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The Impact of the Real Effective Exchange Rate on Poland's Food and Live Animal Exports

Abstract. In this study, for the 2012M1-2020M1 period, the relationship between Poland's real effective exchange rate and its food and animal exports were examined by the bounds test. The stationary analyses of variables were examined by the ADF and PP tests. According to the results of a cointegration test, a cointegration relation among the real effective exchange rate, food and live animal exports, as well as industrial production was determined. It was also concluded that the real effective exchange rate has a long-term negative impact on Poland's food and live animal exports. This research also established that a 1% increase in the real effective exchange rate in the long-term would decrease Poland's food and animal exports by 3.091%. Also, industrial production has a positive impact on Poland's food and animal exports, as expected. It was determined that a 1% increase in industrial production would increase Poland's food and animal exports by 2.803%. On the other hand, the error correction term coefficient was found to be -0.119, indicating that 11% of the imbalance in the short-term will be recovered in the next period.

Key words: exchange rate, ARDL bounds test analysis, time series analysis, food and live animal exports, cointegration

JEL Classification: F1, F14, C58

Introduction

Movement in the exchange rate is one of the most important factors causing uncertainties in commodity prices. This causes a major problem in determining the scope and volume of trading behaviour. However, the effect of exchange rate movement on exports, especially agricultural exports, is difficult to predict. With the collapse of the Bretton Woods Agreement in the 1970's, and with the adoption of a floating exchange rate regime, economists have given higher importance to examining the exchange rate and the effects of exchange rate volatility on import and export. Devaluation of local currency is expected to increase agricultural export. However, one of the important conclusions of the financial crises determined that large depreciation in the exchange rate has had little impact on exports.

Fluctuations in exchange rates lead to uncertainties in global commodity prices, which in the end results in a significant problem in estimating the extent and nature of commercial behaviors between exporting and importing countries (Orden, 2002). The unpredictable nature of the exchange rate always forces risk-avoiding traders to reduce their commercial activities carried out in foreign countries, and this collective risk avoidance of traders

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negatively affects the total trade of the country by reducing export and import volumes. However, it should be noted that exchange rate fluctuations may also have a positive or negative impact on the economy, especially with respect to agricultural sectors.

The Polish exchange regime has recently been converted to a floating regime from a fixed exchange rate. After the accession of Poland into the European Union, exchange rate has become more important for the Polish economy than ever before (Bańbuła, Koziński, Rubaszek, 2011). Ozturk and Kalyoncu (2009) found that the real effective exchange rate has had a negative impact on Poland's exports.

Agricultural exports include various food products. Through the period of this study, an average of 11% of Poland's total exports were food and animal exports. In fact, Poland is a major regional exporter of fruit, some types of vegetables, and mushrooms (FAO, 2020).

The primary objective of this study is to determine the impact of the real effective exchange rate on food and live animal exports, one of Poland's major export groups.

The objective of this study is to determine whether exchange rate fluctuations have a significant impact on agricultural products export of Poland in the period 2012-2020, and to examine whether policies focusing on reducing exchange rate fluctuation will expand export markets of Poland. In order to achieve the set objective the following variables were used, ie: Real Effective Exchange Rate, Advanced Economies Industrial Production, Poland's Food and Live Animal Exports, respectively from BIS, OECD and Eurostat databases. The study also assesses the behavioral coverage of trade flow settings in response to exchange rates within a cointegration framework. The framework developed in this study enables the characterization of adjustment towards equilibrium when deviations from predicted actual trade flows take place while allowing determinants of trade flows.

Literature Review

For quite some time, the importance of the exchange rate on agricultural exports has been overlooked in the literature of agricultural exports. Schuh (1974) states in his pioneering study that the exchange rate is an important variable affecting trade, demonstrating the importance of the exchange rate on agricultural exports.

Vellianitis-Fidas (1976) have tested the hypothesis that changes in exchange rates had a significant effect on the agricultural export demands of the United States. As a result of the analysis conducted using the OLS method in the study, they concluded that the exchange rate change in the US dollar does not significantly affect agricultural trade.

