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BILATERAL TRADE FLOWS, THE LINDER HYPOTHESIS, AND EXCHANGE RISK

by

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1. INTRODUCTION

The empirical literature on the determinants of bilateral trade flows has largely focused on (i) the gravity model, (ii) the Linder hypothesis, and (iii) the effect of exchange rate variability. The gravity model specifies the value of trade between two countries as a positive function of incomes of the countries and a negative function of the distance between them. It has a long history of empirical success (see Deardorff (1984) for a survey) and has been justified theoretically by Leamer and Stern (1970), Anderson (1979), and Bergstrand (1985). The bilateral version[1] of Linder's hypothesis is that trade of manufactured goods between two countries will be inversely related to the difference in their per capita incomes. While, empirically, a high proportion of bilateral trade occurs between countries with similar levels of per capita income, studies which have controlled for the role of transport costs have tended to reject this hypothesis (see Deardorff (1984) and references therein). Finally, Hooper and Kohlhagen (1978), Abrams (1980), Cushman (1983), and Thursby and Thursby (1985) have found support for the hypothesis that exchange rate variability affects the pattern of bilateral trade.

This paper examines the Linder hypothesis and the effect of exchange rate variability in a gravity-type trade model derived from an underlying demand and supply model. Previous studies have tended to address the three issues separately,[2] and with the exception of Linneman (1966), Bergstrand (1985), Hooper and Kohlhagen (1978), and Cushman (1983), the equations estimated in the empirical studies have been ad hoc specifications. Our purpose is to show that a behavioral model can be used to justify examining these issues jointly, and that, in fact, such a model performs well empirically. In Section 2 we present a demand and supply model general enough to allow for the effects of exporters and importers hedging through the forward exchange market. In Section 3 it is shown that this system leads to a reduced form equation similar to a gravity model capable of examining the Linder hypothesis and the effects of exchange rate variability when commonly used proxies are substituted for unobtainable data.

The model is estimated for a sample of 17 countries for the period 1974-1982. Estimation procedure and results are given in Sections 4 and 5. We find overwhelming support for the Linder hypothesis and this version of the gravity model. Moreover, we find strong support for the hypothesis that increased exchange rate variability affects bilateral trade flows. Several distinguishing features of our approach make these results particularly interesting: i) to our knowledge this sample size (in terms of countries and time period) is larger than others; ii) rather than arbitrarily deciding to pool data across countries, we test for the appropriateness of the common practice of estimating a single equation for all countries and find that such pooling is inappropriate; iii) we estimate equations using both real and nominal measures of exchange rates; and finally iv) we use a non-nested test procedure to test which of our equations, if any, are correctly specified. This last procedure applied to our estimates suggests that for most countries our specifications are appropriate and that the effects of real and nominal exchange rate variability are largely indistinguishable.

2. THE MODEL

The model is a static demand and supply model explaining the pattern of aggregate exports from some country i to a set of countries j ($j=1,...,16$). The underlying model of demand is a standard one in which the quantity of i's aggregate export good demanded by the jth importing country is a function of the import price of that good, the price to importers in country j of other goods, and j's income and tastes. The underlying supply model is one in which the ith exporting country's supply of its good to country j is a function of the price in its own currency of selling to j, the price of selling the good elsewhere, and production possibility (proxied by income).

We express the import price of i's export good as $PD^i_j = P^i_j \cdot R^i_j \cdot T^i_j \cdot C^i_j \cdot HI^i_j$ where P^i_j denotes the export price in i's currency, R^i_j is the spot price of i's currency in terms of j, T^i_j is one plus any tariff j places on i's good, C^i_j is a transport cost factor (c.i.f./f.o.b.), and HI^i_j is a factor to reflect any hedging done by importers in j. If importers in j do not hedge in the forward market, $HI^i_j=1$, and our expression for PD^i_j is the commonly assumed one in studies abstracting from exchange risk. However, to the extent that importers hedge against foreign exchange risk, their cost of foreign exchange is not R^i_j but is a weighted average of the forward and spot exchange rate with the weights depending on the portion of contracts hedged through the forward market (see Ethier (1973) and Hooper and Kohlhagen (1978) for examples). In that case R^i_j is not the correct rate of conversion between the currencies, and HI^i_j is included to reflect the extent to which the true cost of foreign exchange to importers differs.

