



**HAL**  
open science

# The effects of exchange rate variability on international trade: a Meta-Regression Analysis

Bruno Ćorić, Geoffrey Thomas Pugh

► **To cite this version:**

Bruno Ćorić, Geoffrey Thomas Pugh. The effects of exchange rate variability on international trade: a Meta-Regression Analysis. *Applied Economics*, 2008, 42 (20), pp.2631-2644. 10.1080/00036840801964500 . hal-00582187

**HAL Id: hal-00582187**

**<https://hal.science/hal-00582187>**

Submitted on 1 Apr 2011

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



**The effects of exchange rate variability on international trade: a Meta-Regression Analysis**

Journal:	<i>Applied Economics</i>
Manuscript ID:	APE-06-0661.R1
Journal Selection:	Applied Economics
Date Submitted by the Author:	27-Dec-2007
Complete List of Authors:	Æorixæ, Bruno; University of Split, Economics Pugh, Geoffrey; Staffordshire University, Business School
JEL Code:	F10 - General < F1 - Trade < F - International Economics, F31 - Foreign Exchange < F3 - International Finance < F - International Economics
Keywords:	Meta-regression analysis, Exchange rate variability, International trade, Hedging, Trade promotion



# The effects of exchange rate variability on international trade: a Meta-Regression Analysis

Bruno Ćorić and Geoff Pugh\*

## Abstract

The trade effects of exchange rate variability have been an issue in international economics for the past 30 years. The contribution of this paper is to apply meta-regression analysis (MRA) to the empirical literature. On average, exchange rate variability exerts a negative effect on international trade. Yet MRA confirms the view that this result is highly conditional, by identifying factors that help to explain why estimated trade effects vary from significantly negative to significantly positive. MRA evidence on the pronounced heterogeneity of the empirical findings may be instructive for policy: first, by establishing that average trade effects are not sufficiently robust to generalise across countries; and, second, by suggesting the importance of hedging opportunities - hence of financial development - for trade promotion. For the practice of MRA, we make a case for checking the robustness of results with respect to estimation technique, model specification and sample.

## Running Title:

Meta-regression analysis of the trade effects of exchange rate variability

---

\* Corresponding author: Prof. Geoff Pugh, Staffordshire University Business School, Leek Road, Stoke-on-Trent, ST4 2DF, UK. 0044 (0) 1782 4902; [geoff@plainfigures.com](mailto:geoff@plainfigures.com). Bruno Ćorić, University of Split, Faculty of Economics, Department of Economics, Matice Hrvatske 31, 21000 Split, Croatia.

# The effects of exchange rate variability on international trade: a Meta-Regression Analysis

## Abstract

The trade effects of exchange rate variability have been an issue in international economics for the past 30 years. The contribution of this paper is to apply meta-regression analysis (MRA) to the empirical literature. On average, exchange rate variability exerts a negative effect on international trade. Yet MRA confirms the view that this result is highly conditional, by identifying factors that help to explain why estimated trade effects vary from significantly negative to significantly positive. MRA evidence on the pronounced heterogeneity of the empirical findings may be instructive for policy: first, by establishing that average trade effects are not sufficiently robust to generalise across countries; and, second, by suggesting the importance of hedging opportunities - hence of financial development - for trade promotion. For the practice of MRA, we make a case for checking the robustness of results with respect to estimation technique, model specification and sample.

# 1 Introduction

Since the onset of generalized floating, there has been extensive theoretical and empirical investigation into the effects of exchange rate variability on international trade. This issue has also been prominent in policy debate. There is a consensus that exchange rate movements cannot be anticipated and, hence, create uncertainty in international trade. However, the literature gives no such clear guidance on the trade effects of exchange rate variability and uncertainty. Gros (1987), Dhanani and Groves (2001), De Grauwe (1988) and Dellas and Zilberfarb (1993) develop models in which exchange rate variability may have either a positive or a negative impact on trade. Unfortunately, the ambiguous implications of the theoretical literature are not resolved by the empirical literature. The conclusions from the 58 studies analysed below are presented in Table 1. In each case, the recording of negative, no statistically significant effects, positive or not conclusive (studies reporting a combination of the previous three categories) reflects authors' own interpretations of their results.

**Table 1: Econometric studies on the trade effects of exchange rate variability (1978-2003)**

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

The largest category, 33 studies, concludes that exchange rate variability exerts an adverse effect on trade.<sup>1</sup> The other 25 studies reach conclusions suggesting that this is not the case. Indeed, six studies report findings that suggest the precise opposite. This range of published results corresponds to the range of possibilities allowed by theory and suggests that the results reported in this literature are unlikely to be driven by publication bias. The theoretical ambiguity in the relationship between exchange rate variability and trade, together with the corresponding non-conclusive nature of the empirical evidence, are likely to reduce the probability that journal editors and authors have systematically favoured studies and results biased in one or other direction or even towards higher levels of statistical significance irrespective of sign.

This paper uses meta-regression analysis (MRA) to make two contributions to the literature on the trade effects of exchange rate variability: to help explain the wide variation of results – ranging from significantly positive to significantly negative effects – in the empirical literature; and to suggest new lines of enquiry. **Because of the pronounced heterogeneity in this literature, we focus on the direction and significance of estimated trade effects. Correspondingly, we do not conclude with a representative estimate of the trade effect, as this would be misleading for most particular contexts of concern to policy makers.**

---

<sup>1</sup> Although some studies concluding that the trade effect is negative nonetheless contain some positive results; for example, Stokman, 1995, reports two positive effects and one zero effect among otherwise consistently negative effects.

1  
2  
3 The work is structured as follows. Section 2 explains how the data was collected and  
4 the choice of effect size. Section 3 explains the MRA of the trade effects of exchange  
5 rate variability. Section 4 reports and interprets the results. Section 5 concludes.  
6  
7  
8  
9

## 10 11 **2 Data and effect size**

12  
13 We used the EconLit data base (period ending March 2003) to identify as far as  
14 possible all econometric investigations of the trade effect of exchange rate variability  
15 that have been published in refereed economics journals.<sup>2</sup> As is the norm in MRA, we  
16 gathered close to but not necessarily the complete population of studies (Rose and  
17 Stanley, 2005). EconLit search is a common approach to minimising the influence of  
18 poorly designed and/or executed studies (Stanley, 2001). However, this approach on  
19 its own was not sufficient to identify the population of relevant papers. On the one  
20 hand, key word(s) search may fail to identify important papers that include estimates  
21 of the trade effects of exchange rate variability but do so only as a subsidiary theme  
22 (e.g., Rose, 2000). Other papers may be overlooked because the key search words are  
23 insufficiently comprehensive and/or authors use terminology that differs from the  
24 mainstream of the literature. On the other hand, many papers thus identified may not  
25 be relevant (e.g., some will be purely theoretical studies) or report no usable effect  
26 size. In practice, therefore, we implemented a more flexible strategy. At first, we used  
27 our own knowledge of the literature and existing narrative literature reviews to  
28 identify the most cited papers. Next, systematic EconLit search added further papers.  
29 In addition, still further papers were brought to our attention during the normal  
30 process of informal and formal review of this study. Finally we expanded our  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58

59  
60  

---

<sup>2</sup> The main combinations of key words used were “exchange rate variability”, “exchange rate  
volatility”, “exchange rate uncertainty/risk” and “trade effect”.

