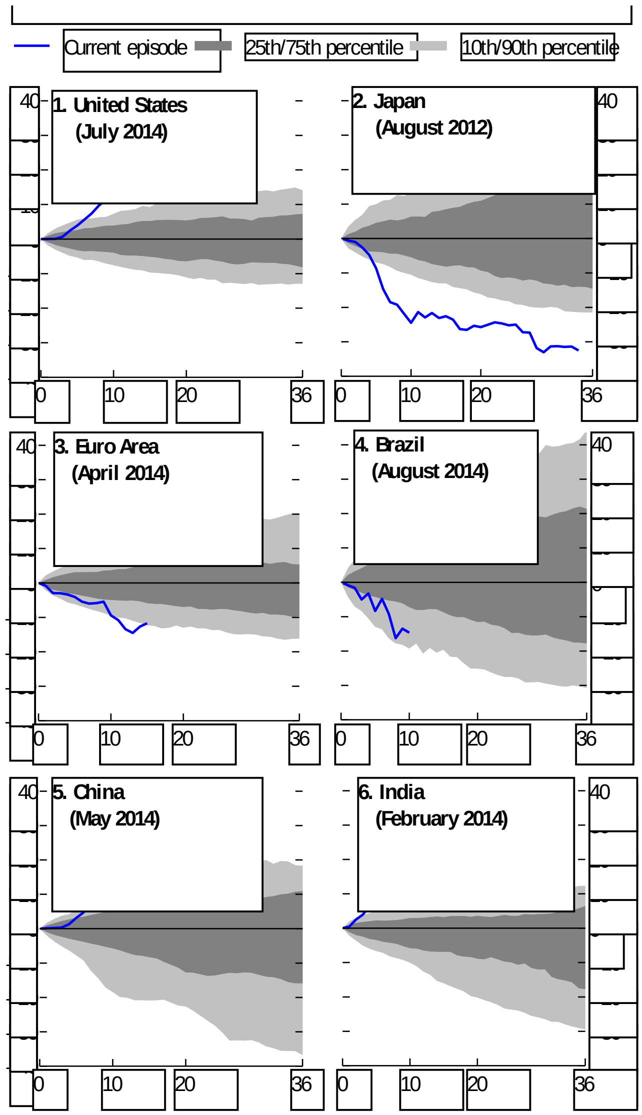
[1] Effective exchange rate refers to the exchange rate weighted by trade flows of a country's partners.

[2] Normal fluctuation range refers to the interval of exchange rate change that occurs with a 90 percent probability.

[3] Although our sample period thus far ends in June of 2015, before the largest recent drop in commodity prices, we still capture the beginning of that movement—and its effects on exchange rates and trade—for some countries and currencies.

Figure 1: Recent Exchange Rate Movements from Historical Perspective



Source: IMF, Information Notice System.
Note: Figure reports historical fluctuation bands for level of CPI-based real effective exchange rate based on all 36-month-long evolutions since January 1980. Confidence band at month *t* is based on all historical evolutions up to month *t*. Blue lines indicate most recent exchange rate paths of appreciation or depreciation that have no interruptions of more than three months. Dates in parentheses mark the starting point for the current episode in each panel. Last observation reported is June 2015.

Standard theoretical models predict that currency changes pass through into consumer prices. A domestic depreciation reduces export prices in a foreign currency and increases import prices in the domestic currency, which leads to more exports and less imports. This is the expenditure-switching effect of a currency depreciation (Obstfeld and Rogoff 2007). Basing his analysis on the above reasoning, Krugman (2015, 2016) predicts that the recent exchange rate movements will have a strong effect on trade. Bussiere et al. (2016) argue that exchange rate changes can play an important role in addressing global trade imbalances by showing that trade elasticities are high for the key economies from the trade perspective. Others argue that there is a disconnect between exchange rates and trade. Recent studies by the OECD (Ollivaud, Rusticelli, and Schwellnus, 2015) and the World Bank (Ahmed, Appendino, and Ruta, 2015) suggest that the increased participation in global value chains (GVCs) is a source of the apparent disconnect.

Claims of an exchange rate – trade disconnect, also referred to as 'elasticity pessimism' (Machlup 1950), gained popularity in the 1980s after the U.S. dollar's depreciation failed to promote U.S. trade, and the yen's appreciation, caused by the 1985 Plaza Accord, had little initial effect on Japanese exports. Nonetheless, the U.S.–Japan trade balance later adjusted in line with the predictions of conventional models (Krugman 1991). The main question, therefore, is whether the current situation is different and trade has become less connected to exchange rates, possibly reflecting the changes in the organization of world trade since the trade liberalization that began in the 1990s.

Whether exchange rates and trade are disconnected is important for the formulation of economic policies. A disconnect could weaken monetary policy, by reducing its effect on trade balance, and it also could slow down the resolution of global imbalances.

The focus of this paper is on the stability of the relationship between exchange rates and trade flows over time. Endogeneity of the studied relation is the most important challenge and which we mitigate in several ways. Mainly, our main analysis focuses on large depreciation episodes, which are less subject to reverse causality from trade to exchange rates. Additionally, we analyze separately the relationship between exchange rates and trade prices (exchange rate pass-through), and that between trade prices and trade volume (price elasticity of trade volume). This allows us to control for foreign and domestic demands in the regression specifications to be in line with theory, mitigating omitted variable biases. In particular, we control for unit labor costs in exchange rate pass-through equations to reduce the bias caused by the Balassa-Samuelson-Baumol effect.[4]

While trade elasticities estimated from the large depreciation episodes are less likely to be confounded by other factors, this strategy, however, would not allow us to address the stability of trade elasticities, which many have challenged recently. That is because large devaluations occur irregularly. So, we compare the large devaluation estimates with various full-sample ("standard") estimates and found the results to be similar. This result suggests that the endogeneity bias is small. Thus, we proceed to estimate full-sample rolling-window trade elasticities that turn out to be stable over time. In doing this exercise, we note that the previous body of work used economically inconsistent deflation methods and failed to account for data outliers, leading to a different conclusion.[5] Finally, although statistically weaker, the results of the sectoral analysis are consistent with the large currency depreciation estimates.

One of our main findings is that we do not find strong and consistent effects of GVC participation on the strength of the exchange rate–trade relationship. While it has increased over time, GVC participation remains low on average. This fact makes it difficult to estimate precisely the effect of GVC participation on the relationship. We find, however, that economic slack and financial conditions do play an important role. Both tighter financial conditions and lower economic slack reduce export volumes' responses to exchange rates.

We conclude, therefore, that exchange rates remain an effective policy tool. We estimate that a 10 percent real effective depreciation in an economy's currency is associated on average with a 1.5 percent increase in real net exports as a share of GDP, with substantial cross-country

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[4] This downward bias on the pass-through elasticity from the real effective exchange rate to trade prices reflects rising distribution and retail costs, owing to the increase in the costs of labor and rent internationally (Balassa-Samuelson effect) and domestically (Baumol effect) over time (Frankel, Parsley, and Wei 2005).

[5] The exchange rate pass-through into consumer prices is much weaker than into border prices. Moreover, the CPI reflects prices of many non-traded goods and services, which do not relate to the cost structure of exports. Both of these factors underscore that the CPI-deflated trade volume is a biased measure of the true volume, and using it in econometric analysis may lead to spurious results. Appendix B discusses in detail the differences between our results and those of Ahmed, Appendino, and Ruta (2015).

variation around this average. Most of the response of trade to exchange rate movements materializes within the first year of the initial exchange rate movement.

Importantly, our study is also the most extensive to date in country coverage. We estimate trade elasticities for 60 - 88 AEs and EMDEs for the period 1980–2014, depending on the specific exercises. Our dataset goes beyond core AEs typically examined in related studies. This fact is important because of the growing importance of EMDEs in world trade.[6] Given that trade data is noisier than other macroeconomic data, individual trade elasticities are typically estimated imprecisely. Our broad country coverage reduces the risk that the stability test results may be driven by idiosyncratic noise.

The remainder of this paper is structured as follows. Section II describes our estimates of trade elasticities at the macroeconomic level. Section III investigates large currency depreciation episodes, and Section IV performs the analysis based on sectoral data. Section V concludes and discusses the main policy implications of our findings.

2. ESTIMATING AGGREGATE TRADE ELASTICITIES

Estimation of the aggregate trade relationships (between exchange rates and trade) has several caveats, the most important being endogeneity. While the latter is likely inevitable, other issues can be avoided or minimized. Importantly, factors such as foreign demand and domestic labor costs are known to affect only the supply of or demand for exports. Hence, we analyze separately the two parts of the trade relationship – the link between the exchange rate and export/import prices and the link between the export/import prices and export/import volumes. While we find that the more-granular approach does not affect our results substantively, it could lead one to a misleading conclusion if the influence of these variables varied over time. Then one could conclude that there is a disconnect between exchange rates and trade if, for

[6] Much of the literature focuses on AEs. Notable exceptions include Bussière, Delle Chiaie, and Peltonen (2014), which estimates trade price equations for 40 economies, whereas Morin and Schwellnus (2014), estimate trade elasticities for 41 economies (most of them OECD members).

example, the effect of foreign demand grew over time.[7] Our approach avoids the potential bias caused by a misspecification of trade equations.

The reverse causality from trade volume to trade prices can lead to a downward bias in the estimate of price elasticity of trade volume as explained in Orcutt (1950). Demands are not observed and preference shocks can lead to a shift in demands not captured by GDP or GDP components. Because the endogeneity bias can be material and it can very over time, we estimate the relations from the sample of large currency depreciation episodes. We use the obtained estimates to test the hypothesis of a disconnect between trade and exchange rates, and the hypothesis that the trade elasticities are driven by the degree of GVC participation. Then, we compare these results to the estimates obtained from the unfiltered sample.

Finally, Imbs and Mejean (2015) show that the heterogeneity of demand elasticities across different goods can lead to a downward bias because goods with lower elasticities have a stronger impact on the aggregate trade elasticities. To evaluate the impact of this bias on our results, we perform the same analysis at the sectoral level.

The pricing-to-market literature (Krugman 1985, 1986; Feenstra, Gagnon, and Knetter 1996; Campa and Goldberg, 2005; Burstein and Gopinath 2014) provides us with a model for the relationship between exchange rate movements and relative export and import prices (referred to as the exchange rate pass-through [ERPT] equation). In this framework, exporting firms maximize profits by choosing export prices, while taking into account the demand for their products and their competitors' prices; currency movements may not be passed into export prices relative to competitors' prices one-for-one. The exchange rate pass-through equation of exports takes the following form:

$$\frac{eP^X}{P^*} = S\left(\frac{ULC}{P}, \frac{eP}{P^*}\right), \qquad \text{Equation 1}$$

where e is the nominal effective exchange rate (NEER); P^X is the price of exports in domestic currency; P^* is the foreign price level; P is the domestic price level; ULC is the nominal unit

[7] In this case the estimated elasticity would be understated because of the negative correlation between foreign demand and the exchange rate.

labor cost, so that *ULC/P* denotes the real unit labor cost; and $eP/P*$ denotes the real effective exchange rate (REER). Controlling for the unit labor cost allows us to mitigate the bias caused by Balassa-Samuelson effects – positive productivity shocks may lead to currency appreciation and lower export prices, confounding the exchange rate pass-through estimation.

The relationship between the relative prices and trade volumes (referred to as the equation for the price elasticity of trade) is motivated from foreign consumers' optimal decisions, which lead export volumes to depend on export prices relative to competitors' prices and foreign demands. The price elasticity of export volume equation takes the following form:

$$X = D\left(\frac{eP^X}{P^*}, Y^*\right), \qquad \text{Equation 2}$$

where $eP^X/P*$ is the foreign currency relative export price; and $Y*$ denotes the foreign demand. The standard practice in the literature is to measure $Y*$ by trade-weighted foreign GDP. Given the difference across GDP components in import intensity, documented by Bussière et al. 2013, we control for GDP components separately. The import price and volume equations can be derived analogously based on the observation that the price of each economy's imports is the price of its trading partners' exports expressed in domestic currency units.[8]

2.1. Empirical Model

Our benchmark is Autoregressive Distributed Lag (ARDL) model, which has been widely used in the literature (see Bussière, Delle Chiaie, and Peltonen 2014 for the most recent application and for references therein). The model can be estimated using individual country data to allow trade elasticities to differ across countries or using the pulled sample. We find large variations across countries in trade elasticities, which cannot be explained by commonly-studied country characteristics[9] and some of which should be attributable to measurement errors in trade variables. Then, to study the stability of trade elasticities over time, we estimate rolling panel regressions that take the same form as the benchmark models.

