

Exchange Rate Risk and U.S. Trade: A Sectoral Analysis

By Keith E. Maskus

Foreign exchange rates have been highly volatile since the currencies of the major industrial countries were allowed to float in 1973. When fixed rates were abandoned, many observers thought exchange rate fluctuations would eventually dampen as market participants gained experience in flexibly priced currency markets. But oscillations in currency values have not declined and may have increased since 1980.¹

Exchange rate volatility is a cause for concern if it impairs the smooth functioning of the world economy. Volatility can be detrimental in several ways. It can reduce the volume of international trade by creating uncertainty

about the profits to be made from international transactions. Fluctuations in exchange rates also might restrict the international flow of capital by reducing both direct investment in foreign operating facilities and financial portfolio investment. Finally, exchange rate volatility might lead to higher prices for internationally traded goods by causing traders to add a risk premium to cover unanticipated exchange rate fluctuations.

In view of these potential problems, this article investigates the effects of exchange rate volatility on U.S. imports and exports during the 1974-84 period. The article first discusses theoretical relationships between exchange rate volatility and international trade and shows that, due to unpredictable fluctuations in real exchange rates, firms engaged in trade have faced exchange rate risk during the period of floating rates. The article then presents the results of an empirical investigation showing that this exchange rate risk had a modest negative effect on U.S. imports and exports during the 1974-84 period. The strength of this effect varied somewhat across sectors and trading partners.

¹ See Craig S. Hakkio, "Exchange Rate Volatility and Federal Reserve Policy," *Economic Review*, Federal Reserve Bank of Kansas City, July/August 1984, pp. 18-31.

Keith E. Maskus is an assistant professor of economics at the University of Colorado, Boulder, and a visiting scholar in the Economic Research Department at the Federal Reserve Bank of Kansas City. Richard Roberts, a research associate at the bank, helped in the preparation of the article. The views expressed in the article are those of the author and do not necessarily reflect the opinions of the Federal Reserve Bank of Kansas City or the Federal Reserve System.

Foreign exchange risk and international trade

When exchange rate volatility cannot be predicted, it creates uncertainty about the magnitude of profits to be realized from international trade. This uncertainty is referred to as exchange rate uncertainty or exchange rate risk.

Nominal foreign exchange risk

Nominal exchange risk occurs when profits are uncertain due to unexpected changes in nominal exchange rates. For example, suppose a U.S. importing firm agrees to purchase commodities from Japan that cost one million yen, with payment due in three months. If the dollar unexpectedly depreciates relative to the yen over the three-month period, the dollar value of the purchase contract rises. This change imposes correspondingly higher costs on the importing firm, making its profits lower than anticipated. Alternatively, if the dollar unexpectedly appreciates, the change causes the importer's profits to exceed expectations. Exporting firms face corresponding uncertainty when their receipts are denominated in foreign currencies.

One way of limiting exposure to nominal exchange risk is by participating in the forward foreign exchange markets. Participants in forward exchange markets contract to buy or sell currencies in the future at currently specified exchange rates. The U.S. firm in the example above could agree to buy, in three months, the yen needed to settle its contract. The price of these future yen is called the forward exchange rate. Because the U.S. firm would know that rate with certainty, it might prefer to trade at the forward rate rather than wait to discover what the current, or spot, exchange rate would be in three months. By

locking in a specified exchange rate at which it can settle the contract, the firm can use the forward market to reduce nominal exchange risk.

Forward markets do not ensure completely against nominal foreign exchange risk, however. One reason is that such insurance is costly. When future spot exchange rates are uncertain, those bearing the risk demand extra compensation, known as the risk premium, to provide currencies at guaranteed forward exchange rates. As a result, there is a wedge between the current forward and expected future spot rates that creates costs of hedging

Exchange rate volatility is a cause for concern if it impairs the smooth functioning of the world economy.

against foreign exchange risk. Available evidence suggests that these costs increase with the uncertainty of exchange rates.²

Another reason forward markets do not ensure completely against nominal exchange risk is that international trade contracts vary in length. The longer protection from risk is needed, the less reliable the predictions of future spot exchange rates. Consequently, suppliers of foreign currencies may not be willing to make forward contracts of long maturities. For this reason, forward markets for contracts longer than one year have not developed fully.