1  
2  
3 database beyond those papers published in refereed economics journals to include  
4 IMF (1984), Akhtar and Hilton (1984) and De Grauwe and Bellfroid (1987), because  
5 these were frequently cited in subsequent studies. Altogether, we identified 58 papers,  
6 most of which report multiple results. Accordingly, our 58 studies generated 835  
7 observations. For comparison, Table 2 displays the number of studies and  
8 corresponding observations together with goodness of fit measures from three  
9 respected MRAs in economics.  
10  
11  
12  
13  
14  
15  
16  
17  
18

19  
20  
21  
22 **Table 2: Number of studies and observations in examples of MRA**  
23  
24  
25  
26

27 A summary measure (effect size) has to be chosen:

- 28 1. to combine and compare effect sizes among studies, obtain their mean value,  
29 and test their differences for statistical significance; and  
30
- 31 2. as the dependent variable of the MRA.  
32  
33  
34  
35

36 We follow Stanley and Jarrell's (1989) recommendation that in economics the t-value  
37 of the regression coefficient is the natural effect size. From each result (regression)  
38 reported in each study, the t-value of the estimated coefficient measuring the trade  
39 effect of exchange rate variability was chosen as the effect size.<sup>3</sup> This exchange rate  
40 variability effect size (ERVES) is independent of the units in which variables in  
41 different studies are measured and, given the large sample, under the null of no  
42 genuine effect approximates the standard normal distribution (Stanley, 2005), which  
43 makes it suitable for the statistical analysis outlined in the following section.  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55

---

56  
57 <sup>3</sup> Some studies employ more than one measure of exchange rate variability (e.g., by including both  
58 current and lagged values). An appendix detailing how the effect size was selected in each such case is  
59 available on request. It is excluded here for reasons of length.  
60



### 3 Meta-regression analysis

#### 3.1 Meta-analysis of the ERVES

835 ERVES were pooled from the 58 collected studies; 52 studies contain more than one estimation of the trade effect of exchange rate variability. The mean ERVES value is -1.31 with standard deviation of 2.93,<sup>4</sup> which by common standards in meta analysis can be characterised as close to a medium ( $0.5\sigma$ ) effect size (Stanley, 1998). The null hypothesis - that the mean ERVES is zero - was rejected at the one percent level ( $t = -12.96$ ;  $p=0.000$ ). This statistically significant negative mean effect size suggests a negative relationship between exchange rate variability and trade. Yet, because the ERVES are  $t$ -values, the mean ERVES suggests that in the typical regression the coefficient on exchange rate variability falls short of conventionally accepted levels of statistical significance. Moreover, this negative effect is not uniform across the literature. The observed ERVES ranges from -22.00 to 14.77, which suggests considerable variation around the mean. However, if the differences among observed ERVES are random sampling effects, then under the null the standard deviation of the ERVES distribution should be one ( $\sigma_{ERVES} = 1$ ); otherwise, in the presence of systematic variation from the mean, the standard deviation exceeds one ( $\sigma_{ERVES} > 1$ ). The null was rejected ( $\chi^2 = 2,441$ ;  $p=0.000$ ). This result supports the alternative hypothesis that the variations of the observed ERVES around their mean are the product of systematic differences in the design of the primary studies. MRA is a method to analyse the specification characteristics that determine differences among the observed ERVES. Hence, in the following section, we discuss the specification of our meta regression model.

---

<sup>4</sup> The mean and standard deviation weighted to give each study equal influence on the estimates are, respectively, -1.21 and 2.55.

### **3.2 Independent variables**

The key to explaining variation among observed ERVES is selection of appropriate moderator variables. This selection was guided both by our interpretation of the studies that provide the data for our MRA and by suggestions from the two most recently published narrative literature reviews (McKenzie, 1999; Pugh, et al., 1999). Moderator variables are constructed as dummy variables (i.e., one for studies with a particular characteristic; otherwise zero). First, we explain those that are needed to account for different definitions of both the dependent variable (trade flows) and the independent variable of interest (exchange rate variability).

Some researchers argue that analysis of aggregate trade flows is misleading (McKenzie 1999) and, instead, use bilateral trade flows. However, because of near perfect multicollinearity between the moderator variable for bilateral trade flows and the moderator variable for bilateral exchange rates (BILATERAL), we use the latter to capture the effect on the ERVES of both of these study characteristics. A few studies examine the impact of exchange rate variability on sectoral trade flows. Hence, we construct a moderator variable for sectoral trade flows (SECTALT) with aggregate trade flows as the benchmark. Researchers also have to make a choice between the effects of exchange rate variability on export supply and the effects on import demand. Because of differences in the currency of invoicing, levels of risk aversion and elasticities of export supply and import demand, the impact of exchange rate variability is likely to vary. Hence, we construct a moderator variable for import demand (IMPORT), with export supply as the benchmark.

1  
2  
3 The definition of the independent variable of interest is also contested. There are  
4 differences in the literature over both the appropriate exchange rate measure and the  
5 appropriate measure of exchange rate variability. The choice between nominal and  
6 real exchange rates is related to the choice of high or low frequency exchange rate  
7 variations. Over short periods, all prices are more or less known except the nominal  
8 exchange rate. However, as the planning horizon of traders is lengthened, the relevant  
9 exchange rate becomes that between domestic cost of production and foreign sale  
10 prices converted into domestic currency (IMF 1984). Hence, we construct a moderator  
11 variable to test the impact of researchers' choice of real exchange rate series  
12 (REALER) on the ERVES, with nominal exchange rate data as the benchmark. Pugh  
13 et al. (1999) distinguish between studies focussing on high-frequency variability and  
14 those focussing on low-frequency variability. This issue is important, because of the  
15 different time horizons of business contracts, and correspondingly different hedging  
16 possibilities. Since low-frequency exchange rate movements are less subject to  
17 hedging (Bodnar, 1997; Cooper, 2000), any mitigating effect will be correspondingly  
18 reduced. Hence, we constructed moderator variables to test the impact of researchers'  
19 choice of daily, weekly, monthly and annual frequency of exchange rate variability on  
20 the ERVES (DAILYER, WEEKLYER, MONTHER and ANNUALER), with the  
21 most used frequency (quarter-to-quarter variations) as the benchmark. Studies also  
22 differed over the choice of measure to proxy exchange rate uncertainty. The most  
23 common measure, the standard deviation of either exchange rate changes or  
24 percentage changes, is used as the benchmark. However, we identified 13 alternative  
25 measures in the literature (MERV 1-13; see Appendix A for definitions) and so  
26 constructed moderator variables to analyse the effect of each of these on the ERVES.  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65  
66  
67  
68  
69  
70  
71  
72  
73  
74  
75  
76  
77  
78  
79  
80  
81  
82  
83  
84  
85  
86  
87  
88  
89  
90  
91  
92  
93  
94  
95  
96  
97  
98  
99  
100

1  
2  
3 rates. Hence, a moderator variable for bilateral exchange rates was constructed  
4 (BILATERAL), with effective exchange rates as the benchmark. The grounds for  
5  
6 different choices between bilateral and effective exchange rates are similar to  
7  
8 Cushman's (1986) case for modelling third-country effects. This third-country effect  
9  
10 suggests that overall decrease in trade occasioned by increased exchange rate  
11  
12 variability will be lower than is likely to be suggested by studies of purely bilateral  
13  
14 trade flows, because traders substitute markets with low exchange rate variability for  
15  
16 markets with higher variability. Hence, a moderator variable is included for all models  
17  
18 that include third-country effects (THIRDCOUN).  
19  
20  
21  
22  
23  
24  
25  
26

27 We construct moderator variables not only to model different definitions of the  
28  
29 dependent and independent variable of interest but also to account for other  
30  
31 differences in datasets and model specification. Many studies have used data from  
32  
33 within floating exchange rate periods only or from within fixed periods only. The  
34  
35 reason is to preclude possible specification bias associated with structural changes in  
36  
37 the relationship between exchange rate variability and trade (Pugh and Tyrrall, 2002  
38  
39 and Arize, 1997a). Hence, moderator variables were constructed for studies using  
40  
41 only fixed (FIXPER) or floating (FLOPER) periods, with studies using both periods  
42  
43 as the benchmark.  
44  
45  
46  
47  
48  
49

50 The type of country can also influence the trade effects of exchange rate variability. In  
51  
52 particular, there are reasons to expect stronger effects on developing economy trade:  
53  
54 these include underdeveloped or nonexistent forward markets; and different trade  
55  
56 structures, with typically greater dependence on primary products. Hence, we  
57  
58 construct moderator variables both for studies focussing solely on trade among  
59  
60

1  
2  
3 developed countries (DC) and for those focussing solely on less developed economy  
4 trade (LDC), with studies pooling data on both type of trade as the reference category.  
5  
6 In addition, we construct a moderator variable for studies that focus exclusively on  
7  
8 US trade flows (US). Possible differences between the impact of exchange rate  
9  
10 variability on US trade and the trade of other countries might arise from the ability of  
11  
12 US traders to invoice in USD.  
13  
14  
15  
16  
17  
18  
19

20 There is likewise no consensus over the choice of model. Most studies have employed  
21  
22 a conventional utility maximisation approach to analyse the trade effects of exchange  
23  
24 rate variability. However, since Abrams (1980) some researchers have argued that a  
25  
26 gravity model provides a better explanation of international trade flows; and, hence,  
27  
28 that the impact of exchange rate variability on trade should be examined within the  
29  
30 gravity framework. Other researchers have specified time series models to estimate  
31  
32 conventional models: at first, with lagged independent variables; subsequently, error  
33  
34 correction modelling; and, finally, cointegration analysis in the context of error  
35  
36 correction modelling. Accordingly, we construct moderator variables to test the  
37  
38 influence on the ERVES of a gravity framework (GRAVITY), lagged independent  
39  
40 variables (LAGTEST), error-correction modelling (ERRORCOR) and cointegration  
41  
42 analysis (LRCOINT), with those studies otherwise estimating conventional utility  
43  
44 maximisation models as the benchmark. We also construct moderator variables to  
45  
46 investigate the effect on the ERVES of cross-section (CROSS) or panel (POOLED)  
47  
48 strategies, with time-series estimation as the benchmark.  
49  
50  
51  
52  
53  
54  
55  
56  
57

