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The Effect of Exchange Rate Volatility upon Foreign Trade of Hungarian Agricultural Products

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Abstract

This paper takes a new empirical look at the long-standing question of the effect of exchange rate volatility on international trade flows of transition economies in Central Europe by studying the case of Hungarian agricultural exports to their export destination countries between 1999 and 2008. Based on a gravity model that controls for other factors likely to determine bilateral trade, the results show that nominal exchange rate volatility has had a significant positive effect on agricultural trade over this period. This positive effect of exchange rate volatility on agricultural exports suggests that agri-food entrepreneurs are not interested in speeding up the process of joining Hungary to the euro zone.

Keywords

international trade, gravity model, exchange rate volatility

Introduction

There is a continuously growing body of literature dealing with the effects of exchange rate uncertainty on international trade since the breakdown of the Bretton Woods system of fixed exchange rates when both real and nominal exchange rates have fluctuated widely. Most of the studies are focused on estimating exchange rate volatility effects on international trade of developed countries, especially in the United States (U.S.) as well as on the trade between developed and developing countries. This topic has been neglected in Central and Eastern European Countries (CEEC), despite an expanding body of literature on agricultural trade in the region (e.g. Fertő, 2008; Bojnec and Fertő. 2008; Bojnec and Fertő, 2009) and macroeconomic aspects of the transition (e.g. Bakucs and Fertő, 2005; Bakucs et al., 2007; Bakucs et al., 2009).

This research focused on the relationship between exchange rate volatility and Hungarian agricultural exports, using a gravity model based on panel data. This issue is important in transition countries because international trade with agricultural products and macroeconomic environment have undergone major changes in the last one and half decades. The short- and long-term impacts of monetary policy have been very important for the agricultural sector in transition economies due to the lack of farm policy credibility, where farm incomes are increasingly influenced by the foreign trade in agricultural products. Consequently the central question of the present research is how the exchange rate affects the agricultural exports in Hungary, where agricultural exports have increased substantially in the past decade, from €2.17 billion in 1999 to €5.74 billion in 2008.

The article is organised as follows. Section 2 surveys the theoretical and empirical contributions in the literature. In section 3 the employed gravity model and some methodological aspects of examination of volatility effects on international trade are presented. Data and the measurement of exchange rate volatility are presented in sections 4 and 5 respectively. Section 6 reports the findings of gravity equation estimations. The last section summarises the results and draws some policy implications.

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The examination of the effect of exchange rate volatility on international trade has become effective after the abandonment of fixed exchange rate regimes which has resulted a growing body of theoretical and empirical literature. A conventional method applied in these studies is the use of gravitational models.

Exchange rate volatility

The widespread popular perception that greater exchange rate volatility reduces trade has helped to drive monetary union in Europe (European Union Commission, 1990) and is strongly related to currency market intervention by central banks (Bayoumi and Eichengreen, 1998). However, the theoretical and empirical contributions in the literature fail to conclusively support this notion. A number of models have been advanced which support the negative hypothesis that volatility acts to the detriment of international trade while other models have supported the positive hypothesis that exchange rate volatility may lead to grater levels of trade (McKenzie, 1999). Then, inevitably, many empirical studies have failed to establish any significant link between measured exchange rate variability and the volume of trade.

One possible reason for such mixed results is the different time horizons of the analyses. One common argument is that exporters can easily ensure against short-term exchange rate fluctuations through financial markets, while it is much more difficult and expensive to hedge against long-term risk. Peree and Steinherr (1989), Obstfeld (1995), and Cho et al. (2002) presented evidence that longer-term changes in exchange rate seem to have more significant impacts on trade than do short-term exchange rate fluctuations that can be hedged at low cost. On the other hand, Vianne and de Vries (1992) show that even if hedging instruments are available, short-term exchange rate volatility still affects trade because it increases the risk premium in the forward market. Furthermore, Krugman (1989), Wei (1999) and Mundell (2000) argue that hedging is both imperfect and costly as a basis to avoid exchange rate risk, particularly in developing countries and for smaller firms more likely to face liquidity constraints. Pick (1990) analyses the effect of exchange rate risk on United States (U.S.) agricultural trade flows and found that exchange rate risk is not a significant factor affecting bilateral agricultural trade from the U.S. to seven out of eight developed markets, but indicates that exchange rate risk adversely affects U.S. agricultural exports to some developing countries. DeGrauwe (1988) illustrated how the relationship between exchange rate volatility, whether long run or short term, and trade flows is analytically indeterminate when one allows for sufficient flexibility in assumptions.

