Varazdin Development and Entrepreneurship Agency
in cooperation with
Azerbaijan State University of Economics (UNEC)
University North
Faculty of Management University of Warsaw
Faculty of Law, Economics and Social Sciences Sale - Mohammed V University in Rabat

Economic and Social Development

37th International Scientific Conference on Economic and Social Development –
"Socio Economic Problems of Sustainable Development"

Book of Proceedings

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MODELLING THE IMPACT OF EXCHANGE RATE VOLATILITY ON AGRICULTURE SPHERE: IN CASE OF AZERBAIJAN

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ABSTRACT

The intensity of economic and political changes in the globalized economy requires significant changes in the exchange rate policies of the developing countries. This has led the determination of tranmission channel from exchange rate volatility to the economy to be much more complex for researchers. Different approaches have been put forward explaining the transmission channel in various countries. The short and long-run, direct and indirect channels of the transmission have been studied in the existing literature. The study examines and defines the tranmission channel from exchange rate volatility to the share of agriculture in GDP of Azerbaijan Republic. Key research variables of the study have been chosen among the main macroeconomic variables of the country. Quarterly data from 2007 to 2018 is taken for the econometric analysis. The paper uses a cointegrated VAR model, VECM model for Azerbaijan in order to study the response of the share of agriculture in GDP to non-oil real effective exchange rates in Azerbaijan. Empirical analysis shows that, for Azerbaijan there is a short-run statistical significant relationship between the non-oil real effective exchange rate and agriculture share in GDP getting its basis from the increasing trade in the country in a short-term. Besides, there have been found a long run relationship running from Imports; Inflation and GDP to share of Agriculture in GDP; and from Imports; Inflation and GDP to non-oil real effective exchange rate in Azerbaijan as well. In conclusion, decreases in trade (exports and imports) are transmitted to higher non-oil real effective exchange rate that also affects the share of agriculture in GDP negatively in a short-run and they relate with each other in a long-run as well.

Keywords: *Exchange rate volatilities, VAR model, VECM model, agriculture share, GDP to share of Agriculture*

1. INTRODUCTION

Oil revenues are very important source of an income for most of the oil exporting countries. Due to that importance and also dependence, other main spheres of the economy such as agriculture lags from development. Most of the times, these development lags are difficult to recover depending on the level of dependence of the economy on the specific natural resource. At the end of 2000, the "natural resource curse" resulted in the oil dependence of oil exporting countries, as well as Azerbaijan. In this regard, the non-oil sector started to weaken and be replaced by imports. The growth of and dependence on oil revenues in the oil exporting countries led to the strengthening of the national currency against other currencies as well. It showed its negative effects when the local currency got devaluated suddenly. Likely to other emerging economies, Azerbaijan has taken a number of economic and political steps to improve

