

## Exchange Rate Volatility and U.S. Poultry Exports: Evidence From Panel Data

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This is a selected paper for the annual meetings of the American Agricultural Economics (AAEA) meetings in Montreal, Canada, July 2003.

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### **Abstract**

Very little research exists on the potential impact of exchange rate volatility on agricultural trade. This paper evaluates the effects of exchange rate volatility on U.S. poultry exports using the gravity model on panel data. We find that exchange rate volatility has a negative effect on the U.S. poultry export but only statistically significant for the model in which we use the variance of spot exchange rate as the measurements. Consistent with previous studies, foreign incomes are also a very important determinant of poultry trade.

**KEYWORDS:** exchange rates, volatility, agricultural trade, poultry exports, panel data

## **Exchange Rate Volatility and U.S. Poultry Exports: Evidence From Panel Data**

### **Introduction**

The U.S. poultry industry, the world's largest producer and exporter of poultry meat, is very dependent on exports to foreign markets. Poultry production in 2001 totaled 42.43 billion pounds, accounting for 24 percent of world total output. In 2000, U.S. poultry exports, at 6.4 billion pounds, accounted for about 33 percent of world poultry trade and about 60 percent were shipped to the Asian market (Foreign Agricultural Service, USDA). Imports are anticipated to increase in all the largest import markets, including Russia, China, Japan, Hong Kong, Mexico, Canada and the Middle East. Shipments of turkey to Russia, the second largest export market of the US, nearly tripled compared with 1999, accounting for almost 12 percent of U.S. turkey exports. Exports to Hong Kong in 2000 were 43 million pounds, up 28 percent from the previous year. Most of the growth in world poultry trade is expected to come from expanded shipments of relatively low-priced poultry parts. As markets have opened to increased poultry trade, the United States has benefited by selling chicken breasts in the domestic market while exporting dark meat and less valuable cuts to foreign markets where they are preferred over breast meat. This strategy has been especially beneficial for the United States, as large markets have developed for leg meat in Russia, wings and feet in Hong Kong and Mainland China.

However, a country with a domestic preference for dark meat, such as China, could reverse this marketing pattern and attempt to export white meat products to developed countries with a preference for those products. Given that about 18 percent of total poultry production is being exported, the U.S. poultry industry is affected by economic conditions in

foreign markets, transmitted via exchange rates fluctuations. In the past few years, Asian and Russian market destinations have experienced significant level of economic uncertainty and volatility in prices for poultry meat. Foreign demand uncertainty can create a tremendous pressure on the profit margin for poultry meat producers. For instance, the Asian financial market crisis in 1997 and the Russian poultry meat embargo in 2001 can have significant income ramifications for foreign poultry meat importers. The Asian crisis started with a wave of currency devaluations, stock market plunges, and business failures in several countries across the East Asian region. Exchange rate, the price of a currency in terms of another currency, is probably the single most important variable in determining the level of trade. The fluctuations in the real exchange rate result in the rise and fall of the prices of U.S. agricultural products in terms of the local currency in foreign countries. The Asian crisis led to the depreciation of the foreign currencies (appreciation of U.S. dollar). A depreciated currency in Asia raises the price of U.S. goods abroad and may consequently lead to a reduction in the volume of U.S. export sales.

Historically, fluctuations in the exchange rates have accounted for and about 25 percent of the change in U.S. agricultural value (Economic Research Service, USDA). Thus, domestic consumption and demand for imports declined dramatically. A severe and prolonged financial crisis abroad could substantially lower U.S. agricultural export earnings and shift trade patterns in some Asian countries.

It is widely believed that the adoption of the floating exchange rate system after the collapse of the Bretton-Woods system increased the level of uncertainty associated with exchange rates. The potential effects of exchange rates uncertainty on the level of exports has been a hotly debated issue which still persist in the literature. The controversy about the role

of exchange rate fluctuations on trade flows has been fueled by the ambiguous and conflicting nature of the existing empirical evidence. The popular assertion has been that exchange rate volatility increases risk and uncertainty and thereby hinders the flow of trade. Theoretical considerations have traditionally been unambiguous in suggesting that increased uncertainty should reduce the level of trade.