Another possible reason for such controversial results is the aggregation problem. The effects of exchange rate volatility on export may vary across sectors (McKenzie, 1999). This may occur because the level of competition, the price setting mechanism, the currency contracting, the use of hedging instruments, the economic scale of production units, openness to international trade, and the degree of homogeneity and storability of goods vary among sectors. The differences among sectors in exporters' access to financial instruments, currency contracting, production scale, storability, etc., may be partly pronounced in developing countries. This contrast is only accentuated by the fact that agriculture is typically a notably competitive sector with flexible pricing on relatively short-term contracts. Furthermore, agricultural products are relatively homogenous, and typically less storable than the exports in other sectors (Such, 1974). Therefore Bordo (1980) and Maskus (1986) argue that agricultural trade may be far more responsive to exchange rate changes than the trade in manufactured products.

Wang and Barett (2007) estimated the impact of the conditional mean and conditional variance of real exchange rates on Taiwan's exports by estimating an innovative rational expectations-based on multivariate GARCH-M model using sector- and destination-specific monthly data. They found that agricultural trade flows are quite significantly negatively affected by high frequency exchange rate volatility that does not seem to impact other sectors significantly. Agriculture appears far more responsive to both expected exchange rates and to expected volatility in the exchange rate and less responsive to importer incomes than do other sectors in Taiwan's economy. Similar results were obtained by Cho et al. (2002) employing gravity models for ten developed countries. They found that real exchange rate uncertainty had a negative effect on agricultural trade over the period between 1974 and 1995. Moreover, the negative impact of uncertainty on agricultural trade has been more significant compared to other sectors.

The available literature dealing with the effect of exchange rate volatility on international trade, focusing on an individual trade commodity, has also found a negative relationship. Sun et al. (2002) estimated the effect of exchange rate volatility on wheat trade worldwide employing a modified gravity-type model. They found that both measures of short-term and long-term exchange rate volatility showed negative effects on world trade, while the long-term effect was even larger. Yuan and Awokuse (2003) analysed the exchange rate volatility and U.S. poultry exports using gravity models with different volatility measures and found that exchange rate volatility has a negative effect on trade in all the three static models and are statistically significant in two of them. Bajpai and Mohanty (2007) found a weak impact of exchange rate volatility on U.S. cotton exports, which could be attributed to the high exposure of the cotton and textile sector to domestic and international policies.

The empirical estimation of the effect of exchange rate volatility on agricultural trade in the literature provided mixed results: the majority of the studies reported a negative impact of exchange rate volatility on trade, but some papers found a positive effect especially in the case of developed countries. This can be possible due to the different time horizon of the investigations and diverse methods of calculating exchange rate volatility.

The Gravity Equation

A gravity model has been employed in this study, which has been extensively applied in international trade analysis. Classical gravity theory[2] according to Anderson and Wincoop (2004) states that the attraction force a_{ij} between two entities i and j is proportional to their respective masses m_i and m_j, usually proxied by GDP and/or population, and inversely proportional to the squared distance d_{ij}^{-2} between these entities. Therefore, this law can be formalised as:

$$a_{ij} = \gamma m_i m_j d_{ij}^{-2} \quad (1)$$

where γ - *is a constant proportionality factor*.

The use of the gravity approach to model international trade flows date back to Tinbergen (1962), Poyhonen (1963) and Linnemann (1966). Linnemann extended the classical gravity equation by adding more variables and went further towards a theoretical justification in terms of Warlasian general equilibrium system. The theoretical aspects of the gravity model for trade are summarised in three main factors: the total potential supply (or exports) of a country to the world market, the total potential demand (or imports) of a country to the world market, and those factors that create a resistance to trade and thus affect the degree of trade intensity. These include ordinary tariff barriers and transport costs. The first and second factors are expected to be equal to one another if one disaggregates the international flow of capital, services or land transfers.