Pick (1990) analyzed the impact of exchange rate risk on U.S. agricultural trade flows with regards to ten countries with data covering 1978-1987 years. While the results of the study support that the real exchange rate is significant in determining U.S. agricultural export rates, the said data indicates that they do not show that exchange rate risk is always significant.

Cho, Sheldon, and McCorriston (2002) studied the effect of medium-and long-term exchange rate uncertainty on agricultural trade, which had not been evaluated beforehand by using bilateral trade flow data from 10 developed countries between 1974 and 1995 years and compared the impact on agricultural trade, which is associated with other sectors. In accordance with finding of the study agricultural trade is more negatively affected by

medium-and long-term uncertainty with respect to real exchange rate compared to other sectors. It has been suggested that exchange rate uncertainty in agricultural trade is more fragile than the level indicated by total data and the negative impact of trade growth on agricultural goods is greater compared to other sectors. Kandilov (2008) expanded the 2002 study conducted by Cho, Sheldon and McCorriston et. al., and concluded that exchange rate volatility has a negative impact on agricultural trade carried out between G-10 countries. Kandilov also obtained findings in his study that reached the same conclusion as Cho and et. al.

Buguk, Işık, Dellal, and Allen (2003) examined the effects of exchange rate and volatility on the basis of Turkey's agricultural exports regarding dried fig and grape rates between 1982-1998 and tobacco export data between 1986-1995 years by using Johansen cointegration and Granger causality tests. The authors conclude that changes in exchange rate value directly affect prices for consumers and producers. Although there are methods of hedging against exchange rate risk, they noted that high exchange rate risk is an important factor in reducing exporters' export supplies. They also specified that the effects of the exchange rate on trade depend on various exporter characteristics and secondary effects such as the discount rate, amount of money farmers receive to fund their activities.

Fidan (2006) examined the dynamics of agricultural exports, imports and real effective exchange rates in his study covering 1974-2004 years by using the techniques of Granger causality and Johansen cointegration tests. The results of the study indicated that there is a relationship between the foreign market and the real effective exchange rate. According to the results of the Granger causality test, it was determined that the export is REER's Granger causality, but the opposite is not valid. The coefficient of REER calculated in the export model was calculated as positive.

Baek and Koo (2009) expanded the number of studies in this field by examining the short-and long-term effects of exchange rate changes with respect to the U.S. agricultural trade balance. Within the framework of the ARDL approach, it was aimed to measure the impact of exchange rate changes on agricultural exports and imports at the bilateral level that took place between the United States and its 10 major trading partners for the period of 1975-2004 years. The study indicated that in the long run, U.S. agricultural exports are highly sensitive to bilateral exchange rates and foreign income, while U.S. agricultural imports are mostly sensitive to U.S. domestic income. On the other hand, in the short term, both bilateral exchange rates and revenues in the U.S. and its trading partners were found to have significant effects on U.S. agricultural exports and imports.

Erdem, Nazlıoğlu, and Erdem (2010) analyzed the effects of exchange rate level and uncertainty on bilateral agricultural trade with Turkey's 20 major trading partners on the basis of annual data for the period of 1980-2005 years with panel cointegration. Experimental findings of the study indicated that the exchange rate level was less associated with trading volume than exchange rate uncertainty. In addition, exchange rate uncertainty is associated with both imports and exports for small trade volumes, but this relationship is stronger in imports than in exports. They concluded that income growth in Turkey is related to imports and income growth in trading partners is related to exports.

In his study regarding relationship between exchange rate and dried apricot trade using the VAR method with monthly time series covering the period 2003-2008 years, Gündüz (2010) concluded that the exchange rate had a significant effect on dried apricot exports and that 20% of the total change in dried apricot exports was explained by the change in

exchange rate. It was determined that applying a standard faulty shock to exports and exchange rates, respectively caused instability in export values and exchange rate until the 11ᵗʰ period, and in the long term it was concluded that instability was eliminated.