Still another reason forward markets do not provide complete protection is that firms can cover only risks for contract amounts that are known with certainty, even in the short term. If future foreign currency-denominated

² See Jacob A. Frenkel and Richard M. Levich, "Transaction Costs and Interest Arbitrage: Tranquil Versus Turbulent Periods," *Journal of Political Economy*, December 1977, pp. 1209-1226.

receipts or expenditures are uncertain, forward markets are of little use in dealing with this uncertainty.

Real foreign exchange risk

Real foreign exchange risk occurs when profits are uncertain due to unexpected changes in the real exchange rate. Because the real exchange rate is the nominal rate adjusted for changes in the prices of traded goods and services, unexpected changes in the real rate depend on changes in both the nominal rate and in the prices of goods and services. For example, in the case of the U.S. firm importing from Japan, an unexpected depreciation of the dollar raises the dollar cost of importing Japanese commodities. But if the yen-denominated price charged by the Japanese suppliers falls over the same period and the dollar price received on the sale of imports in the United States rises, the effects of the dollar depreciation on the profits of the U.S. importer are mitigated. If prices move in the opposite direction, the effects of the dollar depreciation are magnified. Since profits are affected by both the nominal exchange rate and the prices of traded goods, it is real exchange risk that matters to the firm.³

Economic theory suggests that real exchange risk should be markedly less than nominal risk would indicate. This is because unanticipated changes in the nominal exchange rate should be accompanied by offsetting changes in price levels, at least for the aggregate economy in the long run. This

assertion is based on the concept of purchasing power parity (PPP), a concept in which exchange rates and prices adjust to equalize the prices of traded goods in all countries. Empirical evidence suggests, however, that exchange rates can deviate substantially from PPP over the periods relevant for decisions made by firms.⁴ Price changes often result from factors that are not directly related to exchange rates, such as weather problems, shifts in consumption behavior, or changes in macroeconomic policies. Therefore, price movements that reinforce the effects of exchange risk are as likely as offsetting ones.

Estimating exchange rate risk

To estimate the magnitude of real foreign exchange rate risk that firms engaged in international trade faced during the 1974-84 period, this study develops a straightforward but heretofore unused measure of risk. The measure has a nominal exchange rate risk component and a price risk component.

The nominal risk component, which attempts to measure unexpected changes in the nominal exchange rate, is based on the idea that the forward exchange rate represents the market's expectation of what the spot rate will be in the future. To the extent that the market predicts accurately, the current forward rate equals the actual spot rate observed later. The difference between the current forward rate and the future spot rate is due to inaccurate predictions. This gap is a measure of unex-

³ Some authors argue that nominal exchange risk is more relevant than real exchange risk, at least for empirical work. See M. A. Akhtar and R. Spence Hilton, "Effects of Exchange Rate Uncertainty on German and U.S. Trade," *Quarterly Review*, Federal Reserve Bank of New York, Spring 1984, pp. 7-16.

⁴ For a description of PPP, see Lawrence H. Officer, "The Purchasing Power Parity Theory of Exchange Rates: A Review Article," *Staff Papers*, International Monetary Fund, March 1976, pp. 1-61. For a description of its frequent failure to hold empirically, see Jacob A. Frenkel, "The Collapse of Purchasing Power Parity During the 1970s," *European Economic Review*, May 1981, pp. 145-165.

pected changes in the nominal exchange rate; that is, it measures nominal exchange rate risk. In this article, the gap is defined as the percentage difference between the daily average of the monthly spot rate and 90-day forward rate recorded three months earlier.⁵

Since profits are affected by both the nominal exchange rate and the prices of traded goods, it is real exchange risk that matters to the firm.

To measure the price risk component of real exchange rate risk, the article used a model to forecast inflation rates three months into the future for the United States and the four trading partners considered—Japan, the United Kingdom, Germany, and Canada. Inflation was forecast for the economies overall and for the specific tradeable goods sectors included in the analysis: agriculture, crude materials except fuels, manufactured goods classified chiefly by material, chemicals and related products, machinery, transport equipment, and miscellaneous manufactured goods. The differences between predicted inflation rates and actual inflation rates were then used as measures of unexpected price changes.

