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RESEARCH ARTICLE

Global Trade Flows: Revisiting the Exchange Rate Elasticities

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Abstract

This paper contributes to the debate on the magnitude of exchange rate elasticities by providing a set of price and quantity elasticities for 51 advanced and emerging-market economies. Specifically, we report for each of these countries the elasticity of trade prices and trade quantities on the export and on the import side, as well as the reaction of the trade balance. To this aim, the paper uses a large unified database of highly disaggregated bilateral trade flows, covering 5000 products and more than 160 trading partners. We present a range of estimates using not only standard regression techniques but also generated regressors that aim to uncover changes in the exchange rate elasticities due to unobserved marginal costs and competitor prices in the importing market. Our results show that quantity elasticities are significantly below one, pass-through is incomplete and export prices react significantly to exchange rate changes. In spite of low quantity elasticities, the trade balance reacts positively to a depreciation in *all* countries because export and import prices adjust. Overall, our findings suggest that exchange rate changes can play an important role in addressing global trade imbalances.

Keywords Exchange rates · Trade elasticities · Exchange rate pass-through · Competitiveness

JEL Classification C51 · F14 · F31 · F33 · F41

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1 Introduction

The large exchange rate movements recorded in recent years have reignited the debate on the effect of exchange rate movements on trade flows and global imbalances. Prominent observers have expressed concerns that large currency depreciations in key economies may have an effect on their own country's competitiveness and raised the fear of "currency wars" across countries (Mantega 2010). Meanwhile, the effect of exchange rate changes on domestic prices (exchange rate pass-through) is a factor that receives significant attention among central bankers, as witnessed for instance by recent speeches by Yellen (2015), Fischer (2015), or Forbes (2015). In spite of the prevalence of these questions in the policy debate, few papers present a range of trade elasticities across countries (see for example Bussière et al. (2014), Gopinath (2015) and Leigh et al. (2015)).

The aim of the present paper is to contribute to the debate on the effectiveness of exchange rate changes in correcting the trade balance by providing country-specific price and quantity elasticities for the export as well as for the import side.[1] For this purpose, we use a very rich database of bilateral trade flows, disaggregated at the six-digit level and covering 5,000 products. As a first step, we estimate country-specific exchange rate elasticities for prices and quantities and calculate the implied effect on the trade balance, i.e., verifying the Marshall-Lerner conditions. Our results show that the trade balance improves significantly following an exchange rate depreciation, particularly for smaller and more open economies. Quantity elasticities are low in almost all countries (Tables 1, 2 and 3).

In a second step, we exploit the structure of our data set and uncover underlying factors determining price and quantity elasticities. The magnitude of the estimated elasticities crucially depends on the extent to which the exchange rate is correlated with unobserved marginal costs and competitor prices in the importing market. Marginal costs may indeed be correlated with exchange rate changes because exports typically have a strong import content, see Ossa (2015): the *ceteris paribus* loss in competitiveness that arises from an appreciation of the exchange rate, for instance, can be partly offset by the fact that it lowers the cost of imported inputs. We can capture the correlation between marginal costs and the exchange rate with time-varying country and product fixed effects. Our data set also allows us to control for the reaction of competitor prices in the import market. When the exchange rate of the exporting country appreciates, for instance, exporters can reduce the level of pass-through by lowering prices in their currency (Amiti et al. 2016). The extent to which this adjustment is needed depends on whether local competitors in the import market raise their prices (responding to a depreciation of their currency).

The main estimation results in this paper can be summarized as follows. First, the baseline regressions suggest that pass-through is incomplete: a 10% nominal depreciation would be associated with a 4.8% rise in import prices (in local currency). This

[1] The list of countries includes 26 emerging markets and 25 advanced economies and broadly corresponds to that of the IMF External Balance Assessment (EBA); see full list of countries in Table 1.

Table 1 Countries in the sample

Country ISO code	Country name	Country ISO code	Country name
ARG	Argentina	ISR	Israel
AUS	Australia	ITA	Italy
AUT	Austria	JPN	Japan
BEL	Belgium	KOR	South Korea
BRA	Brazil	LKA	Sri Lanka
CAN	Canada	MAR	Morocco
CHE	Switzerland	MEX	Mexico
CHL	Chile	NLD	Netherlands
CHN	China	NOR	Norway
COL	Columbia	NZL	New Zealand
CRI	Costa Rica	PAK	Pakistan
CZE	Czech Republic	PER	Peru
DEU	Germany	PHL	Philippines
DNK	Denmark	POL	Poland
EGY	Egypt	PRT	Portugal
ESP	Spain	RUS	Russia
FIN	Finland	SAU	Saudi Arabia
FRA	France	SGP	Singapore
GBR	United Kingdom	SWE	Sweden
GRC	Greece	THA	Thailand
GTM	Guatemala	TUN	Tunisia
HKG	Hong Kong	TUR	Turkey
HUN	Hungary	URY	Uruguay
IDN	Indonesia	USA	United States
IND	India	ZAF	South Africa
IRL	Ireland		

number corresponds to the median across countries but hides substantial heterogeneity.[2] For instance, we find that exchange rate pass-though is much lower than the median in the United States (30%) but much higher in Turkey (80%) or Japan (87%). In large European countries such as France, Germany, Italy or the United Kingdom the level of pass-though is close to the median.[3] Consistent with our result of incomplete pass-through to import prices, we find that export prices in producer currencies react significantly to exchange rate changes, especially for emerging-market

[2]In Tables 2 and 3 we report other key statistics such as the simple mean, a weighted mean using the relative size of nominal exports and imports, as well as the standard deviation of the coefficients across countries. In Section 4 we comment on selected country-specific results and compare aggregate elasticities between advanced and emerging-market economies.

[3]The coefficients that we estimated in the baseline regression for export and import prices are positively correlated with existing studies, as explained in Section 4.

Table 2 Summary statistics on exchange rate elasticities for export volumes and prices

	Median	Mean	Std. Dev.
Unweighted			
Price elasticity – baseline	0.655	0.687	0.217
Price elasticity – product-time fixed effects	0.866	0.885	0.184
Price elasticity – 2-way fixed effects	0.570	0.576	0.226
Quantity elasticity – baseline	0.347	0.345	0.222
Quantity elasticity – product-time fixed effects	0.469	0.431	0.280
Quantity elasticity – 2-way fixed effects	0.364	0.353	0.250
Weighted by trade in 2012 $(X + M) \div 2$			
Price elasticity – baseline	0.704	0.711	0.177
Price elasticity – product-time fixed effects	0.897	0.902	0.130
Price elasticity – 2-way fixed effects	0.627	0.683	0.185
Quantity elasticity – baseline	0.348	0.359	0.188
Quantity elasticity – product-time fixed effects	0.450	0.418	0.205
Quantity elasticity – 2-way fixed effects	0.351	0.353	0.188
Advanced economies			
Price elasticity – baseline	0.719	0.797	0.155
Price elasticity – product-time fixed effects	0.897	0.911	0.127
Price elasticity – 2-way fixed effects	0.631	0.664	0.178
Quantity elasticity – baseline	0.337	0.368	0.185
Quantity elasticity – product-time fixed effects	0.442	0.428	0.184
Quantity elasticity – 2-way fixed effects	0.370	0.353	0.169
Emerging-market economies			
Price elasticity – baseline	0.592	0.597	0.252
Price elasticity – product-time fixed effects	0.837	0.878	0.224
Price elasticity – 2-way fixed effects	0.511	0.493	0.254
Quantity elasticity – baseline	0.356	0.315	0.257
Quantity elasticity – product-time fixed effects	0.495	0.458	0.350
Quantity elasticity – 2-way fixed effects	0.358	0.355	0.312

economies. This reaction of export prices to a change in the exchange rate contributes to an improvement of the trade balance following a depreciation.[4] We also find that the reaction of export prices is positively correlated with that of import prices: the countries that have high exchange rate pass-through to import prices also tend to adjust their export prices significantly. This is either because the determinants of these elasticities are the same or because imports are used as intermediate inputs (so the countries that have high pass-through can adjust export prices to a greater extent), a point that the alternative specification allows us to explore further.

[4]Note that our specifications are symmetric and linear, so an appreciation is expected to have the same effect as a depreciation, with the opposite sign.

Table 3 Summary statistics on exchange rate elasticities for import volumes and prices

	Median	Mean	Std. Dev.
Unweighted			
Price elasticity – baseline	0.480	0.468	0.161
Price elasticity – product-time fixed effects	0.220	0.188	0.192
Price elasticity – 2-way fixed effects	0.682	0.625	0.192
Quantity elasticity – baseline	−0.245	−0.204	0.202
Quantity elasticity – product-time fixed effects	−0.217	−0.158	0.268
Quantity elasticity – 2-way fixed effects	−0.520	−0.447	0.233
Weighted by trade in 2012 $(X + M) \div 2$			
Price elasticity – baseline	0.452	0.429	0.161
Price elasticity – product-time fixed effects	0.178	0.166	0.129
Price elasticity – 2-way fixed effects	0.720	0.724	0.181
Quantity elasticity – baseline	−0.166	−0.126	0.157
Quantity elasticity – product-time fixed effects	−0.172	−0.132	0.155
Quantity elasticity – 2-way fixed effects	−0.483	−0.438	0.157
Advanced economies			
Price elasticity – baseline	0.472	0.473	0.158
Price elasticity – product-time fixed effects	0.228	0.232	0.126
Price elasticity – 2-way fixed effects	0.692	0.662	0.196
Quantity elasticity – baseline	−0.217	−0.186	0.165
Quantity elasticity – product-time fixed effects	−0.215	−0.158	0.168
Quantity elasticity – 2-way fixed effects	−0.473	−0.438	0.140
Emerging-market economies			
Price elasticity – baseline	0.487	0.462	0.167
Price elasticity – product-time fixed effects	0.212	0.164	0.242
Price elasticity – 2-way fixed effects	0.671	0.614	0.191
Quantity elasticity – baseline	−0.271	−0.223	0.232
Quantity elasticity – product-time fixed effects	−0.219	−0.150	0.341
Quantity elasticity – 2-way fixed effects	−0.564	−0.470	0.292

Second, export and import quantities also react to exchange rate changes. The median elasticities of the baseline regressions are in the range of 0.2 – 0.4. Yet, for the two quantity equations there is significant heterogeneity across countries, especially for the import quantity equation. Indeed, for many countries the coefficient of the exchange rate in this regression is not significantly different from zero. Building on the reaction of export and import prices and quantities, we can derive the overall reaction of the trade balance, taking the example of the 2012 trade balance as a starting point. Overall, the results suggest that a 10% nominal depreciation would be associated with a change in the trade balance of about 2% of GDP (towards a higher surplus or lower deficit). Heterogeneity for the estimated elasticities of export and import quantities and prices, and especially the degree of trade openness, translate into significant heterogeneity of trade balance response across countries: while some countries see a small change in their trade balance (notably Japan, the United States, and Norway), others are estimated to experience much larger changes (in particular Hong Kong, Ireland, and Costa Rica, reflecting, to a large extent, their high openness to trade). Overall, we find that the Marshall-Lerner conditions hold for all countries: following a depreciation, the trade balance improves for all of them. This is largely because we consider here the full Marshall-Lerner conditions, i.e., taking into account not just the sum of the export and import quantity elasticities, but also the reaction of export and import prices. To the extent that exchange rate pass-through is incomplete in most countries, and that export prices in the producer (exporter) currency react significantly to exchange rate changes, this substantially contributes to the overall improvement of the trade balance.

The third set of results stems from our alternative regressions. Controlling for time-varying country and product fixed effects substantially modifies the results and their interpretations. For export prices, the median exchange rate pass-through coefficient increases to 87% (from 65% in the baseline). One interpretation is that this alternative specification controls for marginal costs and therefore focuses on the reaction of profit margins only, suggesting that a significant part of the reaction of export prices in producer currency comes from varying costs (associated, e.g., with import costs). In the import price equation, the alternative specification controls for time-varying conditions in the importing countries, and in particular local prices. This alternative specification reduces the pass-through coefficient compared with the baseline (as foreign exporters take into account the reaction of local prices). Generally, turning to the fixed-effects equations reduces the dispersion of the coefficients, suggesting that controlling for unobserved variables removes a substantial source of cross-country heterogeneity. The implied average response of the trade balance following an exchange rate shock using the new set of elasticities increases significantly compared to the baseline. However, the cross-country ranking in terms of magnitude of the effect remains broadly unchanged.

Overall, the different specifications we explore yield complementary insights on exchange rate elasticities. The baseline specification is very close in spirit to the standard macro approach, the magnitude of these elasticities being correlated with existing macro studies. This first set of results is very relevant from a policy perspective, as they suggest that exchange rate changes can play an important role in addressing global trade imbalances. The fixed-effects approach goes one step further and helps us disentangle the different mechanisms at work when the exchange rate varies. This second approach highlights that the reaction of export prices to exchange rate changes stems to a large extent from the reaction of marginal costs.

Our paper relates to the existing literature in the following way. Empirical research on exchange rate elasticities is often separated into two distinct approaches: the macro and the micro approaches. Papers following the macro approach (Leigh et al. 2015; Bussière et al. 2014) for pass-through) estimate the response of aggregate exports and imports to changes in the aggregate price index, like the real effective exchange rate, following mostly a time series analysis for a particular country, or using panel data. By contrast, the micro approach (Gaulier et al. 2008; Feenstra et al.

2014; Fitzgerald and Haller 2014; Imbs and Méjean 2015; Bas et al. 2017) focuses on the bilateral variation in trade and relative price differences across countries at different levels of aggregation (firm or sectoral level). Similarly, this paper exploits the bilateral variation of prices and quantities and shows that the obtained elasticities are comparable to the macro elasticities and aggregation biases between bilateral and aggregate time series are small. Furthermore, to the best of our knowledge, this is the only paper that presents a complete set of exchange rate elasticities for a large number of countries, covering export prices, export quantities, import prices and import quantities within a unified approach. Our elasticities are comparable across countries, allowing us to draw implications for model parameters in aggregate pricing models and to derive the reaction of the trade balance following a change in the exchange rate, i.e., checking whether the Marshall-Lerner conditions hold.

In general, empirical papers on the transmission of exchange rate shocks into prices and quantities are based on the export pricing models going back to Krugman (1986) and Knetter (1989). The underlying mechanisms, like firm heterogeneity (Atkeson and Burstein 2008; Berman et al. 2012), distribution costs (Corsetti and Dedola 2005), the importance of trade integration Auer (2015), the import intensity of exports (Amiti et al. 2014), strategic complementarities (Amiti et al. 2016), market structure (Amiti et al. 2016; Auer and Schoenle 2016), the lack of information about competitors (Garetto 2016) as well as the choice of the invoicing currency (Friberg and Wilander 2008; Devereux et al. 2015) and the role of the US dollar (Boz et al. 2017), are key in order to understand the aggregate response of exchange rate shocks. While this paper does not directly identify the channels at work, it shows that the estimation of aggregate exchange rate elasticities changes radically if the underlying mechanism is correlated with the exchange rate and not taken into account. For example, if firms participate in global value chains, their exported products will contain intermediate inputs from abroad. As a result, any change in the exchange rate will affect their marginal costs and their optimal export prices. Similarly, if firms have to maintain a distribution network or change their export price due to competitor price changes in the importing destination, markups will be correlated with the exchange rate and thus affect the optimal pricing decision with respect to the exchange rate. We address this correlation by exploiting the panel structure of the data set and introducing time-varying country and product fixed effects and generated regressors as proxies for unobserved omitted variables. This makes it possible to offer new insights on the determinants of aggregate exchange rate pass-through and trade elasticities.

The rest of the paper is organized as follows. Section 2 explains the theoretical framework and derives the corresponding estimation equations. Section 3 discusses our empirical strategy. The main results and their interpretations are presented in Section 4. Section 5 provides robustness tests and further results. Section 6 concludes.

2 Theoretical Framework

Complete exchange rate pass-through implies that import prices (expressed in the importer's currency) move one to one with changes in the exchange rate, while movements in export prices (expressed in the exporter's currency) are insensitive to currency changes. At the other extreme, exporters could reduce pass-through to zero if they decided to (and could) offset all changes in the exchange rate by adjusting their prices in the exporter's currency. In practice, pass-through estimates are generally between zero and one. This section explains what may affect the degree of exchange rate pass-through.

2.1 Pricing Decision of Firms

Before presenting the estimation equations, we discuss the pricing decision of exporting firms in different destination markets. We start with a very general accounting framework that is common to most of the pass-through models, see Amiti et al. (2016). Based on this framework, we will derive the estimation equation under general demand and cost structures. Define the export price (fob) that an exporting firm from country i of product k to destination j charges in destination j in importer currency as p_{ijkt}^{fob}:

$$p_{ijkt}^{fob} = \frac{\theta_{ijkt} mc_{ikt}}{s_{ijt}}, \tag{1}$$

where θ_{ijkt} is the markup that a firm of exporting country i in the product class k charges in importing country j at time t. mc_{ikt} is the marginal cost in the producer's currency, which is assumed to be the same across all destination markets j. s_{ijt} is the bilateral exchange rate between exporter i and importer j denominated in country i's currency per unit of country j's.[5] Note that the markup specification is very general and allowed to be different in each destination for every product. The corresponding import price (cif) expressed in importer's currency is

$$p_{ijkt}^{cif} = \frac{\theta_{ijkt} \tau_{ijkt} mc_{ikt}}{s_{ijt}}, \tag{2}$$

where τ_{ijkt} are bilateral product-specific trade costs. This general pricing equation relies on the following assumptions: (1) the demand is invertible, (2) firms are risk neutral and (3) firms are static profit maximizers under full information, which excludes any form of dynamic price-setting considerations given that exchange rate uncertainty does not play any role. From now on, we assume that these assumptions are satisfied.[6] Note that the pricing decision in Eq. 2 does not depend on the nature of market competition, i.e., allowing for both monopolistic and oligopolistic

[5]Given this definition of exchange rates, an increase in s_{ijt} implies a depreciation of country i's currency, which improves its competitiveness in foreign markets.