Erdal, Erdal, and Esengün (2012) examined the effects of real effective exchange rate fluctuation on Turkey's agricultural exports and imports using Johansen cointegration and Granger causality tests on the basis of data from 1995-2007 years. According to the results of empiric analyses, they concluded that in the long term, there is only causation from REERV towards agricultural exports. Increases in exchange rates increase agricultural exports, meaning that Turkey's agricultural exports are significantly affected by movements in real effective exchange rates.

Mao (2019) examined China's food industry using panel data analysis techniques for 1998-2017 years and as a result of the study they have found that there is a positive relationship between real exchange rates and agricultural exports at firm-product-country level.

In his study covering the period of 1980-2017 years Ng'ong'ola (2020) examined the effect of exchange rate movements on agricultural products trade in Malawi using the ARDL bounds test. As a result of the study, no long-term relationship was found between the exchange rate and the export of agricultural products.

Model and Data

The variables used in this study are Poland's food and live animal exports, real effective exchange rates, and advanced economies industrial production. The monthly data covers the period between the first month of 2012 and the first month of 2020. Series are adjusted for seasonality through the Census X-13 approach.

Table 1. Variables Used in Analyses

Abbreviation	Period	Explanation	Source
LNREER	2012M1-2020M1	Real Effective Exchange Rate	BIS
LNIP	2012M1-2020M1	Advanced Economies Industrial Production	OECD
LNEXP	2012M1-2020M1	Poland's Food and Live Animal Exports	Eurostat

Sources: Authors own study.

The following specification was used in the empirical model to examine the relationship among Poland's food and animal exports, real effective exchange rate, and industrial production by using time series approach.

$$LNEXP_t = \alpha_0 + \alpha_1 LNREER_t + \alpha_2 LNIP_t + e_t \tag{1}$$

LNEXP represents the natural logarithm of Poland's food and live animal exports while LNREER and LNIP represent the natural logarithm of Poland's real effective exchange rate obtained from the Bank of International Settlements (BIS) and advanced economies industrial production which is used for the world income obtained from the OECD database, respectively.

Methodology and Empirical Results

First of all, for the empirical analysis, stationarity levels of the variables were examined by applying the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. After determining the stationary levels of the variables, the cointegration relationship among the variables was investigated through the bounds testing approach developed by Pesaran, Shin, and Smith (2001).

Stationary Tests

In the study, the ADP and PP unit root tests were used for the stationarity analysis. The results of these tests for LNEXP, LNREER, and LNIP are presented in Table 2. According to the test results, variables of the study have unit root by both the ADF and PP tests. However, when the first difference of the variables is taken, the stationary hypothesis is accepted.

Table 2. Results of Stationarity Tests

ADF				
At Level				
		LNEXP	LNIP	LNREER
With Constant	t-Statistic	-0.663	-0.963	-1.796
	Prob.	0.850	0.764	0.381
With Constant & Trend	t-Statistic	-3.123	-1.381	-2.188
	Prob.	0.107	0.861	0.490
Without Constant & Trend	t-Statistic	3.374	2.002	0.182
	Prob.	1.000	0.989	0.737
At First Difference				
		d(LNEXP)	d(LNIP)	d(LNREER)
With Constant	t-Statistic	-15.804	-9.147	-9.742
	Prob.	0.000	0.000	0.000
With Constant & Trend	t-Statistic	-15.707	-9.100	-9.697
	Prob.	0.000	0.000	0.000
Without Constant & Trend	t-Statistic	-14.632	-8.860	-9.794
	Prob.	0.000	0.000	0.000
PP				
At Level				
		LNEXP	LNIP	LNREER
With Constant	t-Statistic	-1.322	-1.019	-1.808
	Prob.	0.617	0.744	0.375
With Constant & Trend	t-Statistic	-10.241	-1.532	-2.239
	Prob.	0.000***	0.812	0.463
At First Difference				
		d(LNEXP)	d(LNIP)	d(LNREER)
With Constant	t-Statistic	-26.213	-9.183	-9.910
	Prob.	0.000****	0.000	0.000
With Constant & Trend	t-Statistic	-	-9.138	-9.881
	Prob.	-	0.000	0.000

a: (*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1% and (no) Not Significant
b: Lag Length based on SIC
c: Probability based on MacKinnon (1996) one-sided p-values.
Sources: Authors own estimation.