These price changes were then combined with the nominal exchange risk measures to develop overall and sectoral estimates of bilateral real exchange risk. Estimates were pre-

pared quarterly for the overall real exchange rate from 1974:Q2 through 1984:Q4 and for each sector from 1975:Q3 through 1984:Q4. The real exchange risk variables effectively measure percentage changes in real spot exchange rates that were unexpected at the beginning of each quarter.⁶

Table 1 shows that real foreign exchange rate risk over the 1974-84 period was substantial, both for the U.S. economy as a whole and for the economy's major sectors. In the average quarter, the dollar unexpectedly fluctuated more than five percentage points in real terms relative to the yen, pound, and deutschemark. Unexpected changes in the real Canadian dollar-U.S. dollar rate were more modest, perhaps because the two economies are highly integrated.⁷

These average figures mask considerable variation in the actual quarter-to-quarter unanticipated changes, which sometimes reached as much as 20 percent of the real spot rate. Because even a 5 percent unexpected change in the exchange rate can markedly affect profits, real exchange rate risk was sizable during the 1974-84 period.

Estimating the impact of exchange rate risk on U.S. trade volume

This section presents the results of an empirical investigation to determine the extent that real exchange rate risk affected the volume of U.S. international trade during the 1974-84 period. The investigation focused on both total U.S. trade and trade conducted by major sectors of the U.S. economy.

⁶ The appendix provides a precise definition of the measure of real exchange rate risk.

⁷ See Charles Freedman, "The Effect of U.S. Policies on Foreign Countries: The Case of Canada," *Monetary Policy Issues in the 1980s*, Federal Reserve Bank of Kansas City, 1982, pp. 97-118.

⁵ This is a common measure of nominal exchange risk. See Peter Hooper and Steven W. Kohlhagen, "The Effect of Exchange Rate Uncertainty on the Prices and Volume of International Trade," *Journal of International Economics*, November 1978. Some argue for a measure based on formal econometric predictions, but these do not seem to provide better forecasts. See Richard Meese and Kenneth Rogoff, "Empirical Exchange Rate Models of the Seventies: Do They Fit Out-of-Sample?" *Journal of International Economics*, February 1983, pp. 3-24.

TABLE 1
Estimates of unexpected changes
in quarterly U.S. real bilateral exchange rates
as a percent of real spot rates

	<u>Yen</u>	<u>Pounds</u>	<u>Deutsche-</u> <u>marks</u>	<u>Canadian</u> <u>Dollars</u>
Total (1974:Q2-1984:Q4)	5.40	5.58	5.85	2.87
Agriculture (1975:Q3-1984:Q4)	5.50	6.99	5.78	2.44
Crude materials (1975:Q3-1984:Q4)	5.12	7.82	6.22	3.53
Manufactured goods classified chiefly by material (1975:Q3-1984:Q4)	4.92	5.16	5.36	2.45
Chemicals (1975:Q3-1984:Q4)	4.76	5.99	5.29	2.29
Machinery (1975:Q3-1984:Q4)	5.39	5.26	5.49	2.75
Transport equipment (1975:Q3-1984:Q4)	5.37	5.53	5.44	2.26
Miscellaneous manufactures (1975:Q3-1984:Q4)	5.44	5.24	5.55	2.36

Previous research

Previous empirical analyses have reached no firm conclusions on the importance of exchange rate risk for international trade. Studies of U.S. trade have typically shown little effect on aggregate trade volumes, although noticeable effects on the prices of traded goods have been found. Most of the studies have relied on measures of the variability of nominal exchange rates as proxies for exchange rate risk.⁸ Two studies examined real exchange rate risk. Only one noted any significant effects on the aggregate volume of trade.⁹ Both studies relied on measures of observed variability in the real exchange rate

as measures of risk. Because these measures do not allow for predictable changes in real exchange rates, they are likely less accurate than the direct measures of unexpected changes used in this study. Moreover, no previous work has considered the effects of risk on U.S. sectoral trade.¹⁰

Sectoral focus

A sectoral focus is useful because exchange rate risk may affect industries differently, either because some industries are more exposed to risk than others or because industries react differently to a given level of exchange risk.

A number of factors affect an industry's exposure to risk. An important one is the extent to which the sector is open to interna-

⁸ See especially Hooper and Kohlhagen, "The Effect of Exchange Rate Uncertainty on the Prices and Volume of International Trade," and Akhtar and Hilton, "Effects of Exchange Rate Uncertainty on German and U.S. Trade."