[6]We refer to Friberg (1998) for the seminal contribution on the exchange rate pass-through with risk averse firms. In the robustness section, we analyze the exchange rate pass-through with respect to the forward exchange rate to mitigate the concern that the aggregate pass-through is driven by firms hedging exchange rate risk.

competition. As a result, we can write the estimation equation of the exchange rate pass-through on export prices in the importer's currency of country $[i]$ as

$$d\log\left(p^{fob}_{[i]jkt}\right) = \alpha_{[i]} - \beta_{1,[i]} d\log(s_{ijt}) + \beta_{2,[i]} d\log(\theta_{ijkt}) + \beta_{3,[i]} d\log(mc_{ikt}) + e_{ijkt}. \tag{3}$$

The variable of interest in Eq. 3 is $\beta_{1,[i]}$. If we could observe markups (θ_{ijkt}) and marginal costs (mc_{ikt}), all the coefficients in Eq. 3 should be one. Empirical difficulties arise due to the fact that θ_{ijkt} and mc_{ikt} are usually unobserved and potentially correlated with the exchange rate, which is why pass-through might be incomplete. Concerning the interpretation of the estimated coefficient $\hat{\beta}_{1,[i]}$, in the case of complete pass-through, i.e., when the exchange rate depreciates ($ds_{ijt} > 0$), the exchange rate change is completely passed on to import prices, $\hat{\beta}_{1,[i]} = 1$, and the export price in the exporter's currency does not change. On the other hand, if the exporter changes the export price one to one with the exchange rate in order to keep the price in the importing country constant, the pass-through coefficient is $\hat{\beta}_{1,[i]} = 0$. Generally, it may be optimal for the exporter to change the export price only partly with the exchange rate (i.e., incomplete pass-through). In this case, the pass-through coefficient lies between zero and one ($0 \leq \hat{\beta}_{1,[i]} \leq 1$). Next, we discuss the potential reasons why marginal costs and markups are potentially correlated with the exchange rate.

2.1.1 Marginal Costs

In general, marginal costs will be correlated with the exchange rate if exporters buy their intermediate goods from abroad. Based on detailed firm-level data from Belgium, Amiti et al. (2014) show that large exporting firms are simultaneously large importing firms and that these firms basically determine the aggregate pass-through. Due to the reliance on intermediate imports, marginal costs of production will depend on exchange rate shocks and change the optimal pricing decision of exports. In particular, firms' marginal costs, mc_{ikt}, will be positively correlated with the exchange rate because a depreciation of the exporter's exchange rate ($s_{ijt} \uparrow$) increases the marginal costs in terms of local currency. With respect to the direction of the bias, we expect that accounting for international input-output linkages of firms will increase the exchange rate pass-through. As Amiti et al. (2014) show, large import-intensive firms have high export market shares and hence set high export markups. These high markups act as a buffer for the exchange rate fluctuations and will limit the effect of exchange rate shocks on export prices.

On a more macroeconomic scale, exchange rate fluctuations can have a direct impact on wages and thus alter marginal costs of firms through several other channels. First, an exchange rate depreciation increases the consumer price index and reduces real wages. At the same time, the depreciation may also change inflation expectations and thus affect the wage-setting mechanism. Second, an exchange rate depreciation increases competitiveness and may increase domestic production, which leads to higher labor demand and wages, see Campa and Goldberg (2001). Third, exchange rate fluctuations may also have a direct impact on domestic labor supply through migration by changing the relative wages across countries, see Mishra and Spilimbergo (2011) for empirical evidence.

2.1.2 Strategic Complementarities in Price Setting

Markups, θ_{ijkt}, are also likely to adjust with the exchange rate. One reason is that firms have to pay distribution costs in the destination country, see Corsetti and Dedola (2005) and Berman et al. (2012). In this case, the pricing decision of the exporter and thus the markup, θ_{ijkt}, is a function of the distribution cost, η_{jkt}. This distribution cost has to be paid in the importer's currency. Therefore, any change in the bilateral exchange rate will change the distribution costs and the optimal pricing decision of the exporter. In particular, an appreciation of the importer's currency, which is equivalent to a depreciation of the exporter's currency ($s_{ijt} \uparrow$), increases the distribution cost in the importing destination j, $\text{Corr}(d \log \eta_{jkt}, d \log s_{ijt}) > 0$ and forces the firm to reduce its markup, $\text{Corr}(d \log \theta_{ijkt}, d \log s_{ijt}) < 0$.

An alternative explanation, highlighted by Amiti et al. (2016), relates to strategic complementarities in price setting, where exporters adjust their prices due to changes in competitors' prices in the importing country. Consider the following example. Suppose there is a currency crisis in the importing country and its currency depreciates, which is equivalent to a appreciation of the exporter's currency ($s_{ijt} \downarrow$). If pass-through is not zero, the exporter does not absorb the full currency change, and the exporter's price in terms of the importer's currency will increase. In oligopolistic markets, the presence of strategic complementarities in price setting implies that competing firms in the importing country will raise their prices as well, which leads to a further reaction of the exporter and so on until the equilibrium is reached. As a result, exporter's will raise their export price by more than in the absence of strategic complementarities and the observed import pass-through is amplified. Overall, we have a negative correlation between the exchange rate and competitors' prices in the importing destination (p_{-jkt}), i.e., $\text{Corr}(d \log p_{-jkt}, d \log s_{ijt}) < 0$.

In both cases, we have an omitted variable bias that implies a change in the observed pass-through if we do not control for changes in export prices due to (1) changes in distribution costs or (2) changes of competitors' prices in the importing country. For this reason, we include importer fixed effects in the empirical specification and expect to observe a lower pass-through compared to the case without importer fixed effects. In the robustness section we provide further evidence on the importance of competitors pricing decision for the exchange rate pass through using information on the concentration of exporters' market shares in the destination country. Next, we present the estimation equation with the empirical specifications.

3 Empirical Analysis

The empirical trade literature often faces a trade-off between sectoral disaggregation, country coverage and data frequency. Bussière et al. (2014), for example, use data on import and export prices at the country level on quarterly frequency. The main drawback of the macro data is that they might be subject to aggregation bias.[7] As a

[7] Mumtaz et al. (2006) find evidence that neglecting cross-sector heterogeneity biases pass-through estimates.

result, aggregate prices make pass-through estimates difficult to discriminate between incomplete pass-through reflecting price discrimination and incomplete pass-through reflecting changes in quality. On the other hand, the product-level data used in this paper allows for a rich set of fixed effects that minimize the aggregation bias and partly control for product differentiation issues.

Our analysis is based on the BACI database developed by the CEPII, see Gaulier and Zignago (2010), which is based on the United Nations COMTRADE database. The data are harmonized in order to reconcile export and import declaration of values and quantities across countries, where precedence is given to countries with more reliable trade statistics. The main advantage of this database is that it has an extensive country coverage at a high level of disaggregation for many years. The data span from 1995 to 2012 and include around 5,000 Harmonized System (HS) six-digit codes for more than 160 countries.

To proxy export prices at the product level, we compute unit values using harmonized trade quantities and values in current US dollars. These unit values are then converted into importer's currency using the bilateral exchange rate data from the IMF's International Financial Statistics. Note that the export prices are free on board (FOB) and can be interpreted as wholesale prices rather than retail prices, i.e., they are not directly affected by transportation costs or tariffs. However, it is important to note that unit values may depart from real export prices. In particular, price proxies based on unit values suffer from measurement errors due to product heterogeneity and unobserved quality differences within each HS six-digit code. To address this issue, we first use product fixed effects that partly control for unobserved, systematic errors. Second, we also exclude annual changes in unit values that are larger than 200%. We consider these large unit value changes as unrealistic measures of price changes. This definition of outliers removes roughly 1% of the total number of observations. However, we want to stress that our results below are robust to alternative definitions of outliers, i.e., removing the top 1% of price changes in each product category or removing no outliers at all.

Importantly also, all our equations are weighted by the magnitude of the flows: large trading partners and large sectors are given a higher weight. This allows discounting the presence of zero trade flows as well as small trade flows, which are generally measured less precisely.

3.1 Exchange Rate Pass-Through

3.1.1 Baseline Regression

We start by describing the export side and then proceed with the import side. Consider exporting country $[i]$. According to Eq. 3, the exchange rate pass-through coefficient $\beta^X_{[i]}$ can be estimated using the following estimation equation:

$$d\log\left(p^{fob}_{[i]jkt}\right) = -\beta^X_{[i]} d\log(s_{ijt}) + f_{[i]jk} + e_{ijkt}, \tag{4}$$

where $d\log(p^{fob}_{[i]jkt})$ is the change of the log of export unit values (prices) of exporting country i to importing country j of product k at time t expressed in the importer's currency and k refers to a six-digit HS code. $\log(s_{[i]jt})$ is the log of the bilateral nominal exchange rate in terms of the exporting country i with respect to the importing country j at time t. $\beta^X_{[i]}$ measures how exporters change their price according to a change in the exporter's exchange rate and is the coefficient of rest. If $\beta^X_{[i]} = 1$, then exporters do not change their export price in terms of exporter's currency and pass the change in the exchange rate completely on to importers, i.e., complete pass-through. Equation 4 also includes bilateral product fixed effects, $f_{[i]jk}$. They capture price discrimination of exporters across different importing countries that are constant over time, i.e., trends in relative price changes specific to the pair of countries and the product.

Similar to the export prices, we can estimate exchange rate pass-through into import prices. The country-specific import price regression is given by the log linear change of Eq. 2:

$$d\log\left(p^{cif}_{i[j]kt}\right) = -\beta^M_{[j]} d\log(s_{ijt}) + f_{i[j]k} + e_{ijkt}, \quad (5)$$

where $d\log\left(p^{cif}_{i[j]kt}\right)$ is the change of the log of import prices in importing country $[j]$ from exporting country i of product k at time t denoted in importer's currency. Concerning the interpretation of the elasticity, if $\beta^M_{[j]} = 0$ the importer's price does not change when the exporter's currency changes. This implies that exporters, who price their goods in the importing country's currency, absorb all changes in the exchange rate, i.e., complete pricing to market and no pass-through. On the other hand, if exporters change their price one-to-one as a result of a change in the importer's currency, we have complete pass-through and the elasticity should be $\beta^M_{[j]} = 1$.

Note that there is a relationship between the export and the import exchange rate pass-through. Under the assumption that $\beta^X_{[i]}$ in Eq. 4 and $\beta^M_{[j]}$ in Eq. 5 are unbiased and consistently estimated, then the weighted average cross-country exchange rate pass-through for exports should be equal to the weighted average of the exchange rate pass-through for imports.[8] At the same time, there is not necessarily a correlation between the import and export exchange rate elasticity at the individual country level. For example, a country may be characterized by complete pass-through on the export side and zero pass-through on the import side.

All our equations are estimated using weighted ordinary least squares (OLS). We use the value of each bilateral flow to calculate the two-period weights as in the computation of Törnqvist price indices.[9]

$$w_{ijkt} = \frac{1}{2}\left[\frac{V_{ijkt-1}}{V_{it-1}} + \frac{V_{ijkt}}{V_i}\right],$$

where i, j, k, and t refer to the exporting country, the importing country, the product and time. V_{ijkt} is the value of the bilateral trade flow denominated in exporter's currency in the exporting equations and in importer's currency in the importing country. $V_{it} = \sum_{jk} V_{ijkt}$ is total exports of country i at time t. Table 4 presents the 51

[8] See the Appendix for details.

[9] We follow Gaulier et al. (2008) and define the weighting variable as follows:

Table 4 Estimates of Exchange Rate Elasticities for export and import prices for the baseline specification

	Export prices				Import prices			
	ER	SE	R2	N	RE	SE	R2	N
ARG	−0.01	0.089	0.08	332,474	0.62**	0.064	0.08	497,445
AUS	0.45*	0.191	0.05	768,120	0.66**	0.089	0.06	975,511
AUT	0.91**	0.085	0.05	1,420,579	0.41**	0.053	0.05	1,009,890
BEL	0.80**	0.051	0.06	2,008,135	0.28**	0.071	0.06	1,109,865
BRA	0.56**	0.054	0.07	831,405	0.55**	0.051	0.10	702,674
CAN	0.60**	0.118	0.07	967,477	0.46**	0.061	0.05	1,011,513
CHE	1.15**	0.062	0.07	1,605,750	0.30**	0.065	0.10	972,820
CHL	1.00**	0.141	0.08	213,100	0.36*	0.142	0.05	573,010
CHN	0.83**	0.032	0.05	3,310,382	0.43**	0.054	0.06	1,080,139
COL	0.69**	0.109	0.09	204,428	0.61**	0.072	0.05	494,584
CRI	0.15	0.324	0.07	106,196	0.73**	0.174	0.08	358,153
CZE	0.67**	0.043	0.08	935,814	0.46**	0.075	0.07	902,908
DEU	0.85**	0.023	0.05	4,041,388	0.38**	0.032	0.05	1,850,435
DNK	0.69**	0.068	0.07	1,221,339	0.37**	0.065	0.06	867,330
EGY	0.37**	0.031	0.13	196,242	0.49**	0.059	0.06	509,180
ESP	0.80**	0.027	0.08	2,055,659	0.35**	0.028	0.04	1,167,904
FIN	0.80**	0.040	0.08	783,183	0.48**	0.056	0.08	801,570
FRA	0.84**	0.028	0.05	3,147,532	0.44**	0.042	0.05	1,511,625
GBR	0.67**	0.036	0.07	3,087,528	0.48**	0.044	0.07	1,555,664
GRC	0.86**	0.067	0.09	457,001	0.62**	0.132	0.08	749,535
GTM	1.03**	0.203	0.05	111,744	0.17	0.095	0.09	330,679
HKG	0.81**	0.083	0.08	1,196,445	0.51**	0.056	0.04	907,330
HUN	0.83**	0.090	0.11	653,992	0.70**	0.096	0.10	811,886
IDN	0.07	0.068	0.15	702,737	0.58**	0.087	0.21	624,210
IND	0.93**	0.065	0.07	1,589,978	0.41**	0.147	0.05	780,974
IRL	0.17	0.137	0.06	484,530	0.47**	0.115	0.07	654,674
ISR	0.73**	0.122	0.07	444,751	0.80**	0.091	0.10	622,914
ITA	0.84**	0.015	0.06	3,359,174	0.41**	0.031	0.05	1,412,602
JPN	0.43**	0.047	0.05	1,981,329	0.87**	0.053	0.05	1,073,561
KOR	0.50**	0.060	0.08	1,417,057	0.66**	0.097	0.09	830,113
LKA	0.68**	0.089	0.09	158,414	0.20*	0.077	0.11	339,284
MAR	0.64**	0.091	0.09	165,625	0.56**	0.165	0.09	461,693
MEX	0.44**	0.159	0.03	637,342	0.40**	0.122	0.03	823,689
NLD	0.81**	0.044	0.06	2,272,159	0.48**	0.072	0.05	1,234,818
NOR	1.11**	0.125	0.10	575,993	0.33**	0.062	0.09	890,442
NZL	0.59**	0.046	0.08	309,538	0.54**	0.097	0.04	640,156
PAK	0.69**	0.057	0.07	239,006	0.35**	0.107	0.09	329,960
PER	0.86**	0.104	0.08	134,825	0.44**	0.114	0.10	445,112
PHL	1.01**	0.290	0.05	326,473	0.51**	0.117	0.07	572,901

Table 4 (continued)

	Export prices				Import prices			
	ER	SE	R2	N	RE	SE	R2	N
POL	0.54**	0.039	0.11	874,663	0.44**	0.054	0.09	879,033
PRT	0.64**	0.048	0.06	641,156	0.49**	0.093	0.07	677,023
RUS	0.49**	0.079	0.13	596,721	0.80**	0.022	0.12	1,051,047
SAU	0.56**	0.150	0.04	136,899	0.26	0.163	0.06	734,435
SGP	0.92**	0.083	0.07	965,740	0.19*	0.078	0.06	939,492
SWE	0.70**	0.055	0.07	1,412,068	0.52**	0.087	0.06	956,155
THA	0.52**	0.084	0.07	1,092,679	0.31**	0.097	0.07	787,460
TUN	0.63**	0.132	0.07	131,372	0.44**	0.104	0.06	403,364
TUR	0.17**	0.046	0.21	1,195,838	0.80**	0.024	0.18	799,509
URY	0.49**	0.068	0.07	62,852	0.47**	0.094	0.06	292,743
USA	0.71**	0.046	0.04	3,769,937	0.29**	0.031	0.05	1,752,663
ZAF	0.36**	0.051	0.12	689,584	0.58**	0.079	0.08	794,363

country-specific results for the Eqs. 4 and 5. However, note that these coefficients are subject to the potential correlation of the exchange rate with marginal costs and markups. Next, we include a series of fixed effects and explain how they correct for the biases step by step.

3.1.2 Fixed-Effect Regressions

In the augmented specification, we include the following time-varying exporter and product fixed effects, $f_{[i]kt}$, in the export price Eq. 4:

$$d\log\left(p^{fob}_{[i]jkt}\right) = \beta^X_{[i]} d\log(s_{ijt}) + f_{[i]kt} + f_{[i]jk} + e_{ijkt} \tag{6}$$

The $f_{[i]kt}$ fixed effects contain product-time fixed effects, f_{kt}, i.e., product changes over time that are common to all exporters and importers. These fixed effects control, among others, for product-specific demand changes over time that are common to all countries (e.g., world demand for cars increases the price of cars relative to bicycles). More importantly, the product-time fixed effects also include an exporting country dimension, which addresses the potential correlation of the exchange rate with unobserved marginal costs, mc_{ikt}. As discussed in the previous section, for example due to intermediate imports, parts of the marginal costs vary with the exchange rate and induce an upward change in the $\beta^X_{[i]}$ coefficient. These fixed effects also capture changes in product-specific properties that are common to all importing countries, for example, quality upgrading.