Cointegration Test

In this study, the relationships among Poland's food and live animal exports, the real effective exchange rate, and industrial production were analysed with the Autoregressive Distributed Lag (ARDL) bounds test, which was developed by Pesaran et al. (2001).

An advantage of this approach is that classical cointegration techniques is that while Engle and Granger (1987); Johansen (1995), require that all variables be stationary at the same level, it can be applied regardless of the levels of stationary at first order I(1). Thus, it eliminates the pre-test problems associated with standard cointegration tests. In addition, ARDL is more robust, effective and performs better for smaller or finite sample sizes than other co-integration techniques (Narayan, Narayan, 2006; Pesaran et al., 2001).

For the bounds test, the unlimited error correction model (UECM) should be used initially. The version of the UECM modified to present model is presented in Equation 2 below.

$$\Delta LNREXP_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i} \Delta LNREXP_{t-i}$$
$$+ \sum_{i=1}^{p} \alpha_{2i} \Delta LNREER_{t-i}$$
$$+ \sum_{i=1}^{p} \alpha_{3i} \Delta LNIP_{t-i} + \alpha_4 LNREXP_{t-1} + \alpha_5 LNREER_{t-1} + \alpha_6 LNRIP_{t-1} + \epsilon_t$$

$$(2)$$

In the model, t represents the trend variable, and p the lag value. In the study, the Schwarz information criterion was used to determine the optimal lag value for the bounds test. The null hypothesis formed for the existence of a cointegration relation can be expressed as: $H_0: \alpha_4 = \alpha_5 = \alpha_6 = 0$. The calculated F-statistic values are compared to the upper and bottom limits at the table in Pesaran et al. (2001) in order to either reject or accept the null hypothesis. If the calculated F-statistic is lower than the critical bottom limit in the table, a cointegration relation does not exist. If it is between the bottom and upper critical limits, no exact interpretation regarding the cointegration relationship can be made. However, if the calculated F-statistic value is greater than the upper critical limit in the table, a cointegration relation exists.

Table 3. ARDL Bounds Test Results

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Significance Level	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	4.836	10%	2.63	3.35
k	2	5%	3.1	3.87
		2.50%	3.55	4.38
		1%	4.13	5
Actual Sample Size	94		Finite Sample: n=80	
		10%	2.713	3.453
		5%	3.235	4.053
		1%	4.358	5.393

Sources: Authors own estimation.

According to the results indicated in Table 3, since the calculated F-statistic value of 4.836 is greater than the upper critical value at 5% significance level, a conclusive long-term relationship among variables can be seen.

Autoregressive Distributed Lag Model

After a cointegration relation was determined among the variables, short-term and long-term relations between the real exchange rate and food and live animal exports were examined using the (ARDL) model. The ARDL model used in this study is given below in Equation 3.

$$LNEXP_t = \alpha_0 + \sum_{i=1}^{k} \alpha_{1t} LNEXP_{t-i} + \sum_{i=1}^{l} \alpha_{2t} LNREER_{t-i} + \sum_{i=1}^{m} \alpha_{3t} LNIP_{t-i} + \varepsilon_t \qquad (3)$$

In Equation 3; k, l, and n indicate the lag values. The optimal lag lengths for the ARDL model were determined by the Schwarz information criterion. The ARDL model results are given below in Table 4.

Table 4. ARDL Model Estimation Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Selected Model: ARDL(3, 0, 1)				
LNEXP(-1)	-0.004	0.087	-0.051	0.960
LNEXP(-2)	0.330	0.078	4.221	0.000
LNEXP(-3)	0.555	0.086	6.468	0.000
LNIP	0.335	0.257	1.305	0.195
LNREER	0.832	0.351	2.369	0.020
LNREER(-1)	-1.201	0.372	-3.229	0.002
C	2.621	1.118	2.345	0.021
Diagnostic Tests				
Autocorrelation		1.54[0.21]		
Normality		1.37[0.50]		
Heteroskedasticity		1.34[0.24]		
Ramsey		0.15[0.69]		

