Intensive and Extensive Margins of Exports and Real Exchange Rates*

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Abstract

Current research in international trade literature centers on the importance of both the intensive margin (i.e. the volume exported by an exporter) and extensive margin (i.e. new exporters) to model export behavior. In this paper I empirically study the behavior of the extensive and the intensive margin to address the elasticity puzzle in international economics. Elasticities of substitution between domestic and foreign goods are thought to be low in international macro models and high in trade models. Empirical evidence does not offer a consensus on this parameter either. I study if mechanisms related to sectoral differences (like Chaney, 2008) or development status of the traders have potential to address the elasticity puzzle. Lastly, I further study the extensive margin of trade and its connection to credit constraints. Following Hummels and Klenow (2005) I measure bilateral extensive and intensive margins of trade. I define a variety as each of the 440 4-digit sectors from the Standard International Trade Classification (SITC) Revision 2. Bilateral export responses to bilateral real exchange rate fluctuations are then decomposed into extensive and intensive margin responses. A bilateral trade sample of 136 countries is studied for the period 1981-1997. Multiple sub-samples are studied by development status of the trading partners and by the type of exported good.

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1 Introduction

The elasticity of substitution between domestic and foreign goods is a key parameter for models in international economics. Different values for this elasticity importantly affect the predictions of models that have an international channel. Calibrations of international macroeconomic models that study real business cycles suggest that values of this elasticity between 1 and 2 are appropriate. Alternatively, trade models that study trade patterns and the impact of tariffs and trade liberalizations suggest that values of the elasticity of substitution between 10 and 15 are appropriate.[1]

This lack of consensus on the elasticity of substitution in the theoretical/calibration literature is also found in the vast empirical literature on this parameter. Imbs and Mejean (2009) and Ruhl (2008) have suggested different patterns in the existing estimates to solve the elasticity puzzle. Imbs and Mejean propose that the level of aggregation used in the elasticity estimation can explain the low aggregate estimates and large micro estimates. Ruhl notes that elasticities estimated with high frequency data (time series) are small and those estimated with cross-country data (or before-after trade liberalizations) are large. Ruhl proposes that the different sources of variation used in the estimation can explain the puzzle given that temporary shocks are predicted to deliver smaller elasticities than permanent changes, building a model with such predictions where the decision to become an exporter (affecting the extensive margin of trade) is central for the results.

Current research in international trade literature centers on the importance of both the intensive margin (i.e. the volume exported by an exporter) and extensive margin (i.e. new exporters) to model export behavior. In this paper I empirically study the behavior of the

[1] I use the stated values for the elasticity puzzle that Ruhl (2008) offers.

extensive and the intensive margin in order to address the described elasticity puzzle. First I study if margin behavior is able to solve the elasticity puzzle as proposed by Ruhl (2008). As I uncover patterns that do not seem to agree with Rhul's theory, I take a closer look at the data in search of an alternative solution to the elasticity puzzle. In particular I focus on how the model of Chaney (2008) can shed light on the puzzle based on the type of sector traded. In a model that directly incorporates extensive margin effects, Chaney (2008) adds market structure to a gravity theory of trade with firm heterogeneity and predicts that the extensive (intensive) margin response of a sector to changes in trade barriers is diminished (amplified) by the elasticity of substitution of the sector. Moreover I investigate if the development status of exporters and importers plays a role in explaining the elasticity puzzle. Lastly I further study the extensive margin of trade and its connection to credit constraints.

This paper uses yearly fluctuations in bilateral real exchange rates as measures of shocks or changes in variable trade costs. Depending on the model that we have in mind, export responses to real exchange rate fluctuations will deliver an estimate of the elasticity of substitution between domestic and foreign goods. For example, simple models of trade with monopolistic competition and representative firms predict that exports respond to variable trade costs as a linear function of the substitution elasticity. These models imply that the estimation strategy in this paper allows us to recover the elasticity of substitution. Moreover, export responses to real exchange rate fluctuations are further decomposed into extensive and intensive margin responses.

Following Hummels and Klenow (2005), I define the bilateral extensive margin of exports as a weighted count of the exporter country's varieties exported to the importer and I define the bilateral intensive margin as the exporter country's relative volume of exports. I define a variety as each of the 440 4-digit sectors from the Standard International Trade Classification (SITC) Revision 2 and use a bilateral trade sample of 136 countries for the period 1981-1997.

In a related exercise Kehoe and Ruhl (2009) build an alternative measure of bilateral extensive margin using a country-pair specific cutoff to determine if a 4-digit sector is traded

or not. Their study offers evidence consistent with Ruhl (2008) as their measure of extensive margin responds to permanent but not transitory shocks in their sample of around twenty country pairs. Note that their exercise is different from the present paper not only in their measure of extensive margin but also in that they focus on a selected group of countries and episodes.

My results indicate that the extensive margin of trade plays a significant role in export adjustments at the yearly frequency. In particular I find that the extensive margin explains on average 70% of overall export responses to real exchange rate fluctuations among the four country samples with significant export responses. By definition the yearly analysis mostly includes transitory shocks as opposed to permanent shocks. Therefore the results contradict Ruhl (2008) as I find that the extensive margin importantly adjusts with respect to transitory shocks. This evidence suggests that Ruhl's theory of transitory versus permanent shocks may not be key in solving the elasticity puzzle.

Chaney (2008) predicts that the degree of substitutability of goods magnifies the intensive margin response and diminishes the extensive margin response to changes in variable trade costs. I interpret my results as supportive of Chaney's predictions. This evidence points to an alternative solution to the elasticity puzzle. As the evidence mostly indicates that the extensive margin of trade is more responsive in less substitutable sectors, and given that the extensive margin seems to dominate the export response, we may explain the puzzle if the high estimated elasticities in the literature are associated with differentiated sectors trade (and low estimates are linked to homogeneous sectors trade). *It may be that the high (low) estimated elasticities correspond to sectors with low (high) elasticity of substitution where the extensive margin is relatively large (small).* Further study of existing estimates in the vast empirical literature is needed in determining the validity of this proposed hypothesis.

An alternative solution to the puzzle is pursued by studying the importance of the development status of the trading partners in the elasticity estimates. Results indicate that export responses from less developed countries to the rest of the world are smaller than those from high-income countries (0.04 versus 0.12). This evidence points to an alternative

solution to the elasticity puzzle. If most high estimates from the literature correspond to samples of high-income exporters (and low estimates correspond to less developed exporters) we may propose that the puzzle relates to a development status story. *It may be that high (low) estimated elasticities mostly correspond to high-income (less developed) exporters.* Again, further study of existing estimates in the vast empirical literature is needed in determining the validity of this proposed hypothesis.

Lastly, from the study of the extensive margin for less developed exporters I find (weak) evidence in support of the importance of sectoral credit constraints on the extensive margin response. This suggests that in solving the elasticity puzzle credit constraints may play a role.

