Currency Unions Cannot Defy Gravity – Mind the Curves and (Slippery) Slopes

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Abstract

It is commonly argued that existing gravity models over-estimate a currency union's impact on bilateral trade because of a failure to adequately account for nonlinearities. Here, we argue that a common currency may alter the *slope* of the relationship between bilateral trade and factors such as distance and GDP. To account for this nonlinearity, we interact the currency union dummy with GDP, per-capita-GDP and distance. We find that the interaction terms are often statistically significant. Their inclusion substantially reduces the currency union effect. While introducing quadratic regressors also shrinks the "Rose effect", the interaction terms have a greater dampening impact.

JEL classification: F15, F33.
Keywords: Currency union; Gravity model.

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1. Introduction

There is considerable disagreement regarding the impact of a currency union on trade between member countries. The introduction of a common European currency has encouraged recent efforts to shed further light on this issue. At the heart of the debate lies the startlingly large currency union effect of 335% initially identified by Rose (2000). Subsequently, numerous studies have sought to identify a more plausible (i.e. smaller) impact using various data sets,[1] estimation techniques[2] and alternative model specifications.[3] Nevertheless, as Baldwin (2006) demonstrates in his excellent critique of the currency union literature, the widespread use of the gravity model has proved somewhat of a slippery slope for those seeking robust estimates of the "Rose effect". [4]

This paper argues that existing gravity model estimates of a common currency's impact on bilateral trade are biased due to the failure of existing work to adequately account for nonlinearities in the data.[5] As discussed by Persson (2001) and subsequently by Baldwin (2006), these nonlinearities may arise due to selection into currency unions by countries which tend to be small, poor and remote. To deal with this problem, Baldwin (2006) suggests the inclusion of quadratic GDP and GDP-per-capita terms in a gravity model to augment the currency union dummy. More generally, Persson (2001) and Baldwin (2006) suggest trying out various forms of nonlinearities. In this paper, we examine a particular form of nonlinearity which has largely escaped the literature's attention to date.

With the notable exception of Rose (2000), existing analyses have universally assumed that the introduction of a common currency between two countries merely varies the level of bilateral trade between them by a constant proportion.[6] That is, existing work assumes that the formation of a currency union does not alter the nature (i.e. slope) of the

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[1] See, for example, Glick and Rose (2002).
[2] See, for example, Persson (2001), Rose and van Wincoop (2001) and Rose and Stanley (2005).
[3] See, for example, Frankel and Rose (2002), Yeyati (2003) and Klein (2005).
[4] In contrast to Baldwin (2006), Henderson and Millimet (2006) argue that concerns over the functional form of the gravity model in the currency union literature appear to be "unwarranted".
[5] In fact, Baldwin (2006) identifies a plethora of potential sources of bias in existing work. In this paper, however, we confine our attention to issues of bias resulting from nonlinearities.
[6] Rose (2000) only includes interaction terms as an after thought – as part of the sensitivity analysis of his preferred specification.

relationship between bilateral trade and its fundamental determining factors such as the GDP of the trading countries and the distance between them.

This paper addresses this oversight by simply interacting the currency union dummy variable with three other variables (namely GDP, GDP-per-capita and distance) that have previously been found to exert a strong influence on bilateral trade. These interaction terms are added to a conventional gravity model side-by-side with other standard control variables including the quadratic GDP and GDP-per-capita terms that Baldwin (2006) argues for so strongly. Since the resultant model clearly nests the conventional gravity specification, the results reported in this paper are directly comparable with those of most of the existing literature.

Notwithstanding its ubiquity, the practice of assuming away any slope effects from the introduction of a common currency appears overly simplistic and perhaps even a little arbitrary. It implies, for instance, that the introduction of a common currency between two very large countries or two very small ones will lead to an identical proportional change in the bilateral trade between each pair. Similarly, the proportional change in bilateral trade resulting from the decision of two neighbouring countries to adopt a common currency will be replicated in a currency union involving nations situated at opposite ends of the earth! At the very least, assumptions such as these deserve to be subjected to more rigorous testing than has been undertaken in the literature to date. This is an important motivation for the current paper.