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8 The equations for imports are similar to the exports equations. The import supply function is $P^M/P = S(eP^*/P, Y)$ and the import demand function is $M = D(P^M/P, Y)$.

9 The results are available upon request.

The panel regression of the exchange rate pass-through to export prices in local currency takes the following form:[10]

$$\Delta \ln\left(\frac{eP^{X}}{P^{*}}\right)_{it} = \mu_i + \tau_t + \rho\Delta \ln\left(\frac{eP^{X}}{P^{*}}\right)_{i,t-1} + \sum_{j=0}^{2}\beta_j \Delta \ln\left(\frac{eP}{P^{*}}\right)_{i,t-j} + \sum_{j=0}^{2}\gamma_j \Delta \ln\left(\frac{ULC}{P}\right)_{i,t-j} + \varepsilon_{it}, \qquad \text{Equation 3}$$

where μ_i denotes country-fixed effects, τ_t denotes time fixed effects, and ε_{it} denotes the residuals. As we find little evidence that export prices adjust in response to exchange rate movements beyond two years, we include only two lags to account for possible delayed effects of exchange rate movements on export prices.

Using the same notation, the equation for the price elasticity of export volume takes the following form:

$$\Delta \ln X_{it} = \mu_i + \tau_t + \rho\Delta \ln X_{i,t-1} + \sum_{j=0}^{2}\beta_j \Delta \ln\left(\frac{eP^{X}}{P^{*}}\right)_{i,t-j} + \gamma\Delta \ln Y_{it}^{*} + \lambda\left(\Delta \ln Y^{*} \times gfc\right)_{it} + \varepsilon_{it}, \qquad \text{Equation 4}$$

where the coefficient on the foreign demand $\Delta \ln Y_{it}^{*}$ is allowed to change during the global financial crisis (defined as years 2008 and 2009)[11].

The equation of exchange rate pass-through to import prices in local currency is:

$$\Delta \ln\left(\frac{P^{M}}{P}\right)_{it} = \mu_i + \tau_t + \rho\Delta \ln\left(\frac{P^{M}}{P}\right)_{i,t-1} + \sum_{j=0}^{2}\beta_j \Delta \ln\left(\frac{eP}{P^{*}}\right)_{i,t-j} + \Delta \ln Y_{it} + \varepsilon_{it}, \qquad \text{Equation 5}$$

The equation of the price elasticity of import volumes is:

$$\Delta \ln M_{it} = \mu_i + \tau_t + \rho\Delta \ln M_{i,t-1} + \sum_{j=0}^{2}\beta_j \Delta \ln\left(\frac{eP}{P^{*}}\right)_{i,t-j} + \delta\Delta \ln X_{it} + \gamma\Delta \ln DD_{it} + \lambda\left(\Delta \ln Y \times gfc\right)_{it} + \varepsilon_{it}, \qquad \text{Equation 6}$$

where we separately control for domestic demands – defined as the sum of real consumption and real investment, and real exports, to account for GDP components' differences in import intensity (Morin and Schwellnus, 2014). In the analysis below, we focus on the long-term elasticity, defined as:

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10 We conduct the panel cointegration tests proposed by Pedroni (2004) and find little evidence of cointegration among the variables.

11 See Bussière et al. (2013) for the argument.

$$\textit{Long-term elasticity} = \sum_{j=1}^{2} \beta_j \,/(1-\rho). \qquad \text{Equation 7}$$

2.2. Data

Table A1, A2, A3, and A4 in the Appendix list the countries included in the various analyses. In addition, Table A5 describes all indicators used in the paper and their sources. Below we describe our main dataset.

The main sample for this analysis includes 60 economies (23 AEs and 37 EMDEs). Depending on the data availability and the economy in question, the sample period starts between 1980 and 1989 and ends in 2014.[12] When estimating trade elasticities for individual economies, the sample is restricted to those countries that have at least 25 years of annual data available.

The main variables used in the analysis are defined as follows: the NEER and CPI-based REER (both taken from the INS) are computed as the gross-export-weighted averages of trading partner bilateral exchange rates. We construct producer price index (PPI)-based REER, and trade-weighted foreign producer prices, using the trade weights from the INS. Whenever the sample size is not a concern, we use PPI-based variables to limit the potential bias caused by the Balassa-Samuelson-Baumol effects. The unit labor costs data of OECD countries come from OECD Statistics. For non-OECD economies, we construct the unit labor cost as the total wage bill divided by real GDP, with the total wage bill[13] and real GDP taken from the IMF's WEO database, Haver Analytics, the International Labor Organization, the IMF's International Financial Statistics, and the CEIC database.

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[12] The sample further excludes a number of AEs with special circumstances: Hong Kong SAR and Singapore, given these economies' significant entrepôt activity; and Ireland, because of its special treatment of export sales (IMF, 2015a,b,c,d). To avoid unduly influencing the results with developments in small or very low-income economies, it excludes economies with fewer than 1 million inhabitants as of 2010, or with an average per capita income (at purchasing-power parity) of less than $3,000 in 2014 prices.

[13] When unavailable, total wage bill data are constructed using the average wage rate and total employment.

3. ANALYSIS OF LARGE CURRENCY DEPRECIATION EPISODES

3.1. Rationale and Empirical Model

Our baseline empirical analysis focuses on large currency depreciation episodes. As argued in the introduction, this approach helps us to reduce the effect of endogeneity. Endogeneity decreases the trade elasticities, but the strength of the bias is unknown. This factor precludes a meaningful analysis of the dynamics of the trade relationships.

The advantage of analyzing large depreciation episodes is that exchange rate fluctuations in such cases are less likely to be driven by foreign demand shocks, and hence they are more likely to be exogenous to export prices and volumes compared with smaller depreciations. It is unlikely that foreign demand and preference shocks change abruptly and simultaneously. The same logic precludes us from analyzing imports which are likely to be influenced by the same factors that drive the currency value.

At times of external stress, the exchange rate changes are likely to be the most significant factor influencing exporters' decisions. Thus, the demand curve for exports should be relatively stable compared to the exchange rate and export changes. As a result, the bias in our implied price elasticities that measure the slope of the demand curve should be minimized.

Key restricting factors. The exchange rate pass-through and price elasticity of trade volume of exports inferred from the large currency depreciation episodes can differ from the "normal-times" responses. For example, exporters may react more strongly to exchange rate movements, as they are more likely to overcome various fixed costs associated with the trade. Still, exports may not always respond stronger during large currency depreciation episodes than in normal times because the financial intermediation (including trade credit) can be severely depressed (Ahn, Amiti, and Weinstein 2011). This factor is especially important for countries with a currency mismatch.

To remove bias due to an interruption of financial intermediation, we exclude episodes associated with banking crises. Producers are also likely to find themselves unable to respond to exchange rate depreciation during high inflation periods as banks may be unwilling to provide working capital at times of increased uncertainty. So, we also exclude episodes with high inflation.

Related work. Episodes of large currency depreciations have been studied in the 1990s and early 2000s by Borensztein and De Gregorio 1989, Frankel and Rose 1996, Goldfajn and Valdés 1999, and Milesi-Ferretti and Razin 2000 among others. These studies found that large exchange rate movements have a significant effect on the current account and CPI. More recently, De Gregorio (2016) examined episodes dating back to the early 1970s and found that the responses of the current account (and CPI) to exchange rate movements had become muted compared with the past. An important difference between our analysis and others is that we focus on exports as imports and exchange rates can move due to unobserved factors. We also study changes in relative export prices rather than CPI. The latter is less likely to be affected by the exchange rate changes because of large distributional costs (see Burnstein and Gopinath, 2014) and because imports constitute a relatively small fraction of many economies' consumption baskets.

Identification of large depreciation episodes. We identify large exchange rate depreciation episodes using two criteria. The first criterion identifies a large depreciation as an unusually sharp nominal depreciation of the currency vis-à-vis the U.S. dollar. Our definition of unusually large depreciation is that it is larger than the 90th percentile of all annual depreciations in the sample. The second criterion ensures that every episode is captured only once. It requires the change in the depreciation rate compared with the previous year to be unusually large, i.e., greater than the 90th percentile of all changes. Because exchange rates tend to be more volatile in the EMDEs than in AEs, both quantiles (for depreciation and depreciation change) are computed separately for the two groups of countries. For the first criterion, the threshold for AEs is a depreciation of 13 percent vis-à-vis the dollar, whereas, for EMDEs, the threshold is 20 percent. For the second criterion, the AE and EMDE thresholds are both about 13 percentage points.

Further, we exclude episodes that are associated with banking crises or annual inflation above 30 percent. An episode is excluded if a banking crisis occurred within three years of the crisis, based on an updated version of the dataset constructed by Laeven and Valencia (2013).

Our methodology identifies 66 episodes of large currency depreciations during 1980–2014. As reported in Table 3, about one-quarter (17) of these episodes occurred in the AEs,[14] with the most notable episode being the 1992 European Exchange Rate Mechanism crisis. The remaining episodes occurred in the EMDEs with the most prominent examples being the 1994 devaluation of the Chinese yuan and the large depreciation of the Venezuelan bolívar in 2002. The episodes that satisfy our selection criteria are driven by concerns about misalignment of exchange rates with fundamentals rather than preference shocks to foreign demands. To illustrate, the Reserve Bank of New Zealand dismissed fundamentals as a cause of the 44 percent depreciation of the New Zealand dollar against the U.S. dollar between 1997 and 2000.[15]

Empirical analysis. Our empirical analysis is similar to how Cerra and Saxena (2008) analyze banking crises, and Romer and Romer (2010) analyze fiscal shocks. We use an ARDL model in first differences and include a dummy $shock_{i,t-j}$ indicating whether a large exchange rate depreciation episode occurred j periods before. The coefficient of this variable – β_j – measures the response of the exchange rate depreciation on exchange rates, export prices, and export volume.

$$\Delta \ln\left(\frac{eP}{P^*}\right)_{it} = \mu_i + \tau_t + \rho\Delta\ln\left(\frac{eP}{P^*}\right)_{i,t-1} + \sum_{j=0}^{2}\beta_j shock_{i,t-j} + \varepsilon_{it}, \qquad \text{Equation 8}$$

$$\Delta \ln\left(\frac{eP^X}{P^*}\right)_{it} = \mu_i + \tau_t + \rho\Delta\ln\left(\frac{eP^X}{P^*}\right)_{i,t-1} + \sum_{j=0}^{2}\beta_j shock_{i,t-j} + \sum_{j=0}^{2}\gamma_j \Delta\ln\left(\frac{ULC}{P}\right)_{i,t-j} + \varepsilon_{it}, \qquad \text{Equation 9}$$

$$\Delta \ln X_{it} = \mu_i + \tau_t + \rho\Delta\ln X_{i,t-1} + \sum_{j=0}^{2}\beta_j shock_{i,t-j} + \gamma\Delta\ln Y^*_{it} + \varepsilon_{it}, \qquad \text{Equation 10}$$

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[14] The baseline results for the effects of large exchange rate depreciation episodes are compared with the results based on the following three alternative approaches: (i) local projection methods; (ii) thresholds based on real effective exchange rate depreciations; and (iii) using Laeven and Valencia's (2013) currency crisis episodes. In each case, the results are similar to the baseline results.

[15] Donald Brash's speech "The fall of the New Zealand dollar - why has it happened, and what does it mean?" of October 5, 2000, addressed to the American Chamber of Commerce, can be accessed at http://www.bis.org/review/r001012b.pdf.

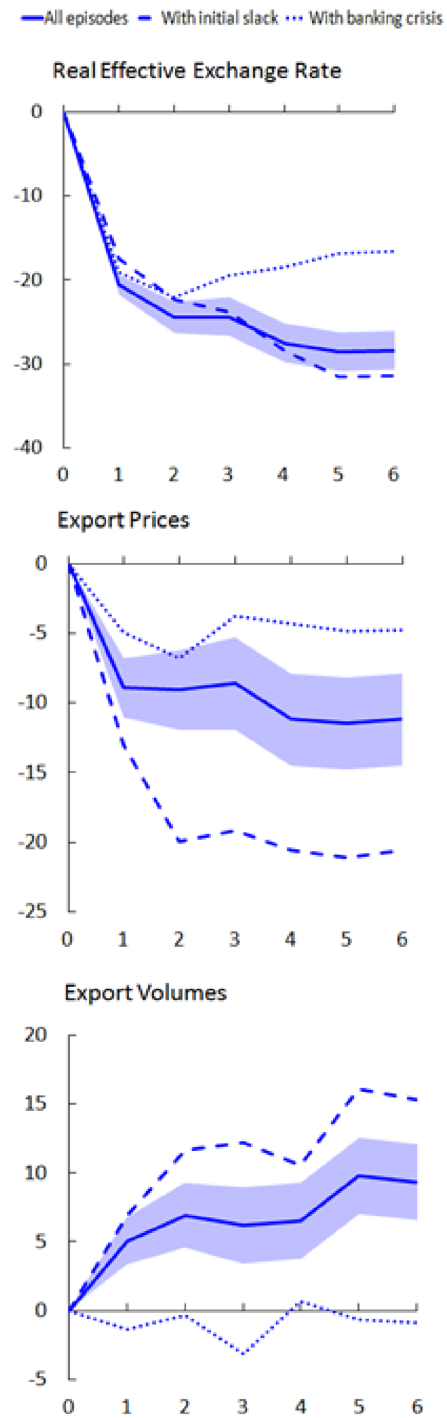
where the subscript *i* denotes the *i-th* country and the subscript *t* denotes the *t-th* year; and *shock* is the dummy variable, indicating the occurrence of a large depreciation. We include country and time dummies to account for country fixed effects and common time trends, respectively. We sum the estimated lagged impacts of large exchange rate depreciation to obtain the cumulative impact on the level of export prices and export volumes.