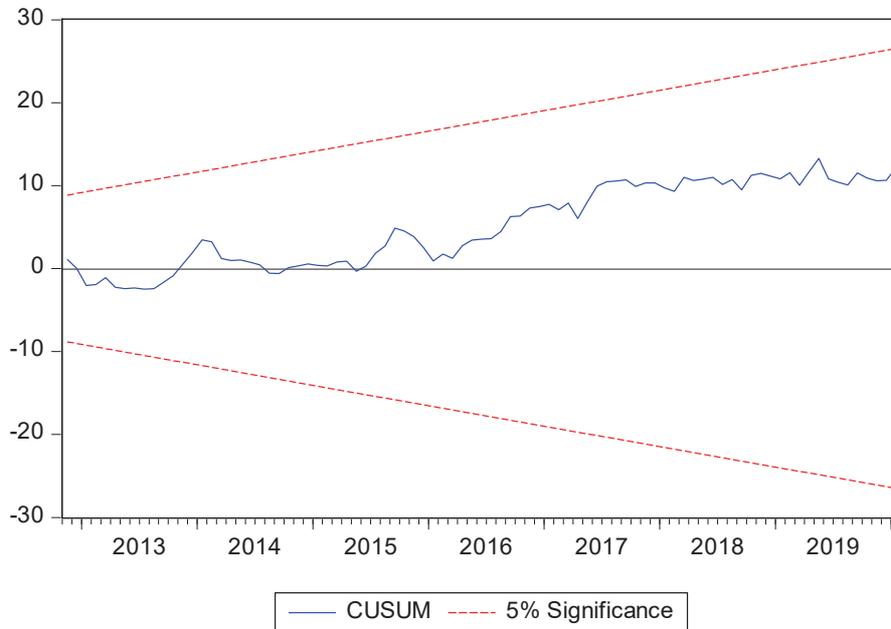Sources: Authors own estimation.

Lon-term Relationship

After determining the relationship among the variables, long-term coefficients of the ARDL model were estimated. Table 5 presents the long-term coefficients of the variables.

Table 5. Long Term Estimation Results of the ARDL Model

| Variable	Coefficient	t-Statistic	Prob.
LNIP	2.803	2.413	0.018
LNREER	-3.091	-2.795	0.006
C	21.925	2.620	0.010

Sources: Authors own estimation.

The long-term results reported in Table 5 show that the real effective exchange rate has a negative impact on Poland's food and live animal exports. For instance, it was found that a 1% increase in the real effective exchange rate would decrease Poland's food and live animal exports by 3.091%, whereas a 1% increase in industrial production would increase Poland's food and animal exports by 2.803%.

The straight lines represent critical bounds at 5% significance level.

Fig. 1. Plot of Cumulative Sum of Recursive Residuals
Sources: Authors own estimation.
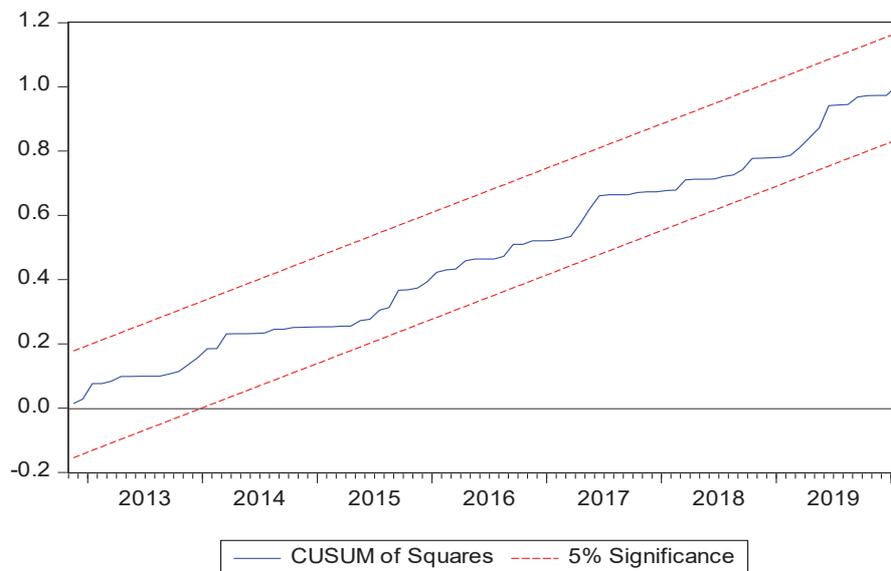
The straight lines represent critical bounds at 5% significance level.

