International Trade Flows Under Flexible Exchange Rates

By Richard K Abrams

World trade has grown rapidly since the breakdown of the Bretton Woods system of fixed exchange rates in early 1973. Although much of the nominal trade growth resulted from inflation, it is apparent that world trade has continued to prosper despite the increase in exchange rate variability permitted by the 1973 shift from fixed to floating exchange rates. Nevertheless, some observers have argued that exchange rate uncertainty may have had an adverse impact on trade. If these observers are correct, the growth in trade of recent years has been the result of favorable influences which have more than offset the adverse impact of exchange rate uncertainty.

This article examines the macroeconomic determinants of international trade flows between developed countries, giving special attention to the effects of exchange rate variability. The article also analyzes whether and to what extent fluctuations in bilateral exchange rates have had an adverse impact on bilateral trade flows.

THE DETERMINANTS OF INTERNATIONAL TRADE FLOWS

One of the primary determinants of the trade flows between two countries is the exporting country's potential supply of exports. A country's export capacity is related to its total productive capacity, which in turn is related to its national income. Other things equal, then, the higher a country's income the more goods a country will tend to export. By the same token, trade flows will also be affected by the income of the importing country. That is, the higher a country's income the greater will be its demand for imports as well as for domestically produced goods.[1]

One economist has argued that demand, rather than supply, is the primary determinant of potential bilateral trade.[2] As a result, he argued that the more similar are the demand characteristics of any pair of countries, the greater will be their potential trade possibilities. While income distribution, politics, climate, and historical background all have an impact on a country's demand patterns, national per capita income is probably the primary determinant. Therefore, the closer the per capita incomes are in any pair of countries, the greater their potential trade.

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1 For a discussion of the impact on trade of income and other factors in this section, see J. Tinbergen, ***Shaping the World Economy.*** Twentieth Century Fund, 1962, and H. Linnemann, ***An Econometric Study of World Trade Flows,*** North-Holland Publishing Co., 1966.

2 See S. Burenstam-Linder, ***An Essay on Trade and Transformation,*** John Wiley & Sons, 1966.

The distance between two countries is another factor that may affect trade because trading across long distances involves greater time and transport costs. Distance may also be related to a country's "psychic" or "economic" horizon.[3] That is, the greater the distance between any pair of countries, the less perfect will be a trader's knowledge about conditions relating to trade between the countries.

Membership in trade preference organizations may also affect international trade flows. One such group is the European Economic Community (EEC), which during the 1973-76 period consisted of Belgium, Denmark, France, West Germany, Ireland, Italy, the Netherlands, and the United Kingdom. Austria, Finland, Iceland, Norway, Portugal, Sweden, and Switzerland were participants in another organization — the European Free Trade Association (EFTA). Membership in a trade preference organization allows each member preferential access to the domestic markets of the other members of the organization. This normally results in an expansion of trade between that country and other countries in the association. Some of the expansion of trade comes at the expense of trade with nonorganizational members (trade diversion), while other portions represent a net trade expansion (trade creation).

Another factor that may have an impact on trade between countries is uncertainty caused by exchange rate variability. Numerous theoretical studies have concluded that increases in exchange rate uncertainty may decrease both import demand and export supply, although empirical studies have not been successful in providing empirical evidence on the impact of uncertainty.[4] For the most part, the empirical studies have emphasized short-run aspects of trade. Exchange rate uncertainty, however, may be more important in affecting the longer term aspects of international trade that go beyond a given contract period and are too uncertain to be hedged.

The longer run aspects of exchange rate uncertainty may tend to reduce international trade by reducing the willingness of international traders to enter into long-term contracts. Also, uncertainty may reduce trade in the long run by causing exporters to reduce or forego the long-term investment necessary for establishing or expanding foreign markets or export facilities. These effects can arise from three sources. First, even when contracts are hedged, exchange rate fluctuations may render long-term contracts unprofitable for the exporter or the importer. Second, over time, exchange rate fluctuations may lead to fear that the international price competitiveness of producers in different countries may be altered. Third, increased exchange rate uncertainty acts to increase the variability of expected earnings flows, which may decrease investment because many firms attach positive utility to the stability of their flow of earnings. As a result of these factors, increases in exchange rate variability may cause both exporters and

3 This point is made by Linnemann in his *An Econometric Study of World Trade Flows.*

4 For theoretical studies, see, for example, P. B. Clark, "Uncertainty, Exchange Rate Risk, and the Level of International Trade," *Western Economic Journal.* September 1973; *W*. Ethier, "International Trade and the Forward Exchange Market," *American Economic Review,* June 1973; and P. Hooper and S. Kohlhagen, "The Effects of Exchange Rate Uncertainty on the Prices and Volume of International Trade," *Journal of International Economics,* November 1978.