We find that on average, exports increase substantially following large depreciations. As shown by the solid line in the top panel of Figure 2, the real effective exchange rate on average declines 25 percent over five years during the identified depreciation episodes. Export prices in foreign currency fall by about 10 percent, with much of the adjustment occurring in the first year (solid line in the middle panel of Figure 2). The implied real exchange rate pass-through to export prices is thus about 0.4, which is similar to the estimate based on the trade equations at macro level presented in section 4. The solid line in the bottom panel of Figure 2 shows that export volume increases gradually with the cumulated change of about 7 and 10 percent over two and five years, respectively.[16] This response suggests an average price elasticity of exports of about 0.7. It is higher than the elasticity of 0.3 estimated using full-sample trade country-level equations. The high estimated price elasticity is consistent with the idea that fixed costs preventing the adjustments of trade volumes during smaller depreciations are less important during large depreciation episodes. Finally, we note that all results are statistically significant at conventional levels.[17]

[16] Consistent with this result, Alessandria, Pratap, and Yue (2013) find that exports rise gradually following a large depreciation, based on data for 11 emerging market economies.

[17] These results are robust to alternative methodologies that estimate the impulse responses or identify large exchange rate movements. We experiment with using nominal exchange rates to define large depreciation episodes and studying the impulse responses using a local project method (Jordà 2005). Results are available upon request.

Figure 2: Export Dynamics Following Large Exchange Rate Depreciations



3.2. Role of Initial Conditions

The analysis of large exchange rate depreciations allows us to investigate how economic conditions affect export responses to exchange rate movements. Our hypothesis is that when there is more economic slack and spare capacity in the economy, there are better possibilities for production, with exports expanding in reaction to exchange rate depreciation. We proxy spare capacity by the difference between the (demeaned) real GDP growth in the year preceding the episode and the median growth for the 66 episodes (which is close to zero).[18]

The results suggest that for the subsample of episodes with initial slack, the export gain is larger than in the full sample by an additional 7 percentage points after five years (dashed lines in Figure 2).[19] Exchange rates also tend to depreciate more, and in a more persistent manner than in the full sample, arguably providing exporters with stronger incentives to cut export prices.

We also consider whether export increases associated with a large exchange rate depreciation depend on the health of the exporting economy's financial sector. Our hypothesis is that banking crises can depress exports by reducing the availability of credit needed to support export production,[20] and the drop in credit availability can offset export gains due to the

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[18] The results are broadly similar when the definition of economic slack is based on the output gap in the year preceding the large exchange rate depreciation.

[19] To ease comparability of the results for the two groups, the estimated impulse responses are scaled to ensure that the first-year impact on the real exchange rate is exactly the same.

[20] Ronci (2004) analyzes the effect of constrained trade finance on trade flows in countries undergoing financial and balance of payments crises, and concludes that constrained trade finance depresses both export and import volumes in the short term. Dell'Ariccia, Detragiache, and Rajan (2005) and Iacovone and Zavacka (2009) find that banking crises have a detrimental effect on real activity in sectors more dependent on external finance, which includes export-oriented sectors. Kiendrebeogo (2013) investigates whether banking crises are associated with declines in bilateral exports, by estimating a gravity model using a sample of advanced economies and developing countries for the period 1988–2010. The results suggest that banking-crisis-hit countries experience lower levels of bilateral exports, with exports of manufactured goods falling particularly hard. More generally, for an analysis of the evolution of trade following large depreciations associated with financial crises, see IMF (2010).

currency depreciation. To test this hypothesis, we restrict the sample to large currency depreciations associated with a banking crisis. We identify 57 new episodes distinct from those included in the baseline large-depreciation analysis. They include the large exchange rate depreciations in Finland and Sweden in 1993; Thailand and Korea in 1997-1998, respectively; Russia in 1998; Brazil in 1999; and Argentina in 2002.[21] The results support our hypothesis. Figure 2 shows that the boost to exports is weaker when the exchange rate depreciation is associated with a banking crisis (dotted lines). In this case export prices decline by less, suggesting an average elasticity of export prices to the real effective exchange rate of 0.25, about half of the baseline estimate. The response of real exports is near zero. Yet for a number of episodes associated with banking crises, some studies find that the effect on exports is positive – for example, the large depreciations of Argentina (2002), Brazil (1999), Russia (1998), and Sweden (1993).[22]

The results in this section suggest that trade responds substantially to exchange rates, with the response being the largest when there is slack in the economy and the financial sector is operating normally. When the economy is at high capacity or when the banking sector is weak exports are expected to respond little. This may be an explanation of the sluggish response of trade to large exchange rate swings in the aftermath of the GFC.

3.3. Dynamic Analysis of Elasticities

To study the stability of trade elasticities, we split the sample into two equal sub-periods and compare the dynamic responses of the variables for these two period subsamples separately. Of the 66 large currency depreciation episodes in the sample, half (33) occurred in 1997 or earlier, and the other half occurred in more recent years. We compare inferred exchange rate

[21] The list of episodes is available upon request. The results for such analysis are also robust to controlling for the occurrence of banking crises in trading partners in the estimated equations.

[22] For additional analysis of the effects of the 2002 Argentina episode, see Calvo, Izquierdo, and Talvi (2006). For the 1998 Russia episode, see Chiodo and Owyang (2002). For the 1993 Sweden episode, see Jonung (2010). See also IMF (2010).

pass-through to export prices and the price elasticity of export volume for those two subsamples.

To compare trade elasticities in the current context of dynamic trade and exchange rate responses to large currency depreciation *events*, we scale the impulse responses so that the first year's exchange rate responses to large currency depreciation events are the same in two subsamples. We then compare the movements of exchange rates after one year, and the changes in export prices and export volumes over time.

Figure 6 shows that exchange rate and export volume movements are very similar between the two subsamples. The export price responses seem to be weaker for the first two years after 1997 compared with before 1997,[23] but the long-term changes are quite similar between the two subsamples. Therefore, we do not find evidence that exchange rate and trade are disconnected over time.

4. INDIVIDUAL ECONOMY ESTIMATES

We re-estimate the benchmark models country-by-country. There are two differences compared with the main specification (Equation 3, Equation 4, Equation 5, Equation 6). The first modification is that we replace time fixed effects with two variables: (i) a time trend, and (ii) a dummy of the global financial crisis. Controlling for the time trend takes into account country-specific productivity trends, which may confound the estimation due to Balassa-Samuelson effects. Additionally, we control for global commodity prices in the exchange rate pass-through equations.

The second modification is that for a large fraction of economies in our sample, a Dickey-Fuller cointegration test cannot reject that a cointegration relationship exists among the

23 We do not have a good explanation for this, which might reflect the different nature of the shocks driving large depreciations of exchange rates. However, when we conduct a rolling regression analysis for one-year and two-year exchange rate pass-through to export prices (results are available upon request), we do not find an evidence of disconnect over time.

variables in the regression equation.[24] For these countries, we estimate the benchmark model in levels rather than in the ARDL form. The lagged dependent variables and lagged changes in other explanatory variables are excluded. Moreover, levels of explanatory variables are included instead of their changes. Taking into account cointegration relationships enables us to estimate trade elasticities more efficiently.

Table 1. Exchange Rate Pass-Through and Price Elasticities

	Exchange Rate Pass-Through		Price Elasticity of Volumes		Marshall-Lerner Condition Satisfied?[1]
	Export prices	Import prices	Exports	Imports	
Based on Producer Price Index[2]					
Long-Term	0.552	–0.605	–0.321	–0.298	Yes
One-Year Effect	0.625	–0.580	–0.260	–0.258	Yes
Based on Consumer Price Index[3]					
Long-Term	0.457	–0.608	–0.328	–0.333	Yes
One-Year Effect	0.599	–0.546	–0.200	–0.200	Yes
Memorandum					
Non–Commodity Exporters[4]					
Long-Term Elasticity[2]	0.571	–0.582	–0.461	–0.272	Yes

Source: IMF staff estimates.

Note: Table reports simple average of individual economy estimates for 60 economies during 1980–2014.

[1]The formula for the Marshall-Lerner condition adjusted for imperfect pass-through is (–*ERPT* of P^X) (1 + price elasticity of X) + (*ERPT* of P^M) (1 + price elasticity of M) + 1 > 0, in which X denotes exports, M denotes imports, and P^X and P^M denote the prices of exports and imports, respectively (Annex 3.3).

[2] Estimates based on producer price index–based real effective exchange rate and export and import prices relative to foreign and domestic producer prices, respectively.

[3] Estimates based on consumer price index–based real effective exchange rate and export and import prices relative to foreign and domestic consumer prices, respectively.

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[24] The share of economies for which there is no evidence of cointegration is 57 percent for export price equation , 50 percent for export volume equation , 56 percent for import price equation , and 54 percent for import volume equation , respectively.

[4] Excludes economies for which primary products constitute the main source of export earnings, exceeding 50 percent of total exports, on average, between 2009 and 2013.

Individual country estimates suggest that exchange rates and trade prices are connected on average in the sample. As presented in the top panel of Figure 4, almost all exchange rate pass-through coefficients fall into the interval of [0,1].[25] Table 1 reports the averages of these coefficients and shows that a 10 percent exchange rate depreciation in real effective terms reduces export prices in local currency by 5.5 percent and increases import prices by 6.1 percent in the long-term,[26] with most of the effects materializing within one year. These results suggest incomplete pass-through and are in line with previous studies. For example, Campa and Goldberg (2005) find that the average of the one-year pass-through coefficients for 23 OECD countries is 0.64, and that of the first quarter pass-through coefficients is 0.46, which is comparable to our estimates of 0.61 and 0.55.[27]

The bottom panel of Figure 4 suggests that trade prices and trade volumes are connected. As the price elasticity of trade volume equations suffer from endogeneity issues, the results should be interpreted with caveats – the reverse causality may bias the coefficient downward, while the measurement errors in trade prices may instead bias the coefficients upward.[28] Overall, we find that the estimated price elasticities of trade volume have expected negative signs. Their average, as reported in Table 1, suggests that a 10 percent increase in export and import prices

[25] It is interesting to note that economies with stronger exchange rate pass-through to export prices in foreign currency tend to have weaker pass-through to domestic import prices, a pattern that also emerges from the findings of Bussière, Delle Chiaie, and Peltonen (2014).

[26] The corresponding response of export prices in *domestic* currency to a real effective currency depreciation of 10 percent would be a rise of 4.5 percent (–10 × (0.552 – 1)).

[27] See Table 3 of the paper.

[28] Trade volumes are measured as trade values divided by trade prices, with trade values likely measured in a more precise way than trade prices.

reduces export and import volumes by about 3 percent in the long term.[29] Most of these effects also materialize within one year.

Our estimated price elasticities of trade volume appear low compared with those used in computable general equilibrium models of international trade policies (for example, see Table 18.1 in Hillberry and Hummels, 2013). One explanation for this outcome is that the average trade elasticities are estimated across all types of episodes.[30] Why does the average shock not induce strong adjustments in trade volume? Given retail price adjustment costs, delivery lags, and transaction-level economies of scale (Alessandria, Kaboski, and Midrigan 2010), it is likely that local retailers do not respond to noisy or transitory movements of import prices. Our results suggest that the reverse causality does not play a significant role, even though it may in theory bias downward estimated price elasticities of trade volume.[31,32]

We further find that the Marshall-Lerner condition under incomplete pass-through[33] holds for the average estimated elasticities, as reported in Table 1. Satisfying this condition suggests that that exchange rate depreciation leads to an improvement of nominal trade balances (i.e., it is connected with trade).

[29] While we present the results with the mean-group estimates in Table 1, the results using the panel estimation (pooled mean group) are similar (not shown here, but available upon request), indicating the robustness of the elasticities estimated.