For example, Clark (1973), Ethier (1973), Hooper and Kohlhagen (1978) and Cushman (1983,1986) have provided useful insights into the ways in which exchange rate volatility may impede international trade flows. However, recent work by Dellas and Zilberfarb (1993) and Viaene (1992) has provided a theoretical basis for positive effect of exchange rate variability on trade. Dellas and Zilberfarb (1993) model nominal un-hedged trade contracts as standard risky assets that can be analyzed in a conventional asset portfolio framework, within this framework the trade effects of an increase in exchange rate volatility will, in general, depend on the risk aversion parameter of the model. They indicate that existing work on the effects of exchange rate uncertainty on trade has employed a restrictive version of the portfolio choice model, which leads to an unambiguously negative relation. Giovannini (1988) discusses the case where increases in exchange rate volatility do not necessarily lead firms to restrict supply, and where, if export prices are invoiced in domestic currency, expected profits might actually increase as a result of increased exchange rate risk, leading firms to reduce their export prices. De Grauwe (1988) argues that the effect of exchange rate volatility on export depends on the degree of risk aversion. De Grauwe (1988) asserted that a very risk-averse exporter who worries about the decline in his or her revenue might export more when risk is high. Klein's (1990) study examined the effects of real exchange rate volatility on specific categories of bilateral exports from the United States over

the period 1978 to 1986, from which he concludes that real exchange rate volatility may stimulate export supply by risk-neutral firms through its effects on their expected profits. It may be considered that increased risk associated with volatility will induce risk-averse agents to direct their economic resources to less risky activities.

Accordingly, risk-averse exporters may be expected to reduce their trade volumes in response to uncertainty generated by greater exchange rate variability, since profits from international trade decline due to unanticipated exchange rate changes. Forward markets can be used for hedging but there are both limitations and costs associated with their use. Caporale and Doroodian (1994) point out that the size of contracts can be a limitation since in the case of US-Canadian trade they must average US \$1 million per contract before hedging can take place. A further limitation is that customers must keep minimum deposits, usually for multiples of 30 days. These factors indicate the difficulties for trading firms in planning the volume and timing of their international transactions to make optimal use of forward markets.

The empirical studies, however, have failed to provide unambiguous evidence in favor of the theoretical predictions. For example, Kenen and Rodrik (1986), Thursby and Thursby (1985), Koray and Lastrapes (1989), Pritchett (1991), Savvides (1992) Pozo(1992), Chowdhury (1993), Arize (1997), Frankel and Wei, Eichengreen and Irwin(1998) found that the risk associated with this exchange rate volatility has reduced the level of exports. Bailey, Tavlas, and Ulan (1986), Gotur (1985), and Hooper and Kohlhaugen (1978) found that the exchange rate uncertainty does not have a significant effect on trade. In contrast, Asseery and Peel (1991) found a positive relationship between exchange rate volatility and exports. The empirical studies do not yield a definite result that increased uncertainty has reduced international trade. Rather, an IMF (1984) survey of the effects of exchange rate variability

on world trade concluded that the “the large majority of empirical studies on the impact of exchange rate variability on the volume of international trade are unable to establish a systematically significant link between measured exchange rate variability and the volume of international trade, whether on an aggregate or on a bilateral basis.”

The use of aggregate trade data ignores the fact that the impact of exchange rates may vary across sectors because different sectors have different degrees of openness to international trade, and because different sectors have different industry concentration levels and make different use of long term contracts, constraining the income, price and exchange rate risk elasticities to be equal across sectors. Given the different nature of the markets in which trade occurs, it is likely that volatility will impact differently on different sectors and aggregating across those sectors means a loss of important information. The use of aggregate data may contribute to the array of conflicting results derived. This is because using national trade data implicitly assumes the impact of exchange rate volatility is uniform between countries and commodities both in terms of direction and magnitude. If this assumption is incorrect, then the examination of aggregate trade data is likely to dilute the true nature of the relationship and lessen the probability of deriving a significant result.

Recognizing this possibility, researchers have adopted trade models, which focus on disaggregated trade data in the form of bilateral and sectoral trade flows. Cushman (1988a) attempted to establish if bilateral trade flows analysis during the floating period alone could verify any of the significant effects by using the U.S. bilateral trade flow from 1974-1983. The use of bilateral trade flows data does not appear to significantly enhance the results when compared to those obtained using aggregate trade flows. It is possible to take this disaggregating process one step further and examine the commodity specific trade data.

Bini-Smaghi (1991) support the hypothesis that variability has decreased trade both in terms of price and quantity by using intra-European Monetary System (EMS) manufacturing trade for the period 1976-1984. Klein (1990) disaggregated U.S. bilateral exports to seven major industrialized countries for the period 1978-1986 into nice categories of traded goods. Six yielded a significant relationship between the volatility estimator and trade, among which five indicated a positive relationship. McKenzie (1998) analyzed the impact of exchange rate volatility on both aggregate and sectoral trade flow data for the Australian economy over the period 1988-1995. Whereas the aggregate trade data revealed limited and conflicting evidence of a relationship, a significant relationship could be established when the data was disaggregated into various commodity sub-groupings.