If a portion of the contracts between exporters and importers in i and j are denominated in j's currency, then exporters may hedge through the forward market. To the extent that this occurs, the own currency receipts of exporters in i will be affected by differences in the forward rate and the relevant future spot rate of exchange. Following Hooper and Kohlhagen, we express the per unit own currency receipt of exporters in i as $PS^i_j = P^i_j \cdot HE^i_j$, where HE^i_j is a factor reflecting the extent to which hedging in the forward market alters the own currency receipts of exporters in i selling to importers in j.

The price of other goods in j's demand for i's exports can be represented by country j's CPI and an index of other import prices. Similarly, the prices to exporter i of selling in markets other than the j'th can be represented by i's CPI and an index of export prices to other countries.

In log form form demand and supply are, respectively,

$$\ln Q^i_{jt} = \alpha^i_0 + \alpha^i_1 \ln P^i_{jt} + \alpha^i_2 \ln R^i_{jt} + \alpha^i_3 \ln T^i_{jt} + \alpha^i_4 \ln C^i_{jt} + \alpha^i_5 \ln HI^i_{jt} + \alpha^i_6 \ln PD^o_{jt} + \alpha^i_7 \ln CPI_{jt} + \alpha^i_8 \ln G_{jt} + \alpha^i_9 \ln Z^i_{jt} + \epsilon^i_{1jt} \qquad (1)$$

$$\ln Q^i_{jt} = \beta^i_0 + \beta^i_1 \ln P^i_{jt} + \beta^i_2 \ln HE^i_{jt} + \beta^i_3 \ln PS^i_{ot} + \beta^i_4 \ln CPI_{it} + \beta^i_5 \ln G_{it} + \epsilon^i_{2jt} \qquad (2)$$

where t refers to the time period;

Q^i_{jt} = quantity of exports from i to j;

PD^i_{jt} = import price of i's exports to j;

PD^o_{jt} = index of import prices of exports of other countries;

$CPI_{\tau t}$ = consumer price index in country τ (τ=i,j);

$G_{\tau t}$ = GNP of country τ (τ=i,j);

P^i_{jt} = export price of i's exports to j;

PS^i_{ot} = index of net export prices of i's exports to other countries;

and Z^i_{jt} = variable reflecting tastes in j for i's export good.

The reduced form equations for $\ln Q^i_{jt}$ and $\ln P^i_{jt}$ are

$$\ln P^i_{jt} = \pi^i_0 + \pi^i_1 \ln R^i_{jt} + \pi^i_2 \ln T^i_{jt} + \pi^i_3 \ln C^i_{jt} + \pi^i_4 \ln HI^i_{jt}$$

$$+ \pi^i_5 \ln PD^o_{jt} + \pi^i_6 \ln CPI_{jt} + \pi^i_7 \ln G_{jt} + \pi^i_8 \ln Z^i_{jt} + \pi^i_9 \ln HE^i_{jt}$$

$$+ \pi^i_{10} \ln PS^i_{ot} + \pi^i_{11} \ln CPI_{it} + \pi^i_{12} \ln G_{it} + v^i_{1jt}$$

$$= \pi^i_0 + \Sigma^{12}_{k=1} \pi^i_k x^i_{kt} + v^i_{1jt} \tag{3}$$

$$\ln Q^i_{jt} = \gamma^i_0 + \gamma^i_1 \ln R^i_{jt} + \gamma^i_2 \ln T^i_{jt} + \gamma^i_3 \ln C^i_{jt} + \gamma^i_4 \ln HI^i_{jt}$$