For a casual examination using annual data, see L. Yeager, *International Monetary Relations,* Harper & Row, 1966. Examples of empirical studies using quarterly data include J. Makin, "Eurocurrencies and the Evolution of the International Monetary System," in *Eurocurrencies and the International Monetary System, C*. Stem, et al., eds., American Enterprise Inst., 1976, and Hooper and Kohlhagen, "The Effects of Exchange Rate Uncertainty."

importers to pursue their business with greater caution.[5]

EMPIRICAL ESTIMATION

The previous section discussed several variables which may influence international trade flows. In this section, the effects of these variables on trade between 19 countries during the 1973-76 period are empirically estimated. For this purpose a single equation econometric model was used. The model can be summarized as follows:[6]

$$X_{ij} = f(GDP_i, GDPj, D_{ij}, PCD_{ij}, EEC_{ij}, EFTA_{ij}, VEX_{ij}, VTREX_{ij})$$

where

i, j = 1 through 19 countries ($i \neq j$). The countries are Austria, Australia, Belgium, Canada, Denmark, Finland, France, West Germany, Iceland, Ireland, Italy, Japan, the Netherlands, Norway, Portugal, Sweden, Switzerland, the United Kingdom, and the United States.

X_{ij} = trade flows af country i to country j; that is, the exports of i to j, measured in constant 1970 SDR's,

GDP_i = the income of country i (the exporting country), measured by i's Gross Domestic Product (GDP) in constant 1970 SDR's,

GDPj = the income of country j (the importing country), measured by j's GDP in constant 1970 SDR's,

D_{ij} = distance between i and j,

PCD_{ij} = absolute percentage difference in real per capita incomes of i and j,

EEC_{ij} = a dummy variable to measure the impact of membership in the EEC. This variable is set equal to 1 if i and j are both members of the EEC and 0 otherwise,

$EFTA_{ij}$ = a dummy variable to measure the impact of membership in the EFTA. This variable is set equal to 1 if i and j are both members of the EFTA and 0 otherwise,

VEX_{ij} = a proxy for exchange rate uncertainty between i and j caused by any bilateral exchange rate variability, and

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5 Finally, many countries choose to inhibit the importation of goods from other countries through both tariff and nontariff barriers. Thus, in general, actual world trading patterns are below their potential levels. Unfortunately, these effects are not quantifiable. For a discussion of how tariff and nontariff barriers inhibit agricultural trade, see R. Abrams and C. E. Harshbarger, "U.S. Agricultural Trade in the 1970s: Progress and Problems," *Economic* Review, Federal Reserve Bank of Kansas City, May 1979.

6 The model is an adaptation of the model developed by Jan Tinbergen and Hans Linnemann in the studies referred to Footnote 1. As a result of trade barriers being nonquantifiable, the model can only depict average trading patterns. For a full discussion of the model, see Richard K Abrams, "Actual and Potential Trade Flows with Flexible Exchange Rates," Federal Reserve Bank of Kansas City, Working Paper 80-01.

$VTREX_{ij}$ = a proxy for exchange rate uncertainty between i and j caused by variation of bilateral exchange rates from trend.

The variable measuring trade flows, X_{ij}, and the income variables, GDP_i and GDPj, are deflated by the exporting country's export price index and the domestic country's CPI, respectively, to keep all values in constant terms. This was done to minimize the effect of inflation on the model. EEC and EFTA are included in the model to quantify the additional trade which usually results when both trading partners are members of the same trade preference organization. Membership in the two associations was treated separately because the impact of associational membership may vary between organizations. D_{ij} measures distance between major ports or the closest distance overland between each pair of countries, while PCD_{ij} is a proxy for the similarity of the demand characteristics of each pair of countries.[7]