There has been little research on the impact of exchange rate variability on agricultural trade. Earlier work on agricultural trade and exchange rates, focused on the impact of changes in the level of real exchange rate and agricultural exports. Examples of this work include Batten and Belongia(1986), Haley and Krissoff (1987), and Bessler and Babula (1987). Reflecting the earlier research in the general literature, empirical research relating to short-run exchange rate volatility and agricultural trade flows has produced ambiguous conclusions. For example, Pick found that exchange rate risk had no effect on U.S. trade flows to other developed countries, though it did have a negative effect on U.S. exports to developing countries. In contrast, Klein found that short-run real exchange rate volatility negatively affected U.S. agricultural exports compared to other sectors. Maskus(1986) also found that the sector most affected by short-run volatility was agriculture, though his empirical model, like Klein, focused on U.S. bilateral trade flows only. Anderson and Garcia (1989) found significant negative effects of exchange rate volatility on U.S. exports of



soybean to three developed countries. More recently, Langley et al. (2000) found that exchange rate volatility had a positive impact on Thailand's exports of poultry, but not on aggregate agricultural exports. Attention has been on short-run exchange rate volatility. The effects of medium to long run exchange rate variability have been ignored even though this is arguably more likely to have a more significant impact on trade.

The aim of this paper is to provide a contribution to the empirical debate on the relationship between exchange rate volatility and trade based on panel data of the US poultry export to 49 countries from 1976 to 2000. Following Cho, Sheldon and McCorrison (2002), we attempted to study the relationship between medium to long run exchange rate uncertainty and U.S. poultry export. A gravity model is applied to these data, which allows for cross-country determinants of trade including income, distance, unit export price and exchange rate uncertainty.

### **Gravity Models**

The so-called gravity equation came into use in social sciences in the 1860s when H. Carey (1871) first applied Newtonian Physics to the study of human behavior. More recently, gravity model studies have achieved empirical success in explaining various types of inter-regional and international flows, including labor migration, commuting, customers, hospital patients, and international trade.

Tinbergen (1962) and Pöyhönen (1963) are the first researchers to propose the gravity model. In its basic form, the amount of trade between two countries is assumed to positively relate with their sizes, as measured by their national incomes, and negatively relate with the transportation costs between them, as measured by the distance between their economic

centers. Linnemann (1966) included population as an additional measure of country size to allow for non-homothetic preferences in the importing country, known as the augmented gravity model. It is also common to specify the augmented model using per capita income, which captures the same effects. Gravity equations become popular in the trade literature on account of its empirical success in predicting the bilateral trade flows of different commodities and under different circumstances. Deardorff (1984) writes that gravity models are “extremely successful empirically” judging by their ability to explain variance in bilateral trade volumes. Leamer and Levinsohn (1997) hold that gravity models “have produced some of the clearest and most robust empirical findings in economics.”

The theoretical background for the framework is found in a set of general equilibrium models that derive specific predictions for bilateral trade. Anderson (1979) gave a theoretical foundation based on the expenditure systems and introduced border taxes and transportation costs as barriers to trade into the model derived from a general equilibrium framework. He assumed complete specialization and identical preference, Cobb-Douglas and Constant Elasticity of Substitution (CES) in the appendix. Bergstrand (1985) used CES preferences over Armington-differentiated goods to derive a reduced form equation for bilateral trade involving price indices. His CES preferences allowed for a different elasticity of substitution among imports than between imports and domestic goods. His empirical estimates supported the assumption that goods were not perfect substitutes and that imports were closer substitutes for each other than for domestic goods.

More recently, there have been several empirical studies on this issue, based on the gravity model of trade, and also making use of panel data. For example, Rose uses bilateral trade for a panel of 186 countries, over the period 1970-90, finding a small, but statistically

significant negative effect of exchange rate volatility on trade. De Grauwe and Skudelny found a statistically significant negative impact of exchange rate volatility on trade in the European Union, as did Dell’Ariccia. Cho, Sheldon and McCorriston (2002) studied the effects of exchange rate uncertainty on agricultural trade in comparison to other sectors, in the context of recent econometric work based on bilateral trade flows between several countries, making use of the gravity model and panel data. One of the advantages of using panel data is that unobservable cross-sectional effects can be accounted for either via fixed effects or random effects specification. The use of panel data also captures changes in variables over time such as income and changes in exchange rate uncertainty.