The empirical analysis detailed below strongly suggests that, controlling for other factors, the introduction of a common currency between two countries does not simply lead to a step change in the level of bilateral trade between them. It also appears to change the slope coefficients on factors such as GDP and distance. In other words, the coefficients on the included interaction terms are often significant. Moreover, empirical testing reveals that the specification which includes these interaction terms is statistically preferred to those specifications which exclude them.

The primary purpose of this paper is to emphasise the importance of slope effects resulting from currency union formation, not to provide an accurate estimate of the impact of common currencies on bilateral trade. Nevertheless, it is reassuring that the inclusion of the currency union interaction terms yields a significantly reduced Rose effect. If nothing else, this provides strong circumstantial evidence in support of our conjecture that existing gravity model specifications, which neglect to account for slope effects, produce upwardly biased estimates of the currency union effect. Finally, it is interesting to note that the reduced Rose effect observed in this paper results primarily from the inclusion of the interaction terms, not from the inclusion of the quadratic terms.

Section 2 below provides some theoretical background to the empirical analysis. Section 3 details the estimation results. Finally, section 4 concludes the paper.

2. The Gravity Model

Existing gravity model specifications of the currency union effect are almost universally based on some variant of equation (1):[7]

$$\frac{V_{od}}{p} = \tau_{od}^{1-\sigma} \frac{E_o}{p_o} \frac{E_d}{p_d}, \qquad \text{where } \tau_{od} = f\left(DIST_{od}, RTA_{od}, CU_{od}, \ldots\right) \qquad \textbf{(1)}$$

where V_{od} measures the total value of trade from the origin ("o") country to the destination ("d") country and τ_{od} captures trade costs (including the distance between "o" and "d", $DIST_{od}$, and whether or not they are members of a regional trade agreement RTA_{od} or share a common currency, CU_{od}). E_o and E_d represent the nominal expenditures of countries "o" and "d" respectively, p is the common (numeraire) price in which bilateral trade and all country expenditures are measured, p_o is the exporting country's producer price and p_d is the importing country's price index for all goods that compete with the imported good.

[7] For a derivation of this functional form, see Baldwin (2006).

The log-linear version of the gravity model estimated in most empirical studies assumes that the trade cost parameters (e.g. distance, membership of a currency union etc.), enter the τ_{od} function multiplicatively.[8] For example,

$$\tau_{od} = RTA_{od}^{\alpha} \times CU_{od}^{\beta} \times DIST_{od}^{\gamma} \times \cdots. \qquad \textbf{(2)}$$

Hence, when implementing the log-linear form of equation (1), the impacts of these variables appear additively in the estimated form of the gravity equation as follows:

$$\ln \tau_{od} = \alpha \ln RTA_{od} + \beta \ln CU_{od} + \gamma \ln DIST_{od} + \cdots. \qquad \textbf{(3)}$$

One purpose of the current paper is merely to point out that the form of the trade costs function, τ_{od}, is unknown. We assume the following alternative trade costs function:

$$\tau_{od} = RTA_{od}^{\alpha} \times CU_{od}^{\beta} \times DIST_{od}^{(\gamma + \delta CU_{od})} \times \cdots. \qquad \textbf{(4)}$$

In log-linear form, this becomes

$$\ln \tau_{od} = \alpha \ln RTA_{od} + \beta \ln CU_{od} + \gamma \ln DIST_{od} + \delta CU_{od} \ln DIST_{od} \cdots. \qquad \textbf{(5)}$$

Hence, by specifying the trade costs function according to (4) we incorporate interaction terms (here between the CU dummy variable and distance) when estimating the gravity

[8] According to Santos Silva and Tenreyro (2005), the conventional log-linear gravity model might violate the standard OLS assumption that the disturbance term is uncorrelated with the regressors. This will be the case if the unobservable determinants of trade in the gravity model, expressed in levels, are heteroskedastic. This argument also applies to the current paper. Nonetheless, our focus is simply on illustrating bias in the estimated currency union effect due to neglecting nonlinearities in the context of the *conventional* log-linear gravity model.

model. Of particular note is the fact that equation (5) nests equation (3), making our specification more general than that adopted in the existing literature.