The last two variables, VEX and VTREX, measure the exchange rate uncertainty that may arise from two somewhat different sources. First, uncertainty may be caused by any variation in bilateral exchange rates. That is, any variation may be unexpected, and therefore, it may increase uncertainty. Alternatively, market participants may expect a trend to develop in bilateral exchange rates. In this case, only deviations from that trend give rise to increased levels of uncertainty. VEX is meant to measure the first form of uncertainty. It assumes that exchange rate uncertainty is related to past variance in bilateral exchange rates. VTREX measures the second form of uncertainty and assumes that exchange rate uncertainty is related to past variance in bilateral rates from their trend.[8]

To determine the impact of the different variables on international trade flows, the coefficients of the single equation model were empirically estimated using ordinary least squares regression analysis. The analysis used pooled time series cross-section data which included observations of the trade flows of the 19 countries in the sample for each of the years from 1973 to 1976.[9]

The model was first estimated using international trade flows, X_{ij}, as the dependent variable, and GDP_i, GDPj, and the other variables listed previously as independent variables. This estimate, however, was unable

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7 PCD is similar to a variable developed by Z. Hirsch and B. Lev in "Trade and Per Capita Income Differentials: A Test of the Burenstam-Linder Hypothesis," World Development, September 1973. $PCD_{ij} = \max (RPC_i/RPC_j, RPC_j/RPC_i)$ where RPC is real per capita income. When the model is placed in log-linear form, PCD_{ij} becomes $|\log RPC_i - \log RPC_j|$.

8 If in year t, j's exchange rate in terms of i's currency is $EX_{i,j,t}$, then

$$VEX_{i,j,t} = \sum_{k=1}^{12} [(EX_{i,j,k} - \overline{EX}_{i,j,t-1}) - 1]^2$$

where k represents the months of year t-1. If monthly changes in bilateral exchange rates are ΔEX_{ij}, then

$$VTREX_{i,j,t} = \sum_{k=1}^{12} [\Delta EX_{i,j,k} - \Delta\overline{EX}_{i,j,t-1}) - 1]^2$$

where k represents the months of year t-1. Both VEX and VTREX use values from the previous year to avoid ascribing excessive knowledge to the transactors.

9 The model was estimated in log-linear form. As a result, the sum of the antilogs of the expected values of the dependent variable was not necessarily equal to the sum of the actual values of the dependent variable. The use of a single equation for the whole period was based on the hypothesis that the relationship of the variables in the model to international trading patterns was stable throughout the period. The stability of each specification of the model across time was tested by stratifying the data and making the equivalent of a four-period Chow test. In no case was it possible to reject the null hypothesis of structural stability at the 5 per cent confidence level. Tests for a time trend in bilateral trade also were insignificant.

Table 1
RESULTS OF THE REGRESSION ANALYSIS OF THE DETERMINANTS OF TRADE FLOWS

Equation	Intercept	GDP_i	GDP_j	D_{ij}	PCD_{ij}	EEC_{ij}	$EFTA_{ij}$	VEX_{ij}	$VTREX_{ij}$	R^2	S.E.E.
	COEFFICIENT										
1.1	0.447	0.756	0.651	-0.251	-0.198	0.313	0.244	-0.052		0.803	0.383
	(6.52)	(47.77)	(41.76)	(24.51)	(-3.09)	(10.15)	(6.64)	(3.96)			
1.2	0.412	0.755	0.650	-0.252	-0.188	0.305	0.248		-0.059	0.803	0.382
	(5.48)	(47.83)	(41.85)	(-24.80)	(-2.94)	(9.91)	(6.78)		(-3.95)		

NOTES: t-statistics in parentheses indicate that all coefficients are statistically significant at the 1 per cent level of confidence. R^2 is the coefficient of determination. S.E.E. is the standard error of the estimate. The empirical equation estimated is as follows:

$$\log X_{ij} = a_0 + a_1 \log GDP_i + a2 \log GDPj + a_3 \log D_{ij} + a_4 \log PCD_{ij} + a_5 EEC_{ij} + a_6 EFTA_{ij} + a_7 \log VEX_{ij} + a_8 \log VTREX_{ij} + e_{ij}.$$

to isolate the separate impacts of VEX and VTREX, due partly to the close relationship between these variables. For this reason, two additional regression equations were estimated. One (equation **1.1)** included all variables except VTREX, while the other (equation **1.2)** excluded VEX and included the other variables. The results of the two versions of the model are presented in Table **1.** All coefficients in both models are statistically significant at the 1 per cent confidence level and have the expected sign.[10] The general fit of the two models was good: the R^2 of both models was 0.80, implying that the model explained about four-fifths of the variation in bilateral trade flows.

