CURRENCY DEPRECIATION AND TRADE BALANCE RELATIONSHIP: MARSHALL-LERNER CONDITION TESTING FOR UKRAINE

by

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Abstract

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In this research, we investigate the long-term relationship between real exchange rate and trade balance. The aim is to test Marshall-Lerner condition, which indicates the responsiveness of the trade balance to currency depreciation. The focus is on trade flows between Ukraine and its four major trading partners – Eurozone countries, Russian Federation, China and Turkey. For this purpose, we employ two most appropriate models to estimate the coefficients of the single trade balance equation – VECM and ARDL, which can deal with cointegrating vectors and non-stationarities of the data. The results provided by these two models appeared to be consistent. We find a strong evidence for M-L condition to hold in all cases except for Russian Federation, meaning that depreciation of hryvnia is going to improve trade balance of Ukraine while trading with Eurozone countries, China and Turkey.

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Chapter 1

INTRODUCTION

Trade balance is an essential economic indicator, which is one of the GDP components and a major exchange rate influencer. Some economists are concerned about trade deficit and consider the latter as a major threat to national production and employment rate. Furthermore, having a downward pressure on country`s currency persistent trade deficit may lead to inflation. In its turn, restrictive monetary policy as a response of the Central Bank to the increasing inflation leads to slower economic growth. According to the theory countries with a persistent trade deficit experience higher foreign direct investments, whereas trade deficit should be offset by the positive capital and financial accounts. This makes the increased proportion of countries assets owned by foreigners, which means stronger influence on the economy from abroad, which is hard to control. Since trade deficit is the result of imbalance between countries` savings and investments economists consider government spending, exchange rate and GDP as more important factors than trade policy in determining overall deficit. All these facts give an undoubtable evidence that studying the behavior of trade balance and all reasonable relationships is an important thing to do in order to understand the economy of the country better and protect it from undesirable consequences. In this study the main focus is on the trade balance exchange rate relationship, however, the influence of foreign and domestic incomes are also taken into account.

Over the years studies about the effect of exchange rate and trade balance have produced ambiguous results. The economists define a number of factors, which determine the impact of depreciation on trade balance. The first one is the direction of domestic and foreign price movement. Since the nominal exchange rates influence trade balance through the channel of real

exchange rates, the effect of nominal exchange rates changes could be fully eliminated by opposite changes in the foreign and domestic price ratio. The second major determinant of the exchange rate and trade balance relationship is the price stickiness. If foreign and domestic prices are sticky and both foreign and domestic incomes are unchanged in the short-run, real exchange rate depreciation will stimulate trade balance improvement. Import costs are the third factor of influence. Depreciation not only makes domestic goods more attractive for foreigners but also increases the cost of imports, which could offset the increase in export income resulting in the trade deficit.

Considering all the factors described above the economists derived so-called Marshall-Lerner (M-L) condition, which states that depreciation improves the trade balance if the sum of elasticities of exports and imports with respect to their prices is greater than one. The aim of this work is to test whether or not M-L condition holds for the Ukrainian economy. The results of estimations and conclusions towards the effect of exchange rate on trade balance are important in terms of economic conditions predicting and performing corresponding trade policy. Furthermore, M-L condition is widely used in models and policy analysis as the primary assumption, despite the reason that it need not be satisfied. Thus, more studies on this issue are beneficial for making its implication validity more clear and justified.

It is worth mentioning, that M-L condition could be satisfied only in the long-run. Empirically it is observed that the right after currency devaluation or depreciation trade balance deteriorates, however, later it bounces back producing a curve similar to the letter J. J-curve effect exists due to a number of reasons such as preexisting trade contracts, the persistence of consumer preferences and tastes, the time needed to expand plant sizes.

M-L condition in this paper is tested using bilateral trade flows between Ukraine and its four major trading partners (Eurozone countries, Russian Federation, China and Turkey). The methodology is to construct one trade balance equation instead of estimating import and export equations

separately. From the IMF, the State Statistics of Ukraine and the UN Comtrade websites we collected series if exports, imports, CPI, deflators, exchange rates and GDP. Further, on the basis of the collected data we computed trade balances, real outputs and real exchange rates. The sign of the latter indicates whether M-L condition is satisfied. To estimate the coefficients we chose VECM and ARDL with error correction approaches, which includes the possibility of cointegration vectors availability between non-stationary series. Obtained results of both models showed a strong evidence for M-L condition to be satisfied in trade with Eurozone countries, China, Turkey, while in case of trade with Russian Federation devaluation of the hryvnia is going to deteriorate the trade balance of Ukraine.

The rest of this research paper is organized as follows: brief literature review of related studies, description of methodology used to construct theoretical and empirical models, description of data properties, discussion of obtained estimation results and conclusions made.

Chapter 2

LITERATURE REVIEW

Looking through the economic literature concerning import and export price elasticities measurement and M-L condition testing we can observe that the results are mixed. The absence of well-defined pattern in obtained results is mainly caused by differences in data samples (countries, periods and proxies) and econometric models to estimate the coefficients. Until the advanced econometric tools for time series analysis were invented, trade balance equations estimated by OLS were likely to suffer from spurious regression caused by data non-stationarity. Another problematic issue is the existence of cointegrating vectors, which demands error correction and long-run coefficients estimation. In contrast, the methodology to construct theoretical equations is considered to be established. Robinson in 1937 for the first time introduced the concept of M-L condition and derived corresponding elasticities (Robinson, 1937).

One of the earliest and basic studies concerning M-L condition is Houthakker and Magee (1969), where two reduced form equations are estimated for 26 developed and developing countries. They use annual data from 1951 to 1966 and OLS method of the regression analysis along with the autocorrelation correction technique. Even though authors do not test the M-L condition formally, they estimate price and income elasticities. The results for income elasticities appeared to be highly statistically significant, with signs corresponding to the economic theory and plausible magnitudes, while price elasticities estimates showed quite a poor performance. The latter could be explained by simultaneous-equations bias and unappropriated econometric model applied, which proved to be unable to capture the demand dynamics. Furthermore, problems with estimated parameters potentially could have been caused by inadequacies in import and export price indexes.

Nevertheless, for some important countries, the sum of import and export elasticities in absolute terms is greater than unity that satisfies the M-L condition. Houthakker and Magee extend their analysis by estimating price and income elasticities for the US bilateral and sectoral trade. Authors conclude that the US income elasticities for imports demand are quite similar to other developed countries, while income elasticities of other countries` exports demand for the US goods are low indicating potential deterioration of the US trade balance.

Marquez (1990) estimated by OLS income and price elasticities for bilateral and multilateral trade flows in 56 countries all over the world on the basis of quarterly data for 1973Q1-1982Q2. To check the robustness of the results the alternative band spectrum analysis developed by Engle was applied. The behavior imperfect-substitute model was chosen as the theoretical model for bilateral trade flows. To forecast the trade balance the multilateral exports and imports income elasticities were compared and M-L condition was tested. The author concluded that estimations of aggregated income as well as price elasticities were consistent with the literature taking into consideration sample differences. Also, Marquez stressed the importance of bilateral trade elasticities estimates relatively to multilateral in forecasting and policymaking.

Rose (1991) examines the relationship between exchange rate and trade balance on the basis of imperfect substitutes model for 5 industrial countries using monthly seasonally adjusted data from 1974 to 1986. Import and export demand are modelled traditionally as functions of relative prices and output. Methodologically Rose estimates the coefficients of trade balance equation, in particular, its log-linear approximation with lags. To address the problem of simultaneity between real exchange rate and trade balance the first differences of logarithms of the short-term interest rate is used as the instrumental variable for the real exchange rate. Linear estimates results showed no evidence for exchange rate being a significant determinant of trade balance. Further estimations obtained with the spectral test developed by

Geweke and non-parametric locally weighted regression also failed to support the empirical relationship between the real effective exchange rate and the real aggregate trade balance at any frequency for any of the countries.

Goldstein and Khan (1978) investigate the price responsiveness of export demand as well as export supply functions using the quarterly data of eight countries for the 1955-1970 period. Employing Full-Information Maximum Likelihood method the authors estimated two models: equilibrium and disequilibrium. To deal with bias caused by two-way relationship between export price and quantity export demand and supply were estimated simultaneously. The results show that in equilibrium model six out of eight countries have a negative significant price elasticity which exceeds unity in absolute terms, income elasticities are consistent with those obtained by Houthakker and Magee (1969), estimates of supply equation implies a positively sloped supply function for exports in each country from the sample except Japan. In the disequilibrium model five out of eight countries have statistically significant negative export short-run price elasticities, while in the supply function all the results appeared to be consistent with theory. Compared to the results of other researches Goldstein and Khan estimations of export demand are substantially larger meaning that M-L condition would be satisfied for almost all the countries under analysis.