In order to investigate the significance of interaction terms involving GDP, we re-parameterize equation (1) in the following way:

$$\frac{V_{od}}{p} = \tau_{od}^{1-\sigma}\left(\frac{E_o}{p_o}\frac{E_d}{p_d}\right)^{\zeta+\eta CU_{od}} \quad \textbf{(6)}$$

In log-linear form this becomes

$$\ln\frac{V_{od}}{p} = \ln\tau_{od} + \left(\zeta + \eta CU_{od}\right)\ln\left(\frac{E_o}{p_o}\frac{E_d}{p_d}\right) + \cdots \quad \textbf{(7)}$$

In Baldwin's (2006) theoretical derivation of the gravity model, it is implicitly assumed that $\eta = 0$ and $\zeta = 1$. Therefore, equation (7), the log-linear form of the gravity model estimated in this paper, nests all existing specifications. This permits us to test whether or not $\eta = 0$.

The theoretical analysis presented in this section has assumed that bilateral trade flows in a particular direction. Consistent with the vast majority of empirical studies in the currency union literature, we estimate a version of this framework which considers aggregate bilateral trade between countries without regard to directional flow.

3. Estimation

The statistical analysis which follows uses the panel dataset constructed by Glick and Rose (2002).[9] Covering 217 countries from 1948 to 1997, this data is particularly suitable for our analysis because it includes a number of cases where a pair of countries have joined or exited currency unions during the sample period and this time-series variation (i.e. within variation)

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[9] We thank Andrew Rose for making this dataset available on his website, http://faculty.haas.berkeley.edu/arose.

can be exploited to identify the effect of currency unions on bilateral trade.[10] Summary statistics of variables used in this paper are presented in Table 1.

Glick and Rose (2002) estimate the currency union effect using several estimation methods: the pooled OLS, the random effects estimator and the fixed effects estimator. In the presence of time-invariant unobserved effects correlated with regressors, the pooled OLS and the random effects estimator are known to provide inconsistent estimates. Since such unobserved heterogeneity cannot be ruled out, and since the nature of this dataset allows us to exploit time-series variation, we focus on the fixed effects estimator.

Our baseline fixed effects model (hereafter referred to as Specification 1) is identical to the following model which is estimated by Glick and Rose (2002):[11]

$$\begin{aligned}\ln\left(TRADE_{ijt}\right) = \beta_0 + \beta_1 CU_{ijt} + \beta_2 \ln\left(Y_i Y_j\right)_t + \beta_3 \ln\left(YPC_i YPC_j\right)_t + \\ \beta_4 RTA_{ijt} + \beta_5 CURCOL_{ijt} + \mu_{ij} + \varepsilon_{ijt}\end{aligned} \quad \textbf{(8)}$$

where X_{ij} is the volume of bilateral trade between countries i and j, CU_{ij} is a dummy variable that takes the value one if countries i and j use the same currency, Y_iY_j is the product of the real GDPs of countries i and j, YPC_iYPC_j refers to the product of real GDP per capita of countries i and j, RTA_{ij} is a dummy variable that is unity if countries i and j are members of the same regional trade agreement and $CURCOL_{ij}$ is a dummy variable which takes the value one if countries i and j are colonies of some country. Finally, μ_{ij} captures the country-pair fixed effects. [12,13]

[10] Specifically, there are 146 cases in the dataset.
[11] We implicitly assume that the disturbance term is not correlated with the currency union dummy variable (i.e., the only source of endogeneity is unobserved heterogeneity). Several studies have addressed this source of endogeneity using the instrument variables estimator (see, for example, Alesina et al. (2002)). However, their estimates are much less plausible (1387%!). Once again, we remind the reader that the objective of the paper is merely to illustrate that neglecting nonlinearities would lead to biased estimates of the Rose effect; our aim is not to correct for bias due to the correlation between the disturbance term and currency union status.
[12] With the pooled OLS model, Glick and Rose (2002) include other control variables such as distance, a common language dummy, a common border dummy, the number of landlocked countries etc. However, these variables are left out of the fixed effects model since they are constant over time.