Overall this paper suggests that the elasticity puzzle is probably worse than the literature has claimed given that the present estimates (together with estimates from Colacelli (2008)) suggest low elasticities of substitution well below one. The evidence presented in this paper suggests that the puzzle may possibly be solved by considering the sectoral composition of trade and the development status of the traders as these dimensions offer heterogeneous export responses to real exchange rate fluctuations.

2 Extensive and Intensive Margins of Trade

In the spirit of Hummels and Klenow (2005) who follow Feenstra (1994), I define the *bilateral extensive margin* as the weighted count of the sectors in which the exporter exports to the importer in a given year. Weights correspond to the relevance of the exported sectors in total exports from the world to the importer (excluding exports from the exporter) in a given year. More precisely EM_{ijt}, the extensive margin between exporter i and importer j in year t, is:

$$EM_{ijt} = \frac{\sum_{s \epsilon S_{ijt}} Exports^{s}_{kjt}}{\sum_{s \epsilon S} Exports^{s}_{kjt}} \tag{1}$$

where k is the "rest of the world" by including all exporters to j except for i. S_{ijt} is the set of sectors s in which exporter i exports to j in year t. S is the set of all 440 sectors. The numerator of EM_{ijt} measures exports from the rest of the world to the importer j in those sectors s in which i exports to j in year t. The denominator includes all exports from the rest of the world to j in all sectors s in year t. If all sectors s have equal importance for j during t, then EM_{ijt} is the fraction of sectors in which i exports to j during t. In general weights on sectors reflect their relevance in k's exports to j. EM_{ijt} is between 0 and 1.

The *bilateral intensive margin* measures exports from the exporter to the importer relative to total exports to the importer (excluding exporter's exports) in those sectors in which the exporter exports to the importer in a given year. In particular:

$$IM_{ijt} = \frac{\sum_{s \epsilon S_{ijt}} Exports^s_{ijt}}{\sum_{s \epsilon S_{ijt}} Exports^s_{kjt}} \tag{2}$$

IM_{ijt} measures the intensive margin between i and j in t by comparing exports from i to j in t with exports from the rest of the world to j in t in the sectors s in which i exports to j in t. IM_{ijt} is positive and can be below or above 1.

As defined by Hummels and Klenow (2005), the product of both margins delivers *overall bilateral exports* from i to j in t, OT_{ijt}, as the ratio of exports from i to j in t over exports from the rest of the world to j in t (numerator of EM_{ijt} is equal to denominator of IM_{ijt}):

$$OT_{ijt} = EM_{ijt} * IM_{ijt} = \frac{\sum_{s \epsilon S_{ijt}} Exports^s_{ijt}}{\sum_{s \epsilon S} Exports^s_{kjt}} \tag{3}$$

Note that Hummels and Klenow (2005) work on decomposing the measure of OT_{ijt} into extensive margin and intensive margin. This work will study the relative importance of the trade margins on the absolute level of bilateral trade flows, T_{ijt}, as opposed to the relative trade measure OT_{ijt}. Such strategy will allow us to tie our findings with previous work on the response of T_{ijt} to fluctuations in the bilateral real exchange rate. In order to do such

decomposition of the variation of bilateral trade flows T_{ijt} we state the relationship between T_{ijt} and OT_{ijt}. Note that T_{ijt} is the numerator of the defined IM_{ijt} in equation (2) (and is also the numerator in equation (3)). Therefore, defining $\sum_{s\epsilon S} Exports^s_{kjt}$ as X_{kjt}, we can express T_{ijt} as:

$$T_{ijt} = OT_{ijt} * \sum_{s\epsilon S} Exports^s_{kjt} = EM_{ijt} * IM_{ijt} * X_{kjt} \quad (4)$$

Given the definitions of margins used, bilateral trade flows T_{ijt} can be decomposed into extensive margin, intensive margin and X_{kjt}. Therefore variations in bilateral trade flows T_{ijt} will be explained by variations in the margins of trade (as defined by Hummels and Klenow (2005)) and also variations in X_{kjt}, where X_{kjt} measures exports from the rest of the world to j in all sectors in year t.

2.1 Descriptive Statistics for Margins

As in Colacelli (2008), I build a country-pair level sample including 136 countries for the period between 1981 and 1997 where the bilateral trade flows are those compiled by Feenstra (2000).[2] The sample includes 13,860 country pairs and 140,013 bilateral-level observations. The country-pair level data on margins are built with approximately 8 million observations from 4-digit bilateral sector trade data. Table 1 provides summary statistics for the described measures of the bilateral extensive margin, the bilateral intensive margin, bilateral exports T_{ijt}, and X_{kjt}.

Statistics are reported for five different samples of countries, depending on the development status of the exporter and importer. The World sample includes all 136 exporters and importers. Following the World Bank 2006 classification of countries based on 2004 GNI per capita, I classify 34 countries as high income and 102 countries as developing countries, as in Colacelli (2008). The "HI" sample includes exporter and importer countries from the high-income group, the "HI&MIX" sample includes exporters from the high-income group but importers from the high-income and developing country groups, and the "DC" and

[2] The raw bilateral trade data is in thousands of US dollars. I obtain the 1995 dollar measure using the US GDP deflator.

"DC&MIX" samples are built similarly for developing countries.

Statistics in Table 1 are reported by type of product exported for the five country samples. As in Colacelli (2008), following Rauch (1999), the focus is on homogeneous and differentiated bilateral trade. Rauch classifies export goods by the availability of information on their price. Differentiated products are defined as those without a reference price or "branded" – i.e. their price can be quoted once mentioning the manufacturer. Homogeneous products are those traded on organized exchanges where reference prices are quoted (for example in the London Metal Exchange). For simplicity this paper ignores the middle category of sectors, reference-price products, which are not "branded" and have prices listed only in trade publications and may have specialized traders who centralize price information.

As described above, EM_{ijt} is the weighted fraction of sectors in which i exports to j during t. The mean exporter in the World sample exports to its typical destination in 33% of all the weighted 4-digit sectors imported by this destination during an average year. The mean extensive margin increases to 59% when we restrict the sample to high-income exporters and importers, and it is only 22% for the DC sample. When focusing on exports in homogeneous sectors only, the bilateral extensive margin is reduced approximately to half of that for all exports. For differentiated sectors the mean bilateral extensive margin is similar to that for all exports in high-income country samples but is reduced to around 15% for samples with developing countries.

IM_{ijt} was defined as the ratio of exports from i to j in t over exports from the rest of the world to j in t in the sectors s in which i exports to j in t. The mean exporter in the World sample during an average year exports to its typical destination 54% of the volume exported by the rest of the world to this destination in those sectors. When focusing on the HI sample this statistic is just 6% which reflects the smaller concentration in exports among high-income countries. When looking at the DC sample the average bilateral intensive margin increases to 90%. Focusing on homogeneous sectors only, the bilateral intensive margin is higher than 100% for all country samples (152-426%) reflecting high bilateral export concentration in such sectors. On the other hand, differentiated sectors show bilateral

intensive margins between 6% and 27% for all samples.