58 Akhtar and Hilton (1984) observed that data on trade flows usually exhibits seasonal  
59  
60 patterns. Hence, a moderator variable was constructed for all models using seasonally

1  
2  
3  
4 adjusted data, testing for seasonality, or including seasonal dummy variables  
5  
6 (SESONADJ). The coefficients on exchange rate variability in Rose's regressions  
7  
8 (2000) were on average estimated with unusually high levels of statistical  
9  
10 significance. Accordingly, we constructed a moderator variable for regressions from  
11  
12 Rose's study (ROSE). Finally, moderator variables were included for all studies that  
13  
14 control for structural breaks (DOCKSTR - including dock strikes, oil shocks, changes  
15  
16 in monetary regime and wars) and to control for the possibility that the trade effects of  
17  
18 exchange rate variability may change through time (T, which is a continuous variable  
19  
20 defined as the mean year of the estimation period).  
21  
22  
23  
24  
25  
26

27 We also include in the MRA the square root of the degrees of freedom (SqRt\_df) from  
28  
29 each regression to test for the existence of an authentic empirical effect in the  
30  
31 literature rather than mere reflection of publication bias (Stanley 2005). In the present  
32  
33 study, theory permits the trade effect of exchange rate variability to be either positive  
34  
35 or negative, and neither alternative is excluded by the empirical evidence. If either  
36  
37 negative or positive effects dominate, then two conditions are necessary to confirm  
38  
39 the existence and the direction of an authentic empirical effect: that a statistically  
40  
41 significant relationship between the effect size and the square root of the degrees of  
42  
43 freedom exists; and that the relationship has the same sign as the estimated average  
44  
45 effect size. In addition, in the presence of the square root of the degrees of freedom,  
46  
47 the intercept term may be interpreted as a test for publication bias and, if statistically  
48  
49 significant, its estimated coefficient measures the direction and strength of publication  
50  
51 bias (Stanley 2005). Hence, non significance constitutes non rejection of the null of no  
52  
53 publication bias.  
54  
55  
56  
57  
58  
59  
60

### 3.3 Model specification

Our benchmark MRA model (following Stanley and Jarrell, 1989) is specified in Equation (1):

$$ERVES_j = Int + \beta\sqrt{DF_j} + \sum \alpha_k Z_{jk} + u_j \quad (1)$$

where

- $j = 1, \dots, 835$  indexes the regressions in the literature,
- $k = 1, \dots, 37$  indexes the moderator variables discussed above,
- $ERVES_j$  is the exchange rate variability effect size – i.e., the reported  $t$ -value for the coefficient on exchange rate variability in the  $j^{\text{th}}$  regression,
- $Int$  is the intercept term,
- $DF_j$  is the degrees of freedom in the  $j^{\text{th}}$  regression,
- the coefficient  $\beta$  is to be estimated and measures the relationship between the square root of  $DF_j$  and the effect size,
- $Z_{jk}$  are  $k$  moderator variables, which reflect the main data and specification characteristics of the  $j^{\text{th}}$  regression,
- $\alpha_k$  are  $k$  coefficients to be estimated, each of which measures the effect of a moderator variable on the effect size,
- and  $u_j$  is the usual regression residual.

## 4 Results

We check the robustness of our results with respect to estimation technique by reporting not only OLS but also weighted least squares (WLS) and cluster-robust estimates. There are two potential problems with OLS estimation. First, there is wide variation in the number of results reported by each study: while the mean number of results per study is 14.15, the range is from one to 54. Weighting studies reporting

1  
2  
3 large numbers of results more heavily than studies reporting fewer may distort MRA  
4 results (Jarrell and Stanley, 1990). Accordingly, to adjust for disparity in the number  
5 of reported results, we weight each result from a particular study by the inverse of the  
6 number of results reported in that study, so that each study is equally weighted, and  
7 estimate the MRA model by Weighted Least Squares (WLS). The second problem is  
8 that reported results in MRA are not sampled independently, but are sampled in  
9 groups (most studies report a group of results). Accordingly, we add cluster-robust  
10 estimates to both our OLS and our WLS results.<sup>5</sup> For these two reasons, in Table 3 we  
11 report four sets of results: OLS; weighted least squares (WLS), cluster-robust linear  
12 regression; and cluster-robust WLS. In all cases, t-statistics and p-values reflect robust  
13 standard errors.  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31

32 We also check the robustness of our results with respect to model specification.  
33 Accordingly, we estimated a fully specified model with all the variables discussed in  
34 Section 3.2 and then two successively more parsimonious versions. Our final  
35 parsimonious model is reported in Table 3; the full and an intermediate parsimonious  
36 model are available on request. Estimates from the fully specified model cannot be  
37 regarded as valid, because both the unweighted and the weighted models are  
38 misspecified with respect to functional form and display evidence of substantial  
39 collinearity. Accordingly, five variables were deleted: “LAGTEST”, “MERV4” and  
40 “MERV9” to ensure adequate specification with respect to functional form; and  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54

---

55 <sup>5</sup> This procedure relaxes the assumption of independence between observations within the same group,  
56 requiring only that observations be independent between groups, and produces “correct” standard  
57 errors ‘even if the observations are correlated’ (StataCorp, 2003; see also Deaton, 1997, pp.73-78 and  
58 Baum et al., 2003).  
59  
60



1  
2  
3 “ROSE” and “DC” to reduce collinearity to conventionally acceptable levels. Finally,  
4  
5 we deleted five more variables that in the first parsimonious model were consistently  
6  
7 estimated with a t-statistic of less than one. Throughout this testing down procedure,  
8  
9 we found that no observations exerted undue leverage, while Cameron and Trivedi's  
10  
11 test (reported) was unable to reject the null hypotheses of no non-normal skewness or  
12  
13 kurtosis (although we note one borderline result at the conventional five percent  
14  
15 level).  
16  
17  
18  
19

20  
21 **Table 3: MRA results for the final (second) parsimonious model (835**  
22 **observations from 58 studies)**  
23  
24  
25

26  
27 The adjusted  $R^2$  measures are within the range typically reported by MRA studies (see  
28  
29 Table 2; also Stanley, 2005, pp.319 and 332). Across all estimation methods in the  
30  
31 two parsimonious models, according to standard criteria, variance inflation analysis  
32  
33 suggests that collinearity is not a problem; moreover, the Ramsey RESET test rejects  
34  
35 the null of omitted variables or incorrect functional form at all conventional levels of  
36  
37 significance. Standard diagnostic tests establish that the baseline OLS model is well  
38  
39 specified as a statistical model with respect to normality and heteroskedasticity;  
40  
41 however, following common practice in MRA, we report robust standard errors.  
42  
43  
44  
45  
46  
47

48  
49 MRA requires additional diagnostic tests to distinguish between authentic empirical  
50  
51 effects and the consequences of publication bias. MRA literature (Stanley, 2005)  
52  
53 distinguishes between publication bias that is directional (Type 1) and publication bias  
54  
55 that merely favours statistical significance regardless of sign (Type 2). We have  
56  
57 already noted the a priori grounds on which Type 1 publication bias is less likely to be  
58  
59 present in this study than in most MRAs; namely, with respect to the trade effects of  
60

1  
2  
3 exchange rate variability, theory does not privilege one direction over another, while  
4 published empirical studies report positive, negative, zero and inconclusive effects  
5 (see Table 1). The number of studies reporting zero effects may also suggest that Type  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

exchange rate variability, theory does not privilege one direction over another, while published empirical studies report positive, negative, zero and inconclusive effects (see Table 1). The number of studies reporting zero effects may also suggest that Type 2 publication bias is less likely in this than in other empirical literatures. The following testing procedure follows Stanley (2005, p.339) and constitutes a ‘conservative approach to the identification of an empirical effect’.