Column (1) in Table 2 reports the replicated results of Glick and Rose (2002) when year effects are controlled for (the first row in Table 5, p. 1134).[14] The estimated coefficient on CU_{ij} is 0.592 and significant at the one percent level, indicating that currency unions increase trade by 80.6%.[15] Baldwin (2006), however, stresses the importance of nonlinearity in the gravity model when estimating the currency union effect. Specifically, he argues that

> *"For policy purposes, we should ignore all Rose effect estimates on large dataset that do not address the nonlinearity-cum-selection issue. Researchers would be wise to address it in both ways: 1) try out various nonlinearities. In the context of Rose effect regressions, be sure to try a quadratic terms for GDP and GDP per capita; 2) try matching procedures like those suggested by Persson or Kenen ..."* (Baldwin, 2006: p. 32).

In the spirit of Baldwin's (2006) first suggestion,[16] quadratic terms of $\ln(Y_i Y_j)$ and $\ln(YPC_i YPC_j)$ are added to Specification 1. This augmented version of the original Glick and Rose (2002) model is hereafter referred to as Specification 2. The results are presented in column (5) of Table 2. Both squared terms are highly significant and the likelihood ratio test (H_0: Specification 1 vs H_1: Specification 2) rejects the null hypothesis at the one percent level (see Table 3, column 1). This clearly suggests the presence of nonlinearity in the gravity model. Importantly, the inclusion of the quadratic terms has reduced the estimated coefficient on CU_{ij} from 0.592 to 0.518 (i.e., currency unions now increase trade by "only" 67.9%).[17]

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[13] Note that equation (8) implicitly assumes that $\mu_{ij} = \mu_{ji}$, i.e. the country pair fixed effects do not depend on the direction of trade. This is because the Glick and Rose (2002) dataset we use aggregates the total value of bilateral trade (in both directions) between all country pairs. See Carrère (2006) for an application to regional trade agreements in which $\mu_{ij} \neq \mu_{ji}$.

[14] Glick and Rose (2002) also report the results without controlling for year effects. In this case, the coefficient on CU_{ij} is estimated to be 0.65.

[15] This is obtained by computing exp(0.592)-1.

[16] We address Baldwin's second suggestion, application of a matching procedure in estimation, in a separate research project currently in progress.

[17] One of the models that Glick and Rose (2002) examine is similar to our Specification 2. Specifically, they estimate our Specification 2 without the quadratic $\ln(YPC_i YPC_j)$ term and time dummies. In this case, the coefficient on CU_{ij} is estimated to be 0.61.

Having confirmed Baldwin's (2006) view regarding the importance of the quadratic GDP and GDP-per-capita terms, we next turn to determining the importance of the interaction terms (i.e. changes in the slope coefficients resulting from a change in currency union status). In particular, to Specification 2, we add the following interaction terms: (i) CU_{ij} and ln($DIST_{ij}$) where $DIST_{ij}$ is the distance between countries *i* and *j*, (ii) CU_{ij} and ln(Y_iY_j), and (iii) CU_{ij} and ln(YPC_iYPC_j). For the remainder of this paper, this interaction-term-augmented gravity model is referred to as Specification 3. As is evident from column (9) of Table 2, all the included interaction terms are highly significant. The quadratic terms also remain significant. Moreover, the likelihood ratio tests reject both restricted models, Specification 1 and Specification 2 (see Table 3, column 1). In short, Specification 3 is preferred to both alternative gravity model specifications.

Since Specification 3 includes interaction terms involving the currency union dummy, when calculating the currency union effect we use the sample means of ln($DIST_{ij}$), ln(Y_iY_j), and ln(YPC_iYPC_j) for the set of countries with currency union memberships. The results are surprising. The estimated effect has shrunk further to 39.9%. The size of this CU effect is in line with Baldwin's (2006) expectations: "(t)he Rose effect on multilateral data is about on the order of 20% to 40%…" (Baldwin, 2006: p. 32).