⁹ Significant effects were found by David O. Cushman, "The Effects of Real Exchange Rate Risk on International Trade," *Journal of International Economics*, August 1983, pp. 45-64. See also "Exchange Rate Volatility and World Trade," Occasional Paper No. 28, International Monetary Fund, July 1984.

¹⁰ The effects of reduced exchange risk associated with a discrete change in exchange rate regimes on Brazilian sectoral trade were studied by Donald V. Coes, "The Crawling Peg and Exchange Rate Uncertainty," in John Williamson, ed., *Exchange Rate Rules: The Theory, Performance, and Prospects of the Crawling Peg*, St. Martin's Press, New York, 1981, pp. 113-136.

tional trade as indicated by the proportion of costs generated through purchase of imports or the proportion of sales resulting from exports. Another determinant of exposure is the extent that trade contracts are denominated in foreign currencies. For example, there is no exposure to nominal exchange rate risk for U.S. firms if

Real foreign exchange rate risk over the 1974-84 period was substantial, both for the U.S. economy as a whole and for the economy's major sectors.

U.S. importers pay for purchases in dollars or if U.S. exporters receive payment in dollars. In these cases, though, the risk is merely shifted to foreigners.¹¹ Additional factors affecting exposure include the length of contracts and susceptibility to unexpected changes in the prices of goods.

Industries may react to exposure differently for several reasons. One is because of differences in profitability. Highly profitable firms, for example, may be able to absorb risk without cutting back on trade. Since profitability is often related to concentration, highly concentrated industries may have a relatively low response to exchange rate risk. Also, industries with multinational operations may have a relatively low response because of their ability to diversify. Such industries may actually respond favorably to exchange rate risk if they

¹¹ Limited evidence suggests that there are some differences across manufacturing sectors in whether the currency denomination is that of the exporter or importer. See Stephen P. Magee, "U.S. Import Prices in the Currency-Contract Period," *Brookings Papers on Economic Activity*, 1974:1, pp. 117-164. For a detailed discussion of the effects of currency denomination on exchange risk, see Peter Hooper and Steven W. Kohlhagen, "The Effects of Exchange Rate Uncertainty on the Prices and Volume of International Trade," *Journal of International Economics*, November 1978, pp. 483-512.

can easily adjust their production and trade patterns across countries.¹² Other factors that may affect the response to risk exposure include the importance of internationally traded inputs to production, the ease of reducing domestic costs of importing and exporting, and the structure of trade restrictions.

Industries also may differ in their attitudes toward risk. Risk implies the possibility of unexpected gains as well as losses, so some firms may prefer to expose themselves to foreign exchange risk rather than limit their exposure. If such firms are important in an industry, an increase in exchange risk may be associated with an increase in international trade. In practice, this reaction is unlikely since few firms are "risk-lovers."

Overall empirical results

To isolate the impact of exchange rate risk on total and sectoral trade during the 1974-84 period, the empirical investigation for this article estimated equations that allow for the impact of all the factors that may have affected trade during the period. In addition to exchange rate risk, the equations allowed for the effects of real GNP, capacity utilization, labor costs, and the level of the exchange rate. Table 2 shows the general form of the equation used to estimate the volume of U.S. trade. Separate equations were estimated for total and sectoral U.S. exports to Japan, the United Kingdom, Germany, and Canada and imports from these countries. The sectors were agriculture, crude materials, manufactured goods classified chiefly by materials, chemicals, machinery, transport equipment, and

¹² See Rachel McCulloch, "Unexpected Real Consequences of Floating Exchange Rates," *Princeton Essays in International Finance*, No. 153, August 1983.

TABLE 2
An equation for the volume of U.S. trade

$$Q = a_0 + a_1y + a_2CU + a_3UC + a_4UC^* + a_5E + a_6R + e$$

where Q = the real volume of U.S. bilateral exports or imports for specific sectors.

y = real GNP in the importing country,

CU = real sectoral capacity utilization in the importing country,

UC = real unit labor costs in the importing country,

UC* = real unit labor costs in the exporting country,

E = sectoral real exchange rate,

R = real exchange rate risk, and

e = error term.

miscellaneous manufacturing. A total of 64 equations were estimated.¹³

The results of the empirical investigations indicated, generally, that exchange rate risk tended to reduce U.S. international trade during the 1974-84 period. Of the 64 equations, 58 had a negative coefficient on the exchange rate risk variable, indicating a negative effect of risk on trade. Of the 58 negative effects, 26 were statistically significant.