[2] Carey (1871) observed the presence of gravitational force in social phenomena, stating that the force was in direct ratio to mass and inverse to distance.

The basic form of the gravity model for examination of international trade according to Matyas (1997; 1998) is:

$$EXP_{ij} = \alpha_0 GDP_i^{\alpha_1} GDP_j^{\alpha_2} POP_i^{\alpha_3} POP_j^{\alpha_4} DIST_{ij}^{-\alpha_5} XV_{it}^{-\alpha_6} TARIF_{it}^{-\alpha_7} D_n^{\alpha_8} \quad (2)$$

where, EXP_{ij} represents the trade flow between country i and j in the year t, α_0 is a constant, and α_0, α_1, α_2, α_3, α_4, α_5, α_6, α_7 are coefficients, weighted geometric averages. GDP_i and GDP_j stand for domestic gross product per capita in country i and j, respectively. POP_i and POP_j represent the population in country i and j, respectively, while DIS_{ij} expresses trade resistance due to the geographical distance between countries i and j and D_n is dummy variable to take into account qualitative resistance factors between country i and j. The equation can be augmented to include other factors that may create trade resistance, such as exchange rate volatility (XV_{ijt}) and bilateral trade tariffs ($TARIF_{ij}$).

Database and methodology

Empirical Specification of the Gravity Equation

The effect of exchange rate volatility on Hungarian agri-food export (i) to the selected most important export destination countries (j) is tested, and this study did not combine bilateral trade between exporter and importer, therefore the gravity mass independent variables (GDP_i, POP_i) are not included in the econometric model of gravity equation as they are constant in any combination of export destination countries. We log-linearised equation (2) to arrive at the estimating equation (3):

$$\ln EXP_{ij} = \alpha_0 + \alpha_1 \ln GDP_j + \alpha_2 \ln POP_j + \alpha_3 \ln DIST_{ij} + \\ + \alpha_4 \ln XV_{ij} + \alpha_5 D_{1,BOR_{ij}} + \alpha_6 D_{2,EU} + \alpha_7 D_{3,CEFTA} + \varepsilon_{ij} \quad (3)$$

where ε_{ij} is an error term assumed to be statistically independent of the rest of the regressors, with a conditional mean of 0. Since estimating a panel data on Hungarian agricultural exports, equation (3) above acquires a time dimension as presented in equation (4) below:

$$\ln EXP_{ij} = \alpha_0 + \alpha_1 \ln GDP_{jt} + \alpha_2 \ln POP_{jt} + \alpha_3 \ln DIST_{ij} + \alpha_4 \ln XV_{ijt} + \\ + \alpha_5 D_{1,BOR_{ij}} + \alpha_6 D_{2,EU} + \alpha_7 D_{3,CEFTA} + \tau_t + \eta_{ijt} \quad (4)$$

where τ_t's are a full set of year dummies, and η_{ijt} is the error term. Additional factors which may enhance or resist exports are also typically included in equation (4). The most common are dummies for common border, common language and regional trade agreements (RTA). In the equation was included a dummy for common border, $D_{1,BOR_{ij}}$ with value 1 when country j shares a common border with country i and 0 otherwise, and dummies $D_{2,EU}$, $D_{3,CEFTA}$ for regional trade agreements. Hungary signed a preferential trade agreement with the European Union in 1991 and joined to the Central European Free Trade Agreement (CEFTA) in 1992. $D_{2,EU}$ with value 1 when the country j is member of EU and *CEFTA* with value 1 when country j is a member of Central European Free Trade Agreement (CEFTA) states; and otherwise 0. According to the gravity approach we expect positive sign for GDP_{jt}, POP_{jt}, $D_{1,BOR_{ij}}$, $D_{2,EU}$ and $D_{3,CEFTA}$, and negative sign for $DIST_{ij}$ variables.

Data

Economic theory would suggest that the income level of the domestic country should contribute to the determination of a country's exports, and since the marginal propensity to import with respect to income is positive, as well as the expected sign of a nation's trading partner's income should also be positive. The domestic and export destination countries' income is collected from the World Economic Outlook Database as well as the number of inhabitants (*POP*) in these countries, while the distance of export destination countries from exporter (*i*) country is obtained from the Pennsylvania State University World Tables. The values of GDP per capita were collected in national currencies and converted to euro at the yearly average exchange rate. The export data of Hungarian agricultural products are also expressed in euro and are taken from the EUROSTAT database; there are included eighty-one export destination countries where Hungary exported agricultural products in every year of the period analysed from 1999 to 2008 (see annex).