It is also noteworthy that the estimated size of the currency union effect in Specification 3 is similar with those effects *nonparametrically* estimated in the literature. Rose (2001), for example, applies the propensity score matching technique (Rosenbaum and Rubin, 1983 and 1984), using the same dataset employed in this paper.[18] He estimates the currency union effect to lie in the range of 21% to 43%. Note, however, that one must exercise caution in interpreting these results. In particular, estimates of the currency union effect would be inconsistent, unless the distribution of covariates is independent of the currency union status conditional on the propensity score (i.e., the balancing property). Since

[18] Persson (2001) also applies the propensity score matching, using the data in Rose (2000). Using stratification, the estimated effect is 13% but not significant at the 10% level. With nearest-neighbour matching, the effect is estimated to be 66% and is significant at the 5% level. However, since the balancing property is not satisfied for several control variables, it is unclear whether his estimates are consistent.

Rose (2001) does not formally test this, it is unclear whether or not his estimates are consistent.

To check the robustness of our results, we estimate the above models over three sub-periods of the data: 1960-1997, 1970-1997, and 1980-1997. The results of the likelihood ratio tests indicate that the full model, Specification 3, is preferred to the two restricted models in all sub-samples (see columns 2-4 in Table 3). As can be seen from columns (10)-(12) of Table 2 the quadratic terms are always highly significant. Moreover, in each case, at least one out of the three interaction terms is significant at the 1% level. The results once again imply that the introduction of a common currency alters the slope of the relationship between bilateral trade and the distance between countries, as well as the slope between bilateral trade and country GDPs. Accounting for nonlinearities seems to be important.

For our preferred model, Specification 3, the estimated currency union effects are 34.2% for 1960-1997 and 23.5% for 1970-1997. These estimates are substantially smaller than those obtained using Specification 1 (i.e., 76.9% and 43.8%, respectively) and Specification 2 (i.e., 62.3% and 41.0%, respectively). Moreover, the pattern observed with the full sample endures: the estimated currency union effect is smallest with Specification 3 and largest with Specification 1. These results, therefore, reconfirm that the omission of the quadratic and interaction terms bias upwards the currency union effect.

Note that for the period 1980-1997 the coefficient on the currency union dummy variable is statistically insignificant for all three specifications. That is, the overall currency union effect is nil in Specifications 1 and 2. At the same time, in our preferred Specification 3, the two interaction terms, $CU_{ij}\times\ln(Y_iY_j)$ and $CU_{ij}\times\ln(YPC_iYPC_j)$, are significant at the one percent level. This implies that currency unions play an important role not in the constant term but in the slope. In spite of this, in Specification 3 (just like in Specifications 1 and 2) the overall estimated currency union effect is *not* significant at the 5% level. This suggests that the (opposite signed) effects of the two significant interaction terms in Specification 3 are working to offset one another on average.

As a final exercise, we compare the relative importance of the quadratic GDP and interaction terms in reducing the size of the overall currency union effect. Consider the full sample. Moving from Specification 1 to Specification 2 (i.e. introducing quadratic GDP terms), reduces the overall currency union effect from 80.6% to 67.9%. Adding the interaction terms (i.e. moving from Specification 2 to Specification 3) further reduces the overall currency union effect to 39.9%. Since this latter reduction is larger than the former, it would appear that the introduction of the interaction terms has played a relatively important role (i.e. relative to the quadratic GDP terms) in reducing the size of the "Rose effect". An identical pattern can be observed for both the 1960-1997 and 1970-1997 sub-samples (in Table 2 compare columns 2, 6, 10 and columns 3, 7, 11 respectively).

4. Conclusion

In summary, we provide simple but, in our view, rather important evidence regarding the need to account for nonlinearities when specifying gravity models to estimate the effect of a common currency on bilateral trade. First, as argued forcefully by Baldwin (2006), we demonstrate that it is important to include the quadratic terms of $\ln(Y_iY_j)$ and $\ln(YPC_iYPC_j)$. Second, it is equally important to include interaction terms involving CU_{ij} and $\ln(DIST_{ij})$, CU_{ij} and $\ln(Y_iY_j)$, and CU_{ij} and $\ln(YPC_iYPC_j)$ in order to capture slope effects that accompany the introduction of a currency union. While the introduction of quadratic regressors has become increasingly popular in the literature, consideration of the interaction terms has invariably been neglected. As the preceding analysis has emphasised, omitting these quadratic and interaction terms from the gravity model equation can substantially bias the currency union effect.