Despite employing some non-parametric estimation methods and spectrum analysis as the alternative to check results for robustness, most of the early studies described above used OLS estimation methods as the main one. In case of dealing with time series data, the latter was heavily criticized due to the possibility of spurious regression. Therefore, recent studies reviewed below apply more progressive estimation methods, which take under consideration non-stationarity and cointegration vectors presented in the data.

Bahmani-Oskoee and Niroomand (1998) tested M-L condition for the sample of about 30 countries over the 1960-1992 period employing the cointegration

analysis developed by Johansen and Juselius. The authors estimated two separate equations of export and import demand functions and the results showed that M-L condition was satisfied for most of the countries considered in this paper meaning that devaluation improve trade balance.

Another study of Bahmani (2013) provides a very broad empirical literature overview concerning M-L condition testing, re-estimation of country-specific results as well as his own estimations of export and import elasticities for 29 countries based on annual data for the 1971-2009 period. The author writes that papers under review are focused mostly on the developed countries trade, Japan, Germany, the USA and UK are among the leaders, while transition economies are investigated poorly. Also, Bahmani indicates that 60% of the studies analyzed in his paper support the M-L condition, while the re-estimation results show that only 30% implies the M-L condition to be satisfied. Further, the author estimates two separate error-correction models using the ADRL approach and real effective exchange rates as the relative prices and concludes that there is only a scant evidence for M-L condition to hold.

Boyd (2001) made another step further towards finding out the evidence for M-L condition to hold using the quarterly data for eight OECD countries over the 1974-1994 period. The author applies structural cointegrating vector autoregressive distributed lag (VARDL) models to estimate the effect of the real exchange rate on the balance of payments. The dependent variable was calculated as the ratio of exports and imports volumes, the list of explanatory variables traditionally include output and real exchange rate. According to cointegrating VAR model the M-L condition is satisfied for Canada Germany and the USA, marginally satisfied for Japan, and not satisfied for France, Italy, the Netherlands and the UK. These results are similar to those obtained by Hooper (1998). Treating output and the real exchange rate as weakly exogenous for the parameters of the cointegrating vector Boyd employs the ADRL model, which showed that the increased degree of conditioning

provided stronger evidence for M-L condition to hold. Also, invariant to ordering generalized impulse response functions were used to check for J-curve effects: for six countries the latter prove with German and France being the exceptions.

Since this paper examines the effect of exchange rate on the trade balance in one specific country, Ukraine, it is relevant to review the results of other country-specific studies.

Jiranyakul and Brahmasrene (2002) examine the impact of real exchange rate on Thailand's exports and imports with its three major trading partners (the USA, Japan and Singapore) applying the dynamic ordinary least squares method developed by Stock and Watson's to deal with problems of simultaneity and serial correlation in the error term. The data used are quarterly non-cointegrating series over the 1990-2000 period. The authors preferred to estimate two separate imports and exports demand equations rather than trade balance equation. Consistently to international trade theory the results indicate that both real income and bilateral real exchange rates have a significant impact on trade flows between Thailand and its three largest trading partners. The only exception is bilateral trade with Japan, where the real exchange rate appeared to have no significant influence on import flows, M-L condition is also satisfied in most of cases. Further, the authors analyze possible policy recommendations and conclude that in improving trade balance export diversification could be an effective alternative.

The paper of Irandoust and Ekblad (2006) estimates price and income elasticities for bilateral trade equations between Sweden and its eight major trading partners over the period 1960–2001 using the likelihood-based panel cointegration method. The results show that according to long-run bilateral exchange rate elasticities estimates depreciation of the Swedish local currency is likely to improve Swedish exports towards six of the major eight trading partners (France, Denmark, Germany, the Netherlands, Norway and the US), while in case of Finland and the UK the effect is opposite. Import demand

function estimates imply that due to depreciation of the local currency Swedish demand for import from Finland, France, the Netherlands and the US is likely to increase, and the opposite effect is going to occur in case of Denmark, Germany, Norway and the UK. The M-L condition holds only while trading with France and the Netherlands, which could be explained by adopting incomplete exchange rate pass-through or pricing-to-market-behavior.

The study written by Yusoff, (2010) investigates the effect of real bilateral exchange rates using Malaysia's bilateral trade flows with its three major partners (the USA, Japan and Singapore). The author derived trade balance equation from the general export and import equations. As the estimation method cointegration and error correction model techniques were applied. Quarterly data 1976:1-2007:4 were used and in addition to standard independent variables two dummy variables were included representing different exchange rate regimes and the period of the financial crisis. The results showed that in the long-run bilateral trade balances in Malaysia are responsive to bilateral real exchange rate in the USA and Singapore. Impulse response functions showed a clear evidence of the J-curve for Malaysia`s trade balance with the US. Marshall-Lerner condition was found to be satisfied in this study meaning that the undervalued exchange rate strategy could be supportive for Malaysia's trade balances with the US and Singapore.

Mohammad and Hussain (2010) study the influence of real exchange rate depreciation on trade balance in Pakistan over the 1970-2008 period. They estimate the multivariate trade balance equation employing Johansen cointegration approach. The obtained results show that for Pakistan trade flows the impact of real effective exchange rate and real income of trading partner's is positive, while the domestic income has no evidence to be different from zero. The impulse response function supports the evidence for J-curve effect existence in Pakistan.

Piontkivsky (1999) investigates the exchange rate effects on the current account in Ukraine over the 1994-1998 period using OLS and ADL methods of estimation. Simulations of the exchange rate effect on the current account imply the M-L condition to hold in trade with the FSU and not to hold in the trade with the ROW. Also, the results indicate the absence of so-called Laursen-Metzler-Harberger effect meaning that foreign and Ukrainian real incomes do not change after devaluation.

Looking through the available literature, where the exchange rate trade balance relationship is analyzed, helps to define the most appropriate methodology to construct the equations and estimation methods. In this work we use single trade balance equation to test the M-L condition for bilateral trade flows of Ukraine with its four major trading partners and VECM and ARDL model to estimate the coefficients, which is described in detail in the next section.

Chapter 3

METHODOLOGY

To test the M-L condition in this study the trade balance equation is estimated on the basis of Ukrainian bilateral trade flows with its four major trading partners (Russian Federation, Turkey, China, Eurozone countries). To construct theoretical and empirical equations the methodology used by Yusoff (2010) was replicated. The trade balance equation is derived from the multiplicative export and import demand functions.

Export demand function:

$$X = X_0 q^{\alpha} Y_f^{\beta}, \quad (1)$$

where X is the quantity of export, X_0 - initial quantity of exports, q – real exchange rate, α and β – elasticities of export demand with respect to relative price of exports and foreign income respectively

Import demand function:

$$M = M_0 q^{\delta} Y_d^{\gamma}, \quad (2)$$

where M is the quantity of import M_0 – initial quantity of imports, Y_d – domestic income, δ and γ – elasticities of import demand.

Real trade balance equations:

$$TB = \frac{X}{(qM)}, \tag{3}$$

$$logTB = log\ X - log\ M - log\ q \tag{4}$$

Substituting import and export equations into trade balance equation results in the following theoretical model:

$$logTB = log\ X_0 - log\ M_0 + \theta\ log\ q + \gamma\ log\ Y_d + log\ Y_f\ , \tag{5}$$

where θ=(α-δ-1)

On the basis of the theoretical model empirical model is constructed:

$$\begin{gathered} logTB_{it} = \alpha_{0i} + \theta_i logRER_{it} + \gamma_i logY_{d_{it}} + \beta_i logY_{f_{it}} + \\ \varphi_{1i}D_{1i} + \varphi_{2i}q_{2i} + \varphi_{3i}q_{3i} + \varphi_{4i}q_{4i} + u_{it}, \end{gathered} \tag{6}$$

where $RER = e(P^*/P)$, where e is a hryvnia-foreign currency exchange rate, P – Ukraine's CPI, P^*– foreign CPI, D_1 – dummy variable responsible for the periods of different exchange rate regimes, which is equal to zero when the exchange rate is fixed and to one when exchange rate is floating , q_2, q_3 and q_4 – seasonal dummies corresponding to the second, third and fourth quarters.