Consistent with the underlying micro-foundations, the empirical analysis uses a multi-country dataset of U.S. poultry exports with its trading partners together with other fundamental economic data on prices, exchange rates and gross domestic products. The gravity model is given as:

$$\log X_{1j} = \beta_0 + \beta_1 \log Y_1 + \beta_2 \log Y_j + \beta_3 \log P_{1j} + \beta_4 V + E_{ij} \quad (1)$$

where

$X_{1j}$  – bilateral trade flow of the U.S. to importing country  $j$ ;

$Y_1, Y_j$  – the per capita income of the U.S. and country  $j$ ;

$P_{1j}$  – unit export price of U.S. poultry;

$V$  – exchange rate volatility;

$E_{ij}$  – distributed error term.

Distance, which reflects the transportation costs between U.S. and other countries, is not included in this empirical model because the fixed effects estimation method of panel data cannot capture the effects of time-invariant variables. Instead, we use unit export value

obtained by dividing the export value by volume to reflect it on the basis that the export value includes the transportation costs. Before commenting specifically on the uncertainty measures, one issue that should be noted is the frequency of the data. Because the aim is to capture medium to long run uncertainty, annual exchange rate data were used.

### **Econometric Methodology**

In this paper, fixed effects methods are employed for the unbalanced panel data. Fixed effects models assume that the intercepts are different for individuals, i.e., countries in this case, and the slope coefficients are constant when we control for time effects, which means that the coefficients do not vary over time. An alternative is the random effects approach, whose intercept is assumed to be a random variable with a mean value. Random effects method is not appropriate in this case because the assumption underlying the random effects models is that the random error term, contained in the intercept, is a random drawing from a much larger population. Therefore, fixed effects model is applied.

Ordinary Least Square (OLS) is applied to the pooling data obtained by averaging over 1993-2000 and two sub-periods 1993-1996 and 1997-2000 for the purpose of comparison. The model is specified as follows:

$$\log X_{1j} = \beta_0 + \beta_1 \log Y_j + \beta_2 LPOP + \beta_3 \log P_{1j} + \beta_4 \log XRAT + \beta_5 LDIST + E_{ij} \quad (2)$$

The U.S. per capita income does not vary with the different cross sections and thus excluded from the model. Distance is included to reflect the transportation costs over countries. In these models, volatility is not defined and thus the level of logarithm of

exchange rate is used instead. ARCH tests are then performed to test heteroskedasticity. By checking the residuals against each explanatory variable, we think that population might cause heteroskedasticity and the logarithm of population is used as weights to correct for it. The results of the cross-sectional data analysis are presented in table 1 in the appendix.

### **Measuring Exchange Rate Uncertainty**

As researchers were trying to establish a systematic relationship between exchange rate volatility with actual trade data, one of the central issues is the appropriate measurement of the uncertainty in exchange rate. McKenzie (1999) provides a comprehensive review of the empirical literature to generate exchange rate volatility. These include absolute percentage change of the exchange rate (Thursby and Thursby 1985; Bailey, Tavlas and Ulan 1986), average absolute difference between the previous forward and current spot rate (Hooper and Kohlhagen 1978), and the moving average of the standard deviation of the exchange rate (Bailey, Tavlas and Ulan 1987; Caballero and Corbo 1989; Koray and Lastrapes 1989; Klein 1990 etc.). More recently, Auto-Regressive Conditional Heteroscedasticity (ARCH) models are more frequently used.

In order to investigate whether different measurements of volatility have effects on the empirical results, we employ four of them in our analysis. The first measure is the absolute percentage change of the exchange rate, i.e.

$$V_1 = |e_t - e_{t-1}|/e_{t-1} \quad (3)$$

The second measure is the variances of the spot exchange rate around its trend, which is predicted from:

$$\ln e_t = \alpha_0 + \alpha_1 t + \alpha_2 t^2 + \varepsilon_t \quad (4)$$

Following Koray and Lastrapes(1989), the third one we use is the moving average of the standard deviation of the exchange rate. The order  $m$  is set to two.

$$V_t = \left[ (1/m) \cdot \sum_{i=1}^m (Z_{t+i-1} - Z_{t+i-2})^2 \right]^{1/2} \quad (5)$$

## Data

As noted above, one of the key motivations is to examine the impact of medium and long run exchange rate uncertainty on U.S. poultry exports; therefore annual exchange rate data are used. The real exchange rate between the U.S. and other 49 countries is obtained from PWT 6.1. The export volume and value over the period 1976-2000 are obtained from Economic Research Service (ERS), U.S. Department of Agriculture (USDA). Economic theory would suggest that the income level of the trading partners of the domestic country should contribute to determination of a nation's exports, and since the marginal propensity to import with respect to income is positive, the expected sign on a nation's trading partner's income should also be positive. It is proxied by the annual real GDP data of the trading partners that was obtained from Penn World Tables (PWT) 6.1. Unit value of poultry exports yields when we divide the export value by export volume.