$$+ \gamma^i_5 \ln PD^o_{jt} + \gamma^i_6 \ln CPI_{jt} + \gamma^i_7 \ln G_{jt} + \gamma^i_8 \ln Z^i_{jt} + \gamma^i_9 \ln HE^i_{jt}$$

$$+ \gamma^i_{10} \ln PS^i_{ot} + \gamma^i_{11} \ln CPI_{it} + \gamma^i_{12} \ln G_{it} + v^i_{2jt}$$

$$= \gamma^i_0 + \Sigma^{12}_{k=1} \gamma^i_k x^i_{kt} + v^i_{2jt} \quad . \tag{4}$$

where $\pi^i_0 = (\alpha^i_0 - \beta^i_0)/D$ $\qquad\qquad$ $\gamma^i_0 = (\alpha^i_0 \beta^i_1 - \alpha^i_1 \beta^i_0)/D$

$$\pi^i_k = \alpha^i_{k+1}/D \quad (k=1,\ldots,8) \qquad \gamma^i_k = \beta^i_1\alpha^i_{k+1}/D \quad (k=1,\ldots,8)$$

$$\pi^i_k = -\beta^i_{k-7}/D \quad (k=9,\ldots,12) \qquad \gamma^i_k = -\beta^i_{k-7}\alpha^i_1/D \quad (k=9,\ldots,12)$$

$$v^i_{1jt} = (\epsilon^i_{1jt}-\epsilon^i_{2jt})/D \qquad v^i_{2jt} = (\beta^i_1\epsilon^i_{1jt}-\alpha^i_1\epsilon^i_{2jt})/D$$

and $D = \beta^i_1-\alpha^i_1$.

3. EMPIRICAL IMPLEMENTATION

Ideally, one would estimate equations (3) and (4); however, data for P^i_{jt} and Q^i_{jt} are not generally available whereas data for their product $PQ^i_{jt} = P^i_{jt}Q^i_{jt}$ is easily obtained, so that the following equation can be estimated

$$\ln PQ^i_{jt} = \ln P^i_{jt} + \ln Q^i_{jt} = \delta^i_0 + \Sigma^{12}_{k=1} \delta^i_k x^i_{kt} + u^i_{jt} \qquad (5)$$

where $\delta^i_\tau = \pi^i_\tau+\gamma^i_\tau$ ($\tau=0,\ldots,12$) and $u^i_{jt} = v^i_{1jt}+v^i_{2jt}$. For variables 1 through 12, only exchange rate, CPI, and income data are available for a large sample of countries. Once we substitute commonly used proxies for the others, equation (5) is similar to the gravity model, with the exception that it allows for the Linder hypothesis and a proxy for exchange risk.

For the c.i.f./f.o.b. factor we substitute distance and a dummy for adjacency. Following Aitken (1973), we substitute dummies for EEC and EFTA membership in place of $\ln T^i_j$. A simple version of the gravity model would include these variables plus the incomes of the exporting and importing countries. Bergstrand (1985) has shown that this simple version of the gravity model can be derived in an optimizing framework with perfect arbitrage if all goods are perfectly substitutable internationally in consumption and production. Since there is considerable evidence that in general neither of these assumptions holds (Richardson (1978), Kravis and Lipsey (1984)), he estimates a generalized gravity equation which includes the exchange rate, domestic price indices for both the exporter and importer, the exporter's unit value of exports, and the importer's unit value of imports. Our inclusion of R^i_j, CPI_i, CPI_j, PD^o_j, and PS^i_o makes equation (5) similar to his estimating equation. As a measure of PD^o_j we follow Bergstrand in using j's unit value of imports, and for PS^i_o we use i's unit value of exports. If import and export price indices are calculated in a comparable fashion across countries, these are reasonable approximations of indices computed from import and export price data for bilateral trade (data for the latter two being unavailable).