The equation (6) suggests that trade balance should be dependent on the real exchange rate and domestic and foreign incomes. If the parameter θ is positive, M-L condition is satisfied meaning that currency devaluation improves the trade balance. Increase in foreign income causes the demand

for exports to increase, which results in trade balance improvement meaning that the expected coefficient on foreign income is positive. Increase in domestic income causes imports to rise, which results in trade balance deterioration meaning that the expected coefficient on domestic income is negative.

To assess the coefficients of the empirical model we applied two approaches VECM and ARDL with error correction to consider data unstationarity and coinatgration vectors availability. The vector error correction model of equation (6) is estimated as the following:

$$\begin{gathered}\Delta Z_{it} = \beta_{0i} + \lambda_i ECT_{it-1} + \sum_{j=1}^{k} \beta_{ij} \Delta logTB_{it-j} + \\ \sum_{j=1}^{k} \gamma_{ij} \Delta logLY_{d\,it-j} + \sum_{j=1}^{k} \beta_{ij} \Delta logY_{f\,it-j} + \\ \varphi_{1i} D_{1i} + \varphi_{2i} q_{2i} + \varphi_{3i} q_{3i} + \varphi_{4i} q_{4i} + \varepsilon_{it},\end{gathered} \tag{7}$$

where Δ is the first difference operator,

$Z = \{log\ TB, logY_f, logY_d, logRER\}$, k – number of the independent variables, ECT – the error correction term, which represents the speed of adjustment.

The ARDL model of the equation (6) is estimated as the following.

$$\begin{gathered}\Delta logTB_{it} = \beta_{0i} + \lambda_i logTB_{it-j} + \sum_{j=1}^{k} \beta_{ij} \Delta logTB_{it-j} + \\ \sum_{j=1}^{k} \gamma_{ij} \Delta logLY_{d\,it-j} + \sum_{j=1}^{k} \beta_{ij} \Delta logY_{f\,it-j} + \\ \varphi_{1i} D_{1i} + \varphi_{2i} q_{2i} + \varphi_{3i} q_{3i} + \varphi_{4i} q_{4i} + \varepsilon_{it},\end{gathered} \tag{8}$$

Each model for each of the four chosen trading partners is estimated with and without regime dummy. After that each model is checked for adequacy

by performing a number of tests: Lagrange-multiplier (LM) test for autocorrelation in the residuals, Jarque-Bera test for normally distributed residuals, eigenvalues stability test for VECMs; and Breush-Godfrey test for autocorrelation, Jarquae-Bera test, White`s test to check for heteroskedasticity and cumulative sums of squares test to check for stability of the system for ARDL models.

Chapter 4

DATA DESCRIPTION

For this paper, quarterly data from the IMF International Financial Statistics, the State Statistics of Ukraine, the UN Comtrade and the National Bank of Ukraine websites were collected. The dataset consists of the following series:

(a) Bilateral exports and imports flows between Ukraine and its three major trading partners – Russian Federation, Turkey and China; monthly data converted to quarterly.
(b) GDP and Industrial Production Index of Ukraine, Russian Federation, Turkey and China.
(c) CPI of Ukraine, Russian Federation, Turkey and China.
(d) Hryvnia exchange rate with respect to ruble (RUB), lira (TRY), yuan (CNY) — daily data converted to quarterly.

The estimation period spans over 2005:01-2018:01 given the data availability. To estimate equations derived in the previous section variables of trade balance, real exchange rate, domestic and foreign incomes were computed on the basis of the dataset. In addition, the dummy variable for different exchange rate regimes was included, which is equal to one in case of floating exchange rate regime and zero in case of fixed rate (before Q1 2015). Trade balance was calculated as the ratio of exports over imports. The real exchange rate is represented by the following formula — $e(P^*/P)$. The real domestic and foreign income were calculated as the ratio of nominal output in nominal currency over deflator for Ukraine-Russian Federation, Ukraine-China and Ukraine-Eurozone cases, while for Ukraine-Turkey trade Industrial Production Index (IPI) was taken as the proxy for real income due to the estimation issues described in the next section. All variables were transformed into logarithms according to the theoretical model specification. Overall number of observations is equal to 54 for Ukraine-China and Ukraine-

Eurozone countries trade and 53 for Ukraine-Turkey and Ukraine-Russian Federation trade. The properties of the variables are presented in Tables 1, 2 and 3. The sign of mean value of trade balance logarithms identifies whether export or import prevails in Ukraine and its trading partners relationships. Ukraine imports more from Turkey than exports, and exports more than imports from China, Russian Federation and Eurozone countries. Means and medians of all series are close meaning that distribution is close to normal. Looking at the graphs of real domestic and foreign incomes (Figure 1, 2, 3 and 4), we can observe seasonality, which is captured by seasonal dummies in the models. Also, we can assume the presence of structural break in real exchange rate series in Ukraine-China (Figure 2) and Ukraine-Eurozone countries (Figure 4) trade flows, which is most probably caused by the changed exchange rate from fixed to floating in 2015 year and captured by the regime dummy in the models.

Table 1. Descriptive statistics for Turkey-Ukraine trade flows

	log_TB	log_RER	log_IPI	log_IPI*
Mean	0.82	1.64	4.59	4.75
Median	0.84	1.59	7.91	4.76
Maximum	1.60	2.09	4.86	5.13
Minimum	-1.08	1.46	4.31	4.42
Std. dev	0.47	0.14	0.14	0.21
Skewness	-1.85	1.11	-0.25	0.14
Kurtosis	6.42	0.99	-0.92	-1.27
N	54	54	53	53

Figure 1. Series for Turkey-Ukraine trade flows

Table 2. Descriptive statistics for China-Ukraine trade flows

	log_TB	log_RER	log_Y	log_Y*
Mean	-1.22	0.33	7.89	8.43
Median	-1.18	0.22	7.91	8.43
Maximum	-0.30	0.90	8.14	8.67
Minimum	-2.87	-0.15	7.62	8.14
Std. dev	0.58	0.33	0.13	0.13
Skewness	-0.59	0.49	-0.26	-0.27
Kurtosis	0.05	-1.20	-0.73	-0.63
N	54	54	54	54

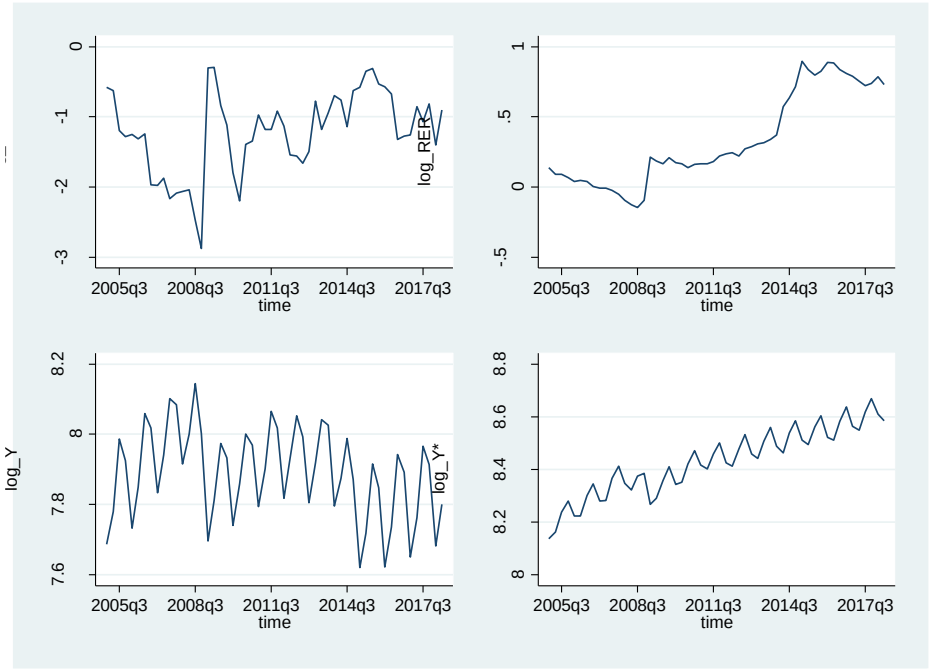

Figure 2. Series for China-Ukraine trade flows

Table 3. Descriptive statistics for Russian Federation-Ukraine trade flows

	log_TB	log_RER	log_Y	log_Y*
Mean	-0.41	-3.62	7.89	11.68
Median	-0.40	-3.62	7.91	11.69
Maximum	0.05	-3.29	8.14	11.85
Minimum	-0.87	-3.86	7.62	11.38
Std. dev	0.18	0.15	0.13	0.11
Skewness	-0.03	0.24	-0.29	-0.53
Kurtosis	0.43	-0.79	-0.72	-0.02
N	53	53	53	53