The estimated effects of income, distance, and 'trade perference on trade flows all generally coincided with the findings of previous research. The coefficient on the GDP_i was about 0.76 in both equations, implying that a 1 per cent increase in the income of an exporting country, on average, resulted in about a three-fourths of 1 per cent increase in its exports to each of its trading partners. The coefficient of 0.65 on GDPj implies that a 1 per cent increase in the income of the importing country is matched by approximately a two-thirds of 1 per cent increase in imports from each trading partner. The larger coefficient on GDP_i than GDPj implies that, other things equal, a higher-income country had a higher ratio of expected exports to expected imports than a lower-income country. This result appears reasonable because the model only deals with trade between a subset of developed countries.

The coefficient on the distance variable was about -0.25 in both of the estimated equations. To understand the significance of this coefficient, assume country A trades with two countries, B and C, which are identical in all respects except that B is 1 per cent further from A than C. In this case, the estimated coefficient on D_{ij} implies that A would be expected to have roughly one-fourth of 1 per cent more

[10] **Certain variables not discussed in the text were included in preliminary versions of the model. For example, the populations of importing and exporting countries were included because Linnemann found that they have a negative impact on trade. However, in tests for this article, population was not found to be statistically significant.**

trade with C than with B.

In both models, the coefficients on the trade preference dummy variables, EEC and EFTA, were about 0.31 and about 0.25, respectively. These findings imply that membership in either the EEC or the EFTA resulted in significantly higher levels of trade with other members of the given trade association than with nonmembers. The larger coefficient on EEC seems to indicate that these effects were more pronounced within the EEC than in the EFTA.

The significant coefficient on PCD lends support to the hypothesis that per capita income differentials affected trade. The point estimates on PCD, ranging from -0.188 to -0.198, imply that, other things equal, a 1 per cent larger per capita income differential resulted in approximately a 0.2 per cent decline in expected trade between the two countries.

The coefficients on the exchange rate uncertainty variables in equations 1.1 and 1.2 were statistically significant when they were tested separately. Moreover, while the model was unable to isolate which form of uncertainty was the primary cause of trade losses, negative coefficients on VEX and VTREX clearly show that exchange rate uncertainty did have an adverse effect on international trade flows in the 1973-76 period. Thus, while previous research has presented theoretical evidence that exchange rate volatility may reduce international trade, this paper is the first to provide empirical support for this hypothesis.

ESTIMATES OF THE TRADE LOSSES FROM EXCHANGE RATE VARIABILITY

This section uses the model to estimate trade losses that resulted from exchange rate uncertainty during the 1973-76 period, the first four years of the generalized float. These estimates were made by using a three-step procedure. The first step was to estimate the levels of bilateral trade flows that would be expected to prevail under conditions that existed during the 1973-76 floating rate period, including the level of exchange rate uncertainty. The second step was to estimate the trade flows that would be expected to prevail under pre-1973 levels of exchange rate uncertainty rather than the uncertainty of the 1973-76 period. The third step was to compare the trade flows estimated in the first step with those estimated in the second to obtain estimates of any trade losses that resulted from increases in exchange rate uncertainty during the 1973-76 period.

The first step-estimating trade flows under 1973-76 uncertainty conditions—involves calculating the model's estimates of trade flows for the period. The calculation uses the estimated values of the model's coefficients along with the 1973-76 values of all of the independent variables, including variables measuring exchange rate uncertainty, VEX, or VTREX. The results indicate that, according to the version of the model containing VEX (equation 1.1), trade flows for the 19 countries would be expected to total approximately SDR659 billion under conditions that prevailed during the 1973-76 period. For the VTREX version (equation 1.2), trade flows would have been expected to be SDR664 billion. (See Table 2.)