Z^i_j is included to reflect differences in importer j's tastes regarding the exports of different countries. Since our specification (by including price variables) is consistent with product differentiation across countries, it is reasonable to assume that tastes regarding these differentiated products will vary. But this is part of Linder's argument as to why trade in manufactured goods will tend to be concentrated among countries with similar levels of per capita income. Linder (1961) hypothesized that suppliers of differentiated products would tailor their products to the tastes of domestic purchasers, and that to the extent that tastes abroad were similar, one would tend to observe intra-industry trade between regions. He went on to recommend per capita income as a measure of demand structure or tastes, so that trade between two regions would be a negative function of the absolute difference in per capita income in the two regions. Substituting this difference for Z_j^i in equation (5) allows us to test Linder's hypothesis.

While most studies of the gravity model have abstracted from issues of foreign exchange risk, we included HI_j^i and HE_j^i in the underlying demand and supply functions to allow us to test for effects of exchange risk on the value of trade. Since direct measures of HI_j^i and HE_j^i do not exist for trade aggregated over goods, we follow other studies in using variability in the exchange rate as a proxy measure for both. Lacking a single theoretically correct measure of variability, previous studies have used a number of measures.[3] The measure we use is the variance of the spot exchange rate[4] around its predicted trend, where trend is estimated from

$$\ln R_{jt}^i = \phi_0^i + \phi_1^i t + \phi_2^i t^2 + \epsilon_{jt}^i \quad . \qquad (6)$$

Our exchange rate data are monthly, so that for each month we estimate equation (6) using exchange rate observations for the twelve preceding months, and the residual variance is our measure of variability for the month. Since the trade flow data used to estimate (5) are annual (see Data Appendix), we use the mean of these variability measures within the year as our variability measure for each year, VAR_j^i. This measure of variability is similar to those used by Thursby and Thursby (1985) and Kenen and Rodrik (1984, 1986). The rationale for this measure is that since variability is a proxy for exchange risk, we are interested in capturing the portion of exchange rate variation which is unexpected or unpredicted. The quadratic form of (6) allows for the possibility that trend may not be linear.

Using yearly trade flow data and monthly exchange rate data also necessitates R_j^i being an aggregate over time and we use the mean rate over the year. Finally, since there has been discussion in the literature as to whether variability in the real or the nominal exchange rate is the appropriate proxy for exchange risk (Akhtar and Hilton (1984), Cushman (1983)), we estimate two versions of (6): one which incorporates variance around predicted trend in the nominal exchange rate and one which measures variance around the predicted trend in $R_j^i CPI_i/CPI_j$.

In summary, we estimate is equation (5) with the following changes. $x_{2t}^i = \ln T_j^i$ is proxied by a dummy for preferential trading. $x_{3t}^i = \ln C_j^i$ is proxied by two variables, log distance ($\ln D_j^i$) and an adjacency dummy (A_j^i). $x_{4t}^i = \ln HI_j^i$ and $x_{9t}^i = \ln HE_j^i$ are proxied by a single variability measure, VAR_j^i.

4. ESTIMATION PROCEDURE

Seventeen regression equations of the form of (5) are estimated. Each equation explains the export pattern for some country i (i=1,...,17) to sixteen other countries over a nine year period for a total of 144 observations for each equation. Our use of the log-log specification for the demand and supply equations is consistent with Bergstrand's derivation.

As it is common in cross-section work to presume heteroscedasticity, particularly when the dependent variable varies substantially across cross-sectional units as it does here, all reported t statistics are based on the estimation procedure suggested by MacKinnon and White (1985). Their method retains the least squares coefficients but uses a consistent covariance matrix estimator. The virtue of the procedure is that it does not require specification of a model of heteroscedasticity and thus avoids the potentially deleterious effects of an incorrect specification. Though the coefficient estimates are inefficient, t and F tests are asymptotically valid.