Note that Hummels and Klenow's data include exports in 1995 from 121 countries to 59 importers in over 5,000 6-digit product categories (Harmonized System classification). The smaller set of possible varieties used in this paper (from the 4-digit classification) decreases the importance of the extensive margin in the results. More disaggregated export data allow to better measure extensive margin response. Indeed a decline in the extensive margin is shown by Hummels and Klenow when using 4-digit versus 6-digit classification. But this decline is very small when compared with the one from 6- to 1-digit classification. Therefore, this work is biased towards finding little relevance of the extensive margin (i.e. "true" extensive margin relevance is higher than the one we uncover). Moreover the loss in detail from 4-digit classification has the benefit of an expanded country coverage and time dimension as we are able to study trade among 136 countries for 17 years.

3 Contribution of Extensive and Intensive Margins

In order to study the composition of the margin response to real exchange rate fluctuations I use a set of bilateral gravity equations. This approach is a combination of standard techniques first developed by Tinbergen (1962) and the work by Hummels and Klenow (2005). Bilateral trade as well as bilateral margins of trade are explained, in separate equations, by the scale of the exporter and importer and measures of trade resistance between trading partners including the measured bilateral real exchange rate. The estimating equation for bilateral trade flows T_{ijt} is:

$$\begin{aligned} \ln(T_{ijt}) = \beta_1^T \ln(Y_{jt}) + \beta_2^T \ln(Y_{it}) + \beta_3^T \ln(y_{jt}) + \beta_4^T \ln(y_{it}) \\ + \eta^T \ln(\widehat{RER}_{ijt}) + \mu^T \ln(d_{ijt}) + \delta_{ij}^T + \tau_t^T + \varepsilon_{ijt}^T \end{aligned} \tag{5}$$

where Y_{jt} is the GDP of the importer at time t, Y_{it} is the GDP of the exporter at time t, d_{ijt} is a time-variable measure of trade resistance or distance between the exporter and the importer, δ_{ij}^T represents country-pair specific measures of trade resistance that affect

bilateral trade, τ_t^T represents a time specific effect on bilateral trade, and ε_{ijt}^T represents country-pair-year specific error. As additional measures of time-varying exporter and importer activity we add GDP per capita of the exporter and the importer represented as y_{it} and y_{jt}. As mentioned this paper interprets the measured real exchange rate between a pair of countries as a measure of trade resistance or distance between them.[3]

In order to decompose the bilateral export response η^T we simply estimate the following parallel models for the extensive and intensive margin defined. The parallel estimating equation for the extensive margin is:

$$\begin{aligned}\ln(EM_{ijt}) = \beta_1^{EM}\ln(Y_{jt}) + \beta_2^{EM}\ln(Y_{it}) + \beta_3^{EM}\ln(y_{jt}) + \beta_4^{EM}\ln(y_{it}) \\ + \eta^{EM}\ln(\widehat{RER}_{ijt}) + \mu^{EM}\ln(d_{ijt}) + \delta_{ij}^{EM} + \tau_t^{EM} + \varepsilon_{ijt}^{EM}\end{aligned} \tag{6}$$

And similarly, the estimating equation for the intensive margin is:

$$\begin{aligned}\ln(IM_{ijt}) = \beta_1^{IM}\ln(Y_{jt}) + \beta_2^{IM}\ln(Y_{it}) + \beta_3^{IM}\ln(y_{jt}) + \beta_4^{IM}\ln(y_{it}) \\ + \eta^{IM}\ln(\widehat{RER}_{ijt}) + \mu^{IM}\ln(d_{ijt}) + \delta_{ij}^{IM} + \tau_t^{IM} + \varepsilon_{ijt}^{IM}\end{aligned} \tag{7}$$

Given that T_{ijt} is defined as $EM_{ijt} * IM_{ijt} * X_{kjt}$, it must be that:

$$\eta^T = \eta^{EM} + \eta^{IM} + \eta^X \tag{8}$$

because of linearity of OLS. η^X represents the coefficient of $\ln(\widehat{RER}_{ijt})$ in a parallel estimating equation where the dependent variable is $\ln(X_{kjt})$. This property (8) of the defined margins allows for a simple decomposition of their contribution to bilateral trade responses to real exchange rate fluctuations.

To perform this analysis, on top of the described margins variables and data, I use

[3] Colacelli(2008) and Bayoumi (1999) follow a similar procedure to obtain the real exchange rate elasticity of exports. Feenstra (1989) finds supporting evidence for the symmetric pass-through of tariffs and exchange rates on US import prices of Japanese cars, trucks and motorcycles.

measures of exchange rate, income and GDP deflators obtained from the World Development Indicators (2001). Real exchange rate, $\widehat{RER}_{ijt}$, is measured by the nominal exchange rate for each country in the pair and GDP deflators such that an increase in $\widehat{RER}_{ijt}$ represents a real depreciation of the exporter country i with respect to the importer country j. Colacelli (2008) details measurement issues of true real exchange rate, RER_{ijt}, and how the inclusion of country-pair fixed effects in the estimation solves it. Descriptive statistics for $\widehat{RER}_{ijt}$ for the defined samples are detailed in Colacelli (2008).

3.1 Estimation Results on Margins' Contribution

Table 2 presents estimation results for equations (5), (6) and (7) in columns (1), (2) and (3) respectively for the World sample for all bilateral trade (top panel). Column (4) presents the estimated η^X from equation (8). Results for homogeneous bilateral trade for the World sample are reported in the middle panel of Table 2 and those results for differentiated bilateral trade are reported in the bottom panel.

Tables 3, 4, 5 and 6 present parallel results for samples HI, HI&MIX, DC and DC&MIX respectively. Four out of the five country sample studied (all except HI) show that the extensive margin of trade plays a significant role in the overall export response to yearly real exchange rate fluctuations. Such extensive margin response varies from 37% (0.045/0.122) of the export response in HI&MIX to 91% (0.039/0.043) in DC&MIX. This evidence contradicts Ruhl (2008) prediction of unimportant extensive margin response to temporary shocks such as the yearly real exchange rate change.

Table 2 shows that bilateral exports of differentiated goods have a larger significant response than those of homogeneous goods (0.08 versus 0.03) for the World sample. This table indicates that the intensive margin has no contribution to the trade response of either homogeneous or differentiated trade (its contribution is significant but negative for differentiated exports) in the World sample. The extensive margin is shown to explain 46% of the differentiated trade response (0.037/0.080) and nothing out of the homogeneous trade response in the World sample.