[30] Moreover, our average shock driving trade prices may also be different from shocks explored in other studies, for example, those during trade liberalization episodes.

[31] Preference shocks, which are hard to be measured or captured by GDP and its components, may drive trade prices and quantities in the same direction.

[32] Notice that we also find that the price elasticities of trade volume inferred from the large currency depreciation episodes in the next section are broadly similar to the numbers estimated here. Using a sector level analysis, we further find that industries with large shares in a country's export—whose foreign demand shifts are more likely to reversely affect exchange rates—have similar response of trade volumes to exchange rates compared with industries with small shares in a country's export.

[33] The condition differs from that under the complete-pass through and its derivation is available in Annex 3.3 of IMF (2015e).

4.1. Dynamic Analysis

If exchange rates and trade are disconnected over time, we should expect the responses of export prices and volumes to exchange rate movements during large depreciations episodes (that are not associated with banking crises) to decline over time.

The exchange rate pass-through and price elasticity of trade volume of exports inferred from large currency depreciations, however, can differ from those inferred from other episodes. Exporters may respond more strongly to exchange rate movements, as they are more likely to overcome fixed adjustment costs of trade. But the exchange rate-trade link may not always be stronger during large currency depreciation episodes, because the financial intermediation can be severely depressed (Ahn, Amiti, and Weinstein 2011), especially for countries with a currency mismatch, dampening the response of exports to exchange rate movements.

To reduce bias due to an interruption of financial intermediation during large currency depreciation episodes, we exclude episodes associated with banking crises. We also exclude episodes with high inflation – those with annual inflation rates above 30 percent.

Episodes of large currency depreciations have been studied in the 1990s and early 2000s by Borensztein and De Gregorio 1989, Frankel and Rose 1996, Goldfajn and Valdés 1999, and Milesi-Ferretti and Razin 2000 among others. These studies found that large exchange rate movements have significant effect on the current account and CPI More recently, De Gregorio (2016) examined episodes dating back to the early 1970s, and found that the responses of the current account (and CPI) to exchange rate movements are had become muted compared with the past. [34] The important difference between our analysis and that of De Gregorio (2016) is that we focus on exports as imports and exchange rates can co-move due to third factors. We also study changes in relative export prices rather than CPI.

This section answers the main question of this paper: Has the relationship between exchange rates and trade remained stable over time? Or has the relationship weakened over time, and if so, what factors have been driving the change?

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[34] Joy et al. (2015) also investigate currency and banking crises, but they focus on the determinants of those crises rather than their effects on trade.

Previous studies have investigated the stability of trade elasticities without reaching a consensus.[35] Several studies find evidence of changing trade elasticities for a single country or a subset of goods. For example, Otani, Shiratsuka, and Shirota (2001) find that the exchange rate pass-through to import prices declined in Japan in the 1990s, compared with the 1980s; and Frankel, Parsley, and Wei (2012) find a downward trend in the pass-through to import prices for EMDEs in a study of eight commodities.[36]

Others contend that the instability results of these studies cannot be generalized. For example, Campa and Goldberg (2008) find that while the pass-through may have declined at import price levels, the results are inconclusive for some types of goods and countries.

Most studies examine the exchange rate pass-through, with the important recent exception of Ahmed, Appendino, and Ruta (2015). Their paper analyzes exchange rate movements' effects on export volume, and finds that trade elasticities have declined in the recent decade. They attribute the results to the expansion of GVCs. We find, however, that their results depend critically on the use of CPIs as the deflator to construct export volumes from export values. The results are also sensitive to excluding outliers during high inflation episodes, as often-used approximate growth rates become inaccurate.[37] These two critiques apply generally, and should be taken into account in every empirical analysis of trade elasticities.

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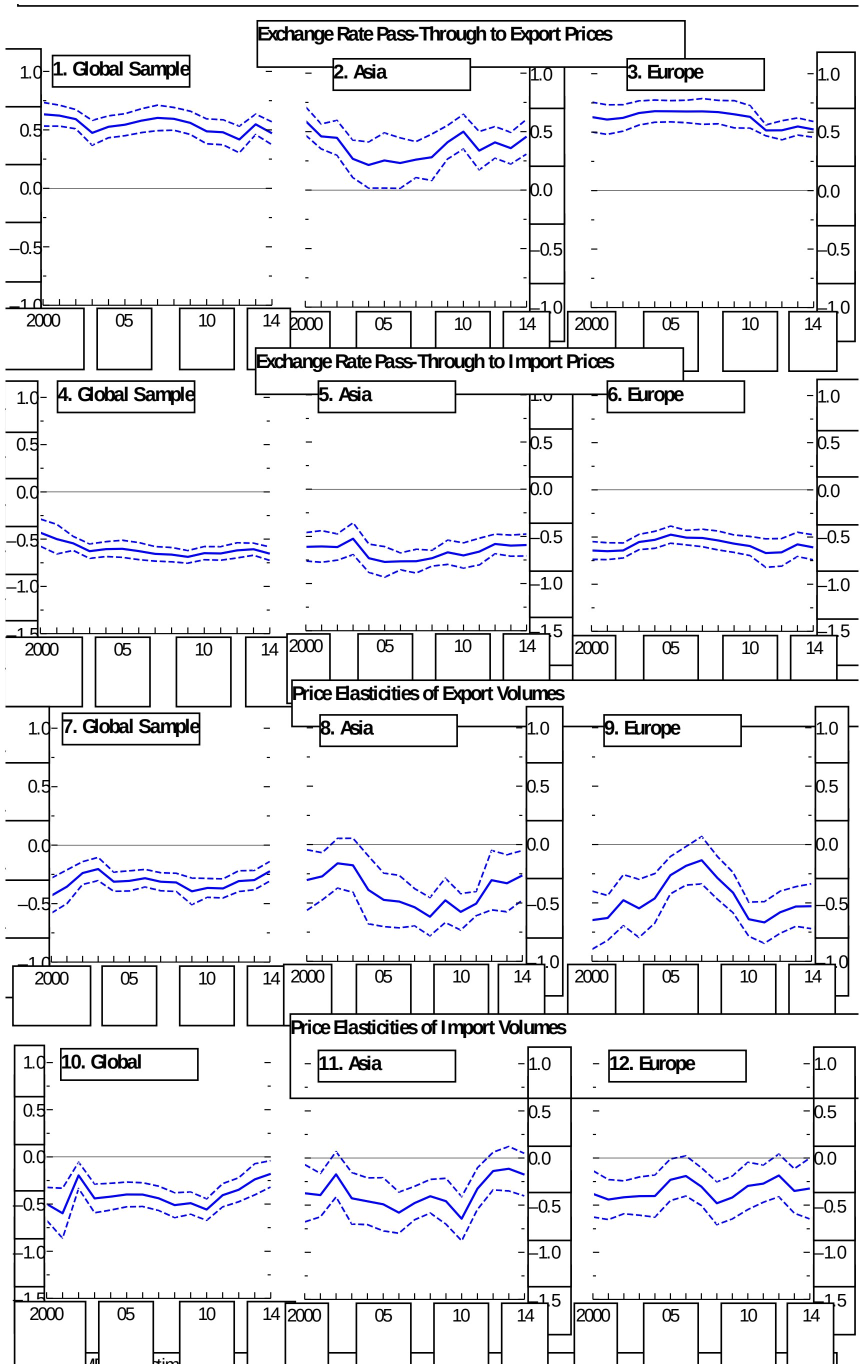
[35] Goldstein and Kahn (1985) provide a comprehensive literature review on early studies.

[36] Gust, Leduc, and Vigfusson (2010) also provide evidence on the declining exchange rate pass-through to import prices over time, and shifts in the invoice currency chosen by economies are likely to play a role (see Gopinath, Itskhoki, and Rigobon 2010).

[37] For more details, see Appendix B.

Figure 3. Trade Elasticities (from 10-year Rolling Windows) in Different Regions



Note: Figure is based on panel estimates using producer price index–based real effective exchange rate and export and import prices relative to foreign and domestic producer prices, respectively. Full sample spans 88 advanced and emerging market and developing economies from 1990 to 2014. Dashed lines denote 90 percent confidence intervals.

We estimate Equation 3 and Equation 4 (for exports), and Equation 5 and Equation 6 (for imports) for successive 10-year rolling intervals for the global sample of countries[38] – Asia and Europe, respectively. Table A1 lists the 88 AEs and EMDEs included in the analysis.[39] We analyze separately the subsamples of Asian and European economies because the expansion of GVCs in these two regions is stronger than elsewhere. If the expansion of GVCs has an economically meaningful impact, we can expect trade elasticities in these two regions to weaken over time.

We find little evidence that exchange rates and trade become disconnected over time.[40] Figure 3 shows that our estimates have narrow confidence intervals and should allow us to detect the instability of trade elasticities if it is significant. Only the elasticity of imports for import prices shows some weakening toward the end of the sample in some regions. We do not regard this as evidence for a disconnect between exchange rates and trade, because the other three types of trade elasticities fail to exhibit the same pattern. It is also difficult to associate the decrease in import price elasticity with the development of GVCs, as the latter experienced rapid expansion during the 1990s and reached a plateau during the mid-2000s. If participation in GVCs affects trade elasticities, we should see a decline in trade elasticity before the mid-2000s, which is not evident in Figure 3.

Structural break tests also rebut the hypothesis of a disconnect between exchange rates and trade. By separating the sample period into 1990–2001 and 2002–2014, Table 4 suggests that the trade elasticities in the two periods are similar. This is true even when the Chow test is restricted to economies with relatively large increases in GVC integration. The stability of

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[38] The first 10-year interval used for estimation is 1990–1999, and the last is 2005–14.

[39] We have more countries included here than with the individual country estimates, as the sample selection criterion here is less stringent: a country is included in the sample if it has 20 years of observation. Recall that the individual country estimations require 25 years. We relax this requirement, as a few countries are unlikely to distort the panel regression results. The gain in improving the efficiency of estimating the average trade elasticities by increasing the sample coverage can be significant.

[40] The finding of broad stability in exchange rate pass-through over time is consistent with the results of Bussière, Delle Chiaie, and Peltonen (2014), which test stability in exchange rate pass-through coefficients for the period 1990–2011 for 40 AEs and EMDEs.

trade elasticities is further obtained when we use samples employed elsewhere, for example, the 46 economies included in the analysis of Ahmed, Appendino, and Ruta (2015).

Figure 5 provides a perspective for understanding why GVC developments may not cause a disconnect between exchange rates and trade. The figure shows that the share of foreign value added (FVA) in world exports has risen from about 15 percent in the 1970s to about 25 percent in 2013.[41] The pace is slow and the bulk of global trade still consists of conventional trade, which helps explain why GVC participation may impact some goods and countries,[42] but not trade elasticities at the macro level.

Thus, we again confirm broad stability of the price elasticity of trade volume. While the analysis of large currency depreciations addressed endogeneity, there remains a possibility that the results are affected by the aggregation bias, which causes the price elasticity of trade volume to reflect a subset of goods that have low price elasticity (Imbs and Mejean 2015). The next section presents the results from the sectoral analysis, which avoids the aggregation bias and which is less prone to endogeneity bias than the analysis presented in this section. We view this analysis as a robustness check because of the apparent measurement error in trade prices.

[41] Figure 3 also suggests that for some economies, such as Hungary, Romania, Mexico, Thailand, and Ireland, the increase has been greater than 20 percentage points. Moreover, some evidence indicates that the rise of GVCs measured along this dimension has slowed in recent years. Indeed, Constantinescu, Mattoo, and Ruta (2015) find that the slower pace of GVC-expansion has contributed to the global trade slowdown observed since the global financial crisis.

[42] The findings of the recent literature further suggest that, for economies that have become more deeply involved in GVCs, trade in GVC-related products may have become less strongly responsive to exchange rate changes. Cheng et al. (2015), for example, find that a real appreciation of a country's currency not only reduces its exports of domestic value added, but also lowers its imports of FVA (in contrast to the traditional rise in imports following currency appreciation). This latter result is consistent with the notion that GVC-related domestic and FVA are complements in production. In addition, the analysis finds that the magnitudes of import and export elasticities depend on the size of a country's contribution to GVCs—smaller domestic contribution of value added tends to dampen the response to exchange rate changes (see also IMF 2015a, 2015b, 2015c).

5. CONCLUSION

This paper finds little support for the assertion that exchange rates and trade are disconnected over time. There is scant evidence of a general weakening in the responsiveness of exports to relative export prices or in the effects of exchange rates on trade prices. These results are reached by examining the exchange rate pass-through to trade prices and the price elasticities of trade volumes separately, which are robust across different types of analyses: a study of events with large currency depreciations, rolling estimations of macro-level trade equations, , and a Chow test at the sector level.