To test for both Type 1 publication bias and for an underlying ‘genuine empirical effect, irrespective of publication bias’ (Stanley, 2005, p.328; see also pp. 320-23 and 329-332), we embed the “Funnel asymmetry precision effect” test within each of our models reported in Table 3, as well as in the full and intermediate models not reported, by including among the independent variables the square root of the degrees of freedom (SqRt\_df). In the full and parsimonious models alike, three of the four estimation methods (the exception in each case being simple OLS) result in intercept terms (\_cons) not significantly different from zero at conventional levels, which suggests non rejection of the null of no publication bias. Moreover, in each case, the coefficient on the square root of the degrees of freedom is negative. In both parsimonious models the coefficients on the square root of the degrees of freedom (SqRt\_df) are estimated as -0.02 in the two unweighted regressions and as -0.04 in the two weighted regressions; moreover, from these eight estimated coefficients, only the two from the cluster-robust least squares estimator fail to achieve statistical significance at conventional levels. Because the ERVES is the t-value on the exchange rate variability coefficient in each regression in our dataset, this result suggests that studies with larger samples on average are more likely to find a statistically significant negative relationship between exchange rate variability and

1  
2  
3 trade.<sup>6</sup> This is consistent with a genuine empirical effect (Stanley, 2005, p.332).  
4  
5  
6 Sampling theory predicts that, holding all other variables constant, a quadrupling of  
7  
8 degrees of freedom doubles the effect size. For example, our weighted meta  
9  
10 regression coefficient of -0.04 suggests that the *t*-statistic on the measure of exchange  
11  
12 rate variability in a trade regression estimated with 100 degrees of freedom will be -  
13  
14 0.4 (=  $-0.04\sqrt{100}$ ); -0.8 with 400 degrees of freedom (=  $-0.04\sqrt{400}$ ); and so on. At  
15  
16 the unweighted mean degrees of freedom (1077.35; SD = 4151.76) the predicted *t*-  
17  
18 statistic is -0.76; and at the weighted mean (430.44; SD = 2432.29) -0.91 (both  
19  
20 calculated using the exact weighted and unweighted coefficients). However,  
21  
22 considerable variation around such predicted values is caused by study characteristics  
23  
24 modelled by the moderator variables, which are discussed below.<sup>7</sup>  
25  
26  
27  
28  
29  
30  
31

32 Type 2 publication bias is manifested as ‘an excessive likelihood of reporting  
33  
34 significant results’ (Stanley, 2005, p.318). The corresponding test was implemented  
35  
36 for both parsimonious models by substituting the absolute value for the actual value of  
37  
38 our dependent variable (ERVES). In this case, a significant intercept term (\_cons)  
39  
40 would indicate Type 2 publication bias (Stanley, 2005, pp.325 and 332). (For reasons  
41  
42 of space, these results are not reported in full; they are available on request.) In the  
43  
44 first parsimonious model, only the intercept in the baseline least squares regression  
45  
46 proved to be significant (p=0.03); the three remaining estimators yielded intercept  
47  
48  
49  
50

51 <sup>6</sup> The 573 *t*-values estimated from 100 or fewer degrees of freedom have a mean of -0.75 (SD=2.02);  
52  
53 the 114 estimated from between 101 and 500 degrees of freedom have a mean of -1.08 (SD=2.60); and  
54  
55 the 148 estimated from more than 500 degrees of freedom have a mean of -3.66 (SD=4.56).  
56

57 <sup>7</sup> In bivariate regressions of ERVES on a constant and the square root of the degrees of freedom  
58  
59 (SqRt\_df), the R<sup>2</sup> measures are, respectively, 0.27 (unweighted) and 0.16 (weighted). In comparison,  
60  
the R<sup>2</sup> measures reported in Table 3 are, respectively, 0.48 and 0.35.

1  
2  
3 terms with a uniform lack of statistical significance ( $p \geq 0.17$ ). In the second  
4  
5  
6 parsimonious model, the intercept terms were uniformly insignificant ( $p \geq 0.14$ ).  
7  
8 Following a suggestion in Stanley (2005) the standard errors were bootstrapped but  
9  
10 without making any noteworthy difference to this pattern of results. Hence, the  
11  
12 preponderance of the evidence does not indicate the presence of Type 2 publication  
13  
14 bias.  
15  
16

17  
18  
19  
20 Taken together, these tests suggest that the negative mean ERVES in the empirical  
21  
22 literature (a  $t$ -value of  $-1.31$ ), although small, reflects a genuine negative relationship  
23  
24 between exchange rate variability and international trade rather than publication bias.  
25  
26 Given that both theory and empirical findings on the trade effects of exchange rate  
27  
28 variability permit both negative and positive effects, these findings are consistent with  
29  
30 the understanding in the meta-regression literature that ‘publication bias will be less  
31  
32 problematic whenever there are countervailing research propositions’ (Stanley, 2005,  
33  
34 p.335). We now turn to the estimated effects of the moderator variables. We restrict  
35  
36 our discussion to those variables that display a consistently significant influence on  
37  
38 the effect size across all specifications (while, because of statistical misspecification  
39  
40 in the full model, giving preference to the parsimonious models) and all different  
41  
42 approaches to estimation.  
43  
44  
45  
46  
47  
48  
49

50  
51 The consistently negative and, with one exception, significant coefficient on real  
52  
53 exchange rate variability (REALER) supports the view that forward markets have a  
54  
55 role in reducing exchange rate uncertainty. If a significant negative trade effect is  
56  
57 more likely to be discovered by analysing real variability than by analysing nominal  
58  
59 variability, this might be because real variability diverges from nominal variability  
60

1  
2  
3 only over long periods (Taylor, 1995) and thus cannot be hedged. This interpretation  
4  
5 is supported by the predominantly negative (six from eight estimates in the  
6  
7 parsimonious models) and significant (half of all estimates) effect of year-to-year  
8  
9 variability (ANNUALER), which is much less subject to hedging than high-frequency  
10  
11 exchange rate variability. In both parsimonious models, the consistently negative and  
12  
13 predominantly significant coefficient on trade among less developed countries (LDC)  
14  
15 also points to the importance of hedging. Underdeveloped or nonexistent forward  
16  
17 markets for LDC currencies, together with capital movement constraints in the LDCs,  
18  
19 reduce the possibility and increase the price of hedging, thereby causing higher  
20  
21 exposure to exchange rate uncertainty and a correspondingly greater trade effect.  
22  
23  
24  
25  
26  
27  
28

29  
30 The consistently and significantly negative coefficients measuring the effect of  
31  
32 gravity (GRAVITY), cross-section (CROSS), cointegration (LRCOINT) and, to a  
33  
34 lesser extent, error-correction (ERRORCOR) modelling suggest that these are all  
35  
36 much more likely to discover statistically significant negative trade effects and less  
37  
38 likely to discover positive effects than other modelling strategies. However, while  
39  
40 there is little distinction to be made between the implications of cross-section and  
41  
42 time-series studies, both contrast with the uniformly insignificant effect of panel  
43  
44 estimation (POOLED). Together, these results suggest that choice of modelling  
45  
46 strategy accounts for some of the wide variation of results in this literature.  
47  
48 Moreover, the consistently and significantly negative results for dummy variables  
49  
50 used to model structural breaks (DOCKSTR) in time series data demonstrate that  
51  
52 these are important controls for estimating the trade effects of exchange rate  
53  
54 variability.  
55  
56  
57  
58  
59  
60

1  
2  
3 Finally, of the 13 moderator variables used to distinguish proxy measures of exchange  
4 rate uncertainty, only five yield estimated coefficients that are both consistently  
5 signed and with at least two from the four reported in Table 3 significant at the five  
6 percent level. MERV11 and MERV8 display positive effects, indicating that studies  
7 employing these definitions are less likely to detect a statistically significant negative  
8 relationship between exchange rate variability and trade. In contrast, MERV3,  
9 MERV7 and, to a lesser extent, MERV13 display negative effects, indicating that  
10 studies employing these definitions are more likely to detect a significant negative  
11 relationship. However, these measures are typically used in only a few studies and  
12 observations.<sup>8</sup> Together with the non-significant effects of the other seven alternative  
13 measures, these results suggest that alternative measures have so far added little to the  
14 conventional approach represented by the reference category.

15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34 The existence of an earlier Working Paper (available on request) using the same  
35 modelling strategy enables robustness also to be investigated with respect to the  
36 sample. The earlier study was based on a smaller sample of 40 papers (544  
37 observations). Accordingly, to address the corresponding possibility of biases  
38 resulting from having in effect a very large sample rather than the complete  
39 population, we treat the databases of our earlier and present studies as different size  
40 samples. By comparing the results from our earlier and the present studies, we  
41 conclude that the evidence reported above on publication bias, the role of hedging and  
42 the influence of various modelling strategies is robust to a major enlargement of the  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57

58  
59  
60  

---

<sup>8</sup> MERV11 is used in one study with 17 observations; MERV8, three and 11, respectively; MERV3,  
three and 24; MERV7, two and 37; and MERV13, one and six.