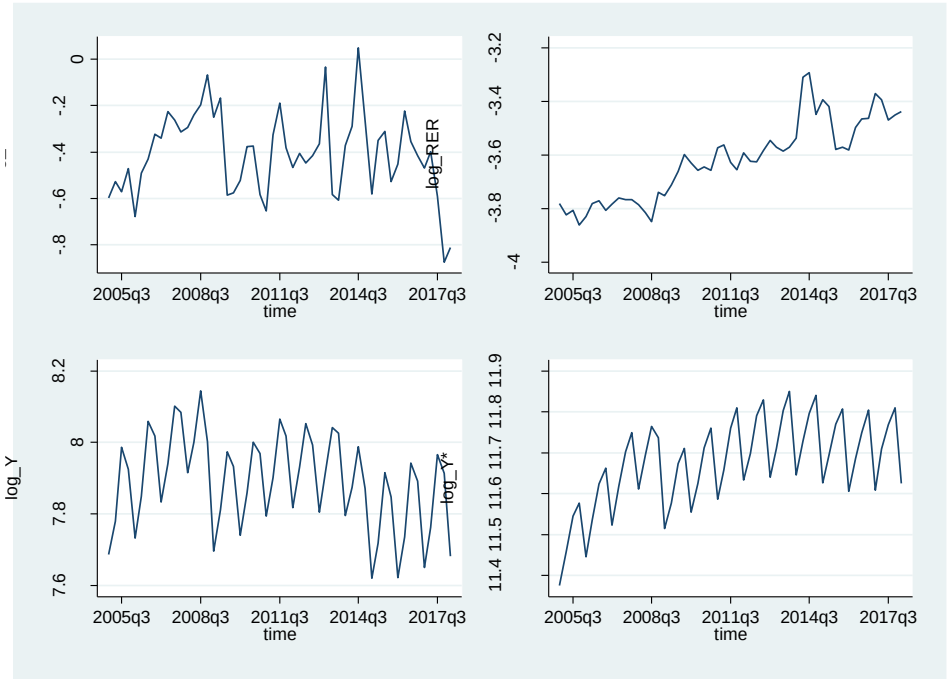

Figure 3. Series for Russian Federation-Ukraine trade flows

Table 4. Descriptive statistics for Eurozone countries-Ukraine trade flows

	log_TB	log_RER	log_Y	log_Y*
Mean	-0.35	2.39	7.89	14.70
Median	-0.37	2.31	7.91	14.70
Maximum	0.13	2.76	8.14	14.79
Minimum	-0.81	2.13	7.62	14.63
Std.dev	0.22	0.16	0.13	0.04
Skewness	0.12	0.55	-0.26	0.47
Kurtosis	-0.33	-1.00	-0.73	0.11
N	54	54	54	54

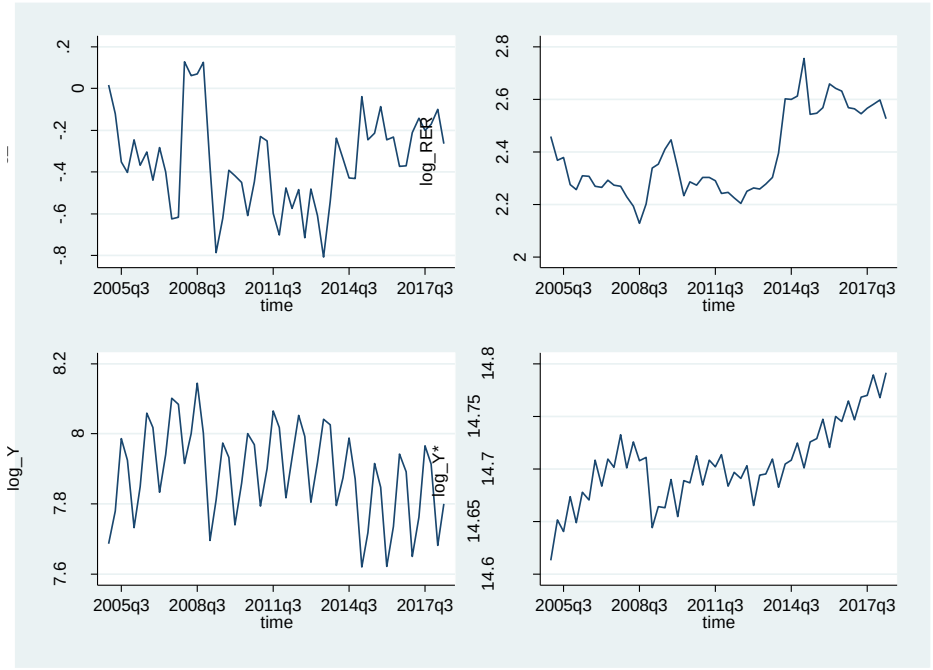

Figure 4. Series for Eurozone countries-Ukraine trade flows

Chapter 5

ESTIMATION RESULTS

Firstly, all series were checked for stationarity using Augmented Dickey-Fuller test, which showed that I(0), I(1) and I(2) variables are present in the dataset. The general pattern is such that trade balance and domestic real income are stationary series, while real exchange rate and foreign income become stationary after taking the first difference (Table 5, 6, 7 and 8). However, the real GDP of Turkey series is integrated of the second order, which makes the VECM and ARDL model implication not valid. Therefore, I took a commonly used proxy for real output-Industrial Production Index, which is first-order integrated. MacKinnon p-values and order of integration of each series are presented in the tables below.

Table 5. Augmented Dickey-Fuller test for Ukraine-Turkey trade

Variable	MacKinnon p-values	First difference p-values	Order of integration
log_TB	0.0270	-	I(0)
log_RER	0.2565	0.000	I(1)
log_IPI	0.4730	0.000	I(1)
log_IPI*	0.9049	0.024	I(1)

Table 6. Augmented Dickey-Fuller test for Ukraine-Russian Federation trade

Variable	MacKinnon p-values	First difference p-values	Order of integration
log_TB	0.0026	-	I(0)
log_RER	0.4904	0.0003	I(1)
log_Y	0.0099	-	I(0)

Table 6. Augmented Dickey-Fuller test for Ukraine-Russian Federation trade – Continued

Variable	MacKinnon p-values	First difference p-values	Order of integration
log_Y^*	0.0506	0.0050	I(1)

Table 7. Augmented Dickey-Fuller test for Ukraine-China trade

Variable	MacKinnon p-values	First difference p-values	Order of integration
log_TB	0.0165	-	I(0)
log_RER	0.8704	0.0001	I(1)
log_Y	0.0131	-	I(0)
log_Y^*	0.8971	0.0376	I(1)

Table 8. Augmented Dickey-Fuller test for Ukraine-Eurozone countries trade

Variable	MacKinnon p-values	First difference p-values	Order of integration
log_TB	0.0008	-	I(0)
log_RER	0.5644	0.0000	I(1)
log_Y	0.0099	-	I(0)
log_Y^*	0.6562	0.0219	I(1)

Since variables have different orders of integration Johansen test could not be applied, hence, the bound test was chosen to check for cointegration. The latter showed availability of cointegration vector for all four cases – Turkey, China, Russian Federation and Eurozone countries, meaning that long-term equations have to be estimated; consequently, VECM and ARDL model with error correction were chosen to estimate long-term elasticities and test the M-L condition. All models are estimated with and without regime dummy. Initially, the number of lags for models to be included was identified by

Akaike criterion, however, since serial autocorrelation was detected, the lags were added to eliminate it.