We also find little evidence that GVC expansion weakens trade elasticities, neither in our rolling estimates of macro-level equations within regions that witnessed greater GVC entrenchment, nor in a Chow test within countries that experienced a stronger increase in GVC participation, nor from a sector-level analysis that interacts GVC participation measures with exchange rates. One explanation is that GVC-related trade has increased only gradually, with the bulk of global trade still consisting of conventional trade.

Based on our estimates at the macro level, we find that a 10 percent real effective depreciation in an economy's currency is associated with, on average, a 1.5 percent increase in real net exports as a share of GDP, with substantial cross-country variation around this average (Figure 8). Through the study of large currency depreciation events, we also find that the effects of exchange rate depreciation on exports are stronger for those economies with economic slack and those whose financial systems are operating normally.

Our findings suggest that exchange rate movements should result in a substantial redistribution of real net exports across economies.[43] Policy considerations based on the traditional relationship between exchange rates and trade are thus still justifiable. The results confirm that exchange rate changes have strong effects on export and import prices due to increasing trade openness (Figure 9). This has implications for inflation dynamics and the transmission of monetary policy changes. Economies in which the rise of GVCs has weakened the effects of

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[43] Overall outcomes for trade will reflect not only the direct effect of exchange rates on trade, but also shifts in the underlying fundamentals driving exchange rates.

exchange rates on trade may have less scope for expenditure switching, and larger adjustments in exchange rates may be required to resolve trade imbalances. In general, however, the role of flexible exchange rates in facilitating the resolution of trade imbalances remains significant.

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APPENDIX

A. TABLES AND FIGURES

Table 2. Large Exchange Rate Depreciation Episodes

Country	Year
Advanced Economies	
Australia	1985
Greece	1991, 1993, 2000
Iceland	1989, 1993, 2001
Ireland	1993
Israel	1989
Italy	1993
Korea	2008
New Zealand	1998, 2000
Portugal	1993
Spain	1993, 1997
United Kingdom	1993
Emerging Market and Developing Economies	
Belarus	2009
China	1994
Comoros	1994
Ethiopia	1993
The Gambia	1987
Ghana	2000, 2009, 2014
Guinea	2005
Haiti	2003
Honduras	1990
Iran, Islamic Republic of	1985, 1989, 1993, 2000, 2002, 2012
Kazakhstan	1999
Kiribati	1985
Libya	2002, 1998
Madagascar	2004
Malawi	1992, 1994, 1998, 2003, 2012
Mozambique	2000
Nepal	1992
Nigeria	1999
Pakistan	2009
Papua New Guinea	1995, 1998
Paraguay	1987, 1989, 2002
Poland	2009
Rwanda	1991
Solomon Islands	1998, 2002
South Africa	1984
Syria	1988
Trinidad and Tobago	1986, 1993
Turkmenistan	2008
Venezuela	1987, 2002, 2009
Zambia	2009

Sources: Laeven and Valencia 2013; and authors' estimates.

Table 3. Trade Elasticities over Time: Stability Tests

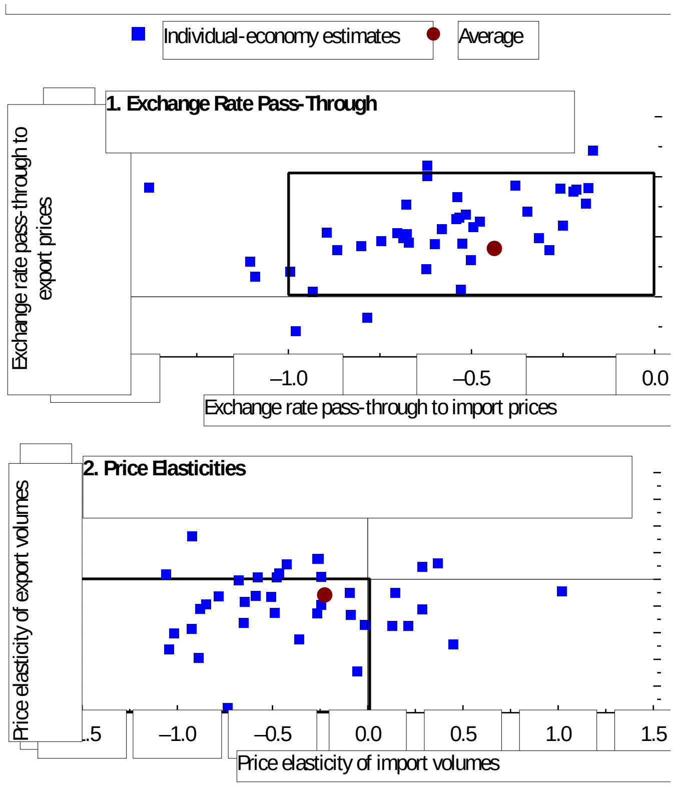
	Full	1990–2001	2002–2014	Significance of the Difference between the Two Periods1
	1. Pass-Through into Export Prices			
By Region				
All Countries	0.569***	0.557***	0.457***	
Asia	0.429***	0.419***	0.346***	
Europe	0.658***	0.647***	0.687***	
By Integration into Global Value Chains				
Countries with Larger Increase	0.572***	0.560***	0.548***	
Countries with Smaller Increase	0.684***	0.608***	0.609***	
	2. Pass-Through into Import Prices			
By Region				
All Countries	-0.612***	-0.549***	-0.632***	
Asia	-0.671***	-0.684***	-0.668***	
Europe	-0.553***	-0.528***	-0.587***	
By Integration into Global Value Chains				
Countries with Larger Increase	-0.621***	-0.545***	-0.618***	
Countries with Smaller Increase	-0.650***	-0.511***	-0.720***	**
	3. Price Elasticities of Exports			
By Region				
All Countries	-0.207***	-0.147***	-0.255***	*
Asia	-0.329***	-0.265***	-0.489***	**
Europe	-0.281***	-0.303**	-0.375***	
By Integration into Global Value Chains				
Countries with Larger Increase	-0.305***	-0.343**	-0.373***	
Countries with Smaller Increase	-0.402***	-0.225	-0.566***	*
	4. Price Elasticities of Imports			
By Region				
All Countries	-0.433***	-0.452***	-0.335***	
Asia	-0.436***	-0.566***	-0.233	
Europe	-0.470***	-0.484***	-0.446***	
By Integration into Global Value Chains				
Countries with Larger Increase	-0.521***	-0.658***	-0.271**	**
Countries with Smaller Increase	-0.467***	-0.455***	-0.420***	

Source: IMF staff estimates.

**p* < 0.1; ***p* < 0.05; ****p* < 0.01.

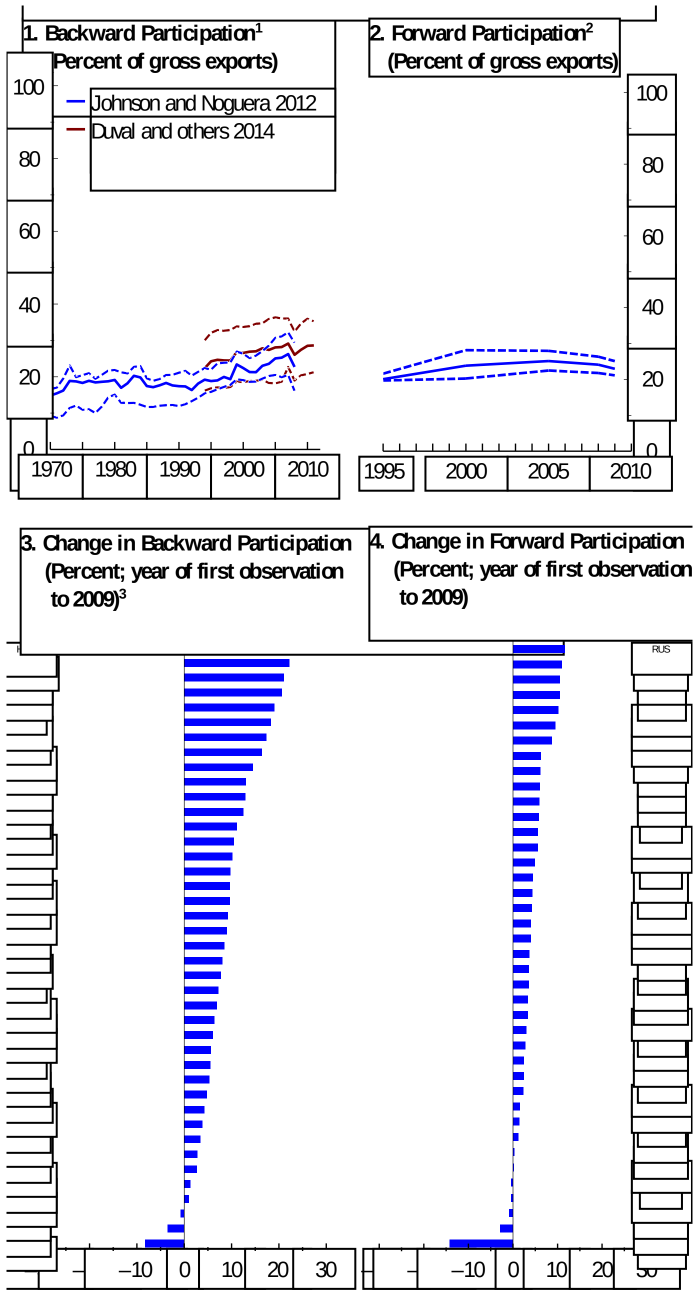
[1] Blank space in this column indicates statistically insignificant difference.

Figure 4. Long-Term Exchange Rate Pass-Through and Price Elasticities



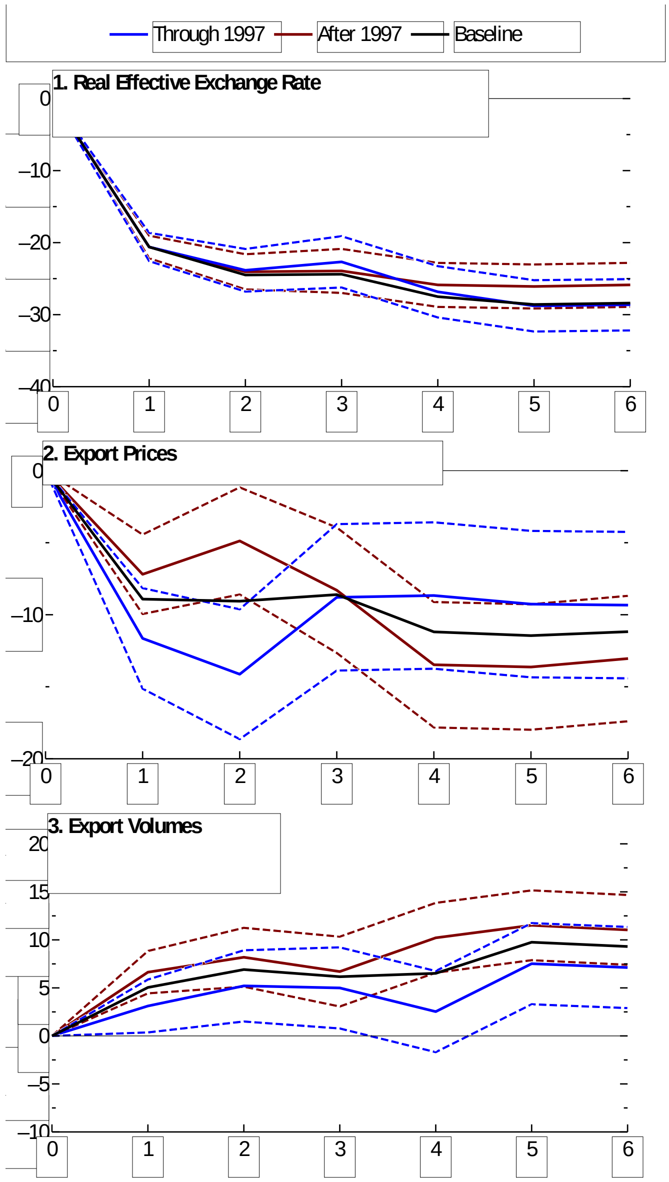
Source: IMF staff estimates.
Note: Estimates based on annual data for 60 advanced and emerging market and developing economies from 1980 to 2014. Boxes indicate the expected sign and, in the case of exchange rate pass-through, the expected size of the estimates.

Figure 5. Evolution of Global Value Chains



Sources: Duval and others 2014; Johnson and Noguera 2012; and Organisation for Economic Co-operation and Development.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes.
[1] Share of foreign value added in gross exports. Solid lines denote the average. Dashed lines denote 25th and 75th percentiles.
[2] Intermediate goods used by trading partners for production of their exports as a share of gross exports.
[3] Based on Johnson and Noguera 2012.