It is not uncommon in studies such as this to pool data from all countries (see, for example, Linneman (1966), Aitken (1973), Abrams (1980), and Bergstrand (1985)). In that case, the implied restrictions for the equations (5) are $\delta^1 = \delta^2 = \ldots = \delta^{17}$ where $\delta^i = (\delta^i_1, \ldots, \delta^i_k)'$, and we test the equality of coefficient vectors for every pair of equations. That is, we test the 136 null hypotheses $\delta^i = \delta^j$ $(i,j=1,\ldots,17;\ i \neq j)$. Due to the possible presence of heteroscedasticity, we use the Wald bounds test suggested by Kobayashi (1986). In every case the Wald statistics are greater than the five percent upper bound, thus we decisively reject the restrictions necessary for pooling any of the data.

As noted in Section 3, a distinguishing feature of this study is that we estimate (5) using measures of both nominal and real exchange rate variability. To distinguish which, if either, of these competing and non-nested models is appropriate, we use the JA test procedure (see, for example, McAleer (1984)). As is the case with all non-nested model test procedures, it is possible to accept both models or to reject both models as well as to accept one and reject the other. A rejection of both models implies that both models are incorrectly specified and a third (and unspecified) model is correct. Acceptance of both models implies that the data are unable to distinguish between the models.

5. EMPIRICAL RESULTS

The results of the JA test procedure suggest that equation (5) is an appropriate specification (based on a 5% significance level) for bilateral trade of all countries in our sample except Switzerland. With few exceptions, the test was unable to distinquish between the real and nominal equations. This is not surprising since there was little difference in the magnitude, sign, and significance of the coefficient estimates for the real and nominal equations. However, only the real equation was accepted for Finland; and only the nominal equation was accepted for France, Greece, and Japan. Table 1 presents the coefficient estimates and t statistics for each country. Because the results are largely indistinguishable, we present only estimates for the nominal equations for all countries except Finland.[5]

In interpreting coefficient estimates, recall that equation (5) is a reduced form equation for the value of bilateral trade. Without data for P^i_j or Q^i_j the structural parameters of the model cannot be recovered. While this does not create statistical bias for the estimators of the coefficients of (5), it leads to possible ambiguity in interpreting coefficients of any variable entering the supply equation (VAR^i_j, G_i, CPI_i, and PS^i_o). On the other hand, the coefficient for any variable which appears only in the demand equation will have the same sign as the structural parameter. Hence we expect the coefficient of Z_j^i to be negative according to the Linder hypothesis, and R_j^i should have a negative coefficient reflecting a decrease in the value of exports (denominated in the exporter's currency) in response to an appreciation of exporter i's currency. Distance should have a negative coefficient; and adjacency (A_j^i), the preferential dummy (E_j^i) and G_j should all have positive coefficients. Depending on the substitutability among goods, the coefficients of CPI_j and PD_j^o may be negative or positive.

Perhaps the most striking result is the overwhelming support for the Linder hypothesis. For all countries except Canada and South Africa, the coefficient for Z_j^i is negative and significant (the United States at the 11% level and all others at the 5 percent level). Since our data are for all merchandise trade and Linder's hypothesis pertains to trade in manufactures, it may not be surprising that it is rejected in those two cases. For most of the countries in the sample, manufactures comprise substantially more than half of exports; but for South Africa, manufactures account for roughly a sixth of exports, and manufactures are barely more than half of Canada's exports.[6]

Our results also support the gravity model, the coefficients for the gravity variables, D_j^i and A_j^i, all being significant and having the expected signs. The preferential dummy appears to be more important for EFTA countries than for those in the EEC since of the EEC countries, it is significant and positive only for Denmark and the United Kingdom (the latter significant at 14%). This result is consistent with Bergstrand's result that the EFTA dummy was significant more often than that for the EEC. Our results are also consistent with his generalized version of the gravity model since for a number of countries the exchange rate and export and domestic price terms are significant. The exchange rate term, R_j^i, is negative and significant at the 5% level for eleven countries. In Bergstrand's study the exchange rate term was significant for one of the three years he studied. Country comparisons with his study cannot be made since he pooled data for all countries.