Estimations of both VECMs with and without regime dummy (Table 9) show that for Ukraine-Turkey trade coefficient on real exchange rate is highly statistically significant and positive. Thus, M-L condition is satisfied, meaning that currency depreciation is going to improve trade balance. Real domestic income represented by Industrial Production Index is statistically significant in both models as well, though with a theoretically contradicting positive sign, while foreign income is insignificant, indicating no effects on trade in the long-term. However, in VECM without regime dummy coefficients of real exchange rate and real domestic income are somewhat higher in magnitude. The 1% increase in the hryvnia-lira real exchange rate is associated with 7.55% and 3.06% increase in the trade balance in models without and with regime dummy respectively in the long-run. The 1% increase in domestic Industrial Production Index is associated with 9.1% and 6.88% increase in the trade balance in VECM without and with regime dummy respectively in the long-run. Post-estimation tests show the absence of autocorrelation problem (Table 10). Yet according to Jarque-Bera test (Appendix A) errors are not normally distributed, which may be caused by the limited number of observations and don`t distort results crucially, since it`s not important for the asymptotic properties of the coefficients in VECM. Also, there is some evidence of structural instability.

Table 9. VECM for Ukraine-Turkey trade

Variable	Coefficients	
	VECM without regime dummy (5 lags)	VECM with regime dummy (4 lags)
ln_RER	7.55 (6.26)	3.06 (2.20)
ln_IPI	9.1 (8.03)	6.88 (6.40)
ln_IPI*	0.57 (1.20)	-0.47 (-0.85)
cons	55.96	33.59

Notes: t-statistics in parentheses

Table 10. LM test for autocorrelation (VECM for Ukraine-Turkey trade)

	Lag	chi2	df	Prob>chi2
without regime dummy	1	12.40	16	0.716
	2	16.29	16	0.433
with regime dummy	1	21.35	16	0.166
	2	18.19	16	0.317
	H_0: no autocorrelation at lag order			

ARDL models for Ukraine-Turkey trade flows (Table 11) are consistent with VECM estimations: coefficients on real exchange rate and real domestic income are statistically significant with positive signs, while real foreign income appeared to be statistically insignificant. Similar to the VECM results in ARDL model with regime dummy estimated coefficients are smaller in magnitude. The elasticities of the hryvnia-lira real exchange rate amount 5.35% and 4.2% in the models without and with regime dummy respectively in the long-run. The elasticities of the domestic Industrial Production Index are equal to 6.2% and 6.19% in models without and with regime dummy respectively in the long-run. Diagnostics imply that both ARDL models have

no problems of autocorrelation (Table 12), heteroscedasticity (Appendix B) and non-stability of eigenvalues (Appendix D); however, errors are not distributed normally (Appendix A).

Table 11. Error correction ARDL (2 5 4 0) model for Ukraine-Turkey trade

Variable	Coefficients	
	without regime dummy	with regime dummy
log_RER	5.35 (3.47)	4.20 (2.21)
log_IPI	6.20 (4.36)	6.19 (4.59)
log_IPI*	.32 (0.63)	0.18 (0.35)
ADJ	-0.72 (-5.53)	-0.77 (-5.47)

Notes: t-statistics in parentheses

Table 12. Breusch-Godfrey LM test for autocorrelation (error correction ARDL for Ukraine-Turkey trade)

	lags(p)	chi2	df	Prob > chi2
without regime dummy	1	1.31	1	0.252
with regime dummy	1	1.96	1	0.161
		H_0: no serial correlation		

For Ukraine-China, trade flows M-L condition is satisfied only in VECM with regime dummy, while in VECM without regime dummy coefficient on real exchange rate is statistically insignificant (Table 13), which indicates the availability of structural break. Coefficients on real domestic income are significant with "right" negative sign and consistent in magnitude in both models, while real foreign income again appeared to be marginally significant

with "right" positive sign in the model without regime dummy and insignificant in the model with regime dummy. The 1% increase in the hryvnia-yuan real exchange rate is associated with 1.19% increase in the trade balance in model with regime dummy in the long-run. The 1% increase in domestic income is associated with 2.87% and 3.08% decrease in the trade balance in VECM without and with regime dummy respectively in the long-run. For both models performed diagnostics confirm no autocorrelation (Table 14), however, errors are not distributed normally (Appendix A), which is similar to VECM for Ukraine-Turkey trade flows.

Table 13. VECM for Ukraine-China trade

Variable	Coefficients	
	without regime dummy (6 lags)	with regime dummy (5 lags)
log_RER	.10 (0.30)	1.19 (2.09)
log_Y	-2.87 (-3.18)	-3.08 (-2.27)
log_Y^*	1.20 (1.84)	-0.32 (-0.35)
cons	-13.1	-27.28

Notes: t-statistics in parentheses

Table 14. LM test for autocorrelation (VECM for Ukraine-China trade)

	Lag	chi2	df	Prob>chi2
without regime dummy	1	13.302	16	0.6505
	2	10.56	16	0.8359
with regime dummy	1	21.02	16	0.17766
	2	21.27	16	0.16821
	H_0: no autocorrelation at lag order			

The results of ARDL model (Table 15) are consistent with VECM estimations: in specification without regime dummy M-L condition is not satisfied, since coefficient on real exchange rate is not statistically significant, while in specification with regime dummy the coefficient is positive and significant, meaning that M-L condition holds. Real domestic income is significant with negative sign in ARDL with regime dummy. The elasticities of the hryvnia-yuan real exchange rate amounts 1.64% in the model with regime dummy in the long-run. The elasticities of the domestic output are equal to -4.37% and -3.42% in models without and with regime dummy respectively in the long-run. Both models have no problems of autocorrelation (Table 16), heteroscedasticity (Appendix B), errors are distributed normally (Appendix A) and the system is stable (Appendix D).

Table 15. Error correction ARDL (4 2 4 1) model for Ukraine-China trade

	Coefficients	
Variable	without regime dummy	with regime dummy
log_RER	-0.27 (-0.23)	1.64 (2.15)
log_Y	-4.37 (-1.54)	-3.42 (-2.07)
log_Y*	1.42 (0.62)	-0.8 (-0.60)
ADJ	-0.92 (-3.86)	-1.40 (-5.12)

Notes: t-statistics in parentheses

Table 16. Breusch-Godfrey test for autocorrelation (error correction ARDL for Ukraine-China)

	lags(p)	chi2	df	Prob > chi2
without regime dummy	1	0.398	1	0.5281
with regime dummy	1	0.135	1	0.7129
		H_0: no serial correlation		

Talking about Ukraine-Russian Federation trade, all estimated coefficients in both VECMs (Table 17) are statistically significant at 1% level, however, M-L condition is not satisfied, since real exchange rate coefficient is with a negative sign, meaning that national currency depreciation is going to deteriorate trade balance. Furthermore, domestic and foreign real incomes are with "right" signs according to the theory in both models. However, in VECM with regime dummy coefficients are a bit larger. The 1% increase in the hryvnia-ruble real exchange rate is associated with 2.47% and 3.06% decrease in the trade balance in models without and with regime dummy respectively in the long-run. The 1% increase in domestic income is associated with 2.96% and 3.37% decrease in the trade balance in VECMs without and with regime dummy respectively in the long-run. The elasticities of the foreign output are equal to 3.92% and 5.27% respectively in models without and with regime dummy. Both models have no autocorrelation (Table 18), albeit errors are not distributed normally (Appendix A). Also, there is some evidence for eigenvalues instability.

Table 17. VECM for Ukraine-Russian Federation trade without dummy

Variable	Coefficients	
	without regime dummy (6 lags)	with regime dummy (5 lags)
log_RER	-2.47 (-4.63)	-3.06 (-4.44)
log_Y	-2.96 (-3.88)	-3.37 (-2.59)
log_Y*	3.92 (4.08)	5.27 (3.86)
cons	33.29	47.44

Notes: t-statistics in parentheses

Table 18. LM test for autocorrelation (VECM for Ukraine-Russian Federation trade)

	Lag	chi2	df	Prob>chi2
without regime dummy	1	18.66	16	0.287
	2	11.95	16	0.747
with regime dummy	1	14.3918	16	0.56955
	2	25.3837	16	0.06334
		H_0: no autocorrelation at lag order		

In both ARDL models (Table 19) M-L condition is not satisfied, since the coefficient on real exchange rate is negative and significant marginally, meaning that devaluation of national currency is going to deteriorate trade balance between Ukraine and Russian Federation. Real foreign income is marginally significant as well with positive sign, meaning that increasing GDP in Russian Federation is going to improve trade balance. The elasticities of the hryvnia-ruble real exchange rate amount -1.45% in the models without and with regime dummy respectively in the long-run. Both models have no problem of autocorrelation (Table 20) and heteroscedasticity (Appendix B), systems are stable (Appendix D) and errors are normally distributed (Appendix A).