Figure 6. Export Dynamics after Large Exchange Rate Depreciations: Before and After 1997



Source: IMF staff estimates.
Note: Dashed lines denote 90 percent confidence intervals.

Figure 8. Effect of a 10 Percent Real Effective Depreciation on Real Net Exports

(Percent of GDP)

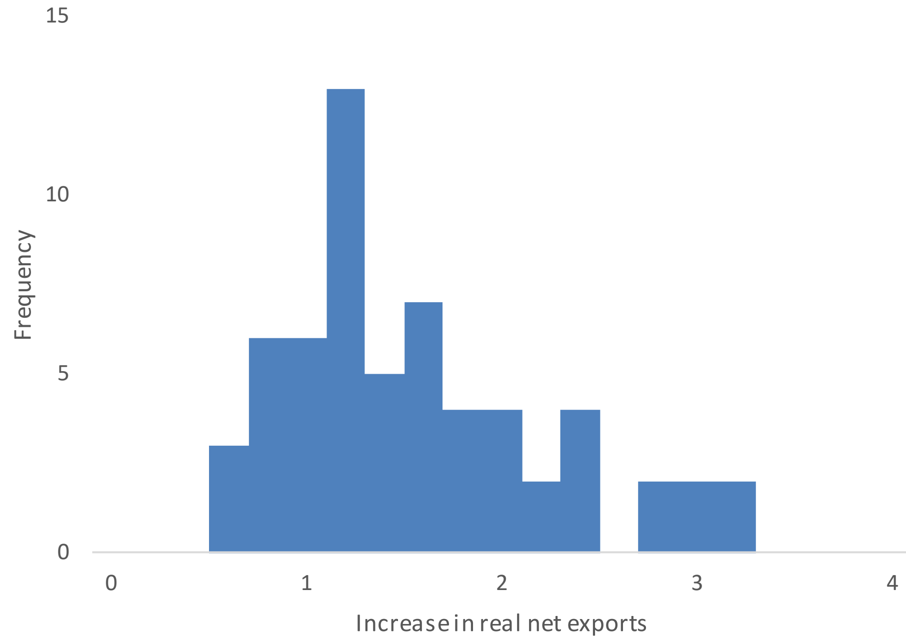
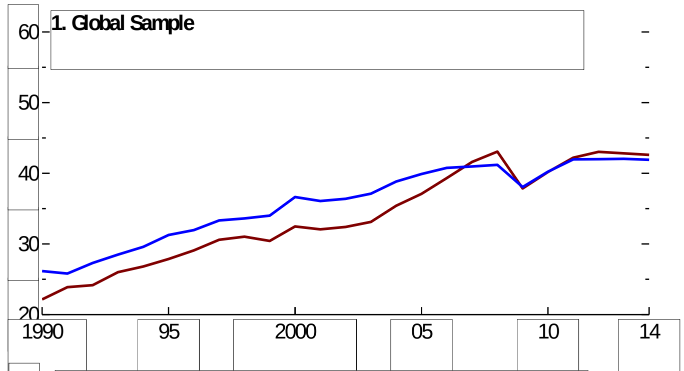
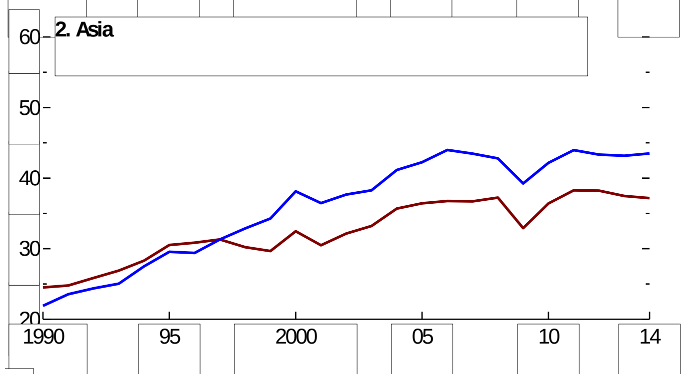
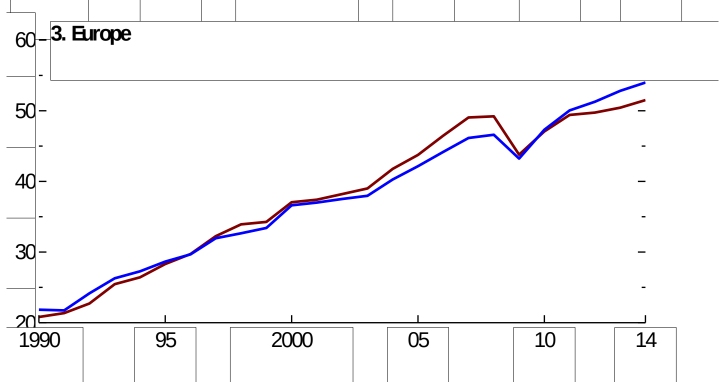


Figure 9. Ratios of Exports and Imports to GDP, 1990–2014

(Percent)







Source: IMF staff calculations.
Note: Figure presents simple averages of economies in the sample.

B. COUNTRY SAMPLES AND DATA SOURCES

Table A1. Economies Included in the Individual Estimation of Trade Elasticities

Advanced Economies	Emerging Market Economies
Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Israel, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Taiwan Province of China, United Kingdom, United States	Algeria*, Argentina, Bangladesh, Bolivia*, Bulgaria, Chile*, China, Colombia*, Republic of Congo*, Costa Rica, Côte d'Ivoire*, Egypt, El Salvador, Guatemala, Honduras, Hungary, India, Indonesia, Islamic Republic of Iran*, Jordan, Kenya, Kuwait*, Malaysia, Mexico, Morocco, Nigeria*, Pakistan, Paraguay*, Philippines, Saudi Arabia*, South Africa*, Sri Lanka, Thailand, Trinidad and Tobago*, Tunisia, United Arab Emirates, Venezuela*

* Denotes commodity exporters, that is, economies for which primary products constitute the main source of export earnings, exceeding 50 percent of total exports, on average, between 2009 and 2013.

Table A2. Economies Included in the Panel Estimation of Trade Elasticities

Albania, Algeria, Argentina, Australia, Austria, Bangladesh, Belgium, Bolivia, Brazil, Bulgaria, Cambodia, Canada, Chile, China, Colombia, Republic of Congo, Costa Rica, Côte d'Ivoire, Croatia, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Estonia, Finland, France, Germany, Ghana, Greece, Guatemala, Honduras, Hungary, India, Indonesia, Iran, Israel, Italy, Japan, Jordan, Kenya, Korea, Kuwait, Kyrgyz Republic, Latvia, Lebanon, Libya, FYR Macedonia, Malaysia, Mexico, Morocco, Netherlands, New Zealand, Nicaragua, Nigeria, Norway, Oman, Pakistan, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Russia, Saudi Arabia, Slovak Republic, Slovenia, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Syria, Taiwan Province of China, Thailand, Trinidad and Tobago, Tunisia, Turkey, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Venezuela, Yemen, Zambia

Table A3. Economies Covered in the Trade in Value Added Database

Argentina, Australia, Austria, Belgium, Bulgaria, Brazil, Brunei Darussalam, Cambodia, Canada, Chile, China, Colombia, Costa Rica, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong SAR, Hungary, Iceland, Indonesia, India, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Malaysia, Malta, Mexico, Netherlands, New Zealand, Norway, Philippines, Poland, Portugal, Russia, Saudi Arabia, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Taiwan Province of China, Thailand, Tunisia, Turkey, United Kingdom, United States, Vietnam

Note: The Trade in Value Added database is from the Organisation for Economic Cooperation and Development and World Trade Organization

Table A4. Economies Covered in the Sector-Level Analysis

Advanced economies	Emerging economies
Australia, Austria, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Italy, Japan, Korea, Latvia, Lithuania, Netherlands, New Zealand, Norway, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States	Algeria, Argentina, Bolivia, Brazil, Chile, China, Colombia, Costa Rica, Croatia, Ecuador, Egypt, Guatemala, Hungary, India, Indonesia, Macedonia, FYR, Madagascar, Malaysia, Mauritius, Mexico, Morocco, Nicaragua, Oman, Paraguay, Peru, Romania, South Africa, Thailand, Trinidad and Tobago, Tunisia, Turkey, Uruguay, Venezuela

Table A5. Data Sources

Indicator	Source
Export Prices	IMF staff calculations using export value divided by export volume
Export Volume	IMF, World Economic Outlook database
Export Value	IMF, World Economic Outlook database
Import Prices	IMF staff calculations using import value divided by import volume
Import Volume	IMF, World Economic Outlook database
Import Value	IMF, World Economic Outlook database
International Comm. Price Index	IMF, Global Assumptions database
International Energy Price Index	IMF, Global Assumptions database
Nominal Effective Exchange Rate	IMF, Information Notice System
Nominal GDP	IMF, World Economic Outlook database
Real Effective Exchange Rate	IMF, Information Notice System
Real GDP	IMF, World Economic Outlook database
Trade-Weighted Foreign CPI	IMF staff calculations
Trade-Weighted Foreign Demand	IMF, Global Economic Environment database
Trade-Weighted Foreign PPI	IMF staff calculations
Unit Labor Cost[1]	OECD Economic Outlook; U.S. Bureau of Labor Statistics; and IMF staff calculations
Indicators Used for Global Value Chain Analysis	
Backward Participation	OECD-WTO, Trade in Value Added database
Forward Participation	OECD-WTO, Trade in Value Added database

Note: CPI = consumer price index; PPI = producer price index.

[1]IMF staff calculations use data from Haver Analytics; International Labor Organization; IMF, World Economic Outlook database; and IMF, International Financial Statistics.

C. ROBUSTNESS TEST: EXCHANGE RATE TO EXPORT VOLUME ELASTICITY

In this section we perform robustness tests on our estimations of trade elasticities. We examine how our results compare with a specification estimating the reduced form effect of exchange rates to export volumes, which is typically used in the literature (for example, Ahmed, Appendino, and Ruta 2015). We estimate the following equation in a panel setup:

$$\Delta X_{i,t} = \mu_i + \tau_t + \beta\, \Delta\left(\frac{eP}{P^*}\right)_{it} + \gamma\, \Delta Y^*_{i,t} + \delta\, Y_{i,t-1} + \varepsilon_{i,t}, \qquad \text{Equation 11}$$

where ΔX is the growth rate of either total real exports, real goods exports, or real manufacturing exports;[44] $\mu_i + \tau_t$ are country- and time-fixed effects, respectively; $\frac{eP}{P^*}$ denotes a country's REER (here CPI-based); $\Delta Y^*_{i,t}$ is the growth rate of foreign (trading partner) GDP; and Y is the (log) level of a country's real GDP in U.S. dollars.

Table 5 reports the results of estimating Equation 11.[45] For this analysis, we use the same period and country sample as in Ahmed, Appendino, and Ruta (2015), with 46 economies, spanning from 1996 to 2012. To test the robustness of our findings in relation to exchange rate–trade stability, we also split that sample into two halves as do those authors (1996-2003 and 2004-2012).

Using that database and specification, we are able to closely replicate the findings of the literature. For total exports, we find a decline in the elasticity between the two subsamples from –1.2 to –0.7 and, for manufacturing exports from –1.3 to –0.6.

We further investigate the robustness of these findings along three simple dimensions. First, we check whether outliers are driving the results. This is particularly the case because the period sample includes a number of financial crises and hyperinflations – Bulgaria in 1997 and

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[44] We use three different specifications, one for each type of export product used in the left-hand side of Equation 11.

[45] Data for total exports and goods exports come from WEO. Data for manufacturing exports come from COMTRADE. Table 1 only reports the estimate of β from Equation 11. The estimates of the other coefficients are available upon request and similar to those obtained in the literature.

Russia in 1999, among others. Since these episodes all occur in the early part of the sample, 1996-2003, they complicate the comparison of trade elasticities in this period and the later period, 2004-2012. Excluding the crises is thus warranted. Such episodes can also be created by factors that have an independent effect on trade, providing another reason for their exclusion.

The second row in Table 5 shows that reestimating E2 while excluding the 13 data points with CPI inflation in excess of 30 percent noticeably reduces the estimated decline in β. For example, for total exports, the decline is now from –0.8 to –0.7 (instead of from –1.2 to –0.7), while, for manufacturing exports, it is from –0.7 to –0.6 (instead of from –1.3 to –0.6). The estimated decline in β is now inside one standard error of the estimate (0.1).