the exchange rate and stabilize the economy in order to avoid the negative effects of those sudden shocks of the exchange rate. Thus, recently there have been some laws and regulations passed by the government based on the international experience mainly to improve the non-oil sector in the country. Due to the urgency of the issue the paper aims to investigate the relationship between exchange rate volatility and agriculture sphere. While investigating the issue, some of the recent existing literature have been reviewed both for Azerbaijan and other countries. Exchange rate fluctuations have a positive impact on the export of agricultural products in Nigeria, in particular, cocoa and agrarian loans. The relative prices of agricultural products, especially cocoa products, have been determined to be related to significant quantities of export. As a result, currency fluctuations have a positive impact on Nigeria's export of cocoa and it is recommended that agricultural loans be restructured in order to increase the production capacity of farmers by meeting their needs. In short, the value of cocoa exports in Nigeria should be determined by free market (Essien, E.B., Dominic, AU and Sunday, E.R., 2011, pp.1-10.). In another study, the impact of fiscal and monetary policies on the Brazilian economy has been assessed using a structural model. The results state the significant role of non-oil production, especially manufacturing in the economic development of the country while having a competitive exchange rate. (Sonaglio, C.M., Campos, A.C. and Braga, M.J., 2016, pp.77-95.) The study conducted by Gebeyehu, A.B. (2015) analyzes the volume of trade in seven of Ethiopia's major agricultural products considering the impact of exchange rate devaluations. Various methods have been used throughout the paper to clarify the issue. Impulse response results show that Ethiopia's trade balance follows J-curve pattern as the real currency depreciates. The study findings point out that the depreciation in real terms improves the BoP within a short period of time. The relative insignificant impact of the industrial production index on the BoP in Ethiopia is also stated using the VECM model. Another method of the autoregressive distribution lag (ARDL) was used to test the hypothesis that there is no short-term and long-term relationship between the exported oilseeds and the explanatory variables in Ethiopia. As a result, exports have shown that oilseeds exports have a negative relationship with exchange rate fluctuations. At the same time, the null hypothesis was denied by confirming that there were long-term relationships between the independent variables included in the model and exports of oilseeds (Mehare, A. and Edriss, A.K., 2012., 3 (11).). Oye, OO, Lawal, AI, Eneogu, A. and IseOlorunkanmi, J. (2018) in their research have had a detailed analysis of the relationship between the exchange rate and agricultural output in Nigeria. Using the Vector Error Correction Model (VECM) the study points out that the real effective exchange rate (REER) has negative linkage with agricultural production in the country. There is also found to have a direct link between REER and export prices. Hence, it also leads to the conclusion that exchange rate volatility is related to export revenues of the country as well. Since the significant effects of lagged effects of export prices on agricultural production are also revealed during the model analysis, the previous export prices can be used to predict the current agricultural output. Among the studies conducted for Azerbaijan in the sphere of agriculture, there are some have to be mentioned while reviewing the existing literature. Tahmasib Huseynov (2014) has analyzed the new approaches required in the growth of agricultural production in Azerbaijan concluding that opportunities in the agricultural share of GDP in the country are not fully used. Relevant statistical methods have been used to reveal the inefficiency in agricultural production of the country. Another related study has been done by Ali Rustamov (2017) about the evaluation of the Marshall-Lerner condition via the ARDL econometric model in Azerbaijan. The findings point out that depreciation in the real effective exchange doesn't have any statistically significant long-run and short-run effects on BoP variable (X/M). These have been found to be due to relatively inelastic import and exports in Azerbaijan against the REER. Consequently, Marshall-Lerner condition doesn't hold for Azerbaijan and there is no sufficient elasticity of exports and imports to improve the trade balance.

Following chapters have been added to the paper. Chapter 2 describes the data and methodology for the econometric framework used throughout the study. Chapter 3 depicts the cointegrated VAR and VECM to estimate the relationship between exchange rate volatility and share of the agricultural sphere in GDP and interpretation of the findings. The conclusion part is given in Chapter 4.

2. METHODOLOGY

The study applies the quarterly data from 2007 to 2018 since using quarterly data in the VAR model is much efficient and avoids the inaccurate conclusion on the lagged effects for the longer period such as in annual data. The following factors have been chosen to be included in the paper: Exports, Imports, Real effective exchange rate for non-oil sector (REER for non-oil), Agriculture share in GDP, Inflation (GDP deflator) and nominal GDP. The data on Exports, Imports (in US million dollars), Agriculture share in GDP (in %) and nominal GDP (in US million dollars) are from Azerbaijan State Statistical Committee. Inflation rate (GDP deflator) and REER for non-oil sectors information are obtained from the Central Bank of Azerbaijan. Due to the long-running fixed nominal exchange rate in Azerbaijan for the period studied, REER for non-oil sectors is included in the model. The study aims to analyze the impact of exchange rate volatility on the share of agriculture in Azerbaijan. The transmission channel of the relationship includes exports, imports, GDP and the inflation rate in it. In order to achieve the proper results and analyze the transmission channel between the variables in detail, the study applies Vector Autoregressive (VAR) model. The model is utilized for forecasting time series and evaluation of the responses to the shocks by interested variables. Some steps in the model building have been taken throughout the paper in order to investigate the transmission channel between the interested variables. The number of lags to be included in the model is defined first due to determine the lagged effects of interested variables on the dependent variable. As the number of lags is chosen, the VAR model is set for the mentioned variables.