Tables 3 and 4 for samples HI and HI&MIX show an extensive margin contribution to

trade responses of differentiated goods of 37% for HI (0.161/0.433) and 13% of the trade response for HI&MIX (0.023/0.178). The intensive margin has no contribution to the trade response of differentiated sectors in either sample. The extensive margin explains 68% of the trade response of homogeneous goods in the HI&MIX sample (no role of IM), and the intensive margin explains over 100% of the trade response of homogeneous goods in the HI sample (no role of the EM).

Tables 5 and 6 present results for samples DC and DC&MIX. Differentiated exports show to have significant responses to real exchange rate fluctuations in both samples where homogeneous exports have insignificant trade responses. The extensive margin contributes to the trade response of differentiated exports around 50% in both samples and the intensive margin shows no significant contribution.

Overall these results support Chaney (2008) prediction of higher extensive margin response and lower intensive margin response for sectors with lower substitutability (differentiated). Only in one sample (HI&MIX) the extensive margin for homogeneous and differentiated sectors are significant, where we observe the opposite that Chaney predicts as the extensive margin is relatively more important for the homogeneous sectors. The other four samples studied though have a significant extensive margin response for differentiated sectors and a response insignificantly different from zero for homogeneous sectors. I interpret this evidence as generally supporting Chaney's prediction on the extensive margin. The intensive margin response is never significant for both homogeneous and differentiated sectors in one sample. The intensive margin response is significantly different from zero only for homogeneous sectors in the HI sample. I interpret such evidence in favor of Chaney's prediction on the intensive margin.

Lastly, export responses to real exchange rate fluctuations from less developed countries to the rest of the world are smaller than those from high-income countries (0.043 for DC&MIX sample versus 0.122 for HI&MIX sample).

4 Extensive Margin of Trade and Credit Constraints

Results described above suggest a more salient role of the extensive margin in explaining bilateral trade responses to real exchange rate fluctuations. This was found to be particularly true for exports of differentiated goods for developing countries (DC and DC&MIX samples). In order to further learn about determinants of the extensive margin response to real exchange rate fluctuations we focus on certain sectoral characteristics.

In particular we study if there is a role of credit constraints on the extensive margin response to real exchange rate fluctuations in DC and DC&MIX samples. Measures of vulnerability to credit constraints are available at the sectoral level: *Asset tangibility* (AT) and *external finance dependence* (EFD) are sector level measures based on average US data of publicly traded firms for the period 1986-1995 (Manova (2006) uses these measures). AT is the share of net property, plant and equipment in total assets for the median US firm in each sector. EFD is the share of capital expenditures not financed by cash flow from operations for the median US firm in each sector. Both sector measures are available for manufacturing industries at the 3-digit ISIC classification. A matching is performed between the 3-digit ISIC sectors with credit constraint data and our 4-digit SITC data when a unique 3-digit ISIC corresponds to each 4-digit SITC. Such matching leaves us with 74 out of 440 4-digit sectors with complete data where 35 (out of the 74) are differentiated sectors.

Moreover 4-digit sectors are classified by the amount of entry and exit in the sector in order to determine which sectors may have a bigger role in the extensive margin. The *fraction of entry* in the sector is defined as the number of country-pair-year that show to start trading in the sector the year of a "large depreciation" (of the exporter with respect to the importer), divided over the number of country-pair-year that were not trading in that sector the year prior to the "large depreciation". The *fraction of exit* in the sector is defined as the number of country-pair-year that stop trading in the sector the year of a "large appreciation" (of the exporter with respect to the importer), divided over the number of country-pair-year that were trading in that sector the year prior to the "large

appreciation".[4] For example, imagine that we observe zero meat exports from Argentina to Brazil in 1990, from Argentina to Chile in 1990, and from Argentina to Bolivia in 1990. Imagine that there is a "large depreciation" between Argentina and those three trading partners between 1990 and 1991. And imagine that we observe positive meat exports from Argentina to Brazil in 1991, and zero meat exports from Argentina to Chile and Bolivia in 1991. Our measure of entry for the meat sector for the period will be 1/3, as there is one new exporter-importer-year trading in meat (after a large depreciation) and there are three exporter-importer-year not trading on meat before the depreciation.

4.1 DC Sample, Differentiated Sectors

From Table 5 it was established that among developing countries (DC sample), 51% of the significant response of differentiated exports to real exchange rate fluctuations seems driven by the extensive margin of trade. Focusing on the DC country-pair-years which faced depreciations (appreciations) of the exporter with respect to the importer, previous findings on the importance of the extensive margin suggest that we should observe positive entry (exit) for the average differentiated sector. We aim to determine weather the vulnerability to credit constraints of the sectors plays a role in the sectoral response.

We have data on entry, exit and credit constraints (AT and EFD) for 35 differentiated sectors traded among DC. Figure 1 shows the relationship between EFD and entry at the sectoral level. The figure shows the expected negative (though insignificant) relationship suggesting that those differentiated sectors which are more vulnerable to credit constraints (higher EFD) experience less entry following a competitive depreciation.

Figure 2 shows the relationship between EFD and exit at the sectoral level among DC countries for differentiated sectors. The expected positive (but insignificant) relationship is observed in the figure suggesting that those differentiated sectors which are more vulnerable to credit constraints (higher EFD) experience more exit following an appreciation.[5]

[4] We have limited the analysis to cases of "large depreciations" and "large appreciations" which are defined as the observations in the top 30 percentile of the distribution of RER fluctuations among country-pair-years in the sample.

[5] AT shows no clear pattern for the DC sample. AT has insignificant positive correlation with exit of 0.0413 (expected to be negative). AT has insignificant positive correlation with entry of 0.025 (expected to

4.2 DC&MIX Sample, Differentiated Sectors

55% of the export response of differentiated sectors was explained by the extensive margin response in the DC&MIX sample (see Table 6).

We have data on entry, exit and credit constraints (AT and EFD) for 35 differentiated sectors traded in the DC&MIX sample. Figure 3 shows the relationship between EFD and entry at the sectoral level. The figure shows the expected negative (though insignificant) relationship suggesting that those differentiated sectors which are more vulnerable to credit constraints (higher EFD) experience less entry following a competitive depreciation.

Figure 4 shows the relationship between EFD and exit at the sectoral level for the DC&MIX sample for differentiated sectors. The expected positive (but insignificant) relationship is observed in the figure suggesting that those differentiated sectors which are more vulnerable to credit constraints (higher EFD) experience more exit following an appreciation.[6]

Overall we find (weak) evidence in support of the importance of sectoral credit constraints for the extensive margin response for developing countries exporting either just to other developing countries (DC sample) or to all countries in the full sample (DC&MIX).

5 Conclusion

The puzzle regarding the elasticity of substitution (between domestic and foreign goods) that affects international economics is found to be probably worse than previously claimed in the literature as my estimates lie below those previously considered low. Evidence presented in this paper suggests that the puzzle may possibly be solved by considering the sectoral composition of trade and the development status of the traders. It is also found that mechanisms proposed by Ruhl (2008) regarding extensive margin responses to temporary/permanent shocks seem unlikely to solve the puzzle.