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Table1: Summary Statistics

	1948-1997				1960-1997				1970-1997				1980-1997			
	NU		CU		NU		CU		NU		CU		NU		CU	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
ln(*TRADEij*)	10.71	3.68	10.57	3.10	10.57	3.80	10.20	3.01	10.40	3.97	9.80	3.09	10.21	4.18	9.70	3.10
ln(*DISTij)*	8.15	0.82	7.08	1.01	8.16	0.81	7.01	1.01	8.17	0.81	6.89	1.03	8.18	0.81	6.78	1.06
ln(*YiYj*)	47.90	2.63	44.71	3.06	47.92	2.66	44.40	2.93	47.99	2.71	44.07	2.88	48.10	2.76	43.99	2.91
ln(*YPCiYPCj*)	16.06	1.44	14.52	1.56	16.10	1.44	14.47	1.56	16.19	1.45	14.46	1.58	16.25	1.46	14.45	1.66
RTAij	0.007	0.081	0.073	0.260	0.007	0.085	0.083	0.276	0.008	0.091	0.114	0.318	0.010	0.099	0.148	0.355
CURCOLij	0.002	0.040	0.162	0.369	0.001	0.037	0.128	0.334	0.001	0.031	0.111	0.314	0.001	0.025	0.108	0.311
$[\ln(YiYj)]^2$	2301.0	252.2	2008.5	274.7	2303.2	254.8	1980.1	261.5	2310.0	259.5	1950.3	254.1	2320.7	264.9	1943.6	255.3
$[\ln(YPCiYPCj)]^2$	260.0	46.0	213.1	47.7	261.4	46.3	211.8	47.7	264.2	46.8	211.5	48.6	266.3	47.2	211.5	51.3
Observations	422715		4077		372674		3594		308055		2610		213140		1633	

Note: NU denotes non-union members. CU denotes currency union members.

Table 2: Estimation Results

	(1) GR (2002)		(2) 1960-1997		(3) 1970-1997		(4) 1980-1997		(5) 1948-1997		(6) 1960-1997	
	Specification 1		Specification 1		Specification 1		Specification 1		Specification 2		Specification 2	
CUij	0.592**	(0.050)	0.570**	(0.054)	0.363**	(0.083)	0.061	(0.174)	0.518**	(0.050)	0.485**	(0.054)
ln(*YiYj*)	0.462**	(0.018)	0.504**	(0.02)	0.668**	(0.027)	0.473**	(0.050)	-2.917**	(0.068)	-3.360**	(0.079)
ln(*YPCiYPCj*)	0.530**	(0.018)	0.463**	(0.02)	0.251**	(0.025)	0.250**	(0.047)	-1.794**	(0.082)	-1.323**	(0.094)
RTAij	0.848**	(0.045)	0.597**	(0.052)	0.377**	(0.063)	0.225**	(0.084)	0.733**	(0.045)	0.487**	(0.051)
CURCOLij	0.232**	(0.088)	0.128	(0.106)	0.068	(0.159)	0.174	(0.577)	0.186*	(0.087)	0.028	(0.105)
$[\ln(YiYj)]^2$									0.038**	(0.001)	0.043**	(0.001)
$[\ln(YPCiYPCj)]^2$									0.062**	(0.002)	0.047**	(0.003)
*CUij**ln(*DISTij*)												
*CUij**ln(*YiYj*)												
*CUij**ln(*YPCiYPCj*)												
Constant	-19.54**	(0.647)	-21.03**	(0.689)	-26.12**	(0.916)	-16.73**	(1.688)	75.81**	(1.643)	82.00**	(1.904)
Estimated CU Effect	0.806**	(0.091)	0.769**	(0.096)	0.438**	(0.119)	0.06	(0.185)	0.679**	(0.084)	0.623**	(0.088)
Year Dummies	Yes		Yes		Yes		Yes		Yes		Yes	
Country Pair Fixed Effects	Yes		Yes		Yes		Yes		Yes		Yes	
R-squared	0.224		0.523		0.523		0.528		0.532		0.524	

Note: GR (2002) indicates results in Glick and Rose (2002). Standard errors are in parentheses. ** and * indicate the significance at the 1 and 5 percent levels, respectively.