The inclusion of these fixed effects implies that $\beta^X_{[i]}$ is identified by heterogeneous bilateral exchange rate changes across importing countries and abstracts from exchange rate shocks of the exporter's currency vis-à-vis a reference currency (for example, the US dollar).[10] Therefore, the coefficient $\beta^X_{[i]}$ can be seen as the pricing-to-market coefficient à la Krugman (1986). To give a concrete example, consider French exporters that sell to Japan and the United States and suppose the euro depreciates 10% against the US dollar and 5% against the Japanese yen. By the arbitrage condition in the foreign exchange rate market, the Japanese yen appreciates 5% against the US dollar. Note that the price adjustment of French exporters due to the common depreciation of the euro against both currencies (for example by invoicing in US dollars in both countries) is absorbed by the time-varying exporter-product fixed effect. The remaining identifying variation is the change in the price of French exporters charged in the US market compared with the one charged in the Japanese market due to the 5% appreciation of the yen against the US dollar.

Regarding the import price Eq. 5, the key difference with respect to the export Eq. 6 lies in the included fixed effects:

$$d\log\left(p^{cif}_{i[j]kt}\right) = \beta^M_{[j]} d\log(s_{ijt}) + f_{[j]kt} + f_{i[j]k} + e_{jkt} \qquad (7)$$

Instead of exporter-product-time fixed effects, the import price regressions contain importer-product-time fixed effects, $f_{[j]kt}$. These fixed effects control for global product-specific demand shocks as well as any importer time variation that is common to all products, for example, higher inflation or product-specific technology progress or demand that changes the price level in a particular product category. Based on the discussion in Section 2, the importer-product-time controls also for local price changes that are correlated with the exchange rate as well as changes in distribution costs that are common to all exporters.

3.1.3 Two-Step Procedure

One key issue is that we cannot include time-varying exporter and importer-product fixed effects because these fixed effects would absorb all exchange rate changes.[11] To circumvent this problem, we take advantage of our bilateral data set and follow the suggested two-step approach of Baker and Fortin (2001) and Redding and Venables (2004) based on Pagan (1984). First, we proxy unobserved marginal costs with a generated regressor from a fixed-effect regression, a method pioneered by Schmalensee and Joskow (1986). In the second step, we use the generated regressor obtained from the first step as explanatory variable in the estimation of the exchange rate pass-through. To be more explicit, consider again the export price Eq. 1 and observe that marginal costs are independent from the destination country j. If we estimate the following export price equation for country i,

$$d\log\left(p^{fob}_{[i]jkt}\right) = \beta^X_{[i]} d\log s_{ijt} + f_{[i]kt} + f_{[i]jk} + e_{ijkt},$$

[10]In the robustness section, we follow Boz et al. (2017) and explicitly distinguish between the bilateral exchange rate variation and the variation of the exporter's currency to the US dollar.

[11]Note that for any triplet of countries a, b and c, we have $\log s_{ab} = -\log s_{ba}$ and $\log s_{ab} = \log s_{ac} - \log s_{cb}$ by arbitrage. The within transformation with time-varying exporter and importer-product fixed effects implies that $\log s_{ab} - \log s_{ac} - \log s_{cb}$ equals zero. In this sense, the exchange rate is a monadic variable, see Head and Mayer (2014).

then the exporter fixed effect $f_{[i]kt}$ will capture all effects that are specific to the exporter (including unobserved marginal costs) and are independent of the exchange rate. Given our export pricing model, we can proxy marginal costs via a linear function of the estimated fixed effect and an error component ($u_{[i]kt}$), i.e., $\widehat{mc_{[i]kt}} = a\hat{f}_{[i]kt} + u_{[i]kt}$.

In the second step, we use this estimated fixed effect as a generated regressor in the import price equation:

$$d\log\left(p^{cif}_{i[j]kt}\right) = \beta^{M}_{[j]} s_{i[j]t} + \gamma_{[j]}\widehat{mc_{ikt}} + f_{[j]kt} + f_{i[j]k} + e_{i[j]kt}, \tag{8}$$

where import price pass-through coefficient $\beta^{M}_{[j]}$ is now consistently estimated, if (1) the exchange rate is uncorrelated to the approximation error, i.e., $Corr(s_{i[j]t}, u_{[i]kt}) = 0$, and (2) the errors are uncorrelated $Corr(u_{[i]kt}, e_{i[j]kt}) = 0$. Given that $\widehat{mc_{ikt}}$ is estimated net of the exchange rate, we assume that this assumptions holds.

We can follow a similar approach when estimating the export pass-through coefficient. We reverse the order and run the import price equation in the first stage. In this case, the importer-time fixed effects will capture all unobserved changes that are common to all exporters. Given the import price Eq. 3, the importer fixed effect will proxy for changes in strategic price setting, $\widehat{\theta_{[j]kt}} = \hat{f}_{[j]kt} + v_{jkt}$. The corresponding second stage export price equation is

$$d\log\left(p^{fob}_{[i]jkt}\right) = \beta^{X}_{[i]} d\log(s_{ijt}) + \gamma_{[i]}\widehat{\theta_{jkt}} + f_{[i]jk} + f_{[i]kt} + e_{ijkt}. \tag{9}$$

We obtain a consistent estimate for the export price pass-through, $\beta^{X}_{[i]}$, if $Corr(s_{ijt}, v_{[j]kt}) = 0$ and $Corr(v_{[j]kt}, e_{ijkt}) = 0$.

3.2 Quantity Elasticities

Before turning to the results of the exchange rate pass-through on prices, we will next discuss the elasticity of trade quantities. The combination of the exchange rate price and quantity elasticities allows computing the reaction of the trade balance and assessing whether an exchange rate depreciation will cause a balance of trade improvement. To estimate the elasticity of trade quantities with respect to the exchange rate, we use the following regression specifications for exports:

$$d\log\left(q^{fob}_{[i]jkt}\right) = \delta^{X}_{[i]} d\log(s_{ijt}) + \vartheta_{[i]} d\log(y_{jt}) + f_{[i]jk} + e_{ijkt} \tag{10}$$

and for imports:

$$d\log\left(q^{cif}_{i[j]kt}\right) = \delta^{M}_{[j]} d\log(s_{ijt}) + \vartheta_{[j]} d\log(y_{jt}) + f_{i[j]k} + e_{ijkt} \tag{11}$$

Equations 10 and 11 are the baseline quantity equations. The dependent variable is the quantity of product k exported from country i to country j at time t. The log change of the importer's GDP, $d\log(y_{jt})$, controls for local demand conditions.[12] Estimating the quantity regressions in log changes rather than in levels is particularly important because we control for the unit of account of the underlying quantity traded, i.e., kilogram, tons or pieces, as well as quality differences across countries that are constant over time. In addition, the time-varying product fixed effects, f_{ijk}, account for product-specific trends.

Regarding our predictions on the exchange rate elasticities, the impact of a depreciation on export quantities (δ^X) is expected to be positive, while negative for the quantities imported (δ^M).

3.3 Trade Balance (Marshall-Lerner Conditions)

In order to assess whether an exchange rate depreciation improves the trade balance, we need price elasticities of exports and imports. To see how exchange rate changes influence the trade balance, we derive the Marshall-Lerner condition. Let's define the trade balance TB_i:

$$TB_i = s_i P_i^X X_i - P_i^M M_i,$$

as the difference between the export sales (export price P_i^X, denoted in foreign currency, times volume X_i) multiplied by the nominal effective exchange rate s_i and the import expenditure (import price P_i^M, denoted in domestic currency, times volume M_i). Next, take the derivative of the trade balance with respect to the nominal effective exchange rate s_i:[13]

$$\frac{\partial TB_i}{\partial s_i} = P_i^X X_i + \frac{\partial P_i^X}{\partial s_i} s_i X_i + \frac{\partial X_i}{\partial P_i^X}\frac{\partial P_i^X}{\partial s_i} s_i P_i^X - \left(\frac{\partial P_i^M}{\partial s_i} M_i + \frac{\partial M_i}{\partial P_i^M}\frac{\partial P_i^M}{\partial s_i} P_i^M\right).$$

Using the definition of the exchange rate pass-through

$$\frac{\partial P_i^X}{\partial s_i}\frac{s_i}{P_i^X} = -\beta_i^X \quad \text{and} \quad \frac{\partial P_i^M}{\partial s_i}\frac{s_i}{P_i^M} = \beta_i^M$$

and the price elasticities of trade volumes

$$-\frac{\partial X_i}{\partial P_i^X}\frac{P_i^X}{X_i} = \mu_i^X \quad \text{and} \quad -\frac{\partial M_i}{\partial P_i^M}\frac{P_i^M}{M_i} = \mu_i^M$$

we can rewrite the previous equation as

$$\frac{\partial TB_i}{\partial s_i}\frac{s_i}{TB_i} = \frac{s_i P_i^X X_i}{TB_i}\left(1 - \beta_i^X + \mu_i^X \beta_i^X\right) - \frac{P_i^M M_i}{TB_i}\left(\beta_i^M - \mu_i^M \beta_i^M\right).$$

[12]The quantity equations are, for example, consistent with a two-tier CES demand system, where changes in GDP capture aggregate demand changes, see among others Imbs and Méjean (2015), and more generally with aggregate exchange rate regressions in the pricing-to-market literature, see Burstein and Gopinath (2014).

[13]In line with the definition of the bilateral exchange rate, a depreciation of the nominal exchange rate of exporter i increases s_i.

Under the assumption that trade is balanced, the Marshall-Lerner condition under which the trade balance improves after an exchange rate depreciation becomes

$$\beta_i^X \left(1 - \mu_i^X\right) + \beta_i^M \left(1 - \mu_i^M\right) < 1. \tag{12}$$

In order to verify the Marshall-Lerner conditions, we need to calculate the price elasticities of exports (μ^X) and imports (μ^M). These elasticities can be estimated using the exchange rate as an exogenous shock to prices. Consider the case for exports:

$$\frac{\partial \log X_i}{\partial \log s_i} = \frac{\partial \log X_i}{\partial \log P_i^X} \frac{\partial \log P_i^X}{\partial \log s_i} = \frac{\partial \log X_i}{\partial \log P_i^X} \left(-\beta_i^X\right)$$

or, simplifying,

$$\mu_i^X = \frac{\delta_i^X}{\beta_i^X}$$

and, equivalently for imports, we have

$$\frac{\partial \log M_i}{\partial \log s_i} = \frac{\partial \log M_i}{\partial \log P_i^M} \frac{\partial \log P_i^M}{\partial \log s_i} = \frac{\partial \log M_i}{\partial \log P_i^M} \left(\beta_i^M\right),$$

which simplifies to

$$\mu_i^M = -\frac{\delta_i^M}{\beta_i^M}.$$

Next, we discuss the main results of the estimation of the exchange rate elasticities for import and export prices as well as for the corresponding quantity elasticities.

4 Results

4.1 Exchange Rate Pass-Through

Figures 1 and 2 plot the baseline results without fixed effects. The corresponding tables with the detailed results are Tables 4 and 5. Overall, the estimation results show that the coefficients of the key variables are statistically significant, with expected signs and magnitudes for all of the 51 countries.

Starting with export prices, the average elasticity of export prices denominated in the importer's currency with respect to the exchange rate, i.e., the exchange rate pass-through, is 0.65. However, as Fig. 1 shows, there is a lot of heterogeneity across countries. We observe an elasticity of 1 for Switzerland, Norway, Guatemala, Philippines, Chile, Singapore and India, i.e., the exporters from these countries do not change their export prices when the exchange rate varies, implying full pass-through for their trading partners. The following countries, however, adopt a complete pricing-to-market strategy and change their price one-to-one with the exchange rate: Argentina, Costa Rica, Indonesia and Ireland. In these countries, exporters do not change their export price in terms of the importer's currency with the exchange rate since their export elasticity is not significantly different from zero. In general, the average exchange rate elasticity of export prices is higher for advanced economies

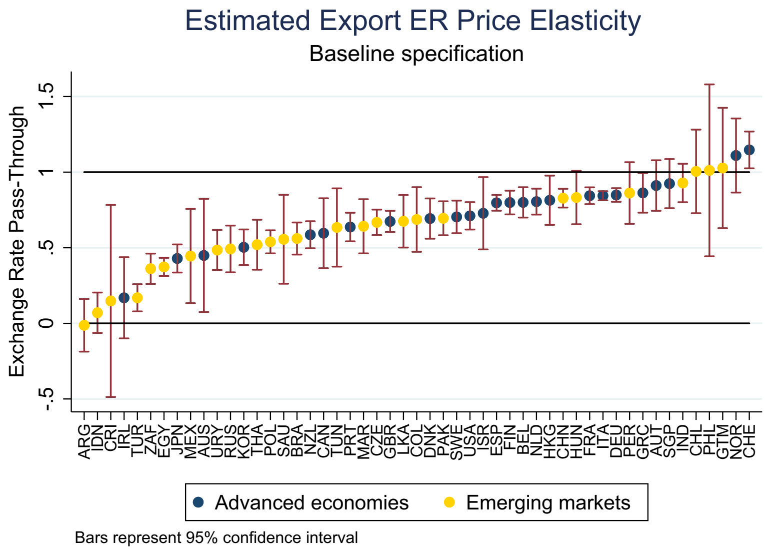


Fig. 1 Estimated Exchange Rate Elasticity of Export Prices. Note: This chart reports point estimates of the exchange rate elasticities as shown in Table 4. Trade prices are expressed in the importer's currency so the coefficients can be read directly as "pass-through coefficients" for the importing countries. The blue circles indicate coefficient estimates for advanced economies and the yellow circles for emerging-market economies. The vertical lines denote 95% confidence intervals

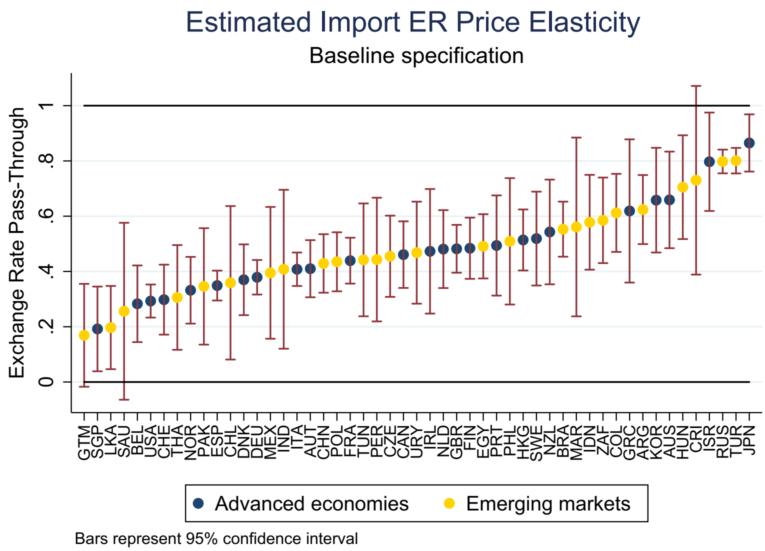


Fig. 2 Estimated Exchange Rate Elasticity of Import Prices. Note: This chart reports point estimates of the exchange rate elasticities as shown in Table 4. The blue circles indicate coefficient estimates for advanced economies and the yellow circles for emerging-market economies. The vertical lines denote 95% confidence intervals

Table 5 Estimates of Exchange Rate Elasticities for export and import volumes for the baseline specification