1  
2  
3 sample, while the effects of different proxy measures of exchange rate uncertainty are  
4  
5 not.  
6  
7

## 8 9 10 **5 Conclusion**

11  
12 We applied MRA to the empirical literature on the trade effects of exchange rate  
13  
14 variability. 58 papers published between 1978 and 2003 provide 835 usable estimates  
15  
16 of our effect size, which is the t-value of the estimated coefficient measuring the trade  
17  
18 effect of exchange rate variability.  
19  
20  
21

22  
23 The theoretical literature does not yield an unambiguous prediction on how exchange  
24  
25 rate variability affects trade, while the corresponding empirical literature has yielded  
26  
27 the full range of possible results and thus has not generated consensus. MRA enables  
28  
29 overall assessment of precisely this kind of diverse and contradictory empirical  
30  
31 literature. Simple “vote counting” (Table 1) and the negative mean effect size (-1.31)  
32  
33 both suggest *a negative relationship between exchange rate variability and trade*.  
34  
35 Moreover, MRA finds little evidence of publication bias together with mainly positive  
36  
37 evidence that this relationship is an authentic empirical effect. Yet the same evidence  
38  
39 also suggests that *this negative relationship is not robust*: the vote count is not  
40  
41 overwhelming; the average effect falls short of conventionally accepted levels of  
42  
43 statistical significance; and MRA identifies sources of variability and corresponding  
44  
45 non-robustness. Accordingly, our main conclusion is that *the empirical literature on*  
46  
47 *exchange rate variability and trade reveals a modestly negative relationship with*  
48  
49 *pronounced heterogeneity*.  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3 This heterogeneity is consistent with Gagnon (1993, p.279) who calibrates a  
4 theoretical model of the trade effects of exchange rate variability and finds that not  
5  
6 only is the negative effect of increasing variability on the level of trade small but also  
7  
8 that the effect 'would not be statistically significant in the sample sizes typically  
9  
10 available to researchers'. Lack of precision of estimates from small sample studies  
11  
12 helps to explain the wide range of findings in the literature; indeed, 68.62 percent of  
13  
14 the reported regressions analysed in this study are estimated from samples of 100 or  
15  
16 fewer observations, which is the number that Gagnon uses as his benchmark.  
17  
18 Accordingly, our finding that the relationship between sample size (degrees of  
19  
20 freedom) and effect size is negative and statistically significant is consistent both with  
21  
22 Gagnon's (1993) insights and with Stanley's (2005) criterion from the meta-  
23  
24 regression literature for an authentic empirical regularity.  
25  
26  
27  
28  
29  
30  
31  
32  
33

34 Two recent studies have suggested that the negative trade effect of exchange rate  
35  
36 variability is 'by no means a robust, universal finding' (Clark et al., 2004, p.6; see  
37  
38 also Solakoglu, 2005). This MRA is able more conclusively to establish that *the trade*  
39  
40 *effects of exchange rate variability are highly conditional*. This finding may be  
41  
42 instructive for policy by providing evidence that the average trade effects suggested  
43  
44 by this literature are not sufficiently robust to generalise across countries.  
45  
46  
47  
48  
49

50 This MRA not only confirms that the relationship between exchange rate variability  
51  
52 and trade is highly conditional, but also identifies factors that help to explain why  
53  
54 estimated trade effects vary from significantly negative to significantly positive. One  
55  
56 of these suggests policy implications and new lines of enquiry.  
57  
58  
59  
60



1  
2  
3 Modelling strategy may substantially influence estimates of the trade effects of  
4 exchange rate variability: in particular, gravity models, both cross sectional and  
5 modern time series approaches and the use of bilateral exchange rates and trade flows  
6 all make more likely the estimation of a significantly negative trade effect. Much of  
7 the research effort in this literature has been devoted to developing and testing proxy  
8 measures of exchange rate uncertainty as alternatives to the standard deviation of  
9 exchange rate changes. However, most of these alternative measures do not robustly  
10 influence the statistical significance of estimated trade effects in a way that differs  
11 from the conventional measure and none are widely used. These results are consistent  
12 with Brodsky (1984) who critically reviewed an earlier literature on the measurement  
13 of exchange rate variability and concluded that the standard deviation is the  
14 appropriate measure. So far at least, innovatory measurement of exchange rate  
15 variability does not appear to have yielded interesting new results on the determinants  
16 of international trade. Our results indicate that a statistically significant negative  
17 impact of exchange rate variability is more likely when it is beyond the range of  
18 forward markets. In particular, the substantially more negative effect associated with  
19 LDC trade connects our investigation with the large literature connecting financial  
20 development, trade and growth. Further investigation of the impact of hedging on  
21 trade may well be a fruitful source of ideas for trade promotion.

22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51 To check the robustness of our estimated influences on effect size and of our tests for  
52 publication bias and an authentic empirical effect, we make a case for applying  
53 different estimation techniques together with a standard testing down procedure. The  
54 presence in MRA databases of studies typically reporting varying numbers of  
55 interdependent results suggests the use of both weighted and cluster-robust estimators  
56  
57  
58  
59  
60

1  
2  
3 to complement OLS estimation. Similarly, because MRA models are specified by  
4  
5 separate judgements about potential moderator variables rather than being derived  
6  
7 from theory, specification may be more arbitrary than is the norm in econometric  
8  
9 studies in economics. If so, then Leamer and Leonard's (1983) and Leamer's (1985)  
10  
11 strictures concerning the robustness of regression estimates may apply with particular  
12  
13 force to MRA. Although we make no attempt to enact Leamer's methods, it is in their  
14  
15 spirit that we recommend robustness checking across a full model including all  
16  
17 moderator variables and successively more parsimonious specifications. In addition,  
18  
19 where it is difficult to identify the entire population either of relevant studies or of  
20  
21 relevant results for MRA, we suggest that it may be instructive to check the  
22  
23 robustness of meta-regression estimates with respect to different samples.  
24  
25  
26  
27  
28  
29  
30  
31

## 32 **Acknowledgements**

33  
34 The authors acknowledge helpful suggestions from Tom Stanley and other  
35  
36 participants at the International Colloquium on Meta-Analysis in Economics,  
37  
38 Sønderborg (September 2007). In addition, the paper was greatly improved by  
39  
40 guidance from our two anonymous referees. The authors alone are responsible for  
41  
42 shortcomings.  
43  
44  
45  
46  
47  
48  
49

## 50 **References**

- 51  
52 Abbott, A., Darnell, A., Evans, L., 2001. The Influence of Exchange Rate Variability on UK  
53  
54 Exports. *Applied Economic Letters* 8, 47--49.  
55  
56 Abrams, R., 1980. International Trade Flows Under Flexible Exchange Rates. *Federal*  
57  
58 *Reserve Bank of Kansas City Economic Review* 65, 3--10.  
59  
60

- 1  
2  
3 Akhtar, M., A., Hilton, R., S., 1984. Exchange Rate Uncertainty and International Trade:  
4  
5 Some Conceptual Issue and New Estimates for Germany and the United States.  
6  
7 *Federal Reserve Bank of New York Research Papers* 8403.  
8  
9  
10 Anderson, M., Garcia, P., 1989. Exchange Rate Uncertainty and the Demand for US  
11  
12 Soybeans, *American Journal of Agricultural Economics* 71, 721--29.  
13  
14 Aristotelous, K., 2001. Exchange-Rate Volatility, Exchange-Rate Regime and Trade Volume:  
15  
16 Evidence from the UK-US Export Function (1889-1999). *Economics Letters*, 72, 87--  
17  
18 94.  
19  
20 Arize, A., C., 1995. The Effect of Exchange Rate Volatility on US Exports. *Southern*  
21  
22 *Economic Journal* 62, 34--43.  
23  
24 Arize, A., C., 1996a., Real Exchange Rate Volatility and Trade Flows: The Experience of  
25  
26 Eight European Economies. *International Review of Economics and Finance* 5, 187--  
27  
28 205.  
29  
30 Arize, A., C., 1996b. The Impact of Exchange Rate Uncertainty on Export Growth: Evidence  
31  
32 from Korean Data. *International Economic Journal* 10, 49--60.  
33  
34 Arize, A., C., 1997a. Conditional Exchange Rate Volatility and Trade Flows: The Experience  
35  
36 of Eight European Economies. *Southern Economic Journal* 64, 235--253.  
37  
38 Arize, A., C., 1997b. Foreign Trade and Exchange rate Risk in G-7 Countries. *Review of*  
39  
40 *Financial Economics* 6, 95--112.  
41  
42 Arize, A., C., 1998. The Effects of Exchange Rate Volatility on U.S. Imports: An Empirical  
43  
44 Investigation. *International Economic Journal* 12, 31--40.  
45  
46 Arize, A., C., Osang, T., Slottje, D., J., 2000. Exchange rate Volatility and Foreign Trade:  
47  
48 Evidence from Thirteen LDC's. *Journal of Business and Economic Statistics* 18, 10--  
49  
50 17.  
51  
52 Arize, A., C., Shwiff, S., S., 1998. Does Exchange-Rate Volatility Affect Import Flows in G-7  
53  
54 Countries? Evidence from Cointegration Models. *Applied Economics* 30, 1269--1276.  
55  
56 Assery, A., Peel, D., A., 1991. The Effect of Exchange Rate Volatility on Exports: Some new  
57  
58 Estimates. *Economic Letters* 37, 173--177.  
59  
60