Table 19. Error correction ARDL (1 3 0 4) model for Ukraine-Russian Federation trade

	Coefficients	
Variable	without regime dummy	with regime dummy
log_RER	-1.45 (-1.87)	-1.45 (-1.84)
log_Y	-1.04 (-0.89)	-1.03 (-0.76)
log_Y*	2.58 (1.78)	2.58 (1.74)
ADJ	-0.59 (-4.00)	-0.60 (-3.92)

Notes: t-statistics in parentheses

Table 20. Breusch-Godfrey test for autocorrelation (error correction ARDL for Ukraine-Russian Federation)

	lags(p)	chi2	df	Prob > chi2
without regime dummy	1	0.312	1	0.5754
with regime dummy	1	0.324	1	0.5695
		H_0: no serial correlation		

M-L condition is satisfied for Ukraine-Eurozone countries trade in both VECMs (Table 21), real domestic and foreign incomes are statistically significant at 1% level, although signs are opposite to theoretical. The 1% increase in the hryvnia-euro real exchange rate is associated with 14.14% and 12.99% increase in the trade balance in models without and with regime dummy respectively in the long-run. The 1% increase in domestic income is associated with 22.46% and 21.30% increase in the trade balance in VECM without and with regime dummy respectively in the long-run. The elasticities of the foreign income amount -17.34% and 17.54% in model without and with regime dummy respectively. Diagnostics show that errors of both models are uncorrelated (Table 22), however, they are not normally distributed (Appendix A).

Table 21. VECM for Ukraine-Eurozone countries trade

	Coefficients	
Variable	without regime dummy (5 lags)	with regime dummy (5 lags)
log_RER	14.14 (4.68)	12.99 (4.29)
log_Y	22.46 (5.09)	21.30 (4.87)
log_Y*	-17.34 (-2.63)	-17.54 (-2.06)
cons	-50.14	-64.31

Notes: t-statistics in parentheses

Table 22. LM test for autocorrelation (VECM for Ukraine-Eurozone countries trade)

	Lag	chi2	df	Prob>chi2
without regime dummy	1	20.2137	16	0.21075
	2	20.7860	16	0.18688
with regime dummy	1	21.7623	16	0.15103
	2	21.3481	16	0.16552
		H_0: no autocorrelation at lag order		

In ARDL model without regime dummy (Table 23) M-L condition is satisfied, real domestic income is significant with a theoretically wrong positive sign, while foreign income appeared to be insignificant. In ARDL model with regime dummy coefficient of real exchange rate is positive and significant at 10% level as well as coefficient on real domestic income, while real foreign income.is insignificant. In addition, it is worth mentioning that estimated coefficients in ARDL models are significantly lower compared to VECM results. The elasticities of the hryvnia-euro real exchange rate amount 3.75% and 4.11% in the models without and with regime dummy respectively in the long-run. The elasticities of the domestic output are equal to 6.58% and -6.44% in models without and with regime dummy respectively in the long-run. Errors of both models are uncorrelated (Table 24), with constant variance (Appendix B) and normally distributed errors (Appendix A). The Cusum-squared test gives an evidence of system`s stability.

Table 23. Error correction ARDL (1 3 3 0) model for Ukraine-Eurozone countries trade

	Coefficients	
Variable	without regime dummy	with regime dummy
log_RER	3.75 (2.07)	4.11 (1.86)

Table 23. Error correction ARDL (1 3 3 0) model for Ukraine-Eurozone countries trade – Continued

Variable	Coefficients	
	without regime dummy	with regime dummy
log_Y	6.58 (2.14)	6.44 (1.98)
log_Y*	-1.75 (-0.50)	-0.18 (-0.03)
ADJ	-0.39 (-3.10)	-0.37 (-2.75)

Notes: t-statistics in parentheses

Table 24. Breusch-Godfrey for autocorrelation (error correction ARDL for Ukraine-Eurozone countries trade)

	lags(p)	chi2	df	Prob > chi2
without regime dummy	1	0.134	1	0.7139
with regime dummy	1	0.024	1	0.8764
	H_0: no serial correlation			

Summing up, VECM results give evidence of M-L condition to be satisfied for all analyzed trade partners except Russian Federation. ARDL model confirms the M-L condition to hold for bilateral trade flows with Turkey, China and Eurozone countries. The estimation for Ukraine-Russian Federation trade implies that devaluation of national currency is going to deteriorate the trade balance, however, the significance is marginal. VECM and ARDL models are consistent in terms of coefficients` signs and significance in almost all cases, albeit, the coefficients estimated by ARDL model are smaller in magnitude. In general, the results provided by ARDL model are more reliable according to post-estimation diagnostics.

Chapter 6

CONCLUSION

The objective of this paper is to assess the long-run impact of the real exchange rate on the Ukraine`s bilateral trade balances with Eurozone countries, Russian Federation, China and Turkey. Since there are no theoretical reasons to associate devaluation with trade balance improvement it is important to estimate long-run import and export elasticities and test M-L condition. M-L condition gives reliable evidence about the responsiveness of trade on exchange rate, which, in turn, is crucial for trade and exchange rate policies.

We make use of two econometric models, which are different in variables` exogeneity treatment. Each model was estimated with and without regime dummy for trade flows between Ukraine and its four major trading partners (Eurozone countries, Russian Federation, China and Turkey). VECM, where all variables are endogenous, implies M-L condition to hold for all analyzed trade partners except Russian Federation. In case of Ukraine-Russian Federation trade flows, balance of trade deteriorates when hryvnia devaluates. However, this may be the result of sanctions imposed by Russian Federation over the last six years and not because of opposite price movements or high import costs, which is an issue of further research. VECM estimations without and with exchange rate regime dummy show the same results almost for all partners, however, in case of Ukraine-China trade coefficient on real exchange rate in VECM without regime dummy is insignificant, which is an indicator of a structural break in hryvnia-yuan real exchange rate caused by the change in exchange rate regime in 2015. The general pattern is that a real domestic output has a positive sign that is not consistent with the theory, while real foreign output is insignificant, except for Ukraine-Russian

Federation trade, where both outputs are significant and with expected signs in VECM.

ARDL model, which treat all variables except trade balance as exogenous, shows the results consistent with VECM estimations in testing M-L condition, however, for trade with Russian Federation it implies only marginal significance of coefficient on real exchange rate with negative sign. Also, the coefficients are smaller in magnitudes compared to VECM estimations. Furthermore, in VECMs evidence for structural instability is present and errors are not distributed normally, which is most probably caused by limited sample size. In general, the estimations of ARDL models are more reliable, since the post-estimation diagnostics showed better results. Overall results give strong evidence for M-L condition to hold for trade with Turkey, China and Eurozone countries.

This work provides an additional justification for models and policy analysis to use M-L condition as an assumption at least in Ukraine-Turkey, Ukraine-China and Ukraine-Eurozone countries trade. Elasticities estimated in this study can be used in trade balance forecasting as the response on fluctuations in real exchange rate, domestic and foreign incomes in the long-run. In turn, trade balance forecasting is important in preventing negative consequences of the trade balance deficit such as inflation, unemployment and economic slowdown. As the issue for further research, it would be useful to estimate the exchange rate and incomes elasticities for all the rest trade partners of Ukraine.