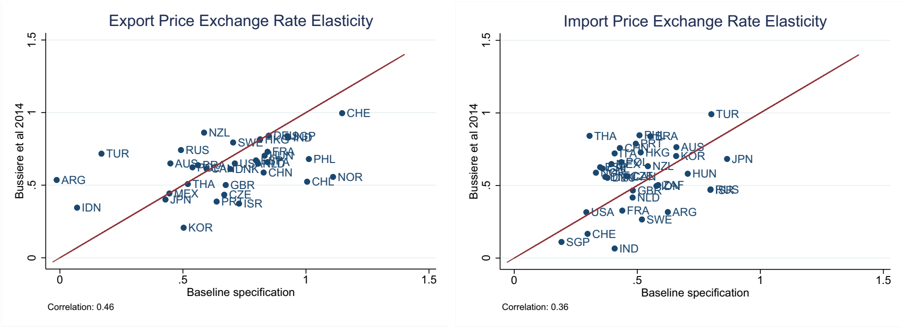
	Export volumes					Import volumes				
	ER	(SE)	log(GDP)	(SE)	R2	ER	(SE)	log(GDP)	(SE)	R2
ARG	−0.16	0.107	1.28	1.697	0.14	0.46**	0.105	1.46**	0.158	0.08
AUS	0.73**	0.221	1.64*	0.712	0.06	0.31*	0.123	1.51*	0.644	0.08
AUT	0.49**	0.109	1.21**	0.214	0.06	0.09	0.073	1.93**	0.208	0.06
BEL	0.57**	0.105	1.66**	0.162	0.07	−0.07	0.102	1.51**	0.241	0.08
BRA	0.28**	0.057	1.71**	0.283	0.08	0.23**	0.047	0.03	0.655	0.14
CAN	0.11	0.197	1.53**	0.445	0.09	0.29**	0.107	1.22*	0.483	0.09
CHE	0.62**	0.117	1.42**	0.329	0.10	0.36	0.289	0.47	0.379	0.07
CHL	0.43**	0.064	1.41**	0.316	0.10	0.34	0.175	1.22**	0.372	0.08
CHN	0.62**	0.047	1.11**	0.166	0.09	−0.04	0.071	0.41	0.482	0.08
COL	0.27	0.147	1.32*	0.517	0.10	0.60**	0.101	1.63*	0.766	0.10
CRI	0.63	0.331	1.16	0.752	0.09	0.79**	0.268	1.27	0.982	0.09
CZE	0.29**	0.084	1.19**	0.161	0.10	0.28**	0.070	0.96**	0.241	0.07
DEU	0.36**	0.051	1.31**	0.055	0.08	0.09	0.047	1.16**	0.184	0.08
DNK	0.38**	0.079	0.91**	0.119	0.10	0.09	0.110	1.28**	0.211	0.08
EGY	0.25	0.155	0.61	0.402	0.11	0.38**	0.136	1.03**	0.382	0.08
ESP	0.43**	0.067	1.17**	0.145	0.10	0.19**	0.061	1.09**	0.222	0.07
FIN	0.44**	0.085	1.54**	0.245	0.11	0.11	0.078	1.60**	0.232	0.10
FRA	0.41**	0.055	0.86**	0.202	0.08	0.20**	0.063	1.93**	0.113	0.08
GBR	0.15**	0.050	1.32**	0.147	0.08	0.14	0.085	1.23**	0.235	0.12
GRC	0.38*	0.153	0.94**	0.213	0.11	0.45	0.240	1.66**	0.327	0.08
GTM	0.30	0.233	0.18**	0.049	0.07	0.18	0.167	1.82	0.963	0.10
HKG	0.30	0.255	0.42	0.329	0.08	0.38**	0.099	0.39	1.000	0.06
HUN	1.02**	0.205	1.43**	0.408	0.11	−0.02	0.086	1.18**	0.263	0.09
IDN	0.36**	0.095	0.60**	0.224	0.11	−0.00	0.148	0.89**	0.231	0.13
IND	0.34**	0.091	0.91**	0.114	0.10	0.52*	0.199	2.04	2.409	0.08
IRL	0.18	0.250	2.01**	0.610	0.07	0.10	0.244	2.07**	0.246	0.09
ISR	0.08	0.264	1.79**	0.475	0.09	0.53**	0.117	1.40	0.916	0.10
ITA	0.22**	0.028	1.26**	0.077	0.08	0.30**	0.049	1.36**	0.132	0.08
JPN	0.28**	0.090	1.91**	0.141	0.08	0.13	0.074	1.57**	0.359	0.07
KOR	0.37**	0.134	1.35**	0.267	0.11	0.07	0.094	1.53**	0.370	0.10
LKA	0.22	0.144	1.38**	0.414	0.11	−0.00	0.165	0.24	0.520	0.10
MAR	0.16	0.122	1.31**	0.293	0.10	0.58**	0.195	0.52**	0.158	0.09
MEX	0.02	0.208	1.64**	0.468	0.06	0.16	0.194	1.19*	0.541	0.04
NLD	0.56**	0.072	1.36**	0.106	0.09	0.29**	0.089	1.90**	0.207	0.09
NOR	0.40	0.210	0.63**	0.229	0.21	0.03	0.138	0.49**	0.127	0.10
NZL	0.22**	0.052	0.76**	0.174	0.08	0.43**	0.152	1.63	1.684	0.06

Table 5 (continued)

	Export volumes					Import volumes				
	ER	(SE)	log(GDP)	(SE)	R2	ER	(SE)	log(GDP)	(SE)	R2
PAK	0.60**	0.131	1.60**	0.239	0.10	0.47*	0.231	1.47	1.203	0.11
PER	0.34*	0.158	1.13**	0.364	0.10	0.63**	0.201	1.38**	0.242	0.11
PHL	0.88**	0.321	0.94	2.388	0.08	0.12	0.142	0.60	0.388	0.09
POL	0.31**	0.077	1.73**	0.242	0.11	0.25**	0.051	1.27**	0.262	0.09
PRT	0.18*	0.078	1.03**	0.113	0.10	0.35**	0.073	1.29**	0.214	0.10
RUS	0.11	0.082	0.76**	0.203	0.13	0.45**	0.054	0.95**	0.137	0.11
SAU	0.84**	0.174	2.02*	0.779	0.09	0.04	0.192	0.60**	0.203	0.09
SGP	0.36*	0.136	0.57	0.518	0.10	0.00	0.113	0.00	0.253	0.08
SWE	−0.01	0.075	1.70**	0.135	0.09	0.49**	0.079	2.04**	0.260	0.08
THA	0.32*	0.126	0.94**	0.227	0.10	0.17	0.136	1.59**	0.205	0.09
TUN	0.12	0.179	1.31	0.728	0.07	0.22	0.113	0.10	0.154	0.08
TUR	0.46**	0.031	1.39**	0.131	0.12	−0.01	0.046	1.53**	0.160	0.10
URY	0.70**	0.157	1.31	0.671	0.08	0.10	0.164	0.65	0.327	0.11
USA	0.19**	0.057	0.69**	0.115	0.06	0.09	0.051	1.76**	0.556	0.08
ZAF	0.29**	0.089	1.17*	0.516	0.12	0.16*	0.060	1.32	1.208	0.10

(on average, 0.72) than for emerging-market economies (on average, 0.59). A possible explanation may be that exporters from emerging-market economies have more market power than those from advanced economies. Turning to imports, the average exchange rate elasticity is 0.48. Only Costa Rica has a pass-through coefficient that is not significantly different from 1, i.e., we observe incomplete pass-through in most countries. In contrast, countries with a relatively low exchange rate elasticity are Guatemala, Singapore, Sri Lanka and Saudi Arabia. However, there is no significant difference in the import pass-through between emerging markets (on average, 0.49) and advanced economies (on average, 0.47).

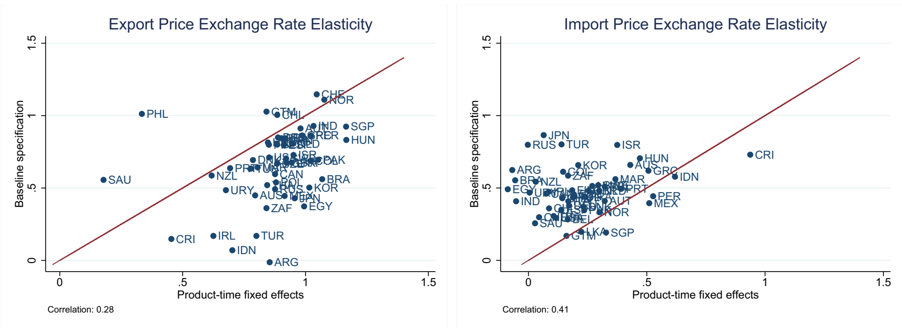
Our results, based on a unified data set, are broadly consistent with existing country-specific studies for advanced economies, compiled from different data sources. For the United States, our import pass-through coefficient is estimated to be around 29%. This result is in line with Ihrig et al. (2006), who find an estimate of 32%, and Corsetti et al. (2007) at 27%, as well as Gopinath (2015), who finds 35%. Gopinath (2015) also provides recent estimates for Turkey and Japan using aggregate import price data. Our product-level-based estimates show 80% pass-through for Turkey and 87% for Japan, which are slightly lower than the 82 and 92% respectively found by Gopinath (2015). For the United Kingdom, we find an exchange rate effect of 48%, in line with that of Campa and Goldberg (2005), equal to 46%, and Bussière (2013), at 48%. More generally, we can compare our elasticities based on product-level data with the macro exchange rate pass-through elasticities from Bussière et al. (2014), who investigate a similar sample in terms of country observations, see Fig. 3. For exports the correlation is 0.46 and for imports 0.36. In line with Bussière et al. (2014), we also find a strong relationship between the estimated elasticities for export and import prices across countries. The correlation coefficient is 0.52.



(a) Exports (b) Imports

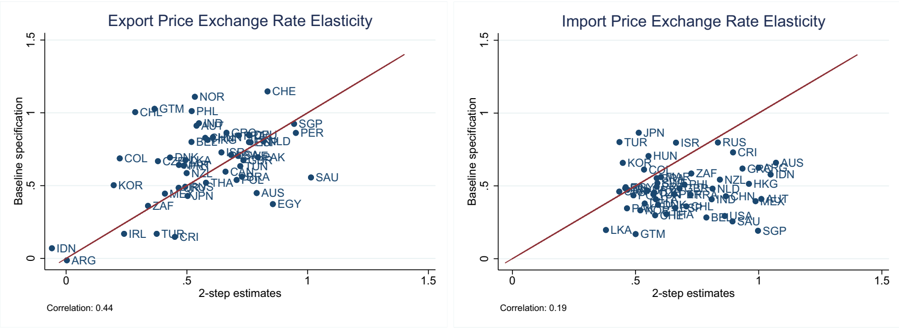
Fig. 3 Export and Import Exchange Rate Pass-Through: comparison of estimates of the baseline specification with Bussière et al. (2014). Note: The red line corresponds to the 45 degree line

In the next step, we can compare the results with no time fixed effects to the 1-step regression with time-varying country and product fixed effects and analyze the sensitivity of the estimated exchange rate elasticities with respect to unobserved marginals cost and strategic complementarities in price setting. Figure 4 shows the comparison for export (Fig. 4a) and for import prices (Fig. 4b) by plotting the 1-step estimates on the horizontal axis and the baseline estimates on the vertical axis. In the case of export prices, we observe that, with the exceptions of the Philippines and Saudi Arabia and to a lesser extend Chile and Guatemala, the 1-step estimates are higher than the baseline ones. Net of changes in the marginal costs, the average exchange rate pass-through increases substantially from 0.65 to 0.87. Note that this implied bias is consistent with our pricing model, which suggests a positive correlation between marginal costs and exchange rate changes, see Section 2.1.2. Similarly, in the case of imports, we observe that with the correction of (importer-)time fixed effects, the estimates are lower than the baseline ones with the exception of Costa Rica, Singapore, Mexico, Peru and Indonesia. Neglecting price adjustments caused by complementarities in price-setting in the importing destination reduces the average exchange rate



(a) Exports (b) Imports

Fig. 4 Export and Import Exchange Rate Pass-Through: comparison of estimates of the baseline specification with the fixed-effect specification. Note: The red line corresponds to the 45 degree line



(a) Exports (b) Imports

Fig. 5 Export and Import Exchange Rate Pass-Through: comparison of baseline estimates with the 2-step approach. Note: The red line corresponds to the 45 degree line

pass-through into import prices substantially from 0.49 to 0.22. The direction of the change is consistent with the pricing model in Section 2.1.1. Price adjustments are positively correlated with the exchange rate and lower the exchange rate pass-through to import prices if omitted from the regression.[14]

Finally, we can compare the 2-step results with the baseline specification of no time fixed effect. Doing so simultaneously controls for marginal costs and local price changes that are correlated with the exchange rate. Figure 5 shows the comparison for export (Fig. 5a) and for import prices (Fig. 5b) by plotting the 2-step estimates on the horizontal axis and the baseline estimates on the vertical axis. In the case of exports, based on the 2-step approach, the reaction of export prices in importer currency to exchange rate changes is the lowest with 0.57, compared with 0.65 with no time fixed effects and to 0.87 with only product-time fixed effects. Note that these changes are again consistent with the correlation implied by the pricing equation in Section 2. In the case of export prices, controlling for marginal costs increases the elasticity, while controlling for local prices reduces the elasticity. As for imports, if we proxy for marginal costs and local prices the average pass-through is the highest with 0.68 compared to 0.49 in the case of no fixed effects and to 0.22 with product fixed effects only. Again, the direction of the change is consistent with the pricing model.

4.2 Quantity Elasticities

This subsection presents the estimated baseline quantity elasticities. Looking at the export side, Fig. 6 plots the quantity elasticities reported in Table 5. Note that all countries have either a zero or a positive quantity elasticity of exports, i.e., an exchange rate depreciation raises the export quantity. While the average elasticity across all countries is 0.35, advanced economies tend to have a slightly higher

[14]The baseline regressions are nevertheless very informative as they report the reaction of prices and quantities to exchange rate changes as observed in the aggregate data. On the other hand, the fixed-effect regressions shed light on the role of specific factors that determine the aggregate response of trade prices and quantities to changes of the exchange rate.

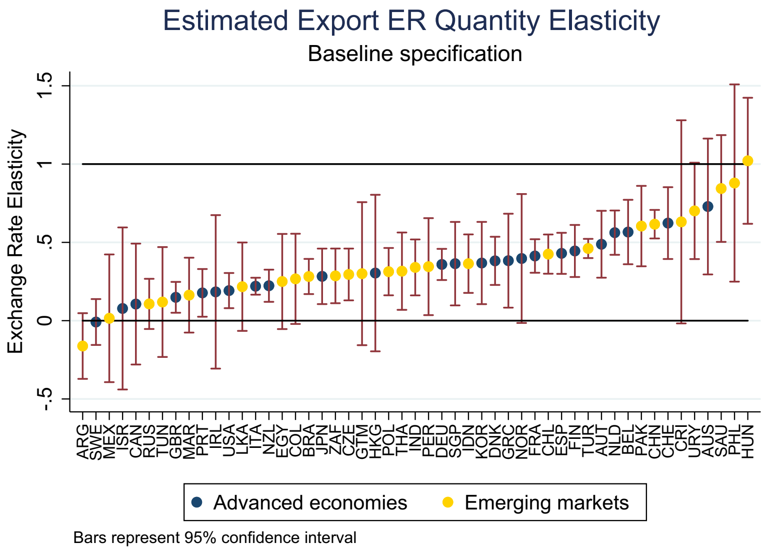


Fig. 6 Estimated Quantity Elasticity for Exports. Note: This chart reports point estimates of the exchange rate elasticities as shown in Table 5. The blue circles indicate coefficient estimates for advanced economies and the yellow circles for emerging-market economies. The vertical lines denote 95% confidence intervals

average elasticity with 0.37 compared to an average elasticity of 0.32 for emerging-market economies. However, this difference is not statistically significant. Countries with a high elasticity are the Philippines and Hungary with 0.88 and 1. On the other hand, countries with low export quantity elasticities that are not significantly different from zero are Argentina, Sweden and Mexico. In general, countries whose export quantities react more strongly to exchange rate changes tend to be countries characterized by a high exchange rate elasticity of export prices (in the importing country's currency, i.e., high pass-through). The cross-country correlation between the two types of elasticities is 0.4.

Turning to import quantity elasticities, our results in Table 5 and plotted in Fig. 7 show that all countries have either a zero or a negative quantity elasticity, i.e., an exchange rate depreciation reduces the quantity of goods imported. The average cross-country elasticity is -0.2 and insignificant between the two country groups. The average elasticity of emerging markets is -0.22 and -0.19 for advanced economies. Countries with strong reactions of import quantities are Costa Rica, Peru, Colombia, Morocco and Israel with elasticities smaller than -0.5. At the same time, for many countries we do not find a response that is significantly different from zero, suggesting that import demand in most countries depends more on income and the business cycle rather than to the exchange rate, see Hooper et al. (2002). Similar to the export quantity elasticities, countries with a stronger reaction in import prices tend to have stronger reactions in their import volumes. The correlation between the import price and quantity elasticities is 0.36.

Table 5 also shows that the estimated coefficient of GDP in both export and import quantity equations is close to or slightly above 1. In theory, there is no reason why this

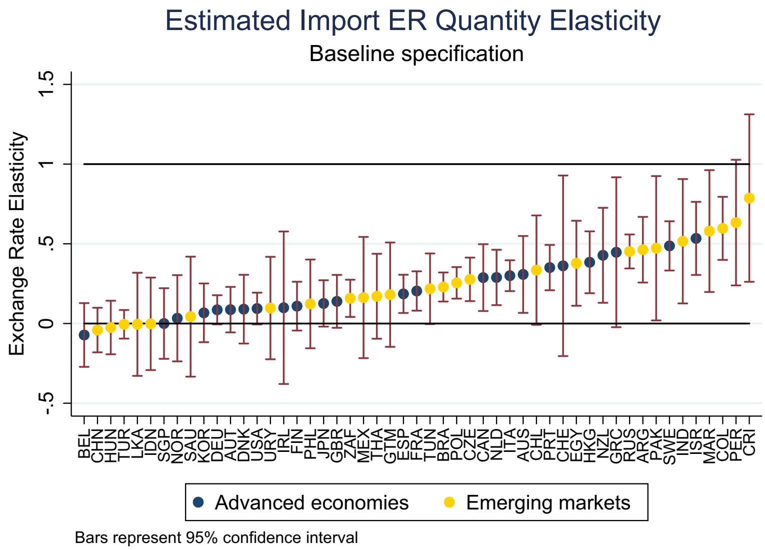


Fig. 7 Estimated Quantity Elasticity for Imports. Note: This chart reports point estimates of the exchange rate elasticities as shown in Table 5. The blue circles indicate coefficient estimates for advanced economies and the yellow circles for emerging-market economies. The vertical lines denote 95% confidence intervals

coefficient should be different from one, but this is a common result in the empirical literature. One potential explanation is that GDP is a crude measure of demand that does not take into account the different import contents of GDP components (see Bussière et al. (2013) for instance).

As in the price equations, we introduce country and product time-varying fixed effects in the quantity equations. The coefficients are affected but to a lesser extent than in the price equations. On average, we find that the median elasticity of export quantity increases from 0.35 to 0.47. One possible explanation is that the time-varying fixed effects capture supply factors not taken into account in the baseline specification, such as productivity shocks, which are associated with an appreciation of the exchange rate and a simultaneous increase in export quantities. Taking the factors into account increases the elasticity. We note that the increase in quantity elasticities is in line with the higher elasticity of export prices when changing from the baseline to the fixed-effect regression (Table 6). By contrast, switching to the fixed-effect specification leaves the elasticity broadly unchanged for import volumes (a slight increase from -0.25 to -0.22) (Table 7).