- 1  
2  
3 Bahmani-Oskooee, M., Payesteh, S., 1993. Does Exchange Rate Volatility Deter Trade  
4  
5 Volume of LDC's ? *Journal of Economic Development* 18, 189--205.  
6  
7  
8 Bailey, M., J., Tavlas, G., S., Ulan, M., 1986. Exchange Rate Variability and Trade  
9  
10 Performance: Evidence for the Big Seven Industrial Countries. *Weltwirtschaftliches*  
11  
12 *Archiv* 122, 467--477.  
13  
14 Bailey, M., J., Tavlas, G., S., Ulan, M., 1987. The Impact of Exchange Rate Volatility on  
15  
16 Export Growth: Some Theoretical Considerations and Empirical Results. *Journal of*  
17  
18 *Policy Modelling* 9, 225--243.  
19  
20  
21 Baum, C., Schaffer, M., Stillman, S., 2003. Instrumental variables and GMM: Estimation and  
22  
23 Testing. *Boston College Department of Economics, Working Paper* 545.  
24  
25 Bini-Smaghi, L., 1991. Exchange Rate Variability and Trade: Why Is It So Difficult to Find  
26  
27 Any Empirical Relationship? *Applied Economics* 23, 927--935.  
28  
29  
30 Bodnar, G., 1997. Exchange rate exposure and market value, in: *Financial Times, Mastering*  
31  
32 *Finance Series*, 1997, 4, p. 2. Reprinted in: *Mastering Finance*, 1998. FT Pitman,  
33  
34 London.  
35  
36 Brodsky, D., 1984. Fixed Versus Flexible Exchange Rates and the Measurement of Exchange  
37  
38 Rate Instability. *Journal of International Economics* 16, 295--306.  
39  
40  
41 Caporale, T., Doroodian, K., 1994. Exchange rate Variability and The Flow of International  
42  
43 Trade. *Economic Letters* 46, 49--54.  
44  
45 Card, D. & Krueger, A.B. 1995, Time Series Minimum Wage Studies: A Meta-analysis,  
46  
47 *American Economic Review*, Vol. 85, pp. 238-243.  
48  
49 Chan, P., Wong, J., 1985. The Effect of Exchange rate variability on Hong Kong's Exports.  
50  
51 *Hong Kong Economic Papers* 10, 27--39.  
52  
53  
54 Chou, W., L., 2000. Exchange Rate Variability and China's Exports. *Journal of Comparative*  
55  
56 *Economics* 28, 61--79.  
57  
58 Chowdbury, A., R., 1993. Does Exchange Rate Volatility Depress trade Flows? *The Review*  
59  
60 *of Economics and Statistics* 75, 45--63.

- 1  
2  
3 Clark, P., Tamirisa, N., Wei, S.-J., Sadikov, A. and Zeng, L. (2004). Exchange Rate Volatility  
4 and Trade Flows: Some New Evidence. International Monetary Fund, Occasional  
5 Paper 235 (May).  
6  
7  
8  
9
- 10 Cooper, R., 2000. Towards a Common Currency. *International Finance* 3, 287--308.  
11
- 12 Cushman, D., O., 1983. The Effect of Real Exchange Rate Risk on International Trade.  
13  
14 *European Economic Review* 15, 45--63.  
15
- 16 Cushman, D., O., 1986. Has Exchange Risk Depressed International Trade? *The Impact of*  
17  
18 *Third Country Exchange Risk. Journal of International Money and Finance* 5, 361--  
19  
20 379.  
21
- 22 Cushman, D., O., 1988. US Bilateral Trade Flows and Exchange Rate Risk during the  
23  
24 Floating Period. *Journal of International Economics* 24, 317--330.  
25
- 26 Daly, K., 1996. The Effect of Exchange Rate Volatility on the Volume of Japan's Bilateral  
27  
28 Trade. *The Singapore Economic Review* 41, 23--39.  
29
- 30 De Grauwe, P., 1988. Exchange Rate Variability and Slowdown in Growth of International  
31  
32 Trade. *IMF Staff Papers* 35, 63--84.  
33
- 34 De Grauwe, P., Bellfroid, B., 1987. Long-run Exchange Rate Variability and International  
35  
36 Trade, in: Arndt, S., Richardson, J.D., *Real- financial Linkages among Open*  
37  
38 *Economies*. The MIT Press, London, pp. 193--212.  
39
- 40 Deaton, A., 1997. *The Analysis of Household Surveys*. The John Hopkins University Press,  
41  
42 Baltimore Maryland.  
43
- 44 Dell'ariccia, G., 1999. Exchange Rate Fluctuations and Trade Flows: Evidence from the  
45  
46 European Union. *International Monetary Fund Staff Papers* 46, 315--334.  
47
- 48 Dellas, H., Zilberfarb, B., 1993. Real Exchange Rate Volatility and International Trade: A  
49  
50 Reexamination of the Theory. *Southern Economic Journal* 59, 641--647.  
51
- 52 Dhanani, A., Groves, R., 2001. The management of strategic exchange risk: evidence from  
53  
54 corporate practices. *Accounting and Business Research* 31, 275--290.  
55
- 56 Doyle, E., 2001. Exchange Rate Volatility and Irish-UK Trade, 1979-1992. *Applied*  
57  
58 *Economics* 33, 249--265.  
59  
60

- 1  
2  
3 Fountas, S., Aristotelous, K., 2003. Does the Exchange Rate Regime Affect Export Volume?  
4 Evidence from Bilateral Exports in US-UK Trade: 1900-98. *The Manchester School*  
5 71, 51--64.  
6  
7  
8  
9  
10 Gagnon, J., 1993. Exchange rate variability and the level of international trade. *Journal of*  
11 *International Economics* 34, 269--287.  
12  
13  
14 Giorgioni, G., Thompson, J., L., 2002. Which Volatility? The Case of the Exports of Wheat.  
15 *Applied Economics Letters* 9, 681--684.  
16  
17  
18 Görg, H. and Strobl, E. (2001) Multinational Companies and Productivity Spillovers: A Meta-  
19 Analysis, *Economic Journal*, 723-739.  
20  
21  
22  
23 Gotur, P., 1985. The Effect of Exchange Rate Volatility on Trade: Some Further Evidence.  
24 *IMF Staff Papers* 32, 475--521.  
25  
26  
27 Grobar, L., 1993. The Effect of Real Exchange Rate Uncertainty on LDC Manufactured  
28 Exports, *Journal of Development Economics* 41, 367--376.  
29  
30  
31 Gros, D., 1987. Exchange Rate Variability and the Foreign Trade in the Presence of  
32 Adjustment Costs. *CESP Working Papers* 8704 (Univesite Catholique de Louvain).  
33  
34  
35 Hassan, M., K., Tufte, D., R., 1998. Exchange Rate Volatility and Aggregate Export Growth  
36 in Bangladesh. *Applied Economics* 30, 189--201.  
37  
38  
39  
40 Holly, S., 1995. Exchange Rate Uncertainty and Export Performance: Supply and Demand  
41 Effect. *Scottish Journal of Political Economy* 42, 381--391.  
42  
43  
44  
45 Hooper, P., Kohlhagen, S., W., 1978. The Effect of Exchange Rate Uncertainty on the Price  
46 and Volume of International Trade, *Journal of International Economics* 8, 483--511.  
47  
48  
49 IMF: International Monetary Fund, Research Department (1984) Exchange Rate Volatility  
50 and World Trade. *International Monetary Fund, Occasional Papers* 28.  
51  
52  
53  
54 Jarrell, S., B., Stanley, T., D., 1990. A Meta-Analysis of the Union-Nonunion Wage Gap.  
55 *Industrial and Labor Relations Review* 44, 54--67.  
56  
57  
58  
59 Kenen, P., B., Rodrik, D., 1986. Measuring and Analyzing the Effect of the Short-term  
60 Volatility in the Exchange Rates. *Review of Economics and Statistics* 68, 311--315.