## Results

The unbalanced panel data contains 49 U.S. trade partners in poultry. The countries are chosen according to their importance in poultry to the U.S. export, data availability and the exchange rate regime. We do not include the fixed exchange rate regime into the analysis because the interest lies in the effects of exchange rate volatility and exchange rates do not change over time in the fixed exchange rate regime. In addition, we use balanced data over

the period 1993-2000 for the purpose of comparison. The results are shown in table 1. The coefficients for exchange rate for the three periods are negative but not statistically significant. Coefficients for unit export value are significantly negative at 5 percent level for all. Per capita GDP are significantly positive for two out of three periods and consistent with economic theory. Although the coefficients for distance are negative but are not statistically significant. R squares are 0.368, 0.284 and 0.322 for 1993-1996, 1997-2000 and 1993-2000 respectively, which are not bad for cross-sectional data. In table 2, the results from the fixed effects methods using the absolute changes (model 1), the moving standard deviation (model 2), the variance of spot exchange rate (model 3) as the uncertainty measures, are presented.

The results shown above proved one of our hypotheses that the measuring techniques do make a difference in examining the effects of volatility of exchange rate on trade. By employing the variance of spot exchange rate, we find that exchange rate volatility has an adverse effect on the U.S. poultry export but the magnitude is small. This is consistent with recent research using the gravity model by dell'Arriccia, Rose and Cho, Sheldon, and McCorriston, who found small but statistically significant effects. For models 1 and 2, exchange rate volatility reduces U.S. exports but not in a significant way. The impacts of foreign income have significantly positive effects on U.S. poultry trade. With the income increases in its largest markets, as Russia, Hong Kong and Mainland China, which still have prospects of income increases, U.S. poultry exports have a great potential. Among the dynamic models, only model 3 that uses variance around the spot exchange rate indicates significant effects of exchange rate volatility.

## **Concluding Remarks**

The potential effect of exchange rate risk on trade has been a subject of controversy. At a theoretical level, researchers have been able to show that the exchange rate volatility may exert a positive or negative impact on trade. Similarly, the available empirical evidence generally conflicting and inconclusive on the possible impact of exchange uncertainty on bilateral trade flows. Previous studies commonly use aggregate or sectoral trade data, in which they assume that the effects of exchange rate volatility are the same over sectors or commodities as the degree of openness varies. The underlying assumptions might contribute to the ambiguity of empirical results. This paper re-examines the impact of exchange rate volatility on U.S. exports by using poultry data for 49 trading partners of the U.S. over 1976 to 2000.

One of the central issues of debate is how to measure the exchange rate volatility. As McKenzie (1999) points out, no general accepted technique exists in the literature. In order to capture the effects of different measurements of exchange rate volatility on trade, three measures are employed in this paper. Using the augmented gravity equation, fixed effects method is applied to panel data of ninety-one importer countries of U.S. agricultural products. Fixed effects approach is used against random effects model in that the latter one assumes that the sample is random chosen from a larger population, which does not fit in this case. We find that exchange rate volatility has a negative effect on trade in all the three static models and are statistically significant in two of them. The measure by the absolute percentage changes and by variance around the spot exchange rate yield statistically negative effects in the long run but the magnitude differs. Consistent with previous authors, we also find that export volume is sensitive to foreign income and price changes.



## References

- Ahmadi-Esfahani, F.Z. "Estimation of Price Elasticities of Export Demand for Canadian and U.S. Wheat: A Nontraditional Approach." *Canadian Journal of Agricultural Economics*. 37 (1989): 173-190.
- Anderson, J. E. "A Theoretical Foundation for the Gravity Equation." *American Economic Review*. 69(1)(1979): 106-116.
- Anderson, M., and P. Garcia. "Exchange Rate Uncertainty and the Demand for U.S. Soybeans." *Amer. J. Agr. Econ.* 71(1989): 721-729.
- Aristotelous K. "Exchange Rate Volatillity, Exchange Rate Regime, and Trade Volume: Evidence from the UK-US Export Function." *Economics Letters*. 72(2001): 87-94.
- Arize, A.C. "Conditional Exchange Rate Volatility and the Volume of Foreign Trade: Evidence from Seven Industrialized Countries." *Southern Economic Journal*. 64(1997): 235-254.
- Arize, A.C., T. Osang, and D.J. Slottje. "Exchange-rate Volatility and Foreign Trade: Evidence from Thirteen LDCs." *Journal of Business and Economic Statistics*. 18(2000): 10-17.
- Asseery, A., and D.A. Peel. "The Effects of Exchange Rate Volatility on Exports." *Economics Letters*. 37(1991): 173-177.
- Babula, R. A., F. J. Ruppel, and D. A. Bessler. "U. S. Corn Exports: the Role of the Exchange Rate." *Agricultural Economics*. 13(1995): 75-88.