While exchange rate risk tended to reduce trade, the size of the impact was fairly modest. For example, as discussed in detail below, of the 26 cases with statistically significant negative effects of exchange risk on trade,

only one showed that trade was reduced more than 7 percent.

Impact on total trade

Numerical estimates of the impact on trade of real exchange risk are presented in Table 3. The table shows estimates of the differences between actual cumulative trade volumes during the 1974-84 period and the volumes that would have occurred had exchange rate risk not been present.¹⁴ Estimates based on statisti-

¹³ The equations, which also include seasonal dummy variables, were estimated under a variety of simple lag structures to allow for time lags between order and delivery dates that are common in international commerce and to reflect the lags between changes in trade determinants, such as real GNP, and the influence asserted on trade volumes. The equations, which were estimated in logarithmic form, were adjusted whenever necessary for first-degree serial correlation.

¹⁴ More precisely, the estimates show differences between actual trade volumes and volumes that would have developed had exchange risk been at a minimum feasible level. Allowance was made for a minimum level of risk because real exchange risk cannot be eliminated completely. The minimum feasible level of risk was assumed to equal the lowest average real risk recorded in four consecutive quarters during the period.

To compute the estimates, the quarterly percentage excess amounts of actual risk over minimum risk were multiplied by the corresponding risk coefficients to calculate the trade volume changes, which were then summed over the whole period. The estimated trade volume reductions in Table 3 are

cally insignificant coefficients are marked with asterisks to stress that they are unreliable.

The estimates show that, considering only significant cases, real exchange rate risk reduced total U.S. trade—imports plus exports—\$13.0 billion in 1980 dollars, or 3.2 percent, during the 1974-84 period (Table 3). A breakdown of the effects on trade with different countries shows that exchange risk had statistically significant negative effects on total U.S. imports from Japan and exports to Germany. If real exchange risk had not been present over the 1974-84 period, total U.S. imports from Japan would have been greater by roughly \$11.4 billion in real terms, or 3.4 percent. Thus, risk-averse behavior characterizes trade between U.S. importers and Japanese exporters.¹⁵ Similarly, total U.S. exports to Germany would have been 2.2 percent greater if risk had not been present. Estimates of the impact of exchange risk on trade with other countries are statistically unreliable. The estimates show that exchange risk had a positive effect on U.S. exports to Japan. This is an anomaly, however, because the effect is statistically insignificant and none of the sectoral exports to Japan shows a similar result.¹⁶

not strictly comparable across sectors and countries because differences in lag structures and data availability led to slightly different estimating periods. As a result, some of the figures are summed over a different number of quarters. The percentage effects are comparable, however.

¹⁵ Which country's traders bear the greater nominal exchange risk burden depends on the currency denomination of the contracts. U.S. imports are split fairly evenly between dollars and foreign currencies, while U.S. exports are invoiced predominantly in dollars. In the case of exports, most nominal risk is borne by foreign importers of U.S. products. The burden of real exchange risk depends also on unexpected relative price changes across countries and no inference on this risk distribution can be drawn from Table 3.

¹⁶ The effects of risk on total imports or exports frequently were estimated to be less than the sum of the effects on individual sectoral imports or exports. This may be because other sectors have been excluded from the analysis, different

Agricultural trade

According to the estimates, real exchange rate risk reduced total U.S. agricultural trade \$656 million, or 6.0 percent, during the 1974-84 period. This is the largest percentage reduction for any sector, so that agricultural trade was the most susceptible to exchange rate uncertainty. The most likely reason is that the sector is highly open to international trade. In 1977, for example, agricultural exports and imports totaled 28 percent of domestic agricultural output, a much higher ratio than most manufacturing sectors.¹⁷ Other factors underlying the high susceptibility of agriculture to exchange risk may include the sector's low level of industry concentration and tendency to enter into lengthy trade contracts.

Estimates of the effects on trade with different countries show that real exchange risk restricted U.S. agricultural exports to Germany and imports from Japan and Germany. Imports from Japan and Germany were reduced 5.8 percent and 4.3 percent, respectively; these countries are not major agricultural exporters to the United States, so the dollar effects were small. U.S. exports to Germany were reduced \$426 million, or 6.6 percent. Thus, Germany would have been a considerably larger market for U.S. agricultural products if exchange risk had not been

lag structures and time periods are involved, and no constraints were placed on the estimating procedure to ensure that such a result would not occur.