Table 1

Summary statistics for the variables used in the estimation of exchange rate volatility on Hungarian agricultural exports for the period of 1999 to 2008

Variable	Mean	St. Dev.	Min	Max
EXP_{ijt}	32,045,897	72,583,126	20	674,654,933
GDP_{it}	7,607	1,946	4,495	10,517
GDP_{jt}	12,869	13,687	103	80,566
POP_{it}	10,139,500	67,185	10,045,000	10,253,000
POP_{jt}	45,530,770	142,262,300	273	1,328,200,000
$DIST_{ij}$	3,833	3,982	159	18,128
XV_{ijt}	0.026	0.017	0.008	0.155

Source: Author's calculations.

Table 1 presents summary statistics for the variables used in the estimation of exchange rate volatility on Hungarian agricultural exports for the period of 1999 to 2008. Note that GDP per capita in Hungary (*i*) is 59% of the average of its export destination countries (*j*) and the variable POP_{it} is only 22% of average variable POP_{jt}. The row labelled XV_{ijt} represents the summary statistics for the estimated exchange rate volatility based on Standard Deviation (St. Dev.) of monthly nominal exchange rates, which is defined in the next section.

The exchange rate volatility of HUF in relation to the national currencies of eighty-one countries (see annex) is calculated and used for estimation. The monthly average nominal exchange rate series and returns[3] of EUR and USD to HUF variability for the analysed period are picked out for illustration and are presented in Figure 1 and Figure 2 respectively. In spite of the fact that the rate of return of exchange rate is increasing from the beginning of the analysed period the variation of exchange rate of HUF is not high as during the examined period it mostly does not exceed the limit of ±5% (Figure 2).

[3] The rate of return of exchange rate is calculated as follows: $(e_m - e_{m-1}) / e_{m-1}$, where e_m represents the monthly average nominal exchange rate.

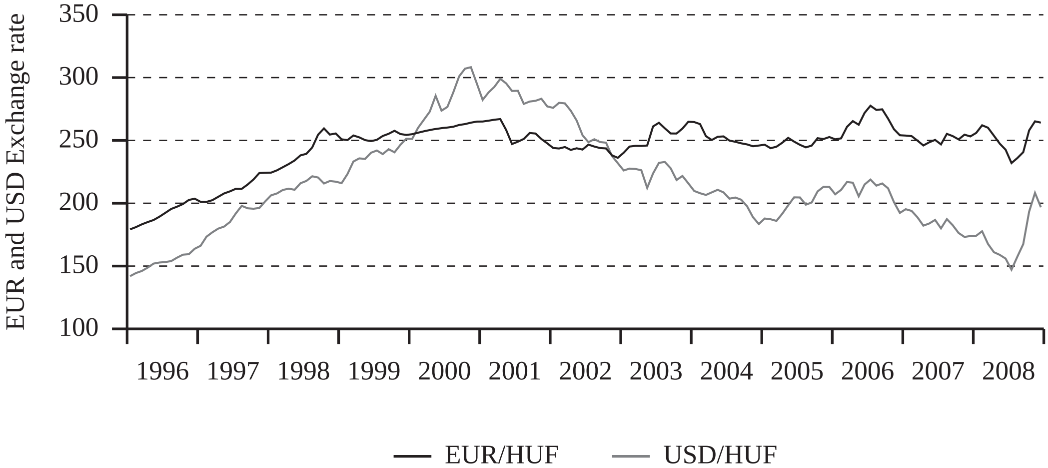

Figure 1: Nominal Exchange Rate Series of EUR and USD to HUF for the period 1996-2008

Source: Average monthly exchange rate from the Hungarian National Bank.