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APPENDIX A. JARQUE-BERA TEST

Table 25. Jarque-Bera test for normality (VECM without regime dummy for Ukraine-Turkey trade)

Equation	chi2	df	Prob>chi2
D_log_TB	10.674	2	0.00481
D_log_RER	51.161	2	0.00000
D_log_IPI	18.235	2	0.00011
D_log_IPI*	6.593	2	0.03702
ALL	86.662	8	0.00000
H_0: residuals are normally distributed			

Table 26. Jarque-Bera test for normality (VECM with regime dummy for Ukraine-Turkey trade)

Equation	chi2	df	Prob>chi2
D_log_TB	66.518	2	0.00000
D_log_RER	60.476	2	0.00000
D_log_IPI	2.474	2	0.29025
D_log_IPI*	26.969	2	0.00000
ALL	156.437	8	0.00000
H_0: residuals are normally distributed			

Table 27. Jarque-Bera test for normality (VECM without regime dummy for Ukraine-China trade)

Equation	chi2	df	Prob>chi2
D_log_TB	13.007	2	0.00150
D_log_RER	0.776	2	0.6785
D_log_IPI	1.538	2	0.46346
D_log_IPI*	0.654	2	0.72114
ALL	15.974	8	0.04275
H_0: residuals are normally distributed			

Table 28. Jarque-Bera test for normality (VECM with regime dummy for Ukraine-China trade)

Equation	chi2	df	Prob>chi2
D_log_TB	7.793	2	0.02032
D_log_RER	8.224	2	0.01638
D_log_IPI	36.096	2	0.00000
D_log_IPI*	0.770	2	0.68062
ALL	52.882	8	0.00000
H_0: residuals are normally distributed			

Table 29. Jarque-Bera test for normality (VECM without regime dummy for Ukraine-Russian Federation trade)

Equation	chi2	df	Prob>chi2
D_log_TB	0.390	2	0.82297
D_log_RER	12.770	2	0.00169
D_log_IPI	10.687	2	0.00478
D_log_IPI*	0.445	2	0.80053
ALL	24.292	8	0.00205
H_0: residuals are normally distributed			

Table 30. Jarque-Bera test for normality (VECM with regime dummy for Ukraine-Russian Federation trade)

Equation	chi2	df	Prob>chi2
D_log_TB	0.258	2	0.87910
D_log_RER	25.173	2	0.00000
D_log_IPI	16.002	2	0.00034
D_log_IPI*	0.917	2	0.63238
ALL	42.349	8	0.00000
H_0: residuals are normally distributed			

Table 31. Jarque-Bera test for normality (VECM without regime dummy for Ukraine-Eurozone countries trade)

Equation	chi2	df	Prob>chi2
D_log_TB	0.073	2	0.96426
D_log_RER	29.734	2	0.00000
D_log_IPI	4.310	2	ท0.11589
D_log_IPI*	0.321	2	0.85185
ALL	34.437	8	0.00003
H_0: residuals are normally distributed			

Table 32. Jarque-Bera test for normality (VECM with regime dummy for Ukraine-Eurozone countries trade)

Equation	chi2	df	Prob>chi2
D_log_TB	0.246	2	0.88425
D_log_RER	32.709	2	0.00000
D_log_IPI	4.322	2	0.11521
D_log_IPI*	0.356	2	0.83688
ALL	37.634	8	0.00001
H_0: residuals are normally distributed			

Table 33. Jarque-Bera test for normality (ARDL models)

Model		chi2(47)	
without dummy	ARDL for Ukraine-Turkey trade	Prob > chi2	6.9e-05
	ARDL for Ukraine-China trade	Prob > chi2	.5369
	ARDL for Ukraine-Russian Federation trade	Prob > chi2	.5274
	ARDL for Ukraine-Eurozone countries trade	Prob > chi2	.2832
with dummy	ARDL for Ukraine-Turkey trade	Prob > chi2	1.6e-04
	ARDL for Ukraine-China trade	Prob > chi2	.541
	ARDL for Ukraine-Russian Federation trade	Prob > chi2	.5403
	ARDL for Ukraine-Eurozone countries trade	Prob > chi2	.2722
H_0: residuals are normally distributed			

APPENDIX B. WHITE'S TEST

Table 34. White's test for homoscedasticity

Model	chi2(47)	
ARDL for Ukraine-Turkey trade	Prob > chi2	0.4321
ARDL for Ukraine-China trade	Prob > chi2	0.4334
ARDL for Ukraine-Russian Federation trade	Prob > chi2	0.4328
ARDL for Ukraine-Eurozone countries trade	Prob > chi2	0.4341
	H_o: homoskedasticity	

APPENDIX C. EIGENVALUES STABILITY CIRCLES

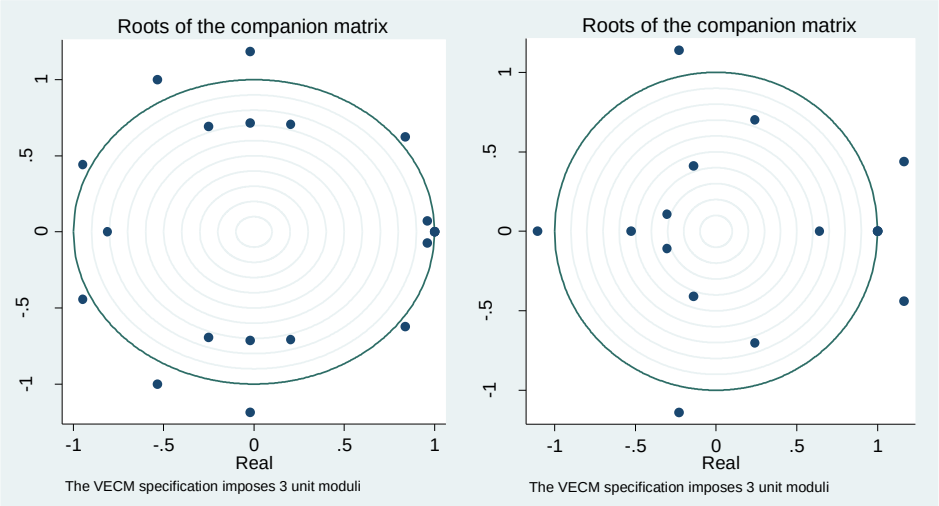

Figure 5. Eigenvalues stability circles (VECMs for Ukraine-Turkey trade

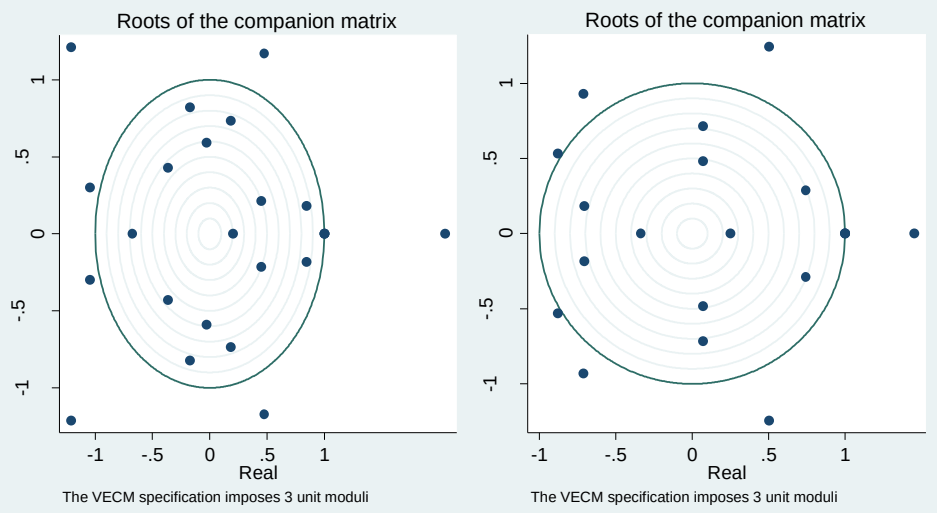

Figure 6. Eigenvalues stability circles (VECMs for Ukraine-Russian Federation trade)

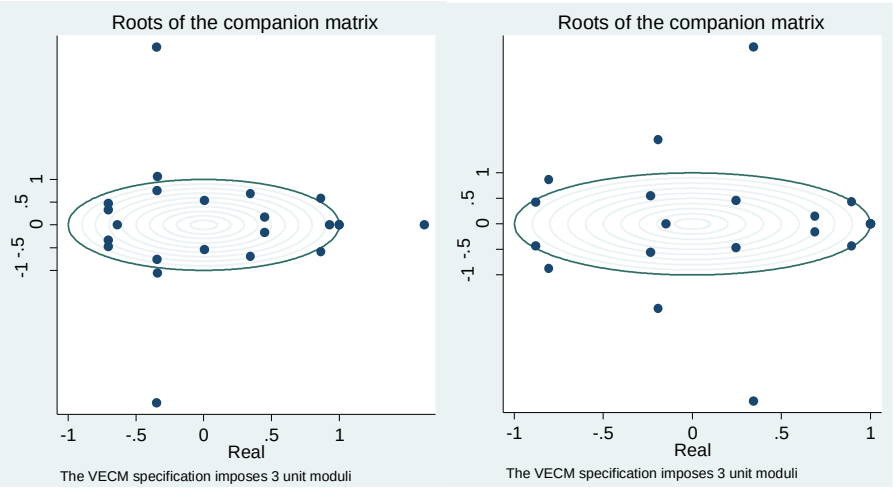

Figure 7. Eigenvalues stability circles (VECMs for Ukraine-China trade)