¹⁷ Some sectoral results should be viewed with caution because the estimated equations do not allow for government trade restrictions that may be important determinants of trade. For example, trade in agricultural goods has typically been subject to restrictive import quotas. One result of these restrictions might be that U.S. exporters would not restrict their shipments to Japan in the face of greater exchange risk for fear of losing their share of the Japanese import quotas. The effects of risk may, therefore, be understated relative to what they would be under free trade.

TABLE 3

Cumulative impact of real exchange rate risk on U.S. trade, 1974-84 (millions of 1980 dollars)

Country	Total				Agriculture			
	Imports		Exports		Imports		Exports	
	Volume	Percent	Volume	Percent	Volume	Percent	Volume	Percent
Japan	-11,395	-3.4	+2,184*	+1.2*	-158	-5.8	-703*	-2.1*
United Kingdom	-1,067*	-0.9*	-1,911*	-2.4*	-15*	-1.2*	-2*	-0.1*
Germany	-813*	-0.6*	-1,567	-2.2	-72	-4.3	-426	-6.6
Canada	-1,536*	-0.3*	-7,172*	-2.0*	-70*	-0.5*	-37*	-0.3*
	Imports plus exports				Imports plus exports			
	Volume		Percent		Volume		Percent	
Total†	-12,962		-3.2		-656		-6.0	
	Crude materials				Manufactured goods classified chiefly by material			
Country	Imports		Exports		Imports		Exports	
	Volume	Percent	Volume	Percent	Volume	Percent	Volume	Percent
Japan	-7*	-1.1*	-1,154*	-2.8*	-1,178*	-2.1*	-433	-4.1
United Kingdom	+51	+6.3	-450*	-8.1*	-699*	-4.9*	-65*	-0.8*
Germany	-72	-6.7	-574	-5.9	-836	-4.2	-151	-2.8
Canada	-2,324	-4.3	-604	-3.7	-291*	-0.4*	-2,239	-5.5
	Imports plus exports				Imports plus exports			
	Volume		Percent		Volume		Percent	
Total†	-3,523		-4.3		-3,659		-4.8	

* Figures were computed from insignificant risk coefficients and should be considered unreliable. Risk coefficients were considered insignificant if the standard deviations of the coefficients were too large to indicate, at a 90 percent level of confidence, that a relationship exists between exchange rate risk and the associated trade volume.

present. This result could be troublesome if real exchange rate uncertainty continues to be large. Real exchange risk had no statistically significant effect on other agricultural trade flows.¹⁸

Crude materials trade

Exchange risk reduced trade in crude materials 4.3 percent, the third largest effect among the sectors. A primary reason for this

relatively large risk effect is that, with trade equaling 30 percent of output in 1977, the sector ranks as the one most open to trade. Other sources of the sensitivity of crude materials trade to risk are unclear. The sector ranks near the middle in industry concentration and trade contract lengths, so these factors may not be important in this case.¹⁹

Except for imports from the United Kingdom and Japan, which were relatively unim-

¹⁸ The sources for computing these ratios were U.S. Department of Commerce, *Highlights of U.S. Export and Import Trade, Report FT990*, December 1977, and *Survey of Current Business*, May 1984.

¹⁹ Import contract lengths with Japan and Germany in 1971 and 1973 for several U.S. industries are estimated in Stephen P. Magee, "U.S. Import Prices in the Currency-Contract Period." Industry concentration measures, given by four-firm concentration ratios, may be found for 1972 in U.S. Department of Commerce, *1972 Census of Manufacturers*.

TABLE 3
(continued)