- 1  
2  
3 Kiheung, K., WooRhee, L., 1996. The Impact of Korea's Exchange Rate Volatility on Korean  
4 Trade, *Asian Economic Journal* 10, 45--60.  
5  
6  
7 Klein, M., W., 1990. Sectoral Effects of Exchange Rate Volatility on United States Exports.  
8 *Journal of International Money and Finance* 9, 299--308.  
9  
10  
11 Kroner, K., Lastrapes, W., 1993. The Impact of Exchange Rate Volatility on International  
12 Trade. *Journal of International Money and Finance* 12, 293--318.  
13  
14  
15 Kumar, R., Dhawan, R., 1991. Exchange Rate Volatility and Pakistan's Exports to the  
16 Developed World, 1974-85. *World Development* 19, 1225--1240.  
17  
18  
19 Leamer, E., 1985. Sensitivity Analyses Would Help. *American Economic Review* 75(3), 308--  
20 313.  
21  
22  
23 Leamer, E., Leonard, H., 1983. Reporting the Fragility of Regression Estimates. *Review of*  
24 *Economics and Statistics* 65, 306--317.  
25  
26  
27 Lee, J., 1999. The Effect of Exchange Rate Volatility on Trade in Durables. *Review of*  
28 *International Economics* 7, 189--201.  
29  
30  
31 McKenzie, M., D., 1998. The Impact of Exchange Rate Volatility on Australian Trade Flows.  
32 *Journal of International Financial Markets, Institutions and Money* 8, 21--38.  
33  
34  
35 McKenzie, M., D., 1999. The Impact of Exchange Rate Volatility on International Trade  
36 Flows. *Journal of Economic Surveys* 13, 71--106.  
37  
38  
39 McKenzie, M., D., Brooks, R., D., 1997. The impact of Exchange Rate Volatility on German  
40 – US Trade Flows. *Journal of International Financial Markets, Institutions and*  
41 *Money* 7, 73--87.  
42  
43  
44  
45  
46  
47  
48  
49 Medhora, R., 1990. The Effect of Exchange Rate Variability on Trade: the case of West  
50 African Monetary Union's Imports. *World Development* 18, 313--324.  
51  
52  
53 Perée, E., Steinherr, A., 1989. Exchange rate uncertainty and foreign trade. *European*  
54 *Economic Review* 33, 1241--1264.  
55  
56  
57 Pozo, S., 1992. Conditional Exchange Rate Volatility and the Volume of International Trade:  
58 Evidence from The Early 1990's. *Review of Economics and Statistics* 74, 325--329.  
59  
60



- 1  
2  
3 Pradhan, K., H., 1988. Exchange Rate Variability of the Rupee and India's Exports. *Margin*  
4  
5 20, 28--47.  
6  
7  
8 Pugh, G., Tyrrell, D., 2002. Will the single currency promote intra-European trade? *European*  
9  
10 *Business Journal* 14, 150--157.  
11  
12 Pugh, G., Tyrrell, D., Tarnawa, L., 1999. Exchange Rate Variability, International Trade and  
13  
14 the Single Currency Debate: a survey, in: Wim M., (Eds.), *Economic Policy in the*  
15  
16 *European Union*, Edward Elgar, Cheltenham, pp. 9--25.  
17  
18 Qian, Y., Varangis, P., 1994. Does Exchange Rate Volatility Hinder Export Growth.  
19  
20 *Empirical Economics* 19, 371--396.  
21  
22  
23 Rose, A., 2000. One Money, One Market: Estimating the Effect of Common Currencies on  
24  
25 Trade. *Economic Policy* 30, 9--45.  
26  
27 Rose, A., 2004. A Meta-Analysis of the Effect of Common Currencies on International Trade.  
28  
29 *NBER Working Paper Series*, Working Paper 10373.  
30  
31 Rose, A., K., Stanley, T., D., 2005. A Meta-Analysis of the Effect of Common Currencies on  
32  
33 International Trade. *Journal of Economic Surveys* 19, 347--366.  
34  
35  
36 Sauer, C., Bohara, A., K., 2001. Exchange Rate Volatility and Exports: Regional Differences  
37  
38 between Developing and Industrialized Countries. *Review of International Economics*  
39  
40 9, 133--152.  
41  
42 Savvides, A., 1992. Unanticipated Exchange Rate Variability and the Growth of International  
43  
44 Trade. *Weltwirtschaftliches Archiv* 128, 446--463.  
45  
46  
47 Sekkat, K., 2001. On The Aggregate Impact of Exchange Rate variability on EU Trade.  
48  
49 *German Economic Review* 2, 57--78.  
50  
51 Smit, B., W., 1991. The Variability of the Rand and South African Exports. *Journal for*  
52  
53 *Studies in Economics and Econometrics* 15, 19--29.  
54  
55 Solakoglu, M., 2005. Exchange Rate Volatility and Real Exports: A Sensitivity Analysis.  
56  
57 *Journal of Economic and Social Research* 7(1), 1--30.  
58  
59 Stanley, T., D., 1998. New Wine in Old Bottles: A Meta Analysis of Ricardian Equivalence.  
60  
*Southern Economic Journal* 64, 713--727.



- 1  
2  
3 Stanley, T., D., 2001. Wheat from Chaff: Meta – Analysis as Quantitative Literature Review.  
4  
5 *Journal of Economic Perspectives* 15, 131--150.  
6  
7 Stanley, T., D., 2005. Beyond Publication Bias. *Journal of Economic Surveys* 19, 309--345.  
8  
9 Stanley, T., D., Jarrell, S., B., 1989. Meta –Regression Analysis: A Quantitative Method of  
10  
11 Literature Surveys. *Journal of Economic Surveys* 3, 161--171.  
12  
13 StataCorp (2003) *STATA User's Guide*. College Station, Texas: Stata Corporation.  
14  
15 Stokman, A., 1995. Effect of Exchange Rate Risk on Intra-EC Trade. *De Economist* 143, 41--  
16  
17 54.  
18  
19 Taylor, M. (1995) Exchange rate Modelling and Macro Fundamentals, *British Review of*  
20  
21 *Economic Issues*, Vol.17, No.42 (June), 1-42.  
22  
23  
24 Thursby, J., G., Thursby, M., C., 1987. Bilateral Trade Flows, the Linder Hypothesis, and  
25  
26 Exchange Risk. *Review of Economics and Statistics* 69, 488--495.  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

## Appendix A: Measures of exchange rate (ER) variability (1; otherwise 0)

MERV1 = 1 if absolute values of ER percentage changes

MERV2 = 1 if average absolute values of ER percentage changes

MERV3 = 1 if absolute or squared differences between previous forward and current spot rates

MERV4 = 1 if the moving standard deviation of ER changes or percentage changes

MERV5 = 1 if the standard deviation of ERs from an ER trend equation

MERV6 = 1 if the standard deviation of ERs from a n-order autoregressive equation

MERV7 = 1 if long-run uncertainty; Perée and Steinherr's (1989) V and U measures

MERV8 = 1 if squared residuals from an ARIMA model

MERV9 = 1 if conditional variance calculated by an ARCH or GARCH model

MERV10 = 1 if variance calculated by a LM (linear moment) model

MERV11 = 1 if the variance of the ER around its trend prediction ( $\ln e_t = \varphi_0 + \varphi_1 t + \varphi_0 t^2 + \varepsilon_t$ )

MERV12 = 1 if unanticipated changes in ERs (used by Savvides, 1992)

MERV13 = 1 if information contained in forward exchange rate concerning exchange rate expectations (used by Cushman, 1988)