4.3 The Reaction of the Trade Balance

Based on these results, we can now verify the Marshall-Lerner conditions by plugging in the estimated price and quantity elasticities given in Tables 4 and 5 into Eq. 12. Our estimates imply that the Marshall-Lerner conditions are verified for all countries. In addition, we can calculate the implied effect of a nominal exchange rate

Table 6 Estimates of Exchange Rate Elasticities for export and import prices for the one step estimation

	Export prices		Import prices	
	ER	SE	ER	SE
ARG	0.854**	0.195	−0.069	0.118
AUS	0.795	0.396	0.430**	0.072
AUT	0.979**	0.079	0.322**	0.078
BEL	0.885**	0.054	0.166**	0.050
BRA	1.068**	0.045	−0.056	0.028
CAN	0.876**	0.060	0.075	0.125
CHE	1.046**	0.054	0.045	0.104
CHL	0.885**	0.054	0.087	0.267
CHN	0.913**	0.050	0.143	0.106
COL	1.020**	0.110	0.146	0.077
CRI	0.454**	0.168	0.937	0.565
CZE	0.884**	0.041	0.192**	0.052
DEU	0.888**	0.022	0.172**	0.026
DNK	0.786**	0.053	0.232**	0.036
EGY	0.994**	0.091	−0.088	0.061
ESP	0.911**	0.033	0.139**	0.036
FIN	0.851**	0.032	0.185**	0.045
FRA	0.902**	0.028	0.239**	0.043
GBR	0.923**	0.059	0.254**	0.032
GRC	0.986**	0.070	0.507**	0.159
GTM	0.841**	0.074	0.161	0.117
HKG	0.847**	0.091	0.270**	0.080
HUN	1.166**	0.139	0.471**	0.096
IDN	0.702**	0.082	0.619**	0.212
IND	1.032**	0.037	−0.052	0.242
IRL	0.625**	0.132	0.085	0.105
ISR	0.951**	0.086	0.375**	0.104
ITA	0.918**	0.017	0.168**	0.021
JPN	0.956**	0.039	0.064*	0.027
KOR	1.015**	0.085	0.210**	0.052
LKA	0.944**	0.059	0.223	0.212
MAR	0.805**	0.069	0.367*	0.183
MEX	0.915**	0.143	0.510**	0.113
NLD	0.948**	0.042	0.299**	0.061
NOR	1.077**	0.124	0.300**	0.054
NZL	0.618**	0.068	0.031	0.117
PAK	1.051**	0.117	0.235**	0.064
PER	1.023**	0.127	0.527**	0.154
PHL	0.334	0.487	0.322*	0.137

Table 6 (continued)

	Export prices		Import prices	
	ER	SE	ER	SE
POL	0.880**	0.042	0.188**	0.030
PRT	0.693**	0.054	0.392**	0.075
RUS	0.876**	0.030	−0.003	0.032
SAU	0.178	0.346	0.028	0.216
SGP	1.165**	0.159	0.328**	0.110
SWE	0.921**	0.046	0.295**	0.073
THA	0.844**	0.076	0.106	0.118
TUN	0.778**	0.154	0.195**	0.051
TUR	0.800**	0.027	0.140**	0.042
URY	0.676**	0.187	0.005	0.144
USA	0.852**	0.063	0.117	0.063
ZAF	0.841**	0.117	0.167	0.087

depreciation on net exports (which equals a change in output assuming no changes in consumption, investment and government spending) as

$$\frac{\partial Y_i}{\partial s_i}\frac{s_i}{Y_i} = \frac{s_i P_i^X X_i}{Y_i}\left(1 - \beta_i^X + \mu_i^X \beta_i^X\right) - \frac{P_i^M M_i}{Y_i}\left(\beta_i^M - \mu_i^M \beta_i^M\right).$$

To calculate the implied effect, we use data on the shares of exports and imports with respect to GDP ($s_i P_i^X X_i / Y_i$ and $P_i^M M_i / Y_i$) as of 2012. Combining the estimates in Tables 4 and 5 together with the trade shares, we find that on average a 10% depreciation in the exchange rate increases net exports by 2% of GDP compared with 1.7 according to Leigh et al. (2015). Table 8 and Fig. 8 show the precise estimates for all countries in our sample. Countries with the strongest effects are Hong Kong and Ireland. For those countries, a 10% depreciation translates into an increase of 7 to 8 percentage points in net exports over GDP. Countries where the exchange rate has only marginal effects on the domestic economy are Japan, United States, Norway and Great Britain. For these countries, a 10% depreciation improves net exports by less than 0.3%. Cross-country differences reflect to a large extent their openness to trade (the correlation between the trade balance effect and the openness index is 0.76).

Instead of using the baseline estimates, we also calculate the response of the trade balance to exchange rate changes using the coefficients of the 2-step fixed-effect approach reported in Tables 9 and 10. The average implied response of the trade balance to a 10% exchange rate depreciation is 2.8% of GDP, notably higher than in the baseline. However, the cross-country ranking in terms of magnitude of the effect remains broadly unchanged. The correlation between the two estimates is 0.75. Overall, the estimated response of the trade balance is similar to Gust et al. (2009), who also investigate the role of incomplete exchange rate pass-through for the adjustment of global imbalances in the wake of exchange rate changes.

Table 7 Estimates of Exchange Rate Elasticities for export and import volumes for the one step estimation

	Export volumes				Import volumes	
	ER	(SE)	log(GDP) Importer	(SE)	ER	(SE)
ARG	0.369	0.264	1.281	1.697	0.030	0.175
AUS	0.951*	0.446	1.639*	0.712	−0.127	0.104
AUT	0.480**	0.099	1.208**	0.214	−0.214	0.109
BEL	0.529**	0.115	1.658**	0.162	−0.107	0.086
BRA	0.588**	0.094	1.705**	0.283	0.131	0.113
CAN	0.282**	0.085	1.533**	0.445	−0.113	0.149
CHE	0.405**	0.111	1.416**	0.329	−0.693	0.500
CHL	0.586**	0.068	1.409**	0.316	−0.325	0.265
CHN	0.418**	0.061	1.114**	0.166	−0.036	0.093
COL	0.445**	0.153	1.319*	0.517	−0.253*	0.112
CRI	0.329*	0.138	1.157	0.752	−1.309*	0.632
CZE	0.574**	0.082	1.190**	0.161	−0.072	0.086
DEU	0.385**	0.042	1.307**	0.055	−0.140**	0.040
DNK	0.439**	0.083	0.911**	0.119	−0.080	0.074
EGY	0.560	0.578	0.612	0.402	−0.220	0.191
ESP	0.502**	0.061	1.174**	0.145	−0.187*	0.090
FIN	0.378**	0.076	1.538**	0.245	−0.155	0.098
FRA	0.402**	0.047	0.861**	0.202	−0.175**	0.062
GBR	0.391**	0.082	1.321**	0.147	−0.086	0.049
GRC	0.455**	0.156	0.945**	0.213	−0.402	0.222
GTM	-0.046	0.266	0.179**	0.049	−0.107	0.271
HKG	0.310	0.261	0.416	0.329	−0.463**	0.165
HUN	0.930**	0.187	1.429**	0.408	−0.042	0.154
IDN	0.365**	0.127	0.604**	0.224	−0.565	0.394
IND	0.480**	0.069	0.912**	0.114	−0.208	0.162
IRL	0.013	0.306	2.008**	0.610	−0.386*	0.191
ISR	0.431**	0.140	1.788**	0.475	−0.569**	0.141
ITA	0.428**	0.028	1.262**	0.077	−0.269**	0.044
JPN	0.650**	0.082	1.913**	0.141	−0.010	0.041
KOR	0.739**	0.098	1.353**	0.267	−0.206**	0.067
LKA	0.202	0.132	1.380**	0.414	0.558	0.445
MAR	0.243*	0.113	1.313**	0.293	−0.480*	0.188
MEX	0.646**	0.210	1.636**	0.468	−0.450**	0.133
NLD	0.464**	0.066	1.356**	0.106	−0.251*	0.099
NOR	0.323	0.194	0.626**	0.229	−0.158	0.101
NZL	0.348**	0.114	0.759**	0.174	0.009	0.178
PAK	0.743**	0.213	1.597**	0.239	−0.453*	0.202
PER	0.036	0.159	1.132**	0.364	−0.810*	0.323
PHL	1.494**	0.409	0.944	2.388	−0.068	0.170

Table 7 (continued)

	Export volumes				Import volumes	
	ER	(SE)	log(GDP) Importer	(SE)	ER	(SE)
POL	0.807**	0.067	1.730**	0.242	−0.282**	0.085
PRT	0.204*	0.093	1.034**	0.113	−0.205*	0.097
RUS	−0.010	0.066	0.756**	0.203	−0.175**	0.049
SAU	1.095**	0.130	2.023*	0.779	−0.091	0.263
SGP	0.585**	0.168	0.568	0.518	−0.132	0.141
SWE	0.666**	0.115	1.697**	0.135	−0.147	0.077
THA	0.204	0.156	0.938**	0.227	−0.126	0.123
TUN	0.120	0.223	1.310	0.728	−0.115	0.163
TUR	0.808**	0.079	1.391**	0.131	−0.237*	0.103
URY	0.471	0.288	1.313	0.671	0.004	0.197
USA	0.300**	0.064	0.694**	0.115	−0.120	0.064
ZAF	0.405	0.209	1.172*	0.516	0.014	0.183

5 Sectoral Heterogeneity

This section sheds light on the sectoral contribution to the aggregate Marshall-Lerner condition. We rely on the Broad Economic Classification (BEC) maintained by the United Nations and consider the following five sectors: consumption goods, semi-finished intermediate goods, parts and components, primary goods and capital goods. Their contribution to the trade balance can be calculated as follows:

$$\frac{\partial TB_i}{\partial s_i}\frac{s_i}{Y_i} = \sum_{k=1}^{K} \frac{s_i P_{ik}^X X_{ik}}{Y_i}\left(1 - \beta_{ik}^X + \mu_{ik}^X \beta_{ik}^X\right) - \frac{P_{ik}^M M_{ik}}{Y_i}\left(\beta_{ik}^M - \mu_{ik}^M \beta_{ik}^M\right)$$

where $(s_i P_{ik}^X X_{ik})/Y_i$ is the share of exports in sector k in total output and $(P_{ik}^M M_{ik})/Y_i$ is the share of imports in sector k in total output. We estimate the sectoral country-specific price and quantity exchange rate elasticities (β_{ik}^X, β_{ik}^M, μ_{ik}^X and μ_{ik}^M) with our baseline specification and calculate the sectoral contribution for each sector.

Figure 9 shows that, on average, the semi-finished intermediate goods sector contributes the most with 25% followed by consumption goods with a contribution of 23%, primary goods with a contribution of 18%, the parts and components sector with a contribution of 16% and capital goods with 14%. The reasons why the semi-finished goods sector is the most important can be twofold: (1) the sectoral specialization and (2) the magnitude of the elasticities across sectors. The sectoral specialization implies that for a given set of non-zero elasticities the trade balance will change more in sectors where countries trade a lot. The magnitude of the price and the quantity exchange rate elasticities imply that an exchange rate shock will have a stronger effect in sectors with high elasticities. The semi-finished intermediate

Table 8 Trade openness and effect of a 1% depreciation of the exchange rate on net exports over GDP

	Exports over GDP	Imports over GDP	Effect on net exports over GDP
ARG	0.174	0.148	0.124
AUS	0.195	0.204	0.177
AUT	0.507	0.475	0.139
BEL	0.762	0.745	0.320
BRA	0.107	0.118	0.039
CAN	0.291	0.310	0.095
CHE	0.642	0.535	0.340
CHL	0.381	0.317	0.152
CHN	0.262	0.232	0.097
COL	0.159	0.178	0.090
CRI	0.382	0.409	0.589
CZE	0.662	0.631	0.303
DEU	0.423	0.371	0.107
DNK	0.497	0.436	0.220
EGY	0.213	0.266	0.157
ESP	0.255	0.268	0.118
FIN	0.387	0.374	0.110
FRA	0.260	0.279	0.083
GBR	0.287	0.311	0.030
GRC	0.221	0.307	0.062
GTM	0.258	0.363	0.075
HKG	2.194	2.135	0.798
HUN	0.826	0.773	0.418
IDN	0.243	0.224	0.184
IND	0.220	0.263	0.119
IRL	0.957	0.782	0.679
ISR	0.350	0.330	0.036
ITA	0.252	0.271	0.065
JPN	0.152	0.140	0.026
KOR	0.494	0.462	0.154
LKA	0.224	0.307	0.059
MAR	0.332	0.431	0.181
MEX	0.299	0.311	0.098
NLD	0.720	0.636	0.423
NOR	0.398	0.286	0.029
NZL	0.305	0.282	0.162
PAK	0.135	0.194	0.147
PER	0.266	0.235	0.173
PHL	0.348	0.366	0.160

Table 8 (continued)

	Exports over GDP	Imports over GDP	Effect on net exports over GDP
POL	0.405	0.423	0.237
PRT	0.299	0.374	0.108
RUS	0.292	0.211	0.107
SAU	0.497	0.331	0.570
SGP	1.993	1.728	0.545
SWE	0.462	0.407	0.120
THA	0.713	0.639	0.481
TUN	0.501	0.548	0.120
TUR	0.212	0.268	0.058
URY	0.263	0.253	0.226
USA	0.124	0.158	0.028
ZAF	0.286	0.274	0.148

goods sector has, on average, the highest pass-through elasticities while being only the fourth largest sector in terms of trade shares with an average ratio of 12% over GDP. On the other hand, the most trade intensive sector is parts and components with an average ratio 27% over GDP but the estimated price and quantity elasticities are the lowest for this sector. To highlight the overall importance of sectoral elasticities and trade shares, we calculate the contribution of the sectoral specialization assuming

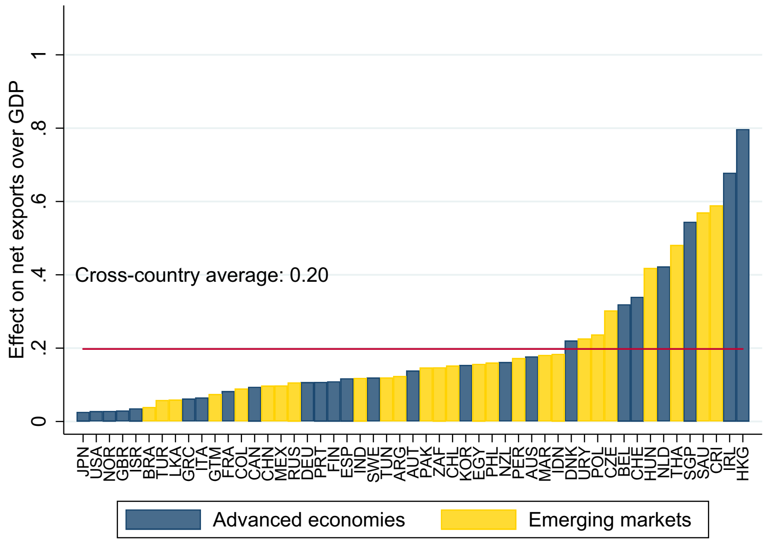


Fig. 8 Effect on net exports over GDP based on estimated exchange rate elasticities and data on exports, imports and GDP in 2012

Table 9 Estimates of Exchange Rate Elasticities for export and import prices for the 2 step approach

	Export prices		Import prices	
	ER	SE	ER	SE
ARG	0.003	0.236	0.999**	0.113
AUS	0.789*	0.378	1.070**	0.077
AUT	0.540**	0.088	1.011**	0.068
BEL	0.519**	0.048	0.788**	0.064
BRA	0.728**	0.056	0.586**	0.106
CAN	0.660**	0.076	0.434**	0.156
CHE	0.834**	0.075	0.580**	0.142
CHL	0.286*	0.110	0.707*	0.274
CHN	0.576**	0.043	0.867**	0.080
COL	0.222**	0.035	0.535**	0.104
CRI	0.450	0.451	0.896	0.653
CZE	0.380**	0.056	0.576**	0.071
DEU	0.757**	0.024	0.537**	0.035
DNK	0.430**	0.051	0.591**	0.055
EGY	0.856**	0.165	0.460**	0.117
ESP	0.764**	0.029	0.662**	0.065
FIN	0.757**	0.033	0.458**	0.056
FRA	0.715**	0.034	0.724**	0.058
GBR	0.734**	0.046	0.679**	0.038
GRC	0.664**	0.110	0.934**	0.209
GTM	0.366*	0.152	0.500**	0.151
HKG	0.586**	0.076	0.960**	0.082
HUN	0.608**	0.138	0.553**	0.110
IDN	−0.059	0.030	1.048**	0.208
IND	0.550**	0.053	0.809**	0.224
IRL	0.240	0.195	0.467**	0.154
ISR	0.643**	0.118	0.664**	0.182
ITA	0.759**	0.018	0.582**	0.051
JPN	0.503**	0.034	0.513**	0.103
KOR	0.197**	0.036	0.448**	0.116
LKA	0.494**	0.116	0.380**	0.109
MAR	0.467**	0.089	0.603*	0.240
MEX	0.409**	0.139	0.987**	0.129
NLD	0.817**	0.043	0.813**	0.078
NOR	0.533**	0.079	0.519**	0.076
NZL	0.499**	0.075	0.842**	0.164
PAK	0.794**	0.109	0.465**	0.139
PER	0.951**	0.162	0.657**	0.183
PHL	0.520	0.269	0.698**	0.188

Table 9 (continued)

	Export prices		Import prices	
	ER	SE	ER	SE
POL	0.706**	0.042	0.491**	0.042
PRT	0.487**	0.079	0.586**	0.085
RUS	0.493**	0.052	0.834**	0.043
SAU	1.014**	0.109	0.894**	0.169
SGP	0.944**	0.108	0.997**	0.167
SWE	0.712**	0.043	0.589**	0.069
THA	0.579**	0.091	0.625**	0.114
TUN	0.721**	0.150	0.572**	0.116
TUR	0.375**	0.034	0.435**	0.077
URY	0.466*	0.180	0.548**	0.176
USA	0.683**	0.051	0.862**	0.053
ZAF	0.339**	0.094	0.726**	0.154

that countries have the same sectoral elasticities and the contribution of the magnitude of the elasticities assuming that all countries have the same sectoral weights using a variance decomposition. We find that sectoral specialization explains 12% whereas elasticity differences explain 18% and the combination of country-specific elasticities and sectoral weights account for the remaining 70%. Overall, the results highlight the importance of the country-specific factors in determining the aggregate response of the trade balance.