To control for potential outliers, we verify our results using the robust regression approach. This econometric technique reduces the weight on observations with relatively large absolute residuals using iterative weighted least squares (Andersen 2008). The results displayed in the row 3 of Table 5 underscore the fragility of the baseline results in row 1. For total exports, the estimated elasticity β remains around –0.7 in the two subsamples in this table. For manufacturing exports, the point estimate of β now rises in absolute value from –0.6 to –0.7, although this change is again within one standard error of the estimate.

Additionally, we use the log of first-difference to calculate the growth rates of the variables instead of percentage changes. Using percentage changes to calculate the growth rate of the variables introduces an asymmetry between increases and decreases – percentage increases are unbounded (because volume could be zero), whereas percentage decreases are bounded by -100 percent. The results are shown in row 4 of Table 5. Using the log first difference approach noticeably reduces the estimated decline in β. For example, for total exports, the decline is now from –0.8 to –0.6 (instead of from –1.2 to –0.7). For manufacturing exports, the decline in the estimate of β is now from –0.8 to –0.7, which is within one standard error of the estimate. This finding relates to the role of outliers, since taking log differences dampens the role of extreme values. The log difference specification is standard and consistent with the assumed log-linear model specification, so we maintain it for the remaining robustness checks.

In line with Equation 4 and Equation 6 we deflate export values and obtain the export volumes in foreign currency. The CPI reflects prices of many non-traded goods and services that do not relate to the cost structure of exports. Also, in the baseline specification of E2, the CPI deflator is used both, in the numerator of the REER variable on the right-hand side and in the denominator as the deflator of nominal exports on the left-hand side, implying a spurious strengthening of the negative comovement between trade volumes and the (CPI-based) REER. This issue holds in general, and specifically in the context of spikes in the CPI associated with high-inflation episodes.[46]

When we deflate total exports using the deflator for total exports of goods and services, and deflate goods and manufacturing exports using the deflator for goods exports from WEO, the absolute size of the estimates of β decline (Table 5, row 5). This result reflects the removal of the spurious correlation already mentioned. The estimated drop in β is also less apparent. For total exports, the elasticity estimate is now unchanged at –0.2 across the two time subsamples, while the point estimates of β for goods and manufacturing exports actually rise slightly (again within one standard error of the estimate).

The final robustness check is to remove the initial domestic GDP control from the equation. This has little effect on our finding that the drop in β over time is insiginificant. The conclusion is also not affected by expanding the sample from the 46 economies to the 88 economies included in Section II.D (see Table A3), or by expanding the time sample to span 1990-2014, instead of 1996-2012. Overall, the analysis in this section confirms our findings that there is no disconnect over time for trade elasticities at the macro level, even at its reduced form.

Table 4. Elasticity of Total Exports to the Real Effective Exchange Rate: Robustness Analysis

Elasticity of Total Exports to the Real Effective Exchange Rate	**Full sample**	**1996–2003**	**2004–2012**
(1) Baseline	-1.046***	-1.245***	-0.664***
(2) As (1) but inflation < 30%	-0.776***	-0.822***	-0.664***
(3) As (1) but without outliers (robust regression) 1/	-0.714***	-0.749***	-0.653***

[46] More generally, the dynamics of export prices (especially of manufacturing goods) and the CPI are quite different. Even for an economy such as the United States with low inflation, the average difference in the growth rate of the CPI and the export deflator for goods over the period 1980-2014 is about 2.5 percentage points per year. So deflating exports with the CPI would imply a substantial difference in real export dynamics. A useful benchmark reference here is the OECD Economics Department working paper by Morin and Schwellnus 2014, which estimates trade elasticities based on export volumes for both AEs and EMDEs.

(4) Log linear specification 2/	-0.734***	-0.780***	-0.633***
(5) As (4) but real exports defined using export prices (not CPI)	-0.180***	-0.196**	-0.174***
(6) As (5) but no domestic real GDP control	-0.177***	-0.186**	-0.176***

Elasticity of Goods Exports to the Real Effective Exchange Rate	**Full sample**	**1996–2003**	**2004–2012**
(1) Baseline	-1.182***	-1.440***	-0.622***
(2) As (1) but inflation < 30%	-0.765***	-0.804***	-0.622***
(3) As (1) but without outliers (robust regression) 1/	-0.688***	-0.856***	-0.626***
(4) Log linear specification 2/	-0.814***	-0.861***	-0.674***
(5) As (4) but real exports defined using export prices (not CPI)	-0.157*	-0.146	-0.169***
(6) As (5) but no domestic real GDP control	-0.156**	-0.130	-0.192***

Elasticity of Manufacturing Exports to the Real Effective Exchange Rate	**Full sample**	**1996–2003**	**2004–2012**
(1) Baseline	-1.081***	-1.294***	-0.592***
(2) As (1) but inflation < 30%	-0.671***	-0.651***	-0.592***
(3) As (1) but without outliers (robust regression) 1/	-0.691***	-0.592***	-0.653***
(4) Log linear specification /2	-0.746***	-0.765***	-0.663***
(5) As (4) but real exports defined using export prices (not CPI)	-0.090	-0.038	-0.166*
(6) As (5) but no domestic real GDP control	-0.087	-0.016	-0.191**

*p < 0.1; ** p < 0.05; *** p < 0.01.
1/ Robust regression downweights observations with larger absolute residuals using iterative weighted least squares (Andersen, 2008).
2/ Growth rates computed as log first differences.

D. Data for Sectoral Analysis

The main dataset used in this analysis is based on UN Comtrade database. To include GVC measures in our regression analysis, we employ data from the OECD TiVA database, which covers 46 countries, and restrict the sample period of this analysis to the years between 1995 and 2011.

The main challenges in assembling the sector-level dataset is to construct effective exchange rates that vary with sectors' destination profiles and price deflators that derive sectoral-level trade volumes from trade values. The UN Comtrade database provides export and import U.S. dollar values, and export and import quantities that allow us to construct product unit values. We aggregate each product unit value into one of 18 sector prices using the HS 2002 6-digit product classification system, based on the OECD Inter-Country Input-Output (ICIO) classification.

Importantly, we construct import and export prices at the sector level as GEKS indexes (Ivancic, Diewert, and Fox 2011; and De Haan and van der Grient 2011), which are the geometric mean of the ratios of all bilateral indexes (computed with the same index number formula) between any two periods. The GEKS index has two advantages over the Fisher chain index on which it is based. First, it uses bilateral information between any two periods. This is useful because trade data at the product level often have gaps, creating issues for the construction of the Fisher chain index. Second, it avoids chain drift, which arises when a selection of goods used to compute an index changes significantly over time. Appendix C provides a detailed description of the index construction.

For calculation of the sector-level exchange rate, we use the Tornqvist method (Kee and Tang 2016). Its most important feature is that it includes only export destination countries to which exports went over two consecutive years. This method helps to avoid compositional bias. Mathematically, for the country pair i, j and sector k, the sector-level exchange rate change from year $t-1$ to year t is defined as:

$$ln(ER^i_{k,t}) - ln(ER^i_{k,t-1})$$

$$\sum_{j \in I^i_{kt} \cap I^i_{kt-1}} \frac{1}{2}\left(s^i_{j,k,t} + s^i_{j,k,t-1}\right)$$

where I^i_{kt} is the set of countries that import from the sector k of country i in year t; $s^i_{j,k,t}$is the country j's share in the exports of sector k of country i; $ln(ER^i_{j,t}) - ln(ER^i_{j,t-1})$ is the change of the bilateral exchange rate between country i and j from year $t-1$ to t.

We exclude outliers as observations with GEKS index changes above 90th percentile and below the 10th percentile of the distribution of price changes in the same industry, and in the same year.

E. ANALYSIS OF REDUCED-FORM TRADE ELASTICITIRES AT SECTOR-LEVEL

This section presents estimates of trade elasticities at the sector level. This has two advantages – compared with estimating trade equations at the macro level – for studying the stability of trade elasticity over time. First, exchange rate movements are less influenced by sector-level trade performances, and therefore more exogenous to trade prices and volumes. Second, the sectoral analysis mitigates the aggregation bias that could confound the study of a possible disconnect between exchange rates and trade.[47,48]

Using sector-level data enables additional analyses. First, the rich variation of GVC measures at the sector level allows us to investigate the relationship between GVC participation and trade elasticities (see Amiti, Itskhoki, and Konings 2014). Second, that a sector's share of a country's exports may change over time, and for some sectors that share may be large, enables us to test the importance of reverse causality between exchange rates and trade. This can be done by examining whether changes in sectoral trade shares affect our estimated trade elasticities or not.

The use of sector-level data may also come at a cost, however. As Russell and Hummels (2013) point out, noise in trade price measures at the sector level bias the price elasticity of trade volume towards one. Therefore, we estimate and draw our conclusions from the "reduced form" formulation in which exchange rate movements affect trade volumes directly.

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[47] Since Machlup (1950) and Orcutt (1950), the literature on estimation of trade elasticities has argued that elasticities estimated at the macro level may be biased downward. This downward bias has been recently emphasized again by Imbs and Mejean (2015). They show that with "well-behaved" residuals, a regression of aggregate imports on aggregate price of imports implies an estimate equal to a weighted average of microeconomic elasticities. With the sector-level heterogeneity in price elasticity of trade volume, the estimate is biased downward, as the aggregate price changes are largely accounted for by products with low elasticity. In this case, residuals correlate systematically with explanatory variables leading to the classic heterogeneity bias as defined by Pesaran and Smith (1995).

[48] The aggregation bias implies that the change of the relative importance of sectors with low trade elasticities can lead to disproportionate changes in estimated macro-level trade elasticities.

We explore two hypotheses. 1) On average, are trade elasticities stable at the sector level? 2) Do GVCs affect the stability of trade elasticities? In addressing the second question, we account for macro variables that may affect both trade elasticities and GVCs, to avoid omitted variable bias. We control for all macro variables accounted for by Campa and Goldberg (2005).

We estimate trade elasticities at the sectoral level as follows:

$$\Delta(X_{ikt}) = \alpha_{ik} + \eta_t + \gamma_k \Delta \ln\left(\frac{eP}{P^*}\right)_{it} + \delta_k^* \Delta \ln(Y_{it}^*) + \delta_k \Delta \ln(Y_{it-1}) + \tilde{Z}_{ikt} + \nu_{ikt}, \qquad \text{Equation 12}$$

$$\Delta(M_{ikt}) = \alpha_{ik} + \eta_t + \gamma_k \Delta \ln\left(\frac{eP}{P^*}\right)_{it} + \delta_k^* \Delta \ln(Y_{it}^*) + \delta_k \Delta \ln(Y_{it-1}) + \tilde{Z}_{ikt} + \nu_{ikt}, \qquad \text{Equation 13}$$

where α_{ik} denotes the country-industry fixed effects; and η_t denotes the time fixed-effects; the real effective exchange rate's coefficient γ_k is allowed to differ across industries; $\beta_t = \beta^{GFC}$ during the global financial crisis, defined as in year 2008 or 2009, and otherwise is another constant. ΔY_{it} is separated into two variables: real exports, and real domestic demand, defined as the sum of real consumption and real investment, to account for different import intensities of GDP components (Bussière et al. 2013, Morin and Schwellnus 2014).

Depending on the model, vector $\tilde{Z}_{ikt}$ include an indicator for years after 2002, measures of GVC participation,[49] and macro variables (money supply growth rate, GDP growth, and inflation, etc), as in Campa and Goldberg (2005).[50] Except for the dummy variable, all variables are demeaned and normalized by their standard deviation to facilitate the economic interpretation of their coefficients. Importantly, including an industry's share of a country's

[49] We follow the standard practice in the literature, and use foreign value-added share in exports as our measure of GVC participation. This measure is constructed both at the country-sector level and at the sector level.

[50] As discussed in Campa and Goldberg (2005), macroeconomic variables may explain cross-country differences in exchange rate pass-through. They include the relative stability of local monetary policy (see Devereux and Engel 2001), as exporters set their prices in the currency of the country that has the most stable monetary policies, import prices in local currency terms should be more stable in countries with more stable monetary policy. All else equal, exchange rate pass-through should be higher for countries with more volatile monetary policy. Country size may be another important factor in ranking pass-through elasticities. Exchange rate pass-through may be higher if the exporters are large in number relative to the presence of local competitors. One approximation to this notion is that a country's pass-through elasticity might be inversely related to real GDP. An alternative approach would be to also consider measures of sector-specific openness for countries.

exports in $\tilde{Z}_{ikt}$ allows us to test the significance of reverse causality in estimating these trade equations.

Further, we assume that foreign and domestic demand have the same coefficients across sectors. This is true if the following two assumptions are satisfied. First, consumers have homothetic utility functions, or equivalently, their demands for final goods are linear in income. Second, firms have homothetic production functions, or equivalently, their demands for intermediate goods are proportional to the firm's total output.