**Table 1: Econometric studies on the trade effects of exchange rate variability (1978-2003)**

	Study	Negative effect	No effect	Positive effect	Not conclusive
1.	Hooper & Kohlhagen (1978)	0	1	0	0
2.	Abrams (1980)	1	0	0	0
3.	Cushman (1983)	1	0	0	0
4.	Akhtar & Hilton (1984)	1	0	0	0
5.	IMF (1984)	0	0	0	1
6.	Gotur (1985)	0	0	0	1
7.	Chan & Wong (1985)	0	1	0	0
8.	Kenen & Rodrik (1986)	1	0	0	0
9.	Bailey, Tavlas & Ulan (1986)	0	1	0	0
10.	Cushman (1986)	1	0	0	0
11.	Bailey, Tavlas & Ulan (1987)	0	0	0	1
12.	De Grauwe & Bellfroid (1987)	1	0	0	0
13.	Thursby & Thursby (1987)	1	0	0	0
14.	Cushman (1988)	1	0	0	0
15.	De Grauwe (1988)	1	0	0	0
16.	Pradhan (1988)	0	0	0	1
17.	Anderson & Garcia (1989)	1	0	0	0
18.	Perée and Steinherr (1989)	1	0	0	0
19.	Klein (1990)	0	0	1	0
20.	Medhora (1990)	0	1	0	0
21.	Bini-Smaghi (1991)	1	0	0	0
22.	Smit (1991)	0	1	0	0
23.	Assery & Peel (1991)	0	0	1	0
24.	Kumar & Dhawan (1991)	1	0	0	0
25.	Pozo (1992)	1	0	0	0
26.	Savvides (1992)	1	0	0	0
27.	Grobar (1993)	1	0	0	0
28.	Bahmani-Oskooee & Payesteh (1993)	1	0	0	0
29.	Chowdbury (1993)	1	0	0	0
30.	Kroner & Lastrapes (1993)	0	0	0	1
31.	Qian & Varangis (1994)	0	0	0	1
32.	Caporale & Doroodian (1994)	1	0	0	0
33.	Arize (1995)	1	0	0	0
34.	Holly (1995)	0	1	0	0
35.	Stokman (1995)	1	0	0	0
36.	Arize (1996a)	1	0	0	0
37.	Arize (1996b)	1	0	0	0
38.	Daly (1996)	0	0	0	1
39.	Kiheung & WooRhee (1996)	0	0	1	0
40.	McKenzie & Brooks (1997)	0	0	1	0
41.	Arize (1997a)	1	0	0	0
42.	Arize (1997b)	1	0	0	0
43.	Arize (1998)	1	0	0	0
44.	Arize & Shwiff (1998)	1	0	0	0
45.	Hassan & Tufte (1998)	1	0	0	0
46.	Mckenzie (1998)	0	0	0	1
47.	Dell'ariccia (1999)	1	0	0	0
48.	Lee (1999)	0	0	0	1

49.	Arize, Osang & Slottje (2000)	1	0	0	0
50.	Rose (2000)	1	0	0	0
51.	Chou (2000)	1	0	0	0
52.	Abbott, Darnell & Evans (2001)	0	1	0	0
53.	Aristotelous (2001)	0	1	0	0
54.	Doyle (2001)	0	0	1	0
55.	Sauer & Bohara (2001)	0	0	0	1
56.	Sekkat (2001)	0	1	0	0
57.	Giorgioni & Thompson (2002)	1	0	0	0
58.	Fountas & Aristotelous (2003)	0	0	1	0
	<b>Total</b>	<b>33</b>	<b>9</b>	<b>6</b>	<b>10</b>

**Table 2: Number of studies and observations in examples of MRA**

	<b>Number of studies</b>	<b>Number of observations</b>	<b>R<sup>2</sup> (or range of R<sup>2</sup>)</b>
<b>Card &amp; Kruger (1995)</b>	15	15	0.02 - 0.10 *
<b>Görg &amp; Strobl (2001)</b>	21	25	0.05 - 0.69
<b>Rose and Stanley (2005)</b>	34	754	0.54 - 0.68

\* Adjusted R<sup>2</sup>

**Table 3: MRA results for the final (second) parsimonious model (835 observations from 58 studies)**

<b>Dependent variable:</b> Exchange rate variability effect size (t-statistic)		<b>OLS (robust SEs)</b>		<b>Cluster-robust Linear Regression</b>		<b>Weighted Least Squares (WLS)</b>		<b>WLS (Cluster robust)</b>	
		Coef.	P> t	Coef.	P> t	Coef.	P> t	Coef.	P> t
Intercept	_cons	3.58	0.05	3.58	0.17	2.17	0.27	2.17	0.42
Square root d.o.f.	SqRt_df	-0.02	0.02	-0.02	0.16	-0.04	0.00	-0.04	0.00
Fixed ER regime	FIXPER	0.40	0.26	0.40	0.45	0.17	0.71	0.17	0.84
Less developed country	LDC	-1.23	0.00	-1.23	0.00	-0.71	0.02	-0.71	0.12
US trade only	US	0.44	0.06	0.44	0.22	0.18	0.64	0.18	0.70
Dep. var. : Sector level	SECTALT	-0.58	0.02	-0.58	0.10	-0.69	0.04	-0.69	0.20
Bilateral ER	BILATER	0.82	0.00	0.82	0.01	0.99	0.00	0.99	0.03
Real ER variability	REALER	-0.39	0.06	-0.39	0.13	-1.03	0.00	-1.03	0.03
Daily ER variability	DAILYER	0.46	0.35	0.46	0.34	-0.43	0.45	-0.43	0.52
Monthly ER variability	MONTHER	0.45	0.06	0.45	0.20	-0.30	0.39	-0.30	0.53
Yearly ER variability	ANNUALER	-1.21	0.01	-1.21	0.03	0.09	0.87	0.09	0.92
Gravity model	GRAVITY	-5.52	0.00	-5.52	0.02	-2.89	0.00	-2.89	0.07
Error-correction model	ERRORCOR	-1.33	0.00	-1.33	0.03	-0.46	0.33	-0.46	0.45
Cointegration analysis	LRCOINT	-1.94	0.00	-1.94	0.00	-2.31	0.00	-2.31	0.00
Structural effects	DOCKSTR	-1.38	0.00	-1.38	0.00	-0.92	0.04	-0.92	0.07
Seasonally-adjusted data	SESONADJ	-0.46	0.10	-0.46	0.25	0.38	0.35	0.38	0.55
Third country effect	THIRDCOUN	-0.58	0.10	-0.58	0.06	-0.68	0.14	-0.68	0.27
Cross-section data	CROSS	-1.07	0.01	-1.07	0.05	-1.65	0.00	-1.65	0.02
Different definitions of ER variability:	MERV1	0.56	0.04	0.56	0.08	-0.69	0.15	-0.69	0.41
MERV1-13	MERV3	-1.85	0.00	-1.85	0.05	-2.27	0.00	-2.27	0.02
	MERV5	-0.43	0.44	-0.43	0.35	0.15	0.79	0.15	0.83
	MERV6	-0.99	0.10	-0.99	0.22	0.34	0.47	0.34	0.68
	MERV7	-0.99	0.13	-0.99	0.20	-2.44	0.00	-2.44	0.02
	MERV8	3.32	0.00	3.32	0.00	1.47	0.18	1.47	0.27
	MERV10	0.73	0.30	0.73	0.21	0.38	0.60	0.38	0.49
	MERV11	3.76	0.00	3.76	0.07	2.33	0.00	2.33	0.04
	MERV12	0.64	0.39	0.64	0.10	0.16	0.83	0.16	0.84
	MERV13	-2.13	0.01	-2.13	0.00	-0.79	0.41	-0.79	0.24
Mid-year of sample period	T	-0.04	0.04	-0.04	0.19	-0.02	0.35	-0.02	0.50
No. of observations		835		835		835		835	

## Diagnostics

R <sup>2</sup>		0.48	0.48	0.35	0.35
F-test		F( 28, 806) = 19.22 Prob>F=0.00			
Maximum VIF		5.6	5.6	2.58	2.58
Mean VIF		2.03	2.03	1.66	1.66
Ramsey RESET test using powers of the fitted values of ERVES	Ho: no omitted variables	F(3,803)=1.69 Prob>F=0.17	F(3,803)=1.69 Prob>F=0.17	F(3,803)=1.15 Prob>F=0.33	F(3,803)=1.15 Prob>F=0.33
Cameron & Trivedi's decomposition of Information Matrix test	Ho: homoskedasticity	Chi-sq.158: = 123.54 p = 0.98	n.a.	n.a.	n.a.
Cameron & Trivedi's decomposition of Information Matrix test	Ho: no non- normal skewness	Chi-sq.28: = 22.37 p = 0.76	n.a.	n.a.	n.a.
Cameron & Trivedi's decomposition of Information Matrix test	Ho: no non- normal kurtosis	Chi-sq. 1 = 4.05 p = 0.044	n.a.	n.a.	n.a.