Fig. 2. Plot of Cumulative Sum of Squares of Recursive Residuals
Sources: Authors own estimation.

Figure 1 and 2 show the CUSUM and CUSUMSQ plots. CUSUM and CUSUMSQ plots do not exceed critical limits, meaning that there is no evidence of any significant structural instability in the model.

Short-Term Relationship

In the study, the relationship between the variables was examined by the error correction model, which is based on the ARDL model. The error correction model which was adapted to this study is presented in Equation 4.

$$\Delta LNEXP_t = \alpha_0 + \alpha_1 EC_{t-1} + \sum_{i=1}^{k} \alpha_{2i}\Delta LNEXP_{t-i} + \sum_{i=1}^{l} \alpha_{3i}\Delta LNREER_{t-i} + \sum_{i=1}^{m} \alpha_{4i}\Delta LNIP_{t-i} + \varepsilon_t$$

(4)

Table 6. Estimation Results of the Error Correction Model Based on the ARDL

Variable	Coefficient	Std. Error	Prob.
D(LNEXP(-1))	-0.884	0.080	0.00
D(LNEXP(-2))	-0.554	0.082	0.00
D(LNREER)	0.831	0.338	0.02
ECT(-1)	-0.119	0.026	0.00

Sources: Authors own estimation.

The coefficient of error correction term indicates the degree to which the short-term imbalance is corrected in the long term. Given that the error correction term coefficient is negative and significant as expected, there is an indication that 11% of an imbalance in the short-term will be recovered in the next period.

Conclusion

The relationship between Poland's food and animal exports and the real effective exchange rate was examined by using monthly data for the period of 2012-2020. First of all, the stationarity of the series was examined by the ADF and PP tests. The short- and long-term relationships between Poland's food and animal exports and the real effective exchange rate was examined by ARDL model. According to the results of ARDL model, as expected, real effective exchange rate negatively and significantly affects Poland's food and animal exports in the long-term. The long-term coefficient of the real effective exchange rate was found to be -3.091, indicating that a 1% increase in real effective exchange rate in the long-term would decrease Poland's food and live animal exports by 3.091%. A strong PLN increases the relative price of the product in the rest of the world, which reduces both the quantity of the exported product and the demand. However, a 1% increase in industrial production would increase Poland's food and animal exports by 2.803%.

The results of the study indicate findings supporting Baek and Koo (2009); Erdal et al. (2012); Erdem et al. (2010); Fidan (2006); Gündüz (2010); Mao (2019); Pick (1990) who concluded that the real effective exchange rate had an effect on agricultural export in parallel with the expectations in the literature. However about whether the effect is positive or negative it has been identified that increases in the real effective exchange rate reached

in the work of Cho et al. (2002); Kandilov (2008) to support the negative impact on agricultural exports, decreased Poland's food and live animal exports.

Also it should be pointed out that Poland, similar to other emerging market countries, often specializes in the production and export of raw materials and agricultural products as well as labour and material-consuming processed goods. Prices of these products are often shaped in organized markets, therefore producing and exporting countries have limited influence on the level of foreign exchange prices. On the other hand, the currencies of these countries are more often than the currencies of highly developed countries the object of speculative attacks, which may result in unpredictable changes in their rates (Gryczka, 2018).

While Poland is a member state of the European Union, it is not a part of the monetary union. Some countries have had dramatic negative experiences being part of the monetary union in times of financial crisis. This study has determined that the exchange rate does indeed have a significant effect on exports of agricultural products in Poland, an EU country which uses its own local currency.

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