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be positive).

[6] AT shows no clear pattern for the DC&MIX sample. AT has insignificant positive correlation with exit of 0.06 (expected to be negative). AT has insignificant positive correlation with entry of 0.0214 (expected to be positive).

Following Hummels and Klenow (2005), I define the bilateral extensive margin of exports as a weighted count of the exporter country's varieties exported to the importer and I define the bilateral intensive margin as the exporter country's relative volume of exports. I define a variety as each of the 440 4-digit sectors from the Standard International Trade Classification (SITC) Revision 2 and use a bilateral trade sample of 136 countries for the period 1981-1997. Bilateral export responses to bilateral real exchange rate fluctuations are studied and decomposed into extensive and intensive margin responses.

My results indicate that the extensive margin of trade plays a significant role in yearly export adjustments. In particular I find that the extensive margin explains on average 70% of overall export responses to real exchange rate fluctuations, among the four country samples with significant export responses.

Evidence mostly indicates that the extensive (intensive) margin of trade is more responsive in less (more) substitutable sectors which I interpret as supportive of Chaney (2008). Further study of literature estimates may allow us to conclude if such sectoral factors can solve the puzzle. In particular, finding that high literature elasticities are mostly derived from estimates for differentiated sectors (and low elasticities from estimates for homogeneous sectors) would address the puzzle. On the development status analysis, results indicate that export responses from less developed countries to the rest of the world are smaller than those from high-income countries. If most high estimates from the literature were to correspond to samples of high-income exporters (and low estimates were to correspond to less developed exporters) we may propose that the puzzle relates to a development status story. Lastly, from the study of the extensive margin for less developed exporters I find (weak) evidence in support of the importance of sectoral credit constraints on the extensive margin response. This suggests that, in solving the elasticity puzzle, credit constraints may play a role.

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A Figures and Tables

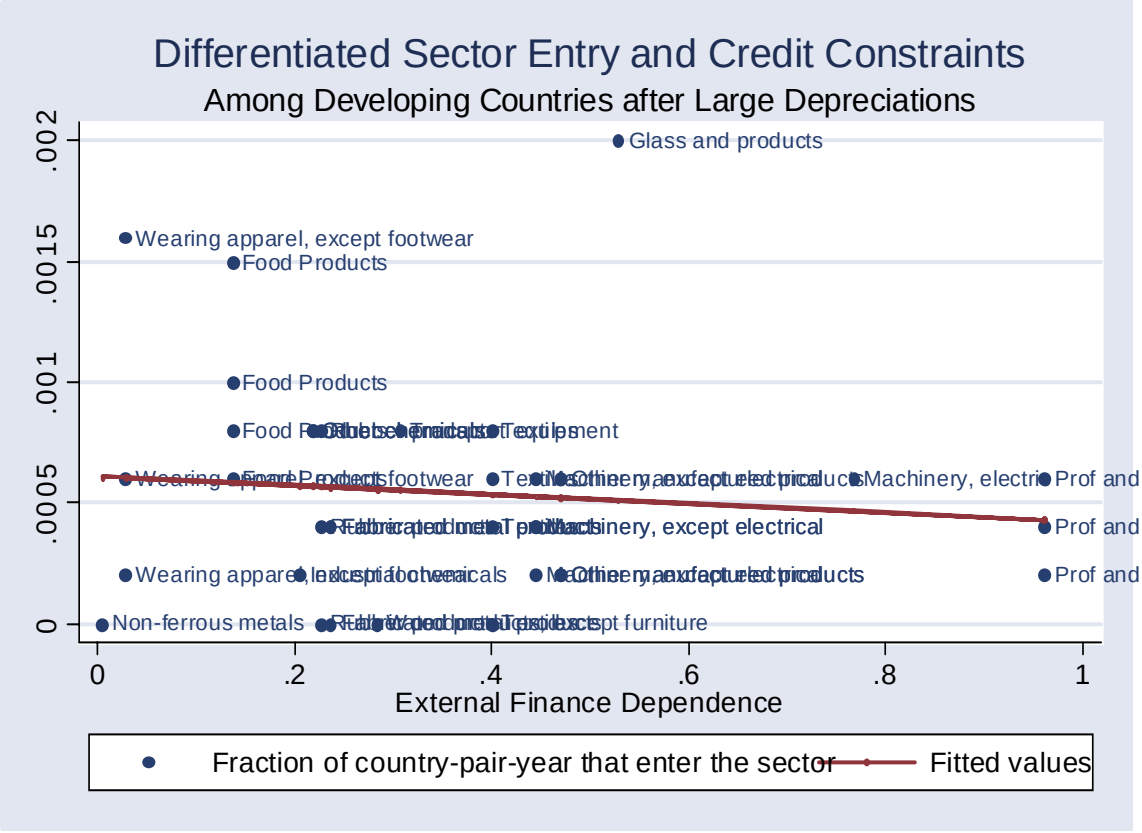

Figure 1: Sectoral Entry and Credit Constraints. DC Sample.