(Table 2 Continued)

	(7) 1970-1997		(8) 1980-1997		(9) 1948-1997		(10) 1960-1997		(11) 1970-1997		(12) 1980-1997	
	Specification 2		Specification 2		Specification 3		Specification 3		Specification 3		Specification 3	
CUij	0.343**	(0.083)	0.143	(0.174)	-5.100**	(0.737)	-5.308**	(0.805)	-5.898**	(1.349)	4.650	(2.835)
ln(*YiYj*)	-2.443**	(0.114)	-1.100**	(0.206)	-2.983**	(0.069)	-3.426**	(0.080)	-2.503**	(0.115)	-1.087**	(0.207)
ln(*YPCiYPCj*)	-0.970**	(0.127)	-1.502**	(0.202)	-1.766**	(0.083)	-1.304**	(0.094)	-0.978**	(0.127)	-1.571**	(0.203)
RTAij	0.291**	(0.063)	0.152**	(0.085)	0.708**	(0.045)	0.463**	(0.052)	0.289**	(0.063)	0.151	(0.085)
CURCOLij	-0.006	(0.159)	0.217	(0.577)	0.104	(0.088)	-0.028	(0.106)	-0.052	(0.159)	0.217	(0.577)
$[\ln(YiYj)]^2$	0.034**	(0.001)	0.018**	(0.002)	0.039**	(0.001)	0.044**	(0.001)	0.035**	(0.001)	0.018**	(0.002)
$[\ln(YPCiYPCj)]^2$	0.033**	(0.004)	0.051**	(0.006)	0.061**	(0.002)	0.046**	(0.003)	0.033**	(0.004)	0.052**	(0.006)
*CUij**ln(*DISTij*)					0.155**	(0.056)	0.204**	(0.060)	0.160	(0.085)	0.018	(0.216)
*CUij**ln(*YiYj*)					0.122**	(0.018)	0.116**	(0.020)	0.103**	(0.032)	-0.209**	(0.076)
*CUij**ln(*YPCiYPCj*)					-0.076*	(0.030)	-0.069*	(0.033)	0.032	(0.049)	0.343**	(0.112)
Constant	55.92**	(2.756)	32.93**	(4.904)	77.23**	(1.656)	83.49**	(1.923)	57.43**	(2.784)	32.99**	(4.930)
Estimated CU Effect	0.410**	(0.117)	0.153	(0.201)	0.399**	(0.076)	0.342**	(0.080)	0.235*	(0.110)	0.677	(0.380)
Year Dummies	Yes		Yes		Yes		Yes		Yes		Yes	
Country Pair Fixed Effects	Yes		Yes		Yes		Yes		Yes		Yes	
R-squared	0.516		0.524		0.530		0.522		0.514		0.524	

Note: Standard errors are in parentheses. ** and * indicate the significance at the 1 and 5 percent levels, respectively. When computing the currency union effect for models (9) - (12), we use the sample means of ln(*DISTij*), ln(*YiYj*), and ln(*YPCiYPCj*) for countries in currency unions.

Table 3: Likelihood Ratio Tests

	(1)	1948-1997	(2)	1960-1997	(3)	1970-1997	(4)	1980-1997
	LR test stat	P-value	LR test stat	P-value	LR test stat	P-value	LR test stat	P-value
H0: Specification 1 vs H1: Specification 2	4648	0.00	3646	0.00	1085	0.00	209.7	0.00
H0: Specification 1 vs H1: Specification 3	4719	0.00	3708	0.00	1108	0.00	221.2	0.00
H0: Specification 2 vs H1: Specification 3	71.4	0.00	62.1	0.00	23.4	0.00	11.4	0.01