We also find support for the hypothesis that exchange risk affects the value of bilateral trade among countries. The VAR_j^i coefficients are negative and significant for ten countries (five are significant at the 1% level, three at the 5% level, plus Italy at 12% and South Africa at 18%; if the real rate is used the coefficients for Italy and South Africa are significant at the 1% and 5% levels, respectively). To interpret these results, recall that exchange risk can affect the value of trade by shifting either demand or supply. We would expect a negative coefficient for VAR_j^i if demand shifted back in response to increased variability or if supply shifted back with elastic demand. In either event, the negative coefficient implies that export volume declines (except in the extreme case of zero elasticity of supply, $\beta_1=0$), but we cannot determine whether the export price rises or declines without data for P_j^i.[7] The cases with insignificant coefficients are consistent with either price and volume effects offsetting each other or no shifts in either demand or supply.

As we would expect, the importing country's GNP is significant and positive in all cases. Results for the exporter's GNP vary. For four countries (Belgium, France, Italy, and United Kingdom) the coefficient is negative and significant at the 5% level. From equations (3) and (4), it can be seen that the coefficient of exporter's GNP (G_i) is $[-\beta_5^i(\alpha_1^i+1)]/D$. Since we expect D and β_5^i to be positive, a negative coefficient implies that the elasticity, α_1^i, is less than 1 in magnitude. Notice that these four countries also have significant, negative coefficients for VAR_j^i. Hence the combined VAR_j^i and G_i results allow us to reject a supply shift with elastic demand as a reason for the negative effect of exchange rate variability on bilateral trade of these four countries.

6. CONCLUDING REMARKS

In this paper we derive and estimate a model to explain a country's bilateral trade pattern. It is shown that an estimating equation similar to a generalized gravity equation can be derived from fairly standard assumptions about demand and supply. If the importer's demand function includes a term to reflect tastes and if, in addition, we allow for the possibility that risk averse exporters and importers may hedge their foreign exchange transactions through the forward market, the estimating equation will include terms which allow tests of the Linder hypothesis and the effects of exchange risk on the value of trade. This is the first paper to show that a complete specification of a gravity equation would include these terms.

The model is estimated for a sample of 17 countries for the period 1974-1982. Based on the JA test procedure, this version of the gravity model is an acceptable specification of bilateral trade in the case of all but one country. Moreover, Wald tests for structural shift support our estimation of separate equations for each country's trade. Not only would pooling data into one equation be inappropriate for this sample, but also we reject the pooling of data for exports for any two countries.

We find overwhelming support of the Linder hypothesis. The coefficient of the Linder term is significant and negative for all countries but two. These results are interesting since previous empirical tests using the gravity model have tended to reject the hypothesis (see Deardorff (1984)).[8]

There is also strong support for the hypothesis that exchange risk affects the value of bilateral trade. Of the countries which have acceptable specifications, ten of the coefficients on exchange rate variability are negative and significant. One virtue of relating equation (5) to the underlying demand and supply equations is that it aids in interpreting these results. While the negative coefficients are consistent with a backward shift in demand, a backward shift in both demand and supply, or a backward supply shift with elastic demand in response to increased variability, the combined results for VAR_j^i and G_i allow us to reject a supply shift with elastic demand for four countries.

Finally, this is the only study to examine these results for both real and nominal measures of exchange risk. Studies by Abrams (1980), Akhtar and Hilton (1984), Hooper and Kohlhagen (1978) have found significant trade flow effects of nominal exchange risk, and Cushman (1983), Kenen and Rodrik (1984, 1986), and Thursby and Thursby (1985) have found significant trade effects of real exchange risk. By including both, we are able to test statistically for whether real and nominal exchange rate variability affect trade differently. At least for this sample the results are indistinguishable.[9]

FOOTNOTES

1. For studies of alternative variants of Linder's hypothesis see Blejer (1978) and Markusen (1986).

2. The gravity model has been used in several studies of the Linder hypothesis (Gruber and Vernon (1970), Hirsch and Lev (1973)) and exchange rate variability (Abrams (1980)).