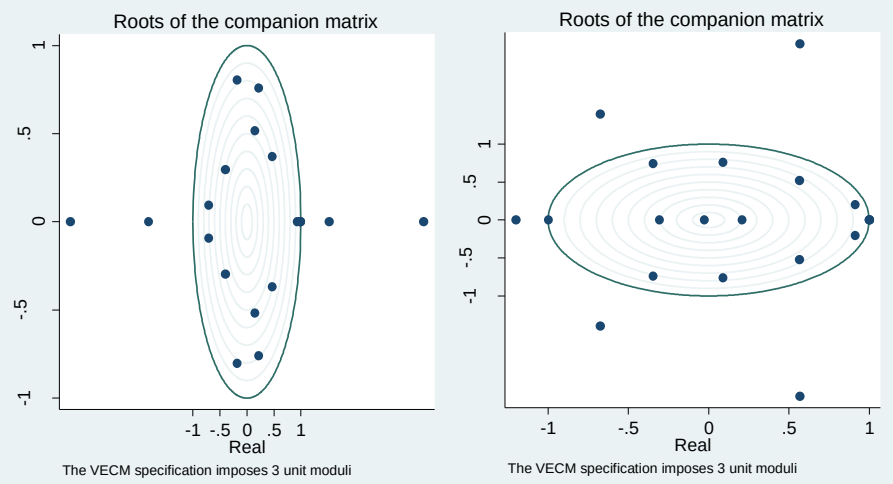

Figure 8. Eigenvalues stability circles (VECMs for Ukraine-Eurozone countries trade)

APPENDIX D. CUSUM-SQUARED TEST

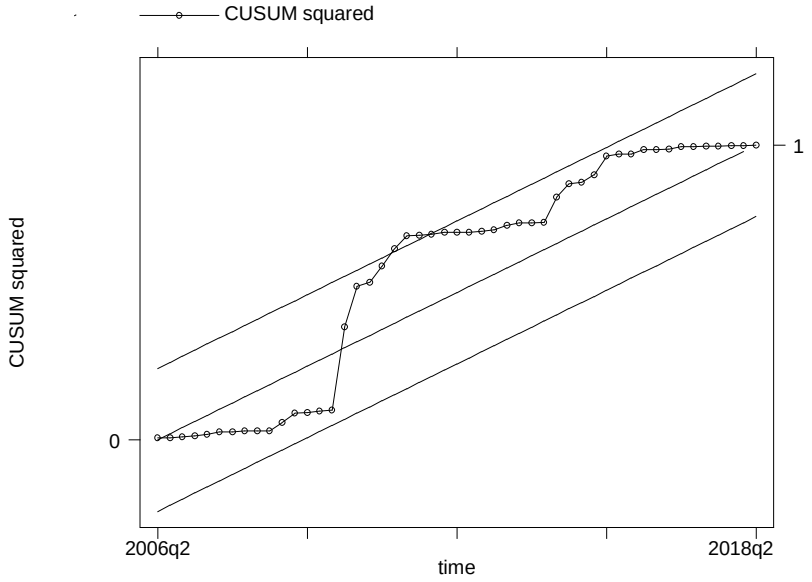

Figure 9. Cumulative sums of squares test (ARDL for Ukraine-Turkey trade)

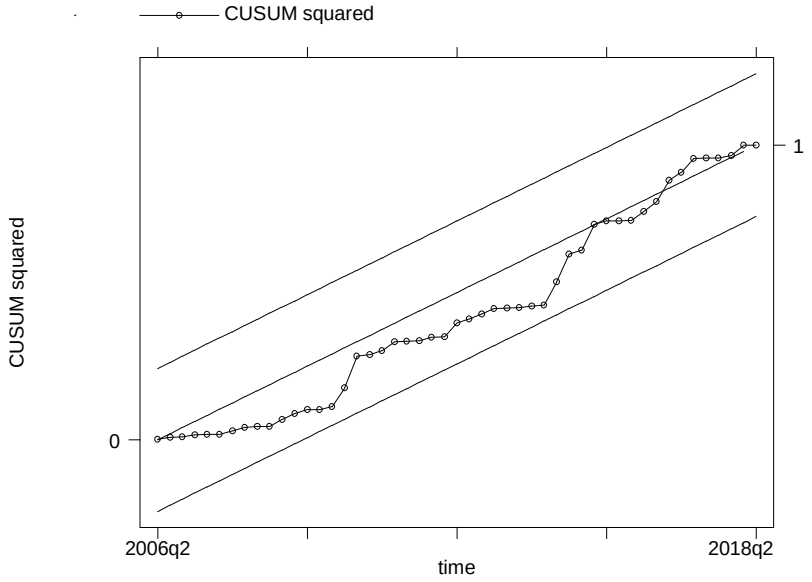

Figure 10. Cumulative sums of squares test (ARDL for Ukraine-China trade)

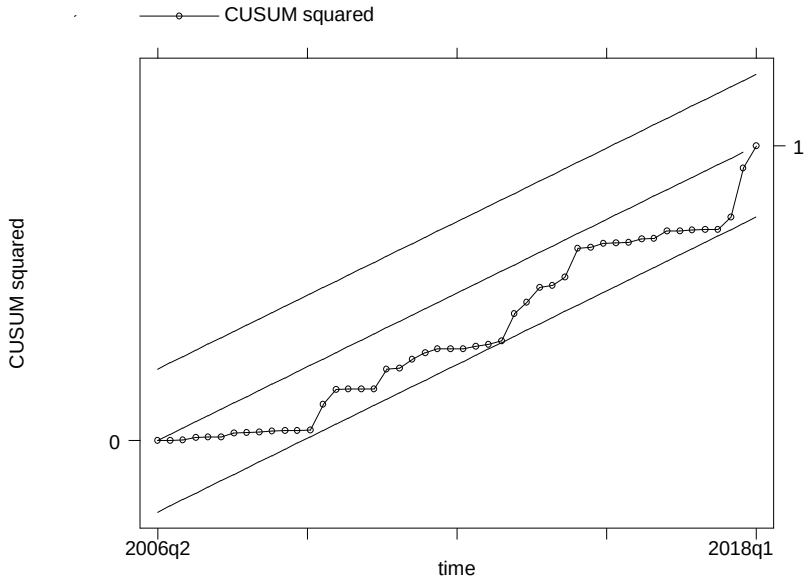

Figure 11. Cumulative sums of squares test (ARDL for Ukraine-Russian Federation trade)

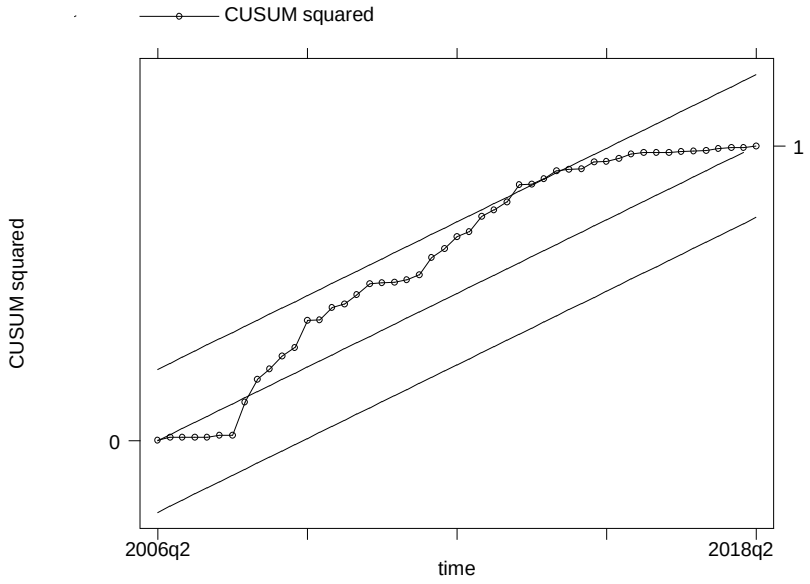

Figure 12. Cumulative sums of squares test (ARDL for Ukraine-Eurozone countries trade)