- Bailey, M. J., G. S. Tavlas and M. Ulan. "Exchange Rate Variability and Trade Performance: Evidence for the big seven industrial Countries." *Weltwirtschaftliches Archiv*. 122(1986): 466-477.
- Bailey, M. J., G. S. Tavlas and M. Ulan. "The Impact of Exchange Rate Volatility on Export Growth: Some Theoretical Considerations and Empirical Results." *Journal of Policy Modeling*. 9(1) (1987): 225-243.
- Batten, D.S., and M.T. Belongia. "Monetary Policy, Real Exchange Rates and U.S. Agricultural Exports." *Amer. J. Agr. Econ.* 68(1986): 422-427.
- Belanger, D., S. Gutierrez, D. Racette and J. Raynauld. "The Impact of Exchange Rate Variability on Trade Flows: Further Results on Sectoral U. S. Imports from Canada." *North American Journal of Economics and Finance*. 3(1992): 888-892.
- Bergstrand, J. H. "The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence." *The Review of Economics and Statistics*. 67(3) (August 1985): 474-481.
- Bessler, D.A., and R.A. Babular. "Forecasting Wheat Exports: Do Exchange Rates Matter?" *J. Bus. Econ. Statist.* 5(1987): 397-406.
- Bini-Smaghi, L. "Exchange Rate Variability and Trade: Why is it so Difficult to Find any Relationship." *Applied Economics*. 23(1991): 927-936.
- Caballero, R. J., and V. Corbo. "The Effect of Real Exchange Rate Uncertainty on Exports: Empirical Evidence." *The World Bank Economic Review*. 3(1989): 263-278.
- Caporale, T. and K. Dorodian. "Exchange Rate Variability and the Flow of International Trade." *Economics Letters*. 46(1994): 49-54.

Carey, H.C. *Principles of Social Science*. Philadelphia, 1871.

Cheng, I-H., and H.J. Wall. "Controlling for Heterogeneity in Gravity Models of Trade and Integration." *Federal Reserve Bank of St. Louis Working Paper 1999-010C*. St. Louis, June 2002.

Cho G, I. M. Sheldon, and S. McCorriston. "Exchange Rate Uncertainty and Agricultural Trade." *American Journal of Agricultural Economics*. 84(November 2002): 931-942.

Chowdhury, A.R. "Does Exchange Rate Volatility Depress Trade Flows? Evidence from Error-Correction Models." *The Review of Economics and Statistics*. 76(1993): 700-706.

Clark, P.B. "Uncertainty, Exchange Risk, and the Level of International Trade." *Western Economic Journal*. 11(1973): 302-313.

Cushman, D.O. "The Effects of Real Exchange rate risk on International Trade." *Journal of International Economics*. 15(1983): 45-63.

Cushman, D.O. "Has Exchange Risk Depressed International Trade: The Impact of Third Country Exchange Risk." *Journal of International Money and Finance*. 5(1986): 361-379.

Deardorff, A.V, "Testing Trade Theories and Predicting Trade Flows." *Handbook of International Economics*. R. W. Jones and P. B. Kenen, Ed., Vol. I. Elsevier, 1984.

DeGrauwe, P. "International Trade and Economic Growth in the European Monetary System." *European Economic Review*. 31(1987): 389-398.

DeGrauwe, P. "Exchange Rate Volatility and the Slowdown in Growth of International Trade." *International Monetary Fund Staff Papers*. 35(1988): 63-84.

- DeGrauwe, P. and De Bellefroid. "Long Run Exchange Rate Variability and International Trade." *Real Financial Linkages Among Open Economies*. S. Arndt and J. D. Richardson, ed., Chapter 8. England: The MIT Press, 1986.
- DeGrauwe, P., and F. Skudelny. "The Impact of EMU on Trade Flows." *Weltwirtschaftliches Archiv* 136(2000): 383-402.
- Dellas, H. and B-Z. Zilberfarb. "Real Exchange Rate Volatility and International Trade: A re-examination of the theory." *Southern Economic Journal*. 59(1993): 641-647.
- Dell'Arricia, G. "Exchange Rate Fluctuations and Trade Flows." *IMF Staff Papers* 4(2000): 293-314.
- Doganlar, M. "Estimating the Impact of Exchange Rate Volatility on Exports: Evidence from Asian Countries." *Applied Economics Letters*. 9(2002): 859-863.
- Eichengreen, B. and D. A. Irwin, "The Role of History in Bilateral Trade Flows," *The Regionalization of the World Economy*. J. A. Frankel, Ed., University of Chicago Press, 1998.
- Ethier, W. "International Trade and the Forward Exchange Market." *American Economic Review*. 63(3) (1973): 494-503.
- Fountas, S., and D. Bredin. "Exchange Rate Volatility and Exports: the Case of Ireland." *Applied Economics Letters*. 5 (1998): 301-304.
- Franke, G. "Exchange Rate Volatility and International Trading Strategy." *Journal of International Money and Finance*. 10(1991): 292-307.