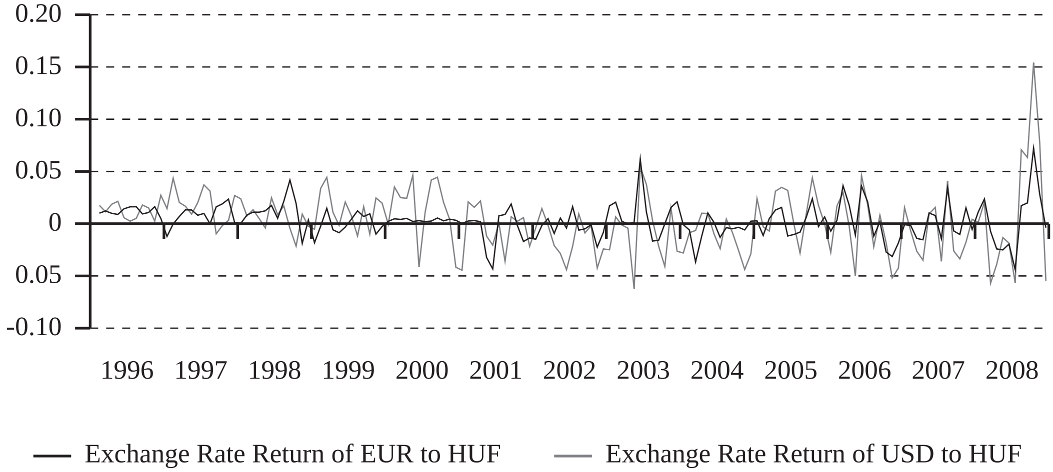

Figure 2: Exchange Rate Return of EUR and USD to HUF for the period 1996-2008

Source: Author's calculations based on average monthly exchange rate from the Hungarian National Bank.

Measuring Exchange Rate Volatility

A variety of measures of exchange rate volatility have been used in the literature. Usually, the measures used are some variant on the standard deviation of the difference in annual or quarterly or monthly exchange rates, for example, the standard deviation of the percentage change in the exchange rate or the standard deviation of the first differences in the logarithmic exchange rate. In this article, in order to capture ex-ante exchange rate uncertainty, the latter measure is used. We constructed the measure of exchange rate volatility based on monthly average nominal exchange rates for the period from 1996 to 2008 for every year analysed from the previous three years to year *t*. The measurement of exchange rate volatility is based on *nominal* bilateral exchange rates. Several studies highlighted that nominal and real exchange rate series generate very similar empirical results (McKenzie and Brooks, 1997; McKenzie, 1999; Quian and Varanges, 1994).

A moving standard deviation of the first differences in the monthly nominal exchange rate over the forty-eight months (m) prior to the year t and the prior three years ($t`$)[4] is applied to estimate exchange rate volatility for year t:

$$XV_{ijt} = \sqrt{\frac{\sum_{m=1}^{48}(x_{ij,m} - \overline{x}_{ij,t'})^2}{48}} \quad (5)$$

where $x_{ij,m} = \ln e_{ij,m} - \ln e_{ij,m-1}$, $\ln e_{ij,m}$ is the log of the monthly nominal exchange rate (e) between countries i and j at the time (month) m, and $\overline{x}_{ij,m} = \frac{\sum_{m=1}^{48} x_{ij,m}}{48}$ is the mean of $x_{ij,m}$ over the forty-eight months prior to year t and the previous three years.

Results

One advantage of using panel data is that unobservable cross-sectional effects can be accounted. However, there are some econometric issues that need to be addressed when estimating the gravity equation (4). Firstly, nonspherical error terms resulting from heteroskedasticity and autocorrelation across panel sets are anticipated in the dataset. In the case of trade between two smaller countries or between a smaller country and a larger country likely to be more volatile compared to trade between two large countries and heteroskedasticity may occur in this case (Frankel, 1997). Autocorrelation within panels may be present, partly reflecting sunk cost effects (Roberts and Tybout, 1997). To address these problems the heteroskedastic corrected standard errors (Prais-Winsten) approach is applied that controls for heteroskedasticity, and panel specific AR (1) is applied to control autocorrelation (Beck and Katz, 1995; 1996).