3. For discussion of these and references see Kenen and Rodrik (1984, 1986), Akhtar and Hilton (1984), and Thursby and Thursby (1985).

4. The difference between the previous forward rate and current spot rate is an appealing measure theoretically (see Ethier (1973) and Hooper and Kohlhagen (1978)). Another alternative is to use forward rates in estimating (6). Given evidence in Mussa (1979), we would not expect much difference in results.

5. It should be noted that equations for Finland, France, Italy, Norway, and South Africa used WPI as the domestic price variable. For these countries, the JA test procedure rejected equations using the CPI, but accepted the specifications noted in the text when the WPI was used.

6. For the period studied, manufactures as a percentage of exports ranged from 69% to 97% for 11 of the countries studied. Countries for which manufactures were less than 60% of exports were Canada, Denmark, Greece, Netherlands, Norway, and South Africa. Sources: IMF, International Financial Statistics: Supplement and Da Gama Publishers, State of South Africa: Yearbook.

7. Had any of the coefficients been positive and significant, we could have inferred that export prices rose with increased variability.

8. In this regard, our results are consistent with those of Abrams (1980) who finds support for the Linder hypothesis in a gravity equation which also includes a term for exchange risk. His analysis differs from ours in that he pools data into a single equation, and he uses different measures of exchange risk and only examines nominal exchange rate variability. Moreover, his specification is ad hoc so that it does not include the other price terms that our underlying model implies should be included in the equation.

9. Addressing a different question, Mark (1986) finds little difference in real and nominal exchange rate changes. Such a phenomenon may underly the similar trade flow effects.

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DATA APPENDIX

All data except trade flows and distance are from International Monetary Fund, International Financial Statistics, and trade flows are taken from International Monetary Fund, Direction of Trade. Exchange rates, CPI, and WPI are monthly, and all other variables are yearly. Economic centers for computing distances are based primarily on those specified in Linneman (1965). Sea distances are from U.S. Naval Oceanographic Office, Distance Between Ports, H.O. Publication #151, U.S. Government Printing Office, 1965, and land distances are from Rand McNally Road Atlas, Rand McNally and Co., 1974.