Country	Chemicals				Machinery			
	Imports		Exports		Imports		Exports	
	Volume	Percent	Volume	Percent	Volume	Percent	Volume	Percent
Japan	-364	-4.9	-233*	-1.3*	-1,465*	-1.6*	-414	-2.1
United Kingdom	-162*	-1.7*	-41*	-0.7*	+762*	+3.3*	-806*	-3.6*
Germany	-357	-3.2	-137*	-2.2*	-414	-1.2	-185*	-1.1*
Canada	-2,723*	-13.0*	-338	-1.5	-914	-2.5	-215*	-0.3*
	Imports plus exports				Imports plus exports			
	Volume		Percent		Volume		Percent	
Total†	-1,059		-2.6		-1,742		-1.9	
Country	Transport equipment				Miscellaneous manufactures			
	Imports		Exports		Imports		Exports	
	Volume	Percent	Volume	Percent	Volume	Percent	Volume	Percent
Japan	-2,181	-2.1	-344*	-4.0*	-733	-2.4	-1,577	-16.3
United Kingdom	-84*	-0.8*	-181*	-2.7*	+315	+3.0	-437	-5.0
Germany	-1,510	-3.7	+144*	+2.5*	-68*	-0.7*	-211*	-3.0*
Canada	+2,433	+2.7	-4,451	-5.0	-431	-3.7	-19*	-0.1*
	Imports plus exports				Imports plus exports			
	Volume		Percent		Volume		Percent	
Total†	-5,709		-1.8		-2,863		-4.1	

† Only statistically significant trade effects were used to calculate the total effects.

portant, all crude materials trade flows were restricted by real exchange rate uncertainty during the 1974-84 period. In absolute terms, the largest reductions were \$2.3 billion in imports from Canada and \$604 million in exports to Canada. The largest percentage reductions were in trade with Germany.

Trade in manufactured goods classified chiefly by material

Total U.S. trade in manufactured goods was 4.8 percent less during the 1974-84 period than would have occurred had exchange rate risk not been present. This was the second

largest risk effect among the sectors. Openness to trade was not the likely cause, however, as trade equaled only 10 percent of output in 1977, the lowest ratio among the sectors. A possible explanation is that the manufactured goods sector was the least multinational of the six nonagricultural sectors. In 1977, only 24 percent of total employment in the manufactured goods sector was accounted for by foreign affiliates, compared with an average of 34 percent in the other sectors.²⁰ Thus, firms in the sector had less oppor-

²⁰ See *Survey of Current Business*, February 1982.

tunity for diversifying foreign exchange risk through international, intra-firm shifts in production and trade. Also helping account for the high risk effect may be the relatively long contract lengths that appear to be common in the manufactured goods industry. In addition, concentration ratios are fairly low in some parts of the industry, such as paper and fabric manufacturers, suggesting a limited ability to absorb unexpected movements in real exchange rates.

U.S. exports of manufactured goods were restricted more by real exchange risk than U.S. imports of these goods. Significant negative effects were estimated for exports to Japan, Germany, and Canada, while only

Empirical evidence reported in this article indicates that real exchange rate risk restricted the volume of U.S. trade during the floating rate period from 1974 through 1984.

imports from Germany were restricted. Overall, the results suggest that risk-averse behavior was noticeable in the manufactured goods industry during the era of flexible exchange rates.

Chemicals trade

U.S. trade in chemicals was 2.6 percent lower than it would have been with no exchange risk during the 1974-84 period (Table 3). This was the third smallest effect among the sectors. One reason for the limited effect is a low degree of openness, as trade was only 13 percent of sector output in 1977. Another reason is a high degree of multinationality, as 38 percent of total sector employment was in foreign affiliates in 1977. Still

another reason is the use of relatively short contract lengths in the chemical sector. The sector is not very concentrated, so this factor was not important in determining responses to exchange risk.

Real exchange risk reduced chemical imports from Japan around 5 percent over the 1974-84 period. Imports from Germany and exports to Canada were also negatively affected.

Machinery trade

Machinery trade was reduced only 1.9 percent by exchange risk, the second smallest sectoral effect. The reduction was small even though the sector was relatively open, with trade accounting for 24 percent of output in 1977. The primary reasons for the small effect may be the high degree of concentration and extensive multinational character of the machinery industry, which allow the industry to adjust more easily to increases in real exchange rate risk.

The country breakdown of trade in machinery shows that, for statistically significant effects, the maximum effect was a reduction of \$914 million in imports from Canada.

Trade in transport equipment

Real exchange rate risk reduced U.S. trade in transport equipment a slight 1.8 percent during the 1974-84 period. The explanations parallel those in the machinery sector, because the two sectors share similar characteristics. One exception is that trade in transport equipment appears to take place with short contract lengths. This would be consistent with small reductions in trade caused by exchange risk.