6 Additional Robustness Tests and Further Results

The aim of this section is to provide a set of additional tests of robustness and further interpretation of some results. As a first robustness test, we add control variables in the baseline regression; specifically, we add inflation of the exporting country to capture aggregate changes in the production cost and inflation of the importing country to account for changes in the price of local goods. The results for prices are presented in Tables 11 and 12, while Tables 13 and 14 report the estimates for trade volumes. Including inflation leaves the results broadly unchanged. For export prices and quantities, the mean elasticity changes from 0.65 to 0.64 and from 0.35 to 0.47, respectively, but these differences are not significant. Similarly, when we compare the mean elasticity for import prices (0.51 versus 0.48) and quantities (0.30 versus 0.28), their changes are not statistically significant either. The correlation with our baseline coefficients is very high, i.e., above 0.75, with the exception of the import quantities coefficients where the correlation is 0.64.

In our baseline specification we assume that firms are risk neutral and estimate the exchange rate pass-through with respect to the change in the spot exchange rate.

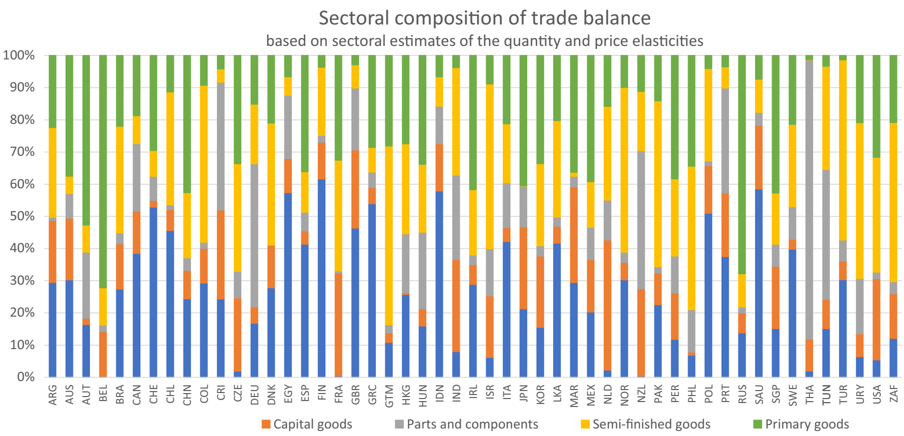
Table 10 Estimates of Exchange Rate Elasticities for export and import volumes for the 2 step approach

	Export Volumes		Import volumes	
	ERC	SE	ERC	SE
ARG	0.264	0.242	−0.842**	0.148
AUS	0.911*	0.412	−0.476**	0.079
AUT	0.333**	0.100	−0.562**	0.081
BEL	0.487**	0.107	−0.438**	0.077
BRA	0.500**	0.086	−0.285**	0.074
CAN	0.256**	0.093	−0.365*	0.150
CHE	0.417**	0.102	−0.638	0.335
CHL	0.269*	0.107	−0.646**	0.213
CHN	0.310**	0.058	−0.405**	0.100
COL	0.223*	0.086	−0.576**	0.107
CRI	−0.133	0.285	−1.521*	0.580
CZE	0.494**	0.077	−0.288**	0.106
DEU	0.353**	0.036	−0.420**	0.040
DNK	0.379**	0.091	−0.428**	0.083
EGY	0.652	0.564	−0.467**	0.145
ESP	0.448**	0.057	−0.492**	0.091
FIN	0.333**	0.074	−0.262**	0.090
FRA	0.363**	0.041	−0.438**	0.069
GBR	0.343**	0.078	−0.447**	0.048
GRC	0.402*	0.151	−0.672**	0.136
GTM	−0.131	0.222	−0.443	0.242
HKG	0.195	0.248	−0.774**	0.098
HUN	0.566*	0.222	−0.248*	0.121
IDN	−0.074	0.119	−0.809*	0.321
IND	0.408**	0.068	−0.416*	0.182
IRL	−0.080	0.286	−0.603**	0.205
ISR	0.315*	0.142	−0.713**	0.155
ITA	0.430**	0.029	−0.527**	0.048
JPN	0.369**	0.060	−0.158*	0.060
KOR	0.199**	0.032	−0.378**	0.085
LKA	0.220*	0.106	−0.156	0.127
MAR	0.184	0.112	−0.742**	0.197
MEX	0.401*	0.185	−0.864**	0.155
NLD	0.435**	0.067	−0.549**	0.078
NOR	0.330	0.218	−0.363**	0.110
NZL	0.341**	0.114	−0.404*	0.159
PAK	0.679**	0.205	−0.686**	0.187
PER	0.073	0.274	−1.000**	0.301
PHL	0.630*	0.292	−0.423*	0.175

Table 10 (continued)

	Export Volumes		Import volumes	
	ERC	SE	ERC	SE
POL	0.756**	0.068	−0.472**	0.080
PRT	0.330*	0.131	−0.340**	0.106
RUS	−0.181	0.095	−0.795**	0.068
SAU	0.937**	0.099	−0.620**	0.184
SGP	0.530**	0.155	−0.417**	0.105
SWE	0.566**	0.098	−0.399**	0.074
THA	0.112	0.125	−0.406**	0.150
TUN	0.165	0.208	−0.407**	0.147
TUR	0.876**	0.083	−0.506**	0.074
URY	0.657	0.408	−0.386*	0.158
USA	0.257**	0.059	−0.568**	0.035
ZAF	0.442*	0.187	−0.264	0.430

We relax this assumption and assume that firms insure the exchange rate risk by buying forward contracts. Assuming that the uncovered interest rate parity (UIP) condition holds, we define the forward exchange rate as the spot exchange rate times the interest rate differential between the 3-month treasure bill of home and foreign from the IMF International Financial Statistics (IFS). The results in Fig. 10 show that comparison between the estimated coefficients of the exchange rate pass through using the spot and the forward exchange rates. The estimated coefficients are very similar to the baseline specification. The correlation in the point estimates between the two specifications is 0.91 for exports and 0.89 for imports.



Av. contribution: Consumption (23%), Capital goods (14%), Parts and components (16%), Semi-finished goods (25%) and Primary goods (22%)

Fig. 9 Sectoral contribution to the change in net exports over GDP based on sectoral estimates of exchange rate elasticities and data on exports, imports and GDP in 2012

Table 11 Estimates of Exchange Rate Elasticities for export prices with inflation as control variable

	Export Prices					
	ER	(SE)	Inflation − Exp.	(SE)	Inflation − Imp.	(SE)
ARG	0.113	0.101	0.000**	0.000	0.374*	0.147
AUS	0.215	0.322	0.690*	0.326	0.946	1.025
AUT	0.924**	0.109	−0.129	0.071	0.561**	0.155
BEL	0.767**	0.064	0.454	0.727	0.165*	0.081
BRA	0.537**	0.056	0.027	0.181	0.649**	0.116
CAN	0.482**	0.122	0.178	0.231	0.655	0.533
CHE	0.809**	0.079	−0.625**	0.128	−0.181	0.160
CHL	1.043**	0.160	−1.019	0.737	−0.546	0.313
CHN	0.845**	0.032	0.000**	0.000	−0.149	0.150
COL	0.651**	0.141	0.130	0.212	0.884	0.590
CRI	0.361	0.256	0.603	0.535	−0.200	0.166
CZE	0.589**	0.050	0.251	0.129	0.327**	0.065
DEU	0.829**	0.027	0.174**	0.046	0.119**	0.029
DNK	0.681**	0.074	0.269*	0.116	0.221	0.131
EGY	0.310**	0.042	0.551**	0.094	0.396*	0.195
ESP	0.777**	0.033	−0.045	0.358	0.105	0.060
FIN	0.734**	0.058	0.577	0.998	0.271*	0.104
FRA	0.831**	0.034	−0.158	0.085	0.100	0.068
GBR	0.663**	0.046	0.188**	0.045	0.439**	0.077
GRC	0.743**	0.101	0.140	0.070	0.238*	0.095
GTM	0.813**	0.242	1.133	0.750	0.471	0.507
HKG	0.791**	0.093	−0.681*	0.260	0.193	0.241
HUN	0.798**	0.106	0.163	0.157	0.298	0.196
IDN	0.063	0.074	0.271	0.195	0.124**	0.029
IND	0.886**	0.074	0.293	0.232	0.344*	0.163
IRL	0.261	0.407	0.585	1.324	0.970	1.049
ISR	0.726*	0.305	−0.228	0.502	−0.035	0.224
ITA	0.811**	0.025	−0.151**	0.050	0.217**	0.029
JPN	0.407**	0.050	0.131*	0.056	0.547**	0.088
KOR	0.668**	0.069	0.256*	0.114	0.502**	0.150
LKA	0.632**	0.086	0.518**	0.188	0.461**	0.133
MAR	0.453**	0.099	0.354*	0.165	0.700**	0.126
MEX	0.414	0.217	0.055	0.215	0.714	0.884
NLD	0.727**	0.053	−0.753*	0.326	0.413**	0.133
NOR	0.704**	0.110	0.193	0.176	0.969*	0.421
NZL	0.590**	0.045	0.220**	0.069	0.368*	0.162
PAK	0.734**	0.057	0.906**	0.157	0.843**	0.221
PER	0.668**	0.120	−0.122	0.065	0.637**	0.232
PHL	0.946**	0.306	0.314*	0.127	−0.730	2.051

Table 11 (continued)

	Export Prices					
	ER	(SE)	Inflation − Exp.	(SE)	Inflation − Imp.	(SE)
POL	0.476**	0.041	−0.001	0.134	0.408**	0.084
PRT	0.512**	0.068	0.268	0.415	0.260*	0.118
RUS	0.852**	0.099	0.964**	0.315	0.335	0.248
SAU	0.210	0.112	−0.784**	0.212	−0.811	1.033
SGP	1.167**	0.151	−0.249	0.249	−0.617	0.347
SWE	0.618**	0.057	0.781	0.470	0.539**	0.104
THA	0.500**	0.095	0.567	0.451	0.723**	0.241
TUN	0.585**	0.140	1.189	1.041	0.260	0.321
TUR	0.542**	0.044	0.258**	0.046	0.508**	0.068
URY	0.793**	0.106	0.182**	0.039	−0.283	0.312
USA	0.848**	0.058	0.128	0.071	−0.758**	0.138
ZAF	0.364**	0.052	0.942*	0.355	0.126**	0.019

Table 12 Estimates of Exchange Rate Elasticities for import prices with inflation as control variable

	Import Prices					
	ER	(SE)	Inflation − Exp.	(SE)	Inflation − Imp.	(SE)
ARG	0.854**	0.063	0.166**	0.045	0.000**	0.000
AUS	0.706**	0.089	0.243	0.334	−0.241	0.124
AUT	0.401**	0.054	0.023	0.130	0.120*	0.057
BEL	0.357**	0.099	0.541	0.581	0.126	0.122
BRA	0.537**	0.059	0.384	0.250	0.123	0.062
CAN	0.419**	0.068	0.562*	0.264	−0.403**	0.088
CHE	0.381**	0.082	0.437	0.296	−0.244	0.152
CHL	0.339*	0.152	−0.758	0.991	0.000**	0.000
CHN	0.471**	0.077	0.256	0.234	0.000**	0.000
COL	0.533**	0.075	−0.213	0.269	0.708**	0.127
CRI	0.568**	0.208	−0.036	0.424	−0.328	0.800
CZE	0.606**	0.057	0.634**	0.205	−0.006	0.217
DEU	0.439**	0.042	0.316**	0.111	0.309**	0.067
DNK	0.423**	0.074	0.430**	0.108	0.849	0.851
EGY	0.590**	0.069	0.709**	0.150	0.607**	0.203
ESP	0.404**	0.039	0.258**	0.088	0.149	0.104
FIN	0.623**	0.093	0.552*	0.220	0.166**	0.056
FRA	0.505**	0.056	0.320**	0.109	0.549	1.258

Table 12 (continued)

	Import Prices					
	ER	(SE)	Inflation − Exp.	(SE)	Inflation − Imp.	(SE)
GBR	0.497**	0.052	0.407**	0.111	0.126*	0.053
GRC	0.737**	0.178	0.449	0.359	0.160	0.094
GTM	0.273**	0.093	0.622*	0.274	0.542	0.567
HKG	0.702**	0.135	−1.164	1.712	−0.525	0.321
HUN	0.776**	0.081	0.651*	0.261	0.406**	0.128
IDN	0.647**	0.057	0.515	0.510	0.485	0.262
IND	0.674**	0.193	0.189	0.108	−0.225	0.124
IRL	0.537**	0.139	0.573	0.392	0.479	0.465
ISR	0.921**	0.089	0.795**	0.178	0.687	0.377
ITA	0.520**	0.053	0.391**	0.106	0.082	0.809
JPN	0.718**	0.067	0.868**	0.207	0.237	0.160
KOR	0.548**	0.097	0.427**	0.123	0.496**	0.083
LKA	0.118	0.110	−0.872	0.720	1.123**	0.334
MAR	0.742**	0.183	0.784**	0.221	0.193*	0.089
MEX	0.087	0.113	0.201**	0.059	−0.146**	0.017
NLD	0.583**	0.089	0.639*	0.251	−0.203	0.736
NOR	0.404**	0.063	0.425**	0.155	0.289	0.550
NZL	0.569**	0.108	0.147*	0.065	0.146	0.261
PAK	0.213	0.121	0.511*	0.249	0.140**	0.025
PER	0.410**	0.119	0.090	0.297	0.145**	0.022
PHL	0.522**	0.139	0.533	0.521	1.084	0.696
POL	0.551**	0.032	0.662**	0.226	−0.038	0.081
PRT	0.551**	0.085	0.223	0.230	0.157	0.094
RUS	0.711**	0.027	0.317**	0.061	0.817**	0.051
SAU	0.099	0.215	−0.401	0.428	0.188**	0.036
SGP	0.375**	0.100	0.817*	0.349	0.209*	0.099
SWE	0.564**	0.081	0.435**	0.114	0.269	0.450
THA	0.257**	0.087	0.728*	0.277	0.174*	0.070
TUN	0.596**	0.164	0.600*	0.265	0.219*	0.085
TUR	0.715**	0.044	0.628**	0.101	0.252**	0.043
URY	0.431**	0.070	−0.491	0.543	0.370**	0.059
USA	0.228**	0.055	0.093	0.110	0.350	0.231
ZAF	0.430**	0.059	0.398	0.229	0.280**	0.037

In Section 2, we argued that importer fixed effects partly control for strategic complementarities in pricing, which reduce the exchange rate pass-through. To provide supportive evidence, we follow the approach of Auer and Schoenle (2016) and

Table 13 Estimates of Exchange Rate Elasticities for export volumes with inflation as control variable

	Export Volumes					
	ER	(SE)	Inflation − Exp.	(SE)	Inflation − Imp.	(SE)
ARG	0.149	0.131	0.000**	0.000	−0.178	0.111
AUS	0.903**	0.240	−0.696	4.137	0.130	0.109
AUT	0.711**	0.133	0.261*	0.098	0.767**	0.175
BEL	0.776**	0.128	0.205*	0.077	0.996**	0.143
BRA	0.250**	0.062	0.174**	0.025	0.775**	0.190
CAN	0.321	0.170	0.167	0.241	1.194*	0.472
CHE	0.906**	0.105	1.051**	0.132	0.212**	0.044
CHL	0.397**	0.114	−0.194*	0.074	0.171**	0.041
CHN	0.695**	0.056	0.000**	0.000	0.817**	0.146
COL	0.385	0.204	0.127**	0.037	−0.221**	0.077
CRI	0.748**	0.130	0.843	2.668	0.257*	0.113
CZE	0.611**	0.092	0.282**	0.031	0.957**	0.149
DEU	0.511**	0.054	0.208	0.598	0.634**	0.047
DNK	0.467**	0.088	0.289	0.954	0.805**	0.150
EGY	0.284*	0.136	−0.155	0.097	0.446	0.391
ESP	0.703**	0.079	0.251**	0.063	0.123**	0.010
FIN	0.749**	0.107	−0.215*	0.106	1.083**	0.152
FRA	0.568**	0.076	0.558**	0.074	0.856**	0.106
GBR	0.464**	0.079	0.123	0.063	0.645**	0.090
GRC	0.713**	0.201	0.208*	0.084	0.630**	0.219
GTM	0.553	0.291	0.749	0.981	0.292	0.436
HKG	0.173	0.295	0.321	0.265	−0.376	0.601
HUN	0.595**	0.173	0.369**	0.047	0.320	0.207
IDN	0.190	0.101	−0.431	0.226	0.463	0.348
IND	0.468**	0.111	−0.139**	0.029	0.629*	0.285
IRL	0.069	0.282	−0.131	0.147	−0.081	0.834
ISR	0.348	0.266	0.178*	0.080	0.840**	0.293
ITA	0.520**	0.033	0.664**	0.044	0.518**	0.042
JPN	0.179	0.099	0.395**	0.063	−0.095	0.156
KOR	0.531**	0.115	0.760**	0.192	0.230	0.313
LKA	0.261	0.149	−0.370	0.256	0.456	0.513
MAR	0.293*	0.143	0.144	0.123	0.303	0.215
MEX	0.373	0.279	0.135**	0.032	1.099	1.227
NLD	0.729**	0.085	0.863	0.529	0.946**	0.115
NOR	0.458*	0.202	0.204**	0.075	0.633	0.426
NZL	0.239**	0.053	−0.117	0.894	0.485	0.289
PAK	0.852**	0.136	−1.174**	0.311	0.678	0.377
PER	0.199	0.101	0.202**	0.064	0.087	0.325
PHL	0.661	0.507	0.160	0.259	1.199	1.734