- Frankel, J.A., and S. J. Wei. "Trade Blocs and Currency Blocs." *NBER Working Paper 4335*, Cambridge, MA: NBER 1993.
- Giovannini, A. "Exchange Rates and Traded Goods Prices." *Journal of International Economics*. 24(1988): 45-68.
- Gonzaga, G. M., and M. C. T. Terra. "Equilibrium Real Exchange Rate, Volatility, and Stabilization." *Journal of Development Economics*. 54 (1997): 77-100.
- Gotur, P. "Effects of Exchange Rate Volatility on Trade: Some Further Evidence." *IMF Staff Papers*. 1985.
- Hailey, S.L., and B. Krissoff. "U.S. Grain Exports and the Value of the U.S. Dollar." *J. Agr. Econ. Res.* 39(1987): 12-21.
- Hassan, M. K., and D. R. Tuft. "Exchange Rate Volatility and Aggregate Export Growth in Bangladesh." *Applied Economics*. 30 (1998): 189-201.
- Hooper, P., and S. W. Kohlhagen. "The Effect of Exchange Rate Uncertainty on the Prices and Volume of International Trade." *Journal of International Economics*. 8(1978): 483-511.
- IMF. "Exchange Rate Volatility and World Trade." *IMF Occasional Papers*. IMF Research Department. July 28, 1984.
- Kenen, P. and D. Rodrik. "Measuring and Analysing the Effects of Short-Term Volatility on Real Exchange Rates." *Review of Economics and Statistics (Notes)*. (1986): 311-315.
- Klein, M.W. "Sectoral Effects of Exchange Rate Volatility on United States Exports." *Journal of International Money and Finance*. 9(1990): 299-308.

- Koray, F., and W. D. Lastrapes. "Real Exchange Rate Volatility and U.S. Bilateral Trade: A VAR Approach." *The Review of Economics and Statistics*. 71(1989): 708-712.
- Kroner, K. F., and W. D. Lastrapes. "The Impact of Exchange Rate Volatility on International Trade: Reduced Form Estimates using the GARCH-in-mean Model." *Journal of International Money and Finance*. 12(1993): 298-318.
- Langley, S.V., M. Guigale, W.H. Meyers, and C. Hallahan. "International Financial Volatility and Agricultural Commodity Trade: A Primer." *Amer. J. Agr. Econ.* 82(2000): 695-700.
- Leamer, E.E., and J. Levinsohn. "International Trade Theory: The Evidence." *The Handbook of International Economics*. G. Grossman and K. Rogoff, ed., Vol. III. Elsevier, 1995.
- Linnemann, H. *An Econometric Study of International Trade Flows*. North-Holland, 1966.
- Maskus, K. "Exchange Rate Risk and U.S. Trade: A Sectoral Analysis." *Federal Reserve Bank of Kansas Econ. Rev.* 3(1986): 16-28.
- McKenzie, M. D. "The Impact of Exchange Rate Volatility On Australian Trade Flows." *Journal of International Financial Markets, Institutions and Money*. 8(1998): 21-38.
- McKenzie, M. D. "The Impact of Exchange Rate Volatility On International Trade Flows." *Journal of Economic Surveys*. 13(1999): 71-106.
- McKenzie, M. D., and R. Brooks. "The Impact of Exchange Rate Volatility On German – U.S. Trade Flows." *Journal of International Financial Markets, Institutions and Money*. 7(1997): 73-87.