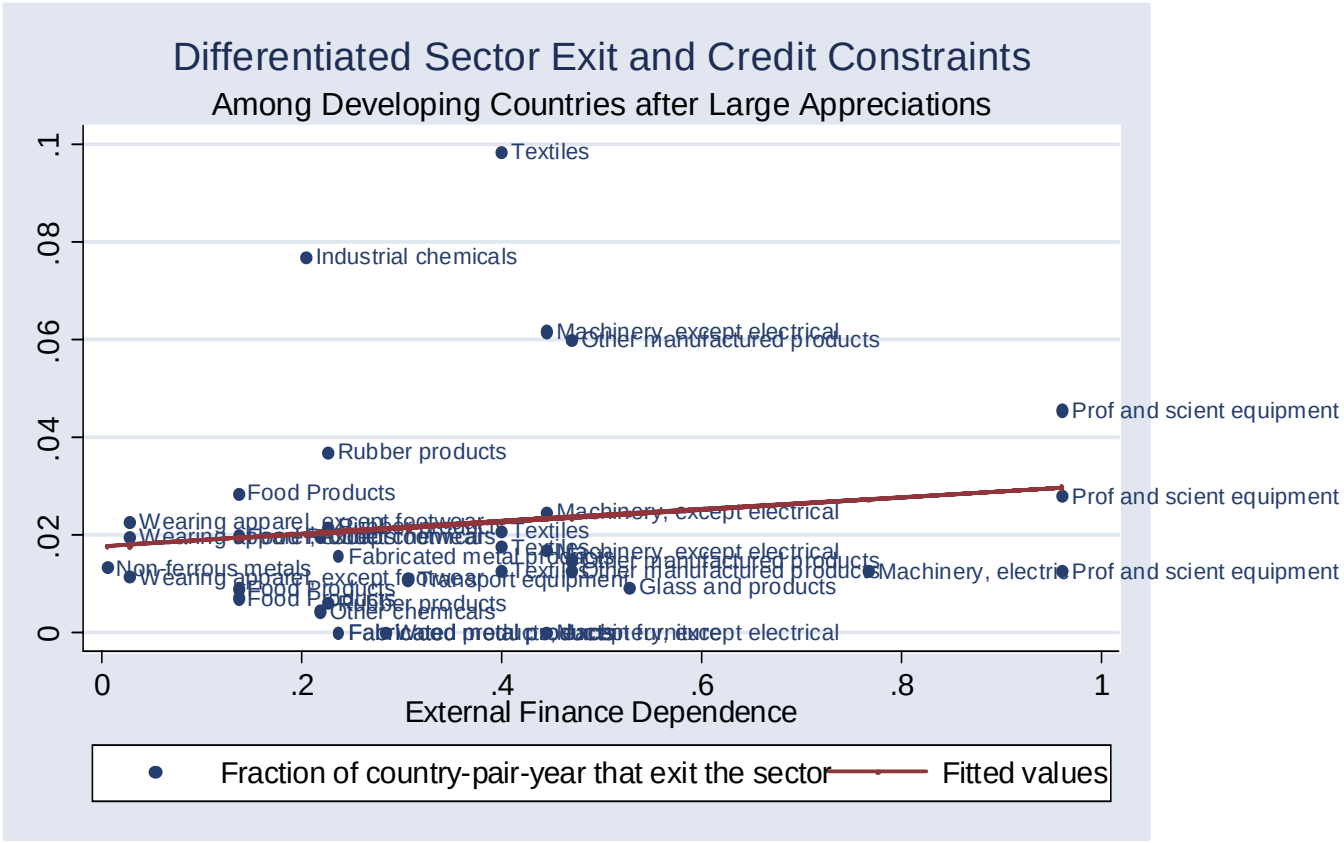

Figure 2: Sectoral Exit and Credit Constraints. DC Sample.

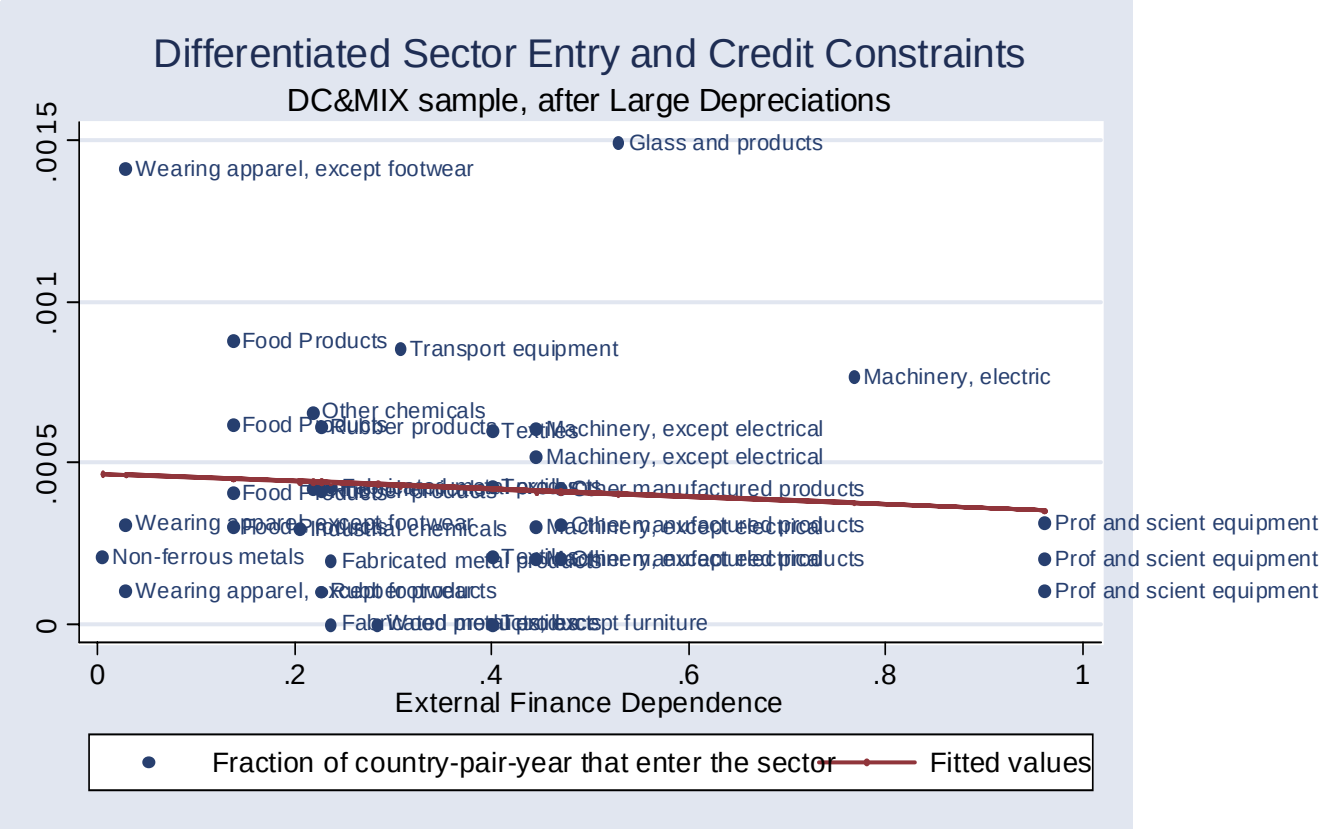

Figure 3: Sectoral Entry and Credit Constraints. DC MIX Sample.