Table 13 (continued)

	Export Volumes					
	ER	(SE)	Inflation − Exp.	(SE)	Inflation − Imp.	(SE)
POL	0.254*	0.095	0.197**	0.023	0.120	0.215
PRT	0.452**	0.122	0.561**	0.091	0.642**	0.161
RUS	0.305**	0.051	0.282	0.166	−0.089	0.257
SAU	0.730**	0.150	0.678	0.436	0.313*	0.148
SGP	0.637**	0.187	0.773	2.635	0.150**	0.021
SWE	0.328**	0.096	−0.539	0.908	0.546**	0.187
THA	0.388**	0.125	0.223**	0.057	0.498*	0.222
TUN	0.013	0.166	−0.382	0.253	0.707	0.472
TUR	0.305**	0.065	0.286**	0.082	0.041	0.135
URY	0.661**	0.185	0.020	0.636	0.156**	0.053
USA	0.389**	0.070	0.250**	0.067	0.131**	0.017
ZAF	0.426**	0.121	−0.973	1.056	0.743*	0.331

Table 14 Estimates of Exchange Rate Elasticities for import volumes with inflation as control variable

	Import Volumes					
	ER	(SE)	Inflation − Exp.	(SE)	Inflation − Imp.	(SE)
ARG	−0.492**	0.104	0.902	0.521	0.000**	0.000
AUS	−0.236	0.123	0.173**	0.064	0.548**	0.158
AUT	−0.143	0.089	0.150**	0.030	0.611	0.647
BEL	−0.135	0.123	0.639	0.495	0.915	0.922
BRA	−0.204**	0.043	1.003**	0.249	−0.095	0.404
CAN	−0.325**	0.091	0.259	0.282	0.316**	0.098
CHE	−0.037	0.218	0.249**	0.087	0.646**	0.186
CHL	−0.332	0.178	0.254**	0.086	0.000**	0.000
CHN	−0.040	0.104	0.420	0.248	0.000**	0.000
COL	−0.584**	0.133	−0.179	0.392	0.595**	0.046
CRI	−0.966*	0.361	0.551	1.361	0.518**	0.101
CZE	−0.286**	0.079	0.084	0.224	0.285**	0.022
DEU	−0.007	0.058	0.454**	0.113	−0.170*	0.081
DNK	−0.247*	0.121	0.667**	0.201	0.817	0.935
EGY	−0.385*	0.182	0.202	0.479	−0.097	0.427
ESP	−0.138*	0.053	0.159	0.201	0.364**	0.069
FIN	−0.197*	0.092	1.187**	0.196	−0.253**	0.060
FRA	−0.138*	0.057	0.448**	0.125	0.443**	0.089
GBR	−0.036	0.111	0.696**	0.174	−0.156*	0.068
GRC	−0.737*	0.337	−0.337	0.499	0.393**	0.100

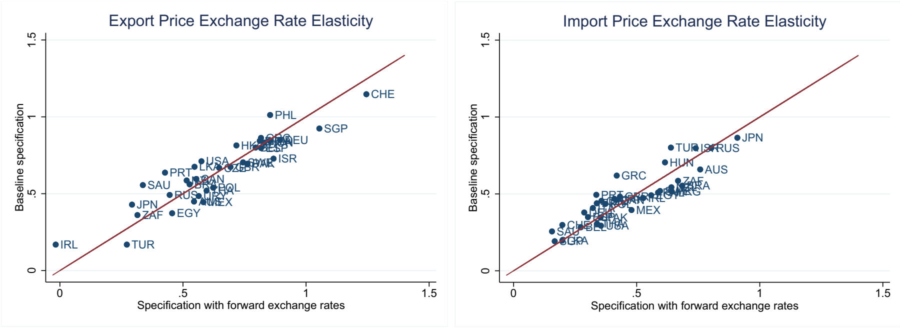
Table 14 (continued)

	Import Volumes					
	ER	(SE)	Inflation − Exp.	(SE)	Inflation − Imp.	(SE)
GTM	−0.260	0.178	0.273	0.373	0.124*	0.057
HKG	−0.018	0.217	0.201	0.146	0.665*	0.304
HUN	−0.270**	0.082	0.049	0.257	0.296**	0.028
IDN	−0.284*	0.117	0.238**	0.068	−1.011**	0.293
IND	−0.642*	0.245	−0.594	0.638	0.229	0.160
IRL	−0.472	0.261	0.816	1.085	−0.057	0.422
ISR	−0.440**	0.141	0.798*	0.349	−0.486	0.375
ITA	−0.303**	0.053	−0.015	0.125	0.211**	0.076
JPN	−0.133	0.099	0.054	0.139	0.243	0.123
KOR	−0.096	0.066	0.327	0.253	0.302**	0.074
LKA	−0.162	0.206	0.203	0.118	−0.151	0.566
MAR	−0.628*	0.245	−0.108	0.318	0.649**	0.139
MEX	−1.229**	0.144	0.137	0.076	0.341**	0.021
NLD	−0.257*	0.119	0.387	0.257	0.283	0.823
NOR	−0.007	0.154	0.438	0.501	−0.352**	0.125
NZL	−0.364*	0.175	0.149	0.082	−0.128	0.236
PAK	−0.216	0.219	−0.470	0.649	−0.239**	0.073
PER	−0.688**	0.214	−0.150	0.306	0.197**	0.036
PHL	−0.113	0.185	0.631	0.547	−0.660	1.136
POL	−0.347**	0.062	0.034	0.252	0.221**	0.013
PRT	−0.247**	0.083	0.485*	0.182	0.218**	0.065
RUS	−0.624**	0.059	0.589**	0.142	0.531**	0.118
SAU	−0.183	0.261	1.127*	0.447	−0.143**	0.041
SGP	−0.104	0.147	0.167	0.366	−0.229	0.126
SWE	−0.129	0.103	0.910**	0.148	−0.732	0.473
THA	−0.226	0.177	1.118**	0.355	0.490	0.821
TUN	−0.412**	0.136	−0.084	0.355	−0.841	0.880
TUR	−0.683**	0.109	−0.876**	0.210	1.178**	0.111
URY	−0.278*	0.118	0.161	0.126	−0.165**	0.057
USA	−0.069	0.056	0.094	0.111	−0.028	1.000
ZAF	−0.050	0.081	1.186**	0.284	−0.318**	0.062

include the change in competitors' prices (p_{ijt}^{comp}) in the destination market as an additional control variable. The resulting regressions looks as follows:

$$d\log\left(p_{[i]jkt}^{fob}\right) = \alpha_{[is]} - \beta_{[i]}^{X} d\log(s_{ijt}) + \gamma_{[i]} d\log\left(p_{ijt}^{comp}\right) + f_{[i]jk} + e_{ijkt} \quad (13)$$

where $\beta_{[j]}^{X}$ measures the country-specific exchange rate pass-through and $\gamma_{[i]}$ captures the reaction of import or export prices to changes in competitors' prices.



(a) Export prices (b) Import prices

Fig. 10 Difference in the exchange rate pass through coefficient of the baseline specification against the ones that uses the forward exchange rate according to UIP

Figure 11 plots the estimated coefficient of competitors' price changes. The estimated coefficients are positive and significant implying that exporters react positively to changes in competitors prices.[15] Consistent with the importance of strategic complementarities in pricing, the estimated pass-through decreases relative to our baseline specification, see Fig. 12, and supports our interpretation of the fixed effects approach.

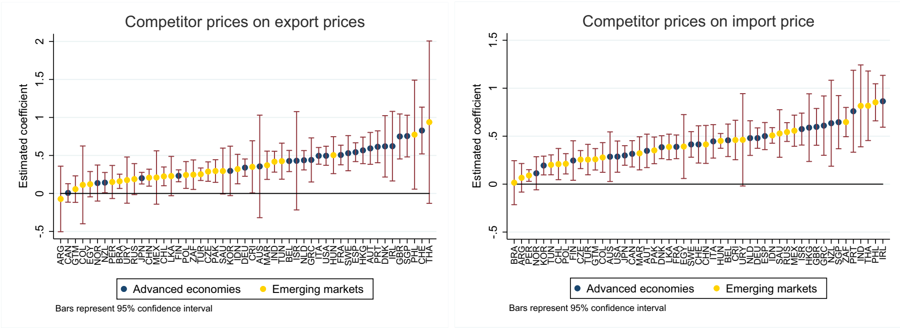
The time-varying fixed effects specification also controls for any country-specific changes that are common to all trading partners such as the country's exchange rate with the US dollar. To focus on the specific role of the USD, which is the main invoicing currency for the majority of countries (see Gopinath (2015)), we estimate the baseline regressions and include the change of the exporter's or importer's currency with the USD as an additional control variable.

$$d\log\left(p^{fob}_{[i]jkt}\right) = \alpha_{[is]} + \beta^{X}_{[i]} d\log(s_{ijt}) + \gamma_{[i]} d\log(s_{i,USD,t}) + f_{[i]jk]} + e_{ijkt}$$

Figure 13 shows the comparison of the estimated pass-through coefficients in the baseline specification and the US dollar specification for export and import prices. In panel (a) the export pass-through into USD is significantly higher for most countries (the majority of countries lie to the right of the 45 degree line), while in panel (b) the import price pass-through is significantly lower (as all of them lie to the left of the 45 degree line). These results imply that part of the lower (higher) pass-through into export (import) prices in the baseline specification is due to the fact that some firms set their prices in US dollars and consistent with the evidence of Boz et al. (2017).

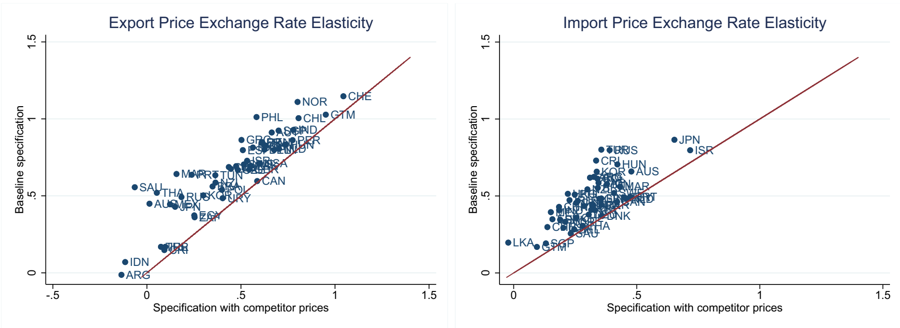
As extensions to our baseline results, we also consider an augmented version of the model, where we include two lags of the exchange rate to analyze the time effects of the exchange rate adjustments. The results are in Tables 15, 16, 17 and 18. Note that for the majority of countries all the exchange rate effects materialize within one year (most of the lagged variables are not significant).

[15] This finding is consistent with the evidence from Auer and Schoenle (2016), who use detailed US import data and show that the exchange rate pass-through is decreasing when controlling for price changes by competitors.



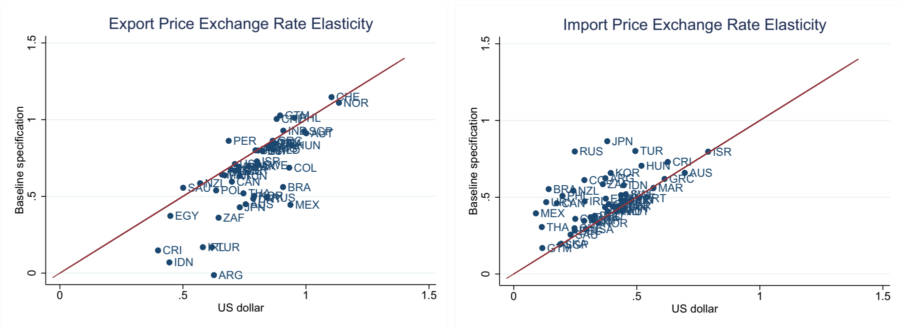
(a) Export prices (b) Import prices

Fig. 11 Country estimates of the coefficient on competitors' price changes in Eq. 13



(a) Export prices (b) Import prices

Fig. 12 Difference in the exchange rate pass through coefficient of the baseline specification against the ones that that include the market share of exporters in the destination market



(a) Export prices (b) Import prices

Fig. 13 Difference in the exchange rate pass through coefficient of the baseline specification and the US dollar exchange rate

Table 15 Estimates of Long Run Exchange Rate Elasticities for export prices

	Export Prices					
	ER	(SE)	LAG.ER	(SE)	LAG.2.ER	(SE)
ARG	0.073	0.085	−0.353**	0.096	−0.102	0.055
AUS	0.652**	0.195	0.304	0.256	−0.465	0.380
AUT	1.055**	0.106	−0.093	0.110	0.113	0.106
BEL	0.839**	0.079	−0.110	0.067	0.073	0.057
BRA	0.537**	0.059	0.101	0.060	−0.037	0.048
CAN	0.511**	0.128	0.306*	0.140	−0.068	0.093
CHE	0.869**	0.076	0.196*	0.075	−0.631**	0.191
CHL	1.174**	0.184	0.078	0.128	0.234*	0.100
CHN	0.890**	0.042	−0.202**	0.043	−0.016	0.049
COL	0.687**	0.082	0.054	0.099	−0.378*	0.163
CRI	−0.286	0.321	0.286	0.257	−0.022	0.190
CZE	0.677**	0.047	0.101*	0.045	−0.060	0.036
DEU	0.895**	0.025	−0.078**	0.022	0.081*	0.032
DNK	0.704**	0.082	−0.078	0.048	0.058	0.049
EGY	0.502**	0.071	−0.295**	0.109	0.200**	0.071
ESP	0.851**	0.030	−0.003	0.037	0.042	0.034
FIN	0.805**	0.046	0.040	0.042	0.027	0.035
FRA	0.916**	0.030	−0.113*	0.045	0.055	0.068
GBR	0.727**	0.062	0.060	0.050	−0.028	0.044
GRC	0.763**	0.136	0.206*	0.078	−0.032	0.058
GTM	1.134**	0.239	−0.314	0.214	0.361*	0.164
HKG	0.864**	0.094	−0.133	0.128	0.222*	0.105
HUN	1.021**	0.166	0.100	0.191	0.118	0.128
IDN	0.007	0.065	0.254**	0.053	0.032	0.049
IND	0.937**	0.074	0.160*	0.062	−0.120*	0.055
IRL	0.418	0.423	−0.410	0.356	0.359	0.377
ISR	0.699	0.394	0.562	0.393	−0.312	0.287
ITA	0.904**	0.022	−0.047	0.027	0.033	0.018
JPN	0.505**	0.053	−0.236**	0.055	0.106**	0.026
KOR	0.513**	0.067	0.217**	0.061	0.029	0.059
LKA	0.675**	0.102	−0.025	0.067	−0.117	0.066
MAR	0.685**	0.130	−0.419	0.239	0.262	0.152
MEX	0.221	0.261	0.128	0.268	−1.150	0.608
NLD	0.855**	0.058	−0.201**	0.065	0.107*	0.048
NOR	0.791**	0.143	−0.081	0.188	−0.415	0.236
NZL	0.550**	0.049	0.170**	0.051	−0.071	0.045
PAK	0.641**	0.068	0.352**	0.115	−0.165	0.099
PER	0.815**	0.124	−0.132	0.098	0.260	0.184
PHL	0.801**	0.296	−0.520	0.646	0.839**	0.310

Table 15 (continued)

	Export Prices					
	ER	(SE)	LAG.ER	(SE)	LAG.2.ER	(SE)
POL	0.524**	0.041	0.085*	0.039	−0.059*	0.025
PRT	0.620**	0.062	0.010	0.075	0.125*	0.060
RUS	0.614**	0.077	−0.403**	0.090	0.158**	0.038
SAU	0.636**	0.220	−0.490**	0.143	−0.197**	0.054
SGP	0.956**	0.079	−0.065	0.061	−0.072	0.115
SWE	0.773**	0.063	0.056	0.072	0.043	0.074
THA	0.480**	0.095	0.357**	0.117	−0.154	0.097
TUN	0.878**	0.119	−0.310*	0.146	0.164	0.096
TUR	0.417**	0.035	0.014	0.028	−0.082**	0.020
URY	0.547**	0.062	−0.262**	0.042	0.135*	0.060
USA	0.830**	0.055	−0.173**	0.046	0.164**	0.059
ZAF	0.345**	0.066	0.103	0.081	0.088	0.061

Table 16 Estimates of Long Run Exchange Rate Elasticities for import prices

	Import Prices					
	ER	(SE)	LAG.ER	(SE)	LAG.2.ER	(SE)
ARG	0.671**	0.056	0.185*	0.092	0.182	0.156
AUS	0.563**	0.124	0.325**	0.112	−0.280*	0.115
AUT	0.494**	0.056	0.115	0.079	0.023	0.069
BEL	0.306**	0.056	−0.070	0.092	−0.010	0.061
BRA	0.588**	0.053	−0.165**	0.033	0.069	0.035
CAN	0.441**	0.059	−0.094	0.064	−0.229*	0.101
CHE	0.262**	0.066	−0.233	0.131	0.155	0.098
CHL	0.256	0.214	−0.338	0.437	−0.053	0.066
CHN	0.381**	0.047	0.184**	0.058	−0.173*	0.077
COL	0.847**	0.081	−0.165	0.099	−0.374**	0.107
CRI	0.713**	0.191	0.244	0.587	0.246	0.385
CZE	0.462**	0.072	−0.121	0.114	0.071	0.072
DEU	0.365**	0.042	0.032	0.082	−0.137**	0.042
DNK	0.391**	0.057	0.085	0.044	−0.068	0.050
EGY	0.409**	0.077	0.239**	0.071	−0.214	0.110
ESP	0.363**	0.044	0.016	0.073	−0.061*	0.026
FIN	0.547**	0.075	−0.257*	0.117	−0.012	0.042
FRA	0.421**	0.072	0.002	0.105	−0.072*	0.035
GBR	0.439**	0.043	0.043	0.054	−0.032	0.044
GRC	0.641**	0.134	0.341	0.308	−0.379	0.367