The breakdown shows that exchange risk noticeably restricted imports of transport equipment, mainly automotive vehicles, from

both Japan and Germany, suggesting that import penetration into the United States by these countries might have been greater if real exchange rate risk had not been present. In an unusual result, exchange risk had a positive effect on U.S. imports of transport equipment from Canada, although risk restricted exports to Canada. This development could be consistent with a shift in U.S. production to Canada, from which markets in both countries can be served. If this is true, it is an example of exchange risk inducing a highly multinational industry to engage in greater international trade, as Canadian exports to the United States have risen.

Miscellaneous manufactures trade

Overall, trade in the miscellaneous manufacturing sector was reduced 4.1 percent by exchange rate risk during the 1974-84 period, a fairly high amount compared with the other manufacturing sectors. In general, the products in this industry are not very open to trade, so the explanation is likely related to other factors. These would include the lack of industry concentration—the sector has the smallest concentration ratio of the nonagricultural sectors—and the tendency for firms in the industry to have few foreign affiliate operations.

The largest effect was on U.S. exports to Japan, which would have been \$1.6 billion, or 16 percent greater, if exchange risk had not been present.

Summary

Two observations on the empirical results may be made. First, the sectoral differences in exchange risk effects on trade are related to specific industry characteristics. Openness to trade is a dominant reason for the susceptibil-

ity of nonmanufacturing trade to risk, while concentration is important in enabling manufacturing sectors to limit the negative effects of exchange rate uncertainty.²¹ Second, there were different effects in different countries as

To the extent that exchange rate uncertainty inefficiently reduces international trade, policies to reduce this uncertainty may be warranted.

well. Trade with Germany was most affected, with ten of the 16 trade flows in Table 3 significantly reduced by real exchange risk. Following Germany are Japan with eight significant declines, Canada with seven, and the United Kingdom with one.

Conclusions

Empirical evidence reported in this article indicates that real exchange rate risk restricted the volume of U.S. trade during the floating rate period from 1974 through 1984. The restrictions were modest on the whole, but there were potentially large effects on some sectors. Differences in effects on sectors and countries imply that risk may have induced shifts in resource allocation.

To the extent that exchange rate uncertainty inefficiently reduces international trade, policies to reduce this uncertainty may be warranted. These could include changes in macro-

²¹ To demonstrate this, the manufacturing sectors were ranked in declining order based on their percentage trade reductions. They were also ranked based on rough measures of concentration, multinationality, openness, and average contract length. All of these ranked characteristics were correlated in the expected direction with the ranked trade reductions, but industry concentration was most strongly correlated.

economic policies to promote a more stable environment in which prices and exchange rates are determined, controls on the international flows of financial capital, greater intervention in the foreign exchange markets, or the adoption of fixed exchange rates.²²

The evidence in this study suggests, how-

ever, that trade gains associated with lower exchange risk are likely to be modest, at least for the United States. These modest gains should be weighed against any problems created by interference in the market determination of the real exchange rate. Fixed exchange rates, for example, may be counterproductive if they hasten the international transmission of recessions. In that case, the resulting reductions in international trade would almost certainly outweigh any gains from lower real exchange rate risk.

²² A discussion of these issues lies outside the scope of this study. See, for example, Hakkio, "Exchange Rate Volatility and Federal Reserve Policy."

Appendix

Defining real exchange risk

Real exchange risk in sector i for U.S. trade with country j in a particular quarter was defined as the average of the three monthly measures in the quarter:

$$\text{RISK}_{i,j} = \frac{1}{3} \sum_{m=1}^3 |\text{NRISK}^m_j + \text{USINFERR}^m_i - \text{INFERR}^m_{i,j}|.$$

In this equation, NRISK^m_j is the percentage difference between the bilateral spot and three-month previous forward rates in month m , USINFERR^m_i is the error made in predicting inflation (usually the percentage change in the wholesale price index) in the United States in sector i in month m , and $\text{INFERR}^m_{i,j}$ is the

corresponding error in country j . Absolute values are used because it is the size of the unexpected change in the real exchange rate that matters for risk, rather than its sign. Because NRISK^m_j is measured as foreign currency units per dollar, if it is positive the dollar has shown an unexpected nominal appreciation. If USINFERR^m_i is also positive, then the U.S. price level in sector i has risen unexpectedly. From an exporter's viewpoint, both of these effects reduce competitiveness, and the reduced competitiveness would be offset only by a higher unexpected price increase abroad. This is why the U.S. inflation error is added to NRISK^m_j , while the foreign inflation error is subtracted.