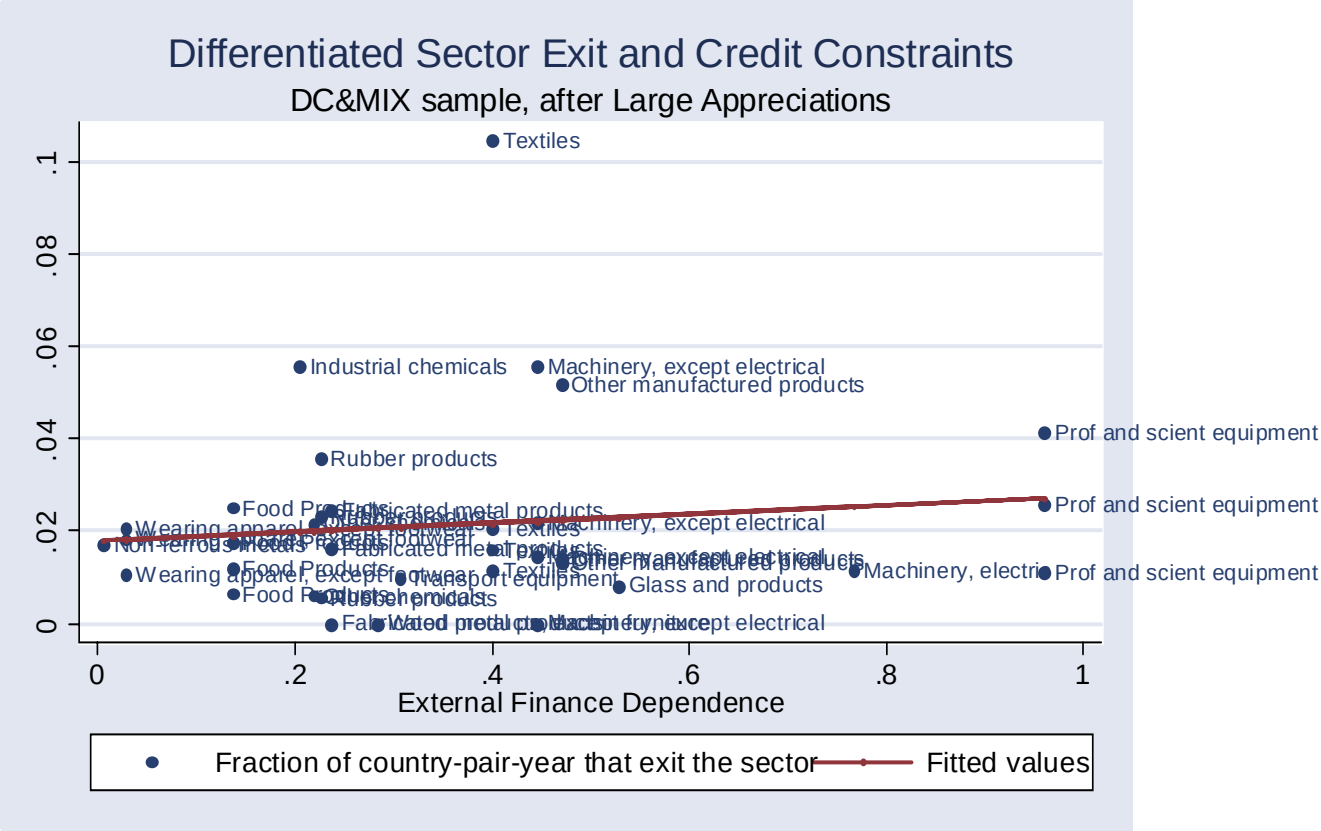

Figure 4: Sectoral Exit and Credit Constraints. DC MIX Sample.

Table 1: Bilateral Trade and Margins of Exports by Exported Good and by Country Group, Summary Statistics. 34 High Income and 102 Developing Countries, 1981-1997.

	All Exports			Homogeneous			Differentiated		
	Mean	**St Dev**	**Obs.**	**Mean**	**St Dev**	**Obs.**	**Mean**	**St Dev**	**Obs.**
	(T and X measured in 1,000 of 1995 US dollars)								
World									
T	370,434	2,902,003	140,013	95,864	581,673	93,617	189,782	1,733,801	125,835
EM	0.33	0.27	140,013	0.15	0.20	93,617	0.29	0.32	125,835
IM	0.54	44.72	140,013	2.26	89.72	93,617	0.13	6.90	125,835
X	38,600,000	85,700,000	140,013	8,489,768	16,800,000	93,617	19,000,000	45,500,000	125,835
HI									
T	2,040,783	7,542,183	17,252	308,215	1,229,359	15,025	1,030,652	4,392,642	16,953
EM	0.59	0.27	17,252	0.26	0.26	15,025	0.60	0.35	16,953
IM	0.06	0.53	17,252	1.52	75.89	15,025	0.06	0.21	16,953
X	71,500,000	111,000,000	17,252	13,600,000	20,300,000	15,025	33,700,000	57,200,000	16,953
HI & MIX									
T	760,709	4,393,713	56,639	135,693	769,854	40,802	385,323	2,547,835	54,802
EM	0.48	0.28	56,639	0.20	0.23	40,802	0.46	0.35	54,802
IM	0.45	47.92	56,639	1.85	78.06	40,802	0.10	0.72	54,802
X	26,300,000	69,100,000	56,639	5,863,345	13,800,000	40,802	12,400,000	35,300,000	54,802
DC									
T	32,412	157,139	46,921	23,359	93,932	25,283	10,346	64,866	38,847
EM	0.22	0.22	46,921	0.10	0.15	25,283	0.14	0.21	38,847
IM	0.90	48.20	46,921	4.26	91.38	25,283	0.27	12.38	38,847
X	10,600,000	20,700,000	46,921	1,947,627	2,995,232	25,283	4,710,254	9,646,196	38,847
DC & MIX									
T	105,306	924,510	83,374	65,094	373,760	52,815	38,923	514,663	71,033
EM	0.23	0.22	83,374	0.11	0.16	52,815	0.15	0.22	71,033
IM	0.61	42.41	83,374	2.58	97.78	52,815	0.16	9.17	71,033
X	46,900,000	94,500,000	83,374	10,500,000	18,500,000	52,815	24,200,000	51,400,000	71,033

Table 2: Bilateral Margins of Export Responses to Real Exchange Rate Fluctuations. Overall, Homogeneous and Differentiated Exports. 136 Sample, 1981-1997.

All Bilateral Exports

Dep. Var. is Log of Bilateral Trade and Margins Measures:	ln(T)	ln(EM)	ln(IM)	ln(X)
Ln(RER)	0.056***	0.045***	-0.048***	0.060***
	[0.008]	[0.007]	[0.008]	[0.003]
Observations	140,013	140,013	140,013	140,013
# country-pairs	13,860	13,860	13,860	13,860
R-squared	0.09	0.06	0.09	0.70

Homogeneous Bilateral Exports

Dep. Var. is Log of Bilateral Trade and Margins Measures:	ln(T)	ln(EM)	ln(IM)	ln(X)
Ln(RER)	0.031***	0.001	0.005	0.026***
	[0.011]	[0.009]	[0.009]	[0.003]
Observations	93,617	93,617	93,617	93,617
# country-pairs	10,543	10,543	10,543	10,543
R-squared	0.02	0.03	0.04	0.29

Differentiated Bilateral Exports

Dep. Var. is Log of Bilateral Trade and Margins Measures:	ln(T)	ln(EM)	ln(IM)	ln(X)
Ln(RER)	0.080***	0.037***	-0.035***	0.078***
	[0.008]	[0.006]	[0.008]	[0.004]
Observations	125,835	125,835	125,835	125,835
# country-pairs	12,991	12,991	12,991	12,991
R-squared	0.16	0.09	0.10	0.77

1. Robust standard errors in brackets
2. * significant at 10%, ** significant at 5%, * significant at 1%**
3. GDP and GDPpc for the exporter and the importer included. Fixed Effects for country-pairs and years included

Table 3: Bilateral Margins of Export Responses to Real Exchange Rate Fluctuations. Overall, Homogeneous and Differentiated Exports. HI Sample, 1981-1997.