The results are presented in Table 3. The three models differ by the set of variables included in $\tilde{Z}_{ikt}$: model (1) only has the period dummy, which tests the overall stability of exchange rate effects on trade prices and volumes; model (2) adds GVC measures to model (1) to study how GVC participation may affect trade elasticities; model (3) further adds macroeconomic variables to model (2) to ensure that GVC results are not driven by omitted variable biases.

Table 5. Estimates of Sector-Level Exchange Rate Effects on Trade Volume

Variables[1]	Exchange rate effects on export volume (1)	(2)	(3)	Exchange rate effects on import volume (1)	(2)	(3)
Average sector-level exchange rate pass-through[2]	-0.244***	0.217	0.221	1.147***	1.423***	1.829***
	(0.124)	(0.152)	(0.184)	(0.107)	(0.147)	(0.178)
∆ln(Exchange rate) × period dummy[3]	-0.552***	-0.949***	-0.786***	-0.826***	-1.634***	-1.604***
	(0.133)	(0.227)	(0.277)	(0.111)	(0.226)	(0.276)
∆ln(Exchange rate) × money growth[4]			-1.246***			0.289
			(0.253)			(0.245)
∆ln(Exchange rate) × real GDP[5]			-0.098			-0.183***
			(0.051)			(0.048)
∆ln(Exchange rate) × inflation rate[6]			1.552***			1.777***
			(0.389)			(0.305)
∆ln(Exchange rate) × country-industry FVA share in		0.320***	0.197**		0.026	0.143
gross exports[7]		(0.094)	(0.104)		(0.081)	(0.091)
∆ln(Exchange rate) × world industry FVA share in		0.379	0.368		1.427***	1.286***
gross exports[8]		(0.298)	(0.377)		(0.281)	(0.328)
∆ln(Exchange rate) × industry share in exports[9]		0.051	-0.013		0.090	0.191**
		(0.096)	(0.103)		(0.097)	(0.104)
∆ln(Real trade weighted foreign GDP)	Yes	Yes	Yes	No	No	No
∆ln(Sum of real consumption and real investment of domestic economy)	No	No	No	Yes	Yes	Yes
∆ln(Sum of real consumption and real investment of domestic economy) × GFC dummy[10]	No	No	No	Yes	Yes	Yes
∆ln(Real exports of domestic economy)	No	No	No	Yes	Yes	Yes
∆ln(Real exports of domestic economy) × GFC dummy	No	No	No	Yes	Yes	Yes
Country and industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.13	0.24	0.25	0.17	0.26	0.28
Adjusted R-squared	0.12	0.22	0.23	0.17	0.25	0.27
Number of observations	10,631	7,108	5,647	12,465	7,376	5,776

Notes:

[1] This table reports estimated coefficients of equations (10) and (12).

[2] The average of sector-specific exchange rate coefficient (γ).

[3] The period dummy is defined as 0 if the year is before 2002, and 1 otherwise.

[4] Money growth is defined as the annual growth rate of M2. For countries where M2 is not available, we use M1 instead, with the data from the IFS.

[5] Real GDP is defined as the annual growth rate of real GDP, with the data from the IMF WEO database.

[6] Inflation is defined as the annual CPI inflation, with the data from the IMF WEO database.

[7] Country-industry FVA share in gross export is defined as the country and industry level based on the OECD TiVA database.

[8] World industry FVA share is defined as the sum of foreign value added across all countries for the industry, divided by the sum of export value for the industry. Data come from the OECD TiVAD and the UNCOMTRADE.

[9] Industry share in exports is defined as the export value of the industry in the country divided by the country's export value.

[10] The GFC dummy is 1 if the year is in 2008 or 2009 and 0 otherwise.

Significance at *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors are in the parentheses.

We draw several conclusions from the results in Table 3. First, there is no consistent evidence from model (1) to support the claim that exchange rates and trade are disconnected over time. The hypothesis of stability of the relationship between exchange rates and trade cannot be rejected in the case of exports. The relationship between exchange rates and import volumes did weaken. This is consistent with the rolling-regression results, which show a decline in the price elasticity of import volumes at the end of the sample period. Our conjecture is that domestic demands are correlated with exchange rate movements, and more so in recent years than the past.

Second, columns (2) and (3) for exchange rate effects on export volumes (Table 3) suggest that sectors with higher shares of foreign value added in their exports are associated with weaker exchange rate effects on export volume. It is difficult to explain why the effects do not appear on the import side. Similarly, while Columns (2) and (3) for exchange rate effects on import volumes (Table 3) suggest that sectors with higher foreign value added in their world exports stronger import elasticities, export elasticities are weaker. Because of the large sample, the insignificant and inconsistent results for the GVC variables are unlikely to be driven by noisy data, thus refuting the claim that GVC participation significantly influences trade elasticities.

Finally, we find little evidence that industries with a larger share of a country's exports have smaller trade elasticities. The only significant results corresponds to the exchange rate effect on import volumes. As we allow the coefficient of exchange rates to differ across industries in all specifications, these results should not be confounded by sectors' intrinsic differences in trade elasticities. The findings suggest that reverse causality plays an insignificant role in driving trade elasticity estimates. As the trade equations and data sources in the sector-level analysis resemble those in the previous section that estimate macro-level trade elasticities, the rejection of any reverse causality significance provides assurance that the earlier results are robust.

F. Analysis of Exchange Rate Pass-Through at Sector-Level

For completeness, we estimate the exchange-rate pass-through equations at the sectoral level:

$$\Delta \ln\left(\frac{eP^X}{P^*}\right)_{ikt} = \alpha_{ik} + \eta_t + \gamma_k \Delta \ln\left(\frac{eP}{P^*}\right)_{it} + \vec{\phi}\, \Delta \ln\left(\frac{eP}{P^*}\right)_{ikt} \times \vec{Z}_{ikt} + \beta_t \Delta \ln\left(\frac{ULC}{P^*}\right)_{it} + \nu_{ikt}, \qquad \text{Equation 14}$$

$$\Delta \ln\left(\frac{eP^M}{P}\right)_{ikt} = \alpha_{ik} + \eta_t + \gamma_k \Delta \ln\left(\frac{eP}{P^*}\right)_{it} + \vec{\phi}\, \Delta \ln\left(\frac{eP}{P^*}\right)_{it} \times \vec{Z}_{ikt} + \beta_t \Delta \ln Y_{it} + \nu_{ikt}, \qquad \text{Equation 15}$$

where the variables are defined as in Section 5.

Table 6. Estimates of Sector-Level Exchange Rate Pass-Through

Variables[1]	Exchange rate pass-through to export prices (1)	(2)	(3)	Exchange rate pass-through to import prices (1)	(2)	(3)
Average sector-level exchange rate pass-through[2]	0.360***	0.297***	0.402***	-0.717***	-0.633***	-0.685***
	(0.040)	(0.050)	(0.066)	(0.026)	(0.048)	(0.062)
∆ln(Exchange rate) × period dummy[3]	0.079	0.279***	0.027	-0.109***	-0.018	-0.060
	(0.042)	(0.075)	(0.104)	(0.03)	(0.071)	(0.098)
∆ln(Exchange rate) × money growth[4]			-0.077			0.005
			(0.08)			(0.004)
∆ln(Exchange rate) × real GDP[5]			0.006			0.0140***
			(0.015)			(0.005)
∆ln(Exchange rate) × inflation rate[6]			-0.435***			0.0232*
			(0.079)			(0.013)
∆ln(Exchange rate) × country-industry FVA share in		-0.020	-0.027		0.012***	0.013***
gross exports[7]		(0.035)	(0.042)		(0.005)	(0.006)
∆ln(Exchange rate) × world industry FVA share in		-0.274***	0.043		0.030***	0.035***
gross exports[8]		(0.099)	(0.13)		(0.009)	(0.010)
∆ln(Exchange rate) × industry share in exports[9]		0.038	0.038		0.009**	0.006
		(0.030)	(0.031)		(0.004)	(0.005)
∆ln(Unit labor costs)	Yes	Yes	Yes	No	No	No
∆ln(Sum of real consumption and real investment of domestic economy)	No	No	No	Yes	Yes	Yes
∆ln(Sum of real consumption and real investment of domestic economy) × GFC dummy[10]	No	No	No	Yes	Yes	Yes
∆ln(Real exports of domestic economy)	No	No	No	Yes	Yes	Yes
∆ln(Real exports of domestic economy) × GFC dummy	No	No	No	Yes	Yes	Yes
Country and industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.23	0.28	0.31	0.33	0.43	0.47
Adjusted R-squared	0.22	0.26	0.29	0.33	0.42	0.46
Number of observations	15,128	7,261	5,706	15,634	7,811	6,143

Notes:

[1] This table reports estimated coefficients of equations (10) and (12).

[2] The average of sector-specific exchange rate coefficient (γ).

[3] The period dummy is defined as 0 if the year is before 2002, and 1 otherwise.

[4] Money growth is defined as the annual growth rate of M2. For countries where M2 is not available, we use M1 instead, with the data from the IFS.

[5] Real GDP is defined as the annual growth rate of real GDP, with the data from the IMF WEO database.

[6] Inflation is defined as the annual CPI inflation, with the data from the IMF WEO database.

[7] Country-industry FVA share in gross export is defined as the country and industry level based on the OECD TiVA database.

[8] World industry FVA share is defined as the sum of foreign value added across all countries for the industry, divided by the sum of export value for the industry. Data come from the OECD TiVAD and the UNCOMTRADE.

[9] Industry share in exports is defined as the export value of the industry in the country divided by the country's export value.

[10] The GFC dummy is 1 if the year is in 2008 or 2009 and 0 otherwise.

Significance at *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors are in the parentheses.

Using model (3) as reference, the results in Table 7 demonstrate that:

- the estimated pass-through coefficients are broadly consistent with the estimates in Table 1;
- the pass-through coefficients were stable over time;
- GVC participation affected only the import pass-through but its effect is economically insignificant.

G. CONSTRUCTION OF THE GEKS INDICES

We construct country-sector level export and import price indexes for 18 tradable sectors using UN Comtrade data at the annual frequency. The 18 sectors are defined in the text. We adopt a method proposed by Ivancic et al. (2011), which is an adapted version of the multilateral GEKS approach. The GEKS index has two properties: (1) it makes maximum use of all possible matches between any two periods, and (2) it has no chain drift.

To construct a price index for sector i from the prices of products $n \in i$, for the period 0 to M, we construct a GEKS price index, denoted as $GEKS_{0,t}$, with $t \in \{0, \dots, M\}$. Hereafter, without confusion, we omit i for simplicity. The construction consists of two steps. First, we obtain sector i -- GEKS price indexes for any two adjacent periods $\tau - 1$ and τ, denoted as $GEKS\tau - 1, \tau$. Second, we calculate $GEKS_{0,t}$ using all $GEKS_{\tau-1,\tau}$ for τ = 1, …, t.

The details are as follows: in the first step, $GEKS_{\tau-1,\tau}$ is the geometric average of the ratios of bilateral Fisher indexes (defined below):

$$GEKS_{\tau-1,\tau} = \prod_{l=0}^{M} \left(P_{\tau-1,l}^{F} / P_{\tau,l}^{F}\right)^{1/M} = \prod_{l=0}^{M} \left(P_{\tau-1,l}^{F} \cdot P_{l,\tau}^{F}\right)^{1/M} \qquad (1)$$

where M + 1 is the number of years, and $P_{\tau,l}^{F}$ denotes the Fisher index between period τ and l.

In the second step, the GEKS index between time 0 and time t is defined as

$$GEKS_{0,t} = \prod_{\tau=1}^{t} \left(GEKS_{\tau-1,\tau}\right) \qquad (2)$$

To construct the bilateral Fisher indices, $P_{Fj,k}$ is defined as:

$$P_{j,k}^{F} = \sqrt{P_{j,k}^{L} * P_{j,k}^{P}}$$

$$P_{j,k}^{L} = \frac{\sum_n \left(P_{n,k} \cdot Q_{n,j}\right)}{\sum_n \left(P_{n,j} \cdot Q_{n,j}\right)}$$

$$P_{j,k}^{P} = \frac{\sum_n \left(P_{n,k} \cdot Q_{n,k}\right)}{\sum_n \left(P_{n,j} \cdot Q_{n,k}\right)}$$

where $P_{j,k}^{L}$ is the Laspeyres price index, and $P_{j,k}^{P}$ the Paasche price index of sector i.Accordingly, the summation in these indexes is carried over products in sector i, with $P_{n,t}$

indicating the price, and $Q_{n,t}$ the quatity of product n in year t. Products are defined at the HS 2002 6-digit level.