Table 1

Variable / Country	Z^i_j	VAR^i_j	G_j	G_i	R^i_j	CPI_j	CPI_i	D^i_j	PS^i_o	PD^o_j	A^i_j	E_j	R^2
Austria	-.245	-.405	.281	.361	-.358	.547	-1.442	-.573	.524	-.056	1.713	.0004	.797
	(-8.736)	(-.811)	(9.567)	(.318)	(-.613)	(.776)	(-.752)	(-9.333)	(.138)	(-.129)	(13.839)	(2.550)	
Belgium	-.223	-1.552	.496	-1.944	-1.884	2.639	-2.701	-.900	1.060	-.495	.841	-.0001	.826
	(-5.373)	(-2.048)	(10.317)	(-1.648)	(-3.152)	(3.738)	(-2.347)	(-13.648)	(.648)	(-1.109)	(4.120)	(-1.943)	
Canada	-.030	-3.031	.597	1.707	-2.336	3.343	-6.379	-6.531	1.034	-.493	1.872	na	.798
	(-.352)	(-3.214)	(9.681)	(1.994)	(-3.271)	(4.474)	(-3.043)	(-7.745)	(.587)	(-.835)	(7.255)		
Denmark	-.381	1.603	.309	.475	-.941	3.106	-.711	-.687	-2.526	-.065	1.153	.004	.691
	(-10.348)	(1.252)	(7.149)	(.553)	(-1.473)	(5.072)	(-.281)	(-9.298)	(-.688)	(-.173)	(3.536)	(5.684)	
Finland	-.348	-.010	.476	-.489	-3.012	.157	1.865	-1.258	-1.065	-.230	.759	.001	.824
	(-9.989)	(-.025)	(14.708)	(-1.026)	(-5.841)	(.585)	(.771)	(-20.321)	(-.490)	(-.726)	(4.015)	(.867)	
France	-.250	-2.884	.515	-1.108	-2.144	3.341	.105	-.764	-2.245	-.431	1.417	-.0001	.833
	(-4.613)	(-4.381)	(11.405)	(-2.371)	(-4.212)	(7.025)	(.081)	(-10.774)	(-2.106)	(-1.471)	(10.767)	(-1.357)	
Germany	-.186	-.295	.469	-.964	-.129	.110	4.418	-.831	-3.575	.068	.625	-.0001	.672
	(-4.545)	(-.358)	(11.443)	(-.731)	(-.269)	(.187)	(2.022)	(-11.712)	(-1.527)	(.231)	(4.444)	(-.555)	
Greece	-.955	-3.349	.946	-.400	-2.550	1.125	-1.328	-1.273	-.543	.985	na	-.0002	.767
	(-15.973)	(-3.290)	(15.578)	(-.842)	(-3.697)	(1.381)	(-.881)	(-9.778)	(-.342)	(2.234)		(-.974)	
Italy	-.774	-.668	1.023	-.564	-1.530	1.277	1.184	-1.340	-1.838	.217	.267	.0000	.942
	(-28.354)	(-1.555)	(44.194)	(-3.160)	(-4.742)	(3.978)	(.519)	(-26.793)	(-.827)	(.875)	(4.747)	(.091)	
Japan	-.275	-3.911	.464	2.448	-4.147	3.618	-3.045	-.892	-3.546	-.520	na	na	.645
	(-4.209)	(-3.467)	(7.085)	(2.127)	(-6.958)	(5.267)	(-2.248)	(-3.898)	(-2.203)	(-1.024)			
Netherlands	-.218	-1.701	.461	-.145	-.908	2.193	-3.633	-.912	1.736	-.478	.976	-.0002	.804
	(-5.837)	(-2.432)	(12.826)	(-.899)	(-1.514)	(3.261)	(-2.515)	(-16.932)	(.858)	(-1.179)	(3.628)	(-.400)	
Norway	-.327	-.603	.423	.539	-2.549	4.053	-11.098	-1.184	5.231	-1.222	.758	.004	.648
	(-8.451)	(-.484)	(8.131)	(.661)	(-3.094)	(5.158)	(-3.171)	(-11.101)	(1.972)	(-2.078)	(4.273)	(2.859)	
South Africa	3.666	-2.023	1.027	-3.448	-4.874	2.511	-8.432	-7.279	6.407	1.606	na	na	.739
	(.218)	(-1.341)	(15.407)	(-.196)	(-5.562)	(2.618)	(-1.154)	(-6.879)	(.944)	(2.739)			
Sweden	-.353	-1.070	.412	.503	-.362	1.079	-4.745	-.986	3.000	-.099	.457	.001	.768
	(-8.467)	(-1.994)	(14.121)	(1.367)	(-.797)	(2.330)	(-2.152)	(-16.975)	(1.476)	(-.372)	(2.611)	(1.755)	
Switzerland	-.417	.227	.453	-1.223	-.460	.879	.790	-.358	-1.559	.054	1.097	.002	.822
	(-8.693)	(.521)	(11.237)	(-1.088)	(-.910)	(1.667)	(.534)	(-6.973)	(-.800)	(.229)	(9.710)	(2.460)	
United Kingdom	-.263	-1.849	.502	-.802	-2.059	2.816	1.956	-.737	-3.774	-.028	na	.002	.698
	(-5.637)	(-2.523)	(13.522)	(-2.568)	(-3.372)	(3.273)	(.787)	(-14.629)	(-1.394)	(-.086)		(1.483)	
United States	-.113	-.949	.548	2.034	-4.126	3.537	-1.365	-2.839	-3.891	.495	1.461	na	.643
	(-1.609)	(-.622)	(10.463)	(1.893)	(-5.644)	(4.308)	(-.339)	(-3.970)	(-.987)	(.973)	(5.748)		

* t-ratios in parentheses