- Pere, E., and A. Steinherr. "Exchange Rate Uncertainty and Foreign Trade." *European Economic Review*. 33(1989): 1241-1264.
- Pozo, S. "Conditional Exchange Rate Volatility and the Volume of International Trade: Evidence from the early 1900's." *The Review of Economics and Statistics*. 74(1992): 325-329.
- Pöyhönen, P. "A Tentative Model for the Volume of Trade Between Countries." *Weltwirtschaftliches Archiv*. 90(1963): 93-100.
- Pritchett, L. "Measuring Real Exchange Rate Instability in Developing Countries." *The World Bank Working Paper*. WPS 791.
- Qian, Y., and P. Varangis. "Does Exchange Rate Volatility Hinder Export Growth: Additional Evidence." *Empirical Economics*. (1994): 371-396.
- Rose, A. K. "One Money, One Market: The Effect of Common Currencies on Trade." *Econ. Policy* 30 (2000): 7-46.
- Savvides, A. "Unanticipated Exchange Rate Variability and the Growth of International Trade." *Weltwirtschaftliches Archiv*. 128(1992): 446-462.
- Sukar, A-H and S. Hassan. "US Exports and Time-Varying Volatility of Real Exchange Rate." *Global Finance Journal*. 12(2001): 109-119.
- Thursby, J.G., and M.C. Thursby. "Bilateral Trade Flows, the Linder Hypothesis and Exchange Rate Risk." *Review of Economics and Statistics*. 69(1987): 488-495.
- Thursby, J.G., and M.C. Thursby. "The Uncertainty Effects of Floating Exchange Rates: Empirical Evidence on International Trade Flows." *Exchange Rates, Trade and the U.S.*

*Economy*. S. W. Arndt, R. J. Sweeney and T.D. Willett, ed., 153-166. Cambridge: Ballinger Publishing Co, 1985.

Tinbergen, J. "Shaping the World Economy - Suggestions for an International Economic Policy." The Twentieth Century Fund, 1962.

Viaene, J.M. and C.G. de Vries. "International Trade and Exchange Rate Volatility." *European Economic Review*. 36(1992): 1311-1321.



**Table 1 – Pooling Data Regression Report**

Dependent Variable: Export volume

Variables	1993-1996	1997-2000	1993-2000
	Average	average	Average
<i>LnXRAT</i>	-0.008 (-1.232)	-0.004 (-0.802)	-0.004 (-0.804)
$\ln Y_j$	0.060 ** (2.629)	0.029 (1.403)	0.046 ** (2.250)
$\ln P_j$	-0.211 ** (-4.720)	-0.161 ** (-4.133)	-0.186 ** (-4.475)
<i>LnD</i>	-0.023 (-0.680)	-0.026 (-0.810)	-0.027 (-0.895)
$R^2$	0.368	0.284	0.322

Note: \* \*stands for significance at 0.05 confidence level.

**Table 2 – Static Panel Data Fixed Effects Model**

Dependent Variable: Export Volume

Variables	Model 1	Model 2	Model 3
<i>DXRAT</i>	-0.3378** (-3.401)	-0.0211 (-0.419)	-0.157** (-2.502)
<i>lnN</i>	-0.0408 (-0.998)	-0.032 (-0.764)	-0.002 (-0.048)
<i>lnY<sub>j</sub></i>	1.2629** (3.440)	1.178 ** (3.093)	1.364** (3.675)
<i>lnY<sub>l</sub></i>	0.162 (0.4226)	0.125 (0.313)	0.084 (0.218)
<i>lnP<sub>j</sub></i>	-1.763** (-14.0128)	-1.825 ** (-14.453)	-1.796** (-14.267)
<i>V<sub>1</sub></i>	-0.355** (-3.521)		
<i>V<sub>2</sub></i>		-0.026 (-0.521)	
<i>V<sub>3</sub></i>			-0.028** (-3.287)
<i>R</i> <sup>2</sup>	0.796	0.812	0.796

\*\* - significant at 5% level; \* - significant at 10% level.

T-values are in parenthesis.

**Table 3 – Dynamic Panel Data Fixed Effects Model**

Dependent Variable: Export Volume

Variables	Model 1	Model 2	Model 3
<i>DXRAT</i>	-0.027 (-0.344)	-0.051 (-1.311)	-0.092** (-1.900)
$\ln N$	-0.011 (-0.351)	-0.010 (-0.314)	0.0102 (0.308)
$\ln Y_j$	0.426 (1.486)	0.408* (1.384)	0.532* (1.839)
$\ln Y_l$	0.063 (0.213)	-0.003 (-0.011)	-0.029 (-0.098)
$\ln P_j$	-1.315** (-13.209)	-1.335** (-13.407)	-1.324** (-13.328)
$\ln X_{t-1}$	0.561** (22.651)	0.561 (22.361)	0.556** (22.870)
$V_1$	0.007 (0.091)		
$V_2$		0.007 (0.170)	
$V_3$			-0.014** (-2.098)
$R^2$	0.878	0.889	0.878

\*\* - significant at 5% level; \* - significant at 10% level.

T-values are in parenthesis.