All Bilateral Exports

Dep. Var. is Log of Bilateral Trade and Margins Measures:	ln(T)	ln(EM)	ln(IM)	ln(X)
Ln(RER)	-0.042	0.225***	-0.585***	0.317***
	[0.103]	[0.049]	[0.091]	[0.022]
Observations	17,252	17,252	17,252	17,252
# country-pairs	1,096	1,096	1,096	1,096
R-squared	0.17	0.11	0.15	0.85

Homogeneous Bilateral Exports

Dep. Var. is Log of Bilateral Trade and Margins Measures:	ln(T)	ln(EM)	ln(IM)	ln(X)
Ln(RER)	-0.234*	0.128	-0.387***	0.024
	[0.123]	[0.089]	[0.086]	[0.020]
Observations	15,025	15,025	15,025	15,025
# country-pairs	1,038	1,038	1,038	1,038
R-squared	0.05	0.10	0.08	0.38

Differentiated Bilateral Exports

Dep. Var. is Log of Bilateral Trade and Margins Measures:	ln(T)	ln(EM)	ln(IM)	ln(X)
Ln(RER)	0.433***	0.161***	-0.240***	0.512***
	[0.062]	[0.042]	[0.056]	[0.022]
Observations	16,953	16,953	16,953	16,953
# country-pairs	1,087	1,087	1,087	1,087
R-squared	0.32	0.11	0.13	0.91

1. Robust standard errors in brackets
2. * significant at 10%, ** significant at 5%, * significant at 1%**
3. GDP and GDPpc for the exporter and the importer included. Fixed Effects for country-pairs and years included

Table 4: Bilateral Margins of Export Responses to Real Exchange Rate Fluctuations. Overall, Homogeneous and Differentiated Exports. HI MIX Sample, 1981-1997.

All Bilateral Exports

Dep. Var. is Log of Bilateral Trade and Margins Measures:	ln(T)	ln(EM)	ln(IM)	ln(X)
Ln(RER)	0.122***	0.045***	-0.045**	0.123***
	[0.017]	[0.013]	[0.019]	[0.007]
Observations	56,639	56,639	56,639	56,639
# country-pairs	4,206	4,206	4,206	4,206
R-squared	0.11	0.06	0.09	0.66

Homogeneous Bilateral Exports

Dep. Var. is Log of Bilateral Trade and Margins Measures:	ln(T)	ln(EM)	ln(IM)	ln(X)
Ln(RER)	0.145***	0.098***	-0.019	0.065***
	[0.022]	[0.018]	[0.020]	[0.008]
Observations	40,802	40,802	40,802	40,802
# country-pairs	3,606	3,606	3,606	3,606
R-squared	0.02	0.05	0.05	0.24

Differentiated Bilateral Exports

Dep. Var. is Log of Bilateral Trade and Margins Measures:	ln(T)	ln(EM)	ln(IM)	ln(X)
Ln(RER)	0.178***	0.023*	-0.009	0.164***
	[0.014]	[0.012]	[0.014]	[0.006]
Observations	54,802	54,802	54,802	54,802
# country-pairs	4,137	4,137	4,137	4,137
R-squared	0.20	0.08	0.10	0.75

1. Robust standard errors in brackets
2. * significant at 10%, ** significant at 5%, * significant at 1%**
3. GDP and GDPpc for the exporter and the importer included. Fixed Effects for country-pairs and years included

Table 5: Bilateral Margins of Export Responses to Real Exchange Rate Fluctuations. Overall, Homogeneous and Differentiated Exports. DC Sample, 1981-1997.

All Bilateral Exports

Dep. Var. is Log of Bilateral Trade and Margins Measures:	ln(T)	ln(EM)	ln(IM)	ln(X)
Ln(RER)	0.065***	0.050***	-0.034***	0.049***
	[0.011]	[0.010]	[0.011]	[0.003]
Observations	46,921	46,921	46,921	46,921
# country-pairs	6,542	6,542	6,542	6,542
R-squared	0.09	0.08	0.06	0.64

Homogeneous Bilateral Exports

Dep. Var. is Log of Bilateral Trade and Margins Measures:	ln(T)	ln(EM)	ln(IM)	ln(X)
Ln(RER)	0.022	-0.006	0.009	0.019***
	[0.015]	[0.012]	[0.013]	[0.004]
Observations	25,283	25,283	25,283	25,283
# country-pairs	4,270	4,270	4,270	4,270
R-squared	0.03	0.04	0.03	0.32

Differentiated Bilateral Exports

Dep. Var. is Log of Bilateral Trade and Margins Measures:	ln(T)	ln(EM)	ln(IM)	ln(X)
Ln(RER)	0.083***	0.042***	-0.022*	0.064***
	[0.011]	[0.009]	[0.012]	[0.004]
Observations	38,847	38,847	38,847	38,847
# country-pairs	5,886	5,886	5,886	5,886
R-squared	0.17	0.11	0.06	0.72

1. Robust standard errors in brackets
2. * significant at 10%, ** significant at 5%, * significant at 1%**
3. GDP and GDPpc for the exporter and the importer included. Fixed Effects for country-pairs and years included

Table 6: Bilateral Margins of Export Responses to Real Exchange Rate Fluctuations. Overall, Homogeneous and Differentiated Exports. DC MIX Sample, 1981-1997.

All Bilateral Exports

Dep. Var. is Log of Bilateral Trade and Margins Measures:	ln(T)	ln(EM)	ln(IM)	ln(X)
Ln(RER)	0.043***	0.039***	-0.041***	0.045***
	[0.009]	[0.008]	[0.009]	[0.003]
Observations	83,374	83,374	83,374	83,374
# country-pairs	9,654	9,654	9,654	9,654
R-squared	0.09	0.07	0.08	0.74

Homogeneous Bilateral Exports

Dep. Var. is Log of Bilateral Trade and Margins Measures:	ln(T)	ln(EM)	ln(IM)	ln(X)
Ln(RER)	0.007	-0.016	0.006	0.017***
	[0.012]	[0.010]	[0.010]	[0.003]
Observations	52,815	52,815	52,815	52,815
# country-pairs	6,937	6,937	6,937	6,937
R-squared	0.03	0.03	0.04	0.36

Differentiated Bilateral Exports

Dep. Var. is Log of Bilateral Trade and Margins Measures:	ln(T)	ln(EM)	ln(IM)	ln(X)
Ln(RER)	0.058***	0.032***	-0.031***	0.057***
	[0.009]	[0.008]	[0.010]	[0.004]
Observations	71,033	71,033	71,033	71,033
# country-pairs	8,854	8,854	8,854	8,854
R-squared	0.15	0.10	0.10	0.79

1. Robust standard errors in brackets
2. * significant at 10%, ** significant at 5%, * significant at 1%**
3. GDP and GDPpc for the exporter and the importer included.
Fixed Effects for country-pairs and years included