Table 16 (continued)

	Import Prices					
	ER	(SE)	LAG.ER	(SE)	LAG.2.ER	(SE)
HKG	0.782**	0.077	−0.015	0.158	−0.093	0.132
HUN	0.725**	0.103	−0.247	0.146	0.100	0.056
IDN	0.660**	0.113	−0.119	0.077	−0.035	0.085
IND	0.431*	0.177	0.243	0.433	0.196	0.155
IRL	0.547**	0.150	0.042	0.122	0.093	0.139
ISR	0.867**	0.105	−0.189	0.124	−0.159	0.109
ITA	0.432**	0.047	−0.070	0.084	−0.008	0.027
JPN	0.957**	0.061	0.251**	0.057	−0.130	0.065
KOR	0.683**	0.083	−0.215**	0.072	−0.022	0.068
LKA	0.102	0.080	0.146	0.095	−0.210**	0.076
MAR	0.650**	0.189	−0.087	0.133	0.025	0.040
MEX	0.507**	0.097	−0.874**	0.130	1.616**	0.149
NLD	0.469**	0.096	−0.116	0.086	−0.051	0.067
NOR	0.362**	0.065	−0.037	0.077	0.088	0.072
NZL	0.588**	0.082	−0.043	0.098	0.009	0.093
PAK	0.298**	0.097	0.054	0.166	0.014	0.111
PER	0.521**	0.118	0.023	0.093	−0.004	0.052
PHL	0.528**	0.126	−0.076	0.159	0.048	0.109
POL	0.443**	0.051	−0.166	0.114	0.078	0.060
PRT	0.458**	0.114	−0.136	0.116	0.014	0.060
RUS	0.842**	0.027	−0.085**	0.024	−0.062**	0.021
SAU	0.105	0.279	0.504	0.330	−0.200	0.114
SGP	0.121	0.085	−0.043	0.063	−0.388**	0.091
SWE	0.476**	0.082	−0.181	0.091	−0.119	0.074
THA	0.188	0.134	0.066	0.129	−0.249*	0.115
TUN	0.445**	0.112	−0.029	0.099	0.041	0.070
TUR	0.832**	0.032	−0.033	0.035	0.125**	0.039
URY	0.206**	0.074	−0.034	0.098	−0.175	0.100
USA	0.316**	0.036	0.020	0.043	0.023	0.070
ZAF	0.498**	0.071	0.283*	0.118	−0.124	0.063

Finally, we also experimented with unweighted regressions instead of weighted regressions. Unweighted regressions change the estimated coefficients significantly. In particular, the estimated pass-through coefficients for exports are higher and the ones for imports are lower (i.e., more pricing-to-market). Still, we prefer the *weighted regression* results as it is sensible to give more weight to price changes in categories and partner countries that have a high trading volume if we want our results to be comparable to those obtained using aggregate data. Another potential concern is that

Table 17 Estimates of Long Run Exchange Rate Elasticities for export volumes

	Export Volumes					
	ER	(SE)	LAG.ER	(SE)	LAG.2.ER	(SE)
ARG	0.001	0.098	−0.470**	0.136	−0.217**	0.071
AUS	0.876**	0.173	−0.076	0.203	−0.281	0.309
AUT	0.567**	0.137	−0.064	0.124	−0.011	0.117
BEL	0.583**	0.124	−0.071	0.079	−0.119*	0.058
BRA	0.434**	0.061	0.246**	0.068	0.140*	0.055
CAN	0.329	0.214	0.158	0.110	0.021	0.106
CHE	0.810**	0.119	0.406**	0.105	−0.806**	0.148
CHL	0.722**	0.099	−0.052	0.151	0.298**	0.097
CHN	0.966**	0.056	0.080	0.050	−0.030	0.055
COL	0.380	0.197	−0.124	0.186	−0.460	0.241
CRI	0.618*	0.275	1.064	0.742	−0.193	0.928
CZE	0.350**	0.086	0.476**	0.086	−0.070	0.076
DEU	0.542**	0.056	0.018	0.028	−0.058	0.035
DNK	0.405**	0.064	0.057	0.053	−0.105	0.088
EGY	0.526*	0.213	−0.222	0.160	0.202	0.164
ESP	0.652**	0.070	−0.006	0.076	−0.152*	0.066
FIN	0.416**	0.096	0.246**	0.089	−0.304**	0.077
FRA	0.474**	0.040	−0.004	0.092	−0.159	0.105
GBR	0.580**	0.090	−0.165**	0.058	−0.028	0.053
GRC	0.596**	0.174	−0.005	0.210	−0.108	0.133
GTM	0.813	0.432	0.343	0.243	0.350	0.237
HKG	0.595*	0.247	−0.351*	0.136	0.267	0.344
HUN	1.062**	0.246	0.231	0.203	0.450*	0.195
IDN	0.517**	0.084	−0.126	0.071	−0.105	0.065
IND	0.448**	0.077	−0.016	0.086	0.108	0.098
IRL	0.642	0.377	−0.555	0.435	0.372	0.343
ISR	0.556	0.307	0.725**	0.175	−0.396	0.243
ITA	0.664**	0.041	−0.099*	0.039	−0.097**	0.026
JPN	0.432**	0.100	0.058	0.074	0.297**	0.052
KOR	0.910**	0.158	0.176**	0.060	0.253*	0.104
LKA	0.435**	0.158	−0.011	0.112	−0.143	0.088
MAR	0.606**	0.133	−0.257	0.164	0.186	0.126
MEX	0.033	0.236	0.562	0.290	−0.823	0.481
NLD	0.608**	0.091	−0.257**	0.084	0.119*	0.059
NOR	0.786**	0.215	−0.318	0.226	−0.009	0.097
NZL	0.540**	0.067	−0.118	0.083	0.123	0.069
PAK	0.630**	0.174	0.301	0.216	−0.403*	0.166
PER	0.476**	0.157	−0.030	0.190	−0.054	0.119

Table 17 (continued)

	Export Volumes					
	ER	(SE)	LAG.ER	(SE)	LAG.2.ER	(SE)
PHL	1.120	0.685	0.391	0.524	1.574**	0.553
POL	0.576**	0.084	0.289**	0.075	−0.248**	0.062
PRT	0.347*	0.139	−0.050	0.130	0.098	0.083
RUS	0.410**	0.090	−0.032	0.039	0.116*	0.051
SAU	1.280**	0.305	−0.374*	0.141	−0.424**	0.103
SGP	0.617**	0.141	0.412**	0.121	−0.243	0.135
SWE	0.418**	0.106	−0.137	0.074	−0.188	0.112
THA	0.597**	0.146	0.495**	0.099	0.219*	0.094
TUN	0.423**	0.114	−0.742*	0.341	−0.101	0.162
TUR	0.534**	0.047	0.132*	0.052	0.209**	0.036
URY	0.640**	0.153	0.214	0.249	0.221*	0.096
USA	0.622**	0.076	−0.059	0.070	0.159*	0.078
ZAF	0.405**	0.086	0.101	0.212	−0.074	0.111

Table 18 Estimates of Long Run Exchange Rate Elasticities for import volumes

	Import Volumes					
	ERC	(SE)	LAG.ERC	(SE)	LAG.2.ERC	(SE)
ARG	−0.384**	0.106	0.170	0.135	0.392	0.196
AUS	−0.131	0.166	0.615**	0.137	−0.263	0.156
AUT	−0.287**	0.086	0.175*	0.079	0.365**	0.074
BEL	−0.623**	0.102	−0.201	0.121	0.259**	0.083
BRA	−0.103*	0.049	−0.221**	0.048	−0.095	0.068
CAN	−0.319**	0.086	0.068	0.074	−0.096	0.112
CHE	−0.605*	0.251	−0.363	0.302	0.464	0.465
CHL	−0.432	0.229	−0.187	0.374	−0.195**	0.065
CHN	−0.124	0.092	0.228**	0.070	0.056	0.075
COL	−1.054**	0.170	−0.936**	0.149	−0.559**	0.172
CRI	−0.623*	0.286	1.019	0.814	−0.819*	0.394
CZE	−0.589**	0.066	−0.404**	0.059	0.076	0.080
DEU	−0.150*	0.058	0.104*	0.048	0.041	0.047
DNK	−0.458**	0.097	0.056	0.053	0.052	0.083
EGY	−0.361*	0.144	0.066	0.098	−0.061	0.161
ESP	−0.268**	0.074	0.166**	0.058	0.063	0.041
FIN	−0.278**	0.088	0.002	0.086	0.217*	0.088
FRA	−0.292**	0.098	0.109	0.110	0.131**	0.048

Table 18 (continued)

	Import Volumes					
	ERC	(SE)	LAG.ERC	(SE)	LAG.2.ERC	(SE)
GBR	−0.106	0.070	0.381**	0.047	0.162*	0.062
GRC	−0.622*	0.285	0.590	0.356	−0.292	0.532
GTM	−0.254	0.320	0.203	0.241	0.040	0.261
POL	−0.454**	0.050	−0.075	0.053	0.146**	0.040
HKG	−0.242	0.149	−0.068	0.174	0.406*	0.162
HUN	−0.172	0.108	−0.295**	0.083	−0.209**	0.073
IDN	−0.192	0.173	0.223*	0.084	−0.102	0.082
IND	−0.584**	0.208	0.546	0.396	0.104	0.186
IRL	−0.544	0.347	0.252	0.164	0.104	0.163
ISR	−0.598**	0.135	−0.244	0.173	−0.078	0.133
ITA	−0.252**	0.047	0.110*	0.051	0.102**	0.035
JPN	−0.188	0.109	0.179**	0.047	−0.060	0.070
KOR	−0.109*	0.048	0.072	0.063	−0.069	0.072
LKA	−0.044	0.182	0.199	0.130	0.248*	0.111
MAR	−0.704**	0.202	−0.119	0.159	0.008	0.088
MEX	−1.145**	0.133	−1.182**	0.156	0.785**	0.077
NLD	−0.497**	0.122	0.020	0.081	0.050	0.080
NOR	−0.056	0.144	0.189*	0.094	0.307	0.170
NZL	−0.274	0.162	0.730**	0.189	−0.164	0.097
PAK	−0.600*	0.294	0.447	0.238	−0.058	0.190
PER	−0.458*	0.204	−0.069	0.161	0.152	0.140
PHL	−0.015	0.152	0.057	0.095	−0.349	0.252
PRT	−0.277**	0.081	0.014	0.125	0.100	0.076
RUS	−0.032	0.069	0.112*	0.044	−0.310**	0.044
SAU	−0.053	0.347	0.580	0.322	−0.078	0.130
SGP	−0.036	0.141	−0.111	0.099	−0.007	0.103
SWE	−0.043	0.067	0.085	0.080	0.160**	0.054
THA	−0.089	0.181	−0.119	0.108	−0.387**	0.093
TUN	−0.388**	0.128	0.231*	0.099	0.117	0.129
TUR	−0.447**	0.088	−0.476**	0.064	−0.335**	0.064
URY	−0.091	0.141	−0.405**	0.096	−0.336**	0.116
USA	−0.094	0.068	0.103**	0.036	0.084	0.070
ZAF	−0.135	0.074	0.313**	0.106	−0.258	0.165

our definition of outliers might influence our results. Indeed, we dropped all those observations with price changes above 200% ($-\log(1+2) < d\log(p_{ijkt}) < \log(1+2)$). Instead of choosing a fixed cutoff of 200%, we experimented also with throwing out observations that are in the top 1 percentile of the price changes in each product category for each exporting and importing country. The results are very similar to our baseline estimates.[16]

7 Conclusion

This paper estimates exchange rate price and quantity elasticities for imports and exports for 51 countries. The analysis is based on a rich database of bilateral trade flows with 160 partner countries and about 5,000 different products. We present standard regressions and complement these baseline results with alternative specifications, building on the multidimensional panel structure of the data set. In particular, these alternative specifications allow us to explore the role of unobserved variables, such as marginal costs and competitor prices in the importing market. We also present a battery of robustness results, controlling for additional lags of the data, and additional control variables, in particular.

The main empirical results on this paper can be summarized as follows. First, our estimates indicate that exchange rate pass-through is incomplete for most countries, and that there is substantial heterogeneity in the reaction of export and import prices across countries. The estimates reveal that, on average, the exchange rate elasticity of export prices is higher in advanced economies than in emerging markets, suggesting that exporters from emerging-market economies have more market power than their counterparts in advanced economies. For import prices, we also find substantial heterogeneity across countries but no significant difference between emerging markets and advanced economies.

Second, our baseline trade quantity regressions yield elasticities in the range of 0.2−0.4. Based on the estimated price and quantity exchange rate elasticities, the results imply that the Marshall-Lerner conditions are satisfied for all countries in the sample. This is largely because pass-through is incomplete in the majority of countries, while export prices in producer (exporter) currency react significantly to exchange rate changes (two results that are of course two sides of the same coin). As a result, the full Marshall-Lerner conditions (taking into account not only the reaction of trade volumes but also trade prices) are satisfied even though some of the exchange rate quantity elasticities are not significantly different from zero (especially on the import side). Cross-country differences in the reaction of the trade balance reflect to a large extent their openness to trade.

Third, controlling for time-varying country and product fixed effects substantially modifies the results and their interpretations. For export prices, the median exchange rate pass-through coefficient increases substantially. One possible interpretation is that this alternative specification controls for marginal costs and therefore focuses on the reaction of profit margins only, suggesting that a significant part of the reaction of export prices in producer currency comes from varying costs (associated, e.g., to imported costs). In the import price equation the alternative specification controls for time-varying conditions in the importing countries and in particular, local prices. This

[16] We do not to report them in order to save space. Detailed results are available upon request.

alternative specification also reduces the pass-through coefficient compared with the baseline (as foreign exporters take into account the reaction of local prices). Generally, turning to the fixed-effects equations reduces the dispersion of the coefficients, suggesting that controlling for unobserved variables removes a substantial source of cross-country heterogeneity.

Overall, these different specifications yield complementary insights on the issue of exchange rate elasticities. While the baseline specification is very close in spirit to the macro approach (the magnitude of these elasticities being correlated with existing macro studies), the fixed-effect approach goes one step further and helps disentangle the different mechanisms at work when the exchange rate varies. From a policy perspective, the results suggest that exchange rate movements can play an important role in addressing global trade imbalances.

Appendix

To show that the import and the export exchange rate pass−through are linked, consider the following simplified example. Suppose there are three countries: France, the United Kingdom and the United States. Based on Eq. 5, we can write the import exchange rate pass−through for the United States as follows:

$$\log\left(\frac{p_{US,i,t}}{p_{US,i,t-1}}\right) = \beta^M_{US}\log\left(\frac{s_{US,i,t}}{s_{US,i,t-1}}\right),$$

where $p_{US,i,t}$ is the import price of the United States from exporter i at the time t and β^M_{US} is the import price elasticity. Equivalently, we can write the change in the import price to the United States as a function of the export price elasticity of all i countries, i.e., France and the United Kingdom. Consider the export price of France to the United States in US dollars:

$$\log\left(\frac{p_{US,FR,t}}{p_{US,FR,t-1}}\right) = \beta^X_{FR}\log\left(\frac{s_{US,FR,t}}{s_{US,FR,t-1}}\right)$$

Then the import price of the United States can be written as the trade−weighted average of the changes in the bilateral import prices with France and the bilateral import prices with the United Kingdom:

$$w_{US,FR,t}\log\left(\frac{p_{US,FR,t}}{p_{US,FR,t-1}}\right) + w_{US,UK,t}\log\left(\frac{p_{US,UK,t}}{p_{US,UK,t-1}}\right)$$
$$= \beta^M_{US}\left(w_{US,FR,t}\log\left(\frac{s_{US,FR,t}}{s_{US,FR,t-1}}\right) + w_{US,UK,t}\log\left(\frac{s_{US,UK,t}}{s_{US,UK,t-1}}\right)\right),$$

where $w_{US,i,t}$ is the import share of country i in total US imports. Substituting the equation of the export elasticity into the import elasticity, we get:

$$w_{US,FR,t}\beta^X_{FR}\log\left(\frac{s_{US,FR,t}}{s_{US,FR,t-1}}\right) + w_{US,UK,t}\beta^X_{UK}\log\left(\frac{s_{US,UK,t}}{s_{US,UK,t-1}}\right)$$
$$= \beta^M_{US}\left(w_{US,FR,t}\log\left(\frac{s_{US,FR,t}}{s_{US,FR,t-1}}\right) + w_{US,UK,t}\log\left(\frac{s_{US,UK,t}}{s_{US,UK,t-1}}\right)\right).$$

Thus, the import pass−through coefficient is a weighted average of all export pass−through coefficients of all trading partners. More generally, we can write the link between the import and elasticity for an arbitrary number of trading partners J:

$$\prod_{j=1}^{J}\left(\frac{s_{US,j,t}}{s_{US,j,t-1}}\right)^{w_{US,j,t}\beta_j^X} = \left(\prod_{j=1}^{J}\left(\frac{s_{US,j,t}}{s_{US,j,t-1}}\right)^{w_{US,j,t}}\right)^{\beta_{US}^M}$$

Next, suppose that the US dollar depreciates by 10% against all other currencies, i.e., $\frac{s_{US,j,t}}{s_{US,j,t-1}} = 1.1\forall j$, then $\sum_{j=1}^{J} w_{US,j,t}\beta_j^X = \beta_{US}^M$ and the import pass−through is an arithmetic mean of the export pass−through coefficient of trading partners.

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