Table 2

Exchange Rate Volatility and Exports

Variable	**lnEXP_{ijt}**
lnGDP_{jt}	0.3020**
lnPOP_{jt}	0.0790
ln$DIST_{ij}$	-1.407***
ln XV_{ijt}	0.4000**
$D_{1,BOR}$	1.2870**
$D_{2,EU}$	0.2810
$D_{3,CEFTA}$	0.1400
R^2	0.9150
N	810
rho	0.4516

Note: The single (*), double (**), or triple (***) asterisk denote significance at the 10%, 5%, and 1% levels, respectively.
Source: Author's calculations.

4 t' represents the period based on monthly data of the year s' t-3, t-2, t-1 and t.

The results of the gravity model equation (4) using the moving standard deviations as a volatility measure are presented in Table 2. The coefficient on XV_{ijt} is positive and significant at the 5% level. This implies that the exchange rate volatility has a positive effect on Hungarian agri-food exports: increasing volatility by 10% results in a 4% increase in agri-food exports. The positive effect of exchange rate volatility on agricultural trade is consistent with the findings of McKenzie and Brooks (1997).

The mass variables of gravity model $\ln GDP_{jt}$ and $\ln POP_{jt}$ have the expected positive sign, but only the first variable is significant. This implies that a higher value of GDP per capita of 10% in the export destination country (*j*) increases Hungarian agri-food export by 3%. The classical trade resistance variable of gravity equation $\ln DIST_{ij}$ has the expected negative sign and is significant at the 1% level: A distance increase of 10% results in a 14% decrease in exports to these export destination countries. The border dummy ($D_{1,BOR}$) is significant and its positive sign indicates that Hungarian agri-food exports are increasing in the relation of countries which have a common frontier with the analysed country. However the qualitative trade resistance variables ($D_{2,EU}$ and $D_{3,CEFTA}$) are not significant.

Conclusions

This article has investigated whether exchange rate volatility has negatively affected the Hungarian agricultural exports. We constructed a balanced panel of Hungarian agri-food exports to 81 export destination countries for the period 1999-2008. This gave a fairly large panel dataset to which we applied the gravity model specification, which has numerous advantages over cross-sectional studies that have typically been used to highlight the impact of exchange rate volatility on bilateral trade flows. Exchange rate volatility is captured by a moving standard deviation of the first differences in the exchange rate over the forty-eight months nominal average exchange rate of year t and the prior three years.

The estimations of the gravity equation indicate that the signs of significant parameters are according to our expectations. The signs of parameters for the variables of population and income (GDP) of export destination countries are positive, while distance is negative. As well as exchange rate volatility has positive effects on Hungarian agri-food exports.

The policy implications of the positive effect of exchange rate volatility on Hungarian agri-food trade are connected to the process of joining to the euro zone and to the attitude of agri-food products trading firms. As the exchange rate volatility has a positive effect on trade with Hungarian agri-food products, the agricultural holdings and firms operating in the food industry are interested in prolonging the process of joining Hungary to the euro zone, introducing euro as late as possible. At the same time, trading firms with Hungarian agri-food products seems to cover their risks which arise from currency volatility using the opportunities offered by the forward and futures markets.

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Annex 1

Agri-food export destination countries from Hungary

Albania	Iceland	Peru
Algeria	Iran	Poland
Argentina	Ireland	Portugal
Armenia	Israel	Republic of Korea
Australia	Italy	Romania
Austria	Japan	Russia
Azerbaijan	Jordan	Saudi Arabia
Belarus	Kazakhstan	Senegal
Belgium	Kenya	Singapore
Bosnia and Herzegovina	Kuwait	Slovakia
Brazil	Kyrgyz Republic	Slovenia
Bulgaria	Latvia	South Africa
Canada	Lebanon	Spain
Chile	Libyan Arab Jamahiriya	Sweden
China	Lithuania	Switzerland
Croatia	Luxemburg	Syrian Arab Republic
Cyprus	Macedonia, FY	Taiwan
Czech Republic	Malaysia	Tajikistan
Denmark	Malta	Thailand
Egypt	Mexico	Tunisia
Estonia	Moldova	Turkey
Finland	Mongolia	Ukraine
France	Morocco	United Arab Emirates
Georgia	Netherlands	United Kingdom
Germany	New Zeeland	United States
Greece	Norway	Uzbekistan
Hong Kong	Pakistan	Venezuela

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