The second step involves simulating the model to estimate the level of trade flows that would be expected had pre-1973 levels of exchange rate uncertainty continued through the 1973-76 period. In simulating the model, the estimated coefficients were used, along with the 1973-76 values of all independent variables except the variables measuring exchange rate uncertainty. For VEX and VTREX, pre-1973 values were used. VEX and VTREX, however, varied markedly from year to year during the latter part of the pre-1973 fixed rate period, with no single year appearing representative. For this reason, one "good" or stable year and

one "bad" or unstable year was used to represent a range for exchange rate uncertainty during the pre-1973 fixed rate period. For the stable year, 1970 was used. Although there were major capital flows taking place in 1970, the only major exchange rate movement was the float of the Canadian dollar in May of that year. For the unstable year, 1971 was selected because the fixed exchange rate system nearly collapsed in that year; 1971 was not only marked by numerous major currency revaluations and devaluations, but, starting in August of that year, the United States suspended dollar convertibility for a four-month period, which resulted in a chaotic period of floating but managed exchange rates.

In summary, a total of four sets of simulations were made. These included two simulations of both equations 1.1 and 1.2 using first 1970 values of VEX and VTREX and, then, 1971 values of these variables. The results are presented in Table 2. The simulations yield estimates of total trade from as high as SDR790 billion using the model with VTREX and 1970 levels of exchange rate uncertainty, to as low as SDR657 billion using the same model and 1971 levels of uncertainty.

Table 2
ESTIMATED TRADE REDUCTION 1973-76 CAUSED BY EXCHANGE RATE UNCERTAINTY
(In billions of 1970 SDR's)

	Exchange Rate Uncertainty Measured by: VEX (eq. 1.1)	VTREX (eq. 1.2)
Total Expected Trade*		
Under 1973-76 levels of exchange rate uncertainty	659.2	663.6
Under pre-1973 levels of exchange rate uncertainty		
1970 levels	756.2	790.5
1971 levels	666.9	656.8
Trade Loss		
1970 levels	97.0	126.9
Per cent of total trade	14.7	19.1
1971 levels	7.7	–6.8
Per cent of total trade	1.2	–1.0

*Actual trade flows totaled SDR690.4 billion during the period.

The results of the third step-comparing the trade flows of the first and second steps—are shown in the last two rows of Table 2. They show that had exchange rate uncertainty remained during the 1973-76 period as it was in 1970, large amounts of additional trade may have taken place. The simulations using the 1970 values of the exchange rate uncertainty imply that from 14.7 to as much as 19.1 per cent more trade would have taken place during the period. On the other hand, if the more unstable conditions of 1971 had prevailed in the 1973-76 period, the model implies that very little more, or possibly less, trade would have taken place.

CONCLUSION

This article has presented a model of macro-economic determinants of trade flows between developed countries. An important feature of the model was the inclusion of variables that measured the effects of the exchange rate uncertainty which resulted from exchange rate variability. The model was used to estimate the trade losses which may have occurred during the 1973-76 period as a result of exchange rate uncertainty generally being greater than in the pre-1973 fixed-rate period.

As in previous research, the incomes of both the exporting and importing countries, the distance between the trading countries, and membership in the same trade preference organization were found to have a significant impact on international trade flows. The findings also supported the hypothesis that

countries with more similar demand characteristics tend to engage in more bilateral trade.

The most important contribution of the model is its isolation of the effects of exchange rate uncertainty on international trade flows. While previous research implies that exchange rate uncertainty may have a negative impact on trade, this model is the first to empirically support the hypothesis that trade is adversely affected by uncertainty.

This study also found that estimated trade losses from increased exchange rate uncertainty during the 1973-76 period depend on the level of uncertainty that was assumed to have prevailed in the pre-1973 period. If exchange rate conditions during the 1973-76 period would have been similar to the relatively stable conditions which existed in 1970, it was estimated that world trade would have expanded considerably more than it actually did. On the other hand, if the unstable exchange rate conditions of 1971 had prevailed in the 1973-76 period, it was estimated that international trade during this period would have closely approximated the trade which actually took place.

Because differing exchange rate regimes may have differing maintenance and adjustment costs as well as differing levels of capital controls, the results of this article cannot be generalized to show one exchange rate regime as being preferable to another. However, the article does show that, other things equal, increased exchange rate volatility is detrimental to trade. Furthermore, if exchange rate volatility could be reduced at a modest cost, it would be a way to increase international trade flows.