2.1. The VAR process

The function of the VAR model is as follows (Enders, 2004):

$$x_t = A_0 + \sum_{1}^{n} A_i x_{t-i} + e_t$$

Where: xt is an (n x 1) vector containing each of the n variables employed in the VAR,
A0 is an (n x 1) vector of intercept terms

$$\begin{bmatrix} x_{1t} \\ x_{2t} \\ . \\ x_{nt} \end{bmatrix} = \begin{bmatrix} A_{10} \\ A_{20} \\ . \\ A_{n0} \end{bmatrix} + \begin{bmatrix} A_{11}(L) & A_{12}(L) & . & A_{1n}(L) \\ A_{21}(L) & A_{22}(L) & . & A_{2n}(L) \\ & . & . & . \\ A_{n1}(L) & A_{n2}(L) & . & A_{nn}(L) \end{bmatrix} \begin{bmatrix} x_{1t-1} \\ x_{2t-1} \\ . \\ x_{nt-1} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \\ . \\ e_{nt} \end{bmatrix}$$

Where: x_{it} are the variables employed in the VAR, i
A_{i0} are the intercept terms
$A_{ij}(L)$ are the polynomials in the lag operator
e_{it} are white-noise disturbances that may be correlated.
The n-equation VAR derived from Enders (2004),
A_i are (n x n) matrices of coefficients
e_{it} is an (n x 1) vector of error terms

The observation matrices for the paper are x_t = [Azerbaijan`s Inflation, real effective exchange rate for non-oil sector, imports, exports, agriculture share in GDP and nominal GDP]. The methodology of the VAR process has also been reviewed in the chapter. Firstly, the stationarity of the included variables should be checked. Unrestricted VAR is available for the stationary variables. However, the variable has to be differenced by the order until it is stationary if it is not stationary. Stationarity of the variables allows the cointegration test to be applied to the model. As the cointegration among variables is present, the process may continue with VECM (Vector Error Correction Model) method. If there is no cointegration, then the process stops with VAR in differenced data (Enders, 2004). Phillips Perron stationarity test is used in order to test stationarity. Based on the test results, the first differences of the variables have been taken in need. Economic models are built based on the first differences and level variables.

2.1.1. Cointegration test

Stationary variables are needed to perform cointegration analysis for the long run relationship among the variables. Since some of the variables are differenced to be stationary, the VECM method is required to be applied to the model. Lag order is selected before the cointegration test in order to implement the further steps of the process. Several methods of choosing the optimal lag order may be seen while determining the optimal lag order. The lag order satisfied by most of them or by the author is chosen for the further processes. A cointegration test based on Trace statistic and Maximum Eigenvalue statistic by Johansen (1988) and Johanson-Juselius (1990) has been used throughout the paper. 5% significance level is chosen for the test to define their statistical significance. The test aims to reveal the number of cointegrated vectors among the variables. Having not any cointegration vectors in the model also states about the absence of long-run relationship among the variables.

2.2. Vector Error Correction Model (VECM)

As the cointegration test states about the presence of the cointegration vectors, that is the presence of the long-run relationship, VECM method is used to reveal the long-run relationships among the variables. The equation of the VECM model is as follows:

$$\Delta x_t = \pi x_{t-1} + \sum_{1}^{p} \pi_i \Delta x_{t-i} + \varepsilon_t$$

The equation may be explained by its three parts: The short-run coefficient matrices, the long run cointegration matrix and the matrix of the speed of adjustment terms. The correctly specified model has to have the negative and statistically significant coefficient of the speed of adjustment as it states the correction of deviation from the long-run equilibrium.

3. RESULTS

As it is mentioned in the methodology part, Phillips Perron stationarity test is used to determine whether the variables are stationary. Due to nonstationarity, the first differences of Exports, GDP and REER variables have been taken and then included to the models.

3.1. Lag order selection process

The results of the lag order selection criteria for VAR, the final prediction error (FPE), likelihood ratio, AIC information criteria, and Hannan-Quinn criterion show that the appropriate number of lag is 4 lags. Since other criteria have close values at this lag level to their lowest, 4 lags is chosen to be the optimal lag structure of the model and to be included in the Johansen test of cointegration.

Table 1: VAR Lag Order Selection Criteria (EViews econometric software)

VAR Lag Order Selection Criteria
Endogenous variables: AGRICULTURE_SHARE D_EXPORTS D_GDP D_REER IMPORTS INFLATION
Exogenous variables: C
Date: 12/01/18 Time: 23:50
Sample: 2007Q1 2018Q2
Included observations: 41

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1240.502	NA	1.03e+19	60.80498	61.05575	60.89629
1	-1168.580	119.2857	1.82e+18	59.05267	60.80804	59.69188
2	-1080.368	120.4838	1.60e+17	56.50578	59.76574*	57.69288
3	-1025.014	59.40424	8.60e+16	55.56168	60.32625	57.29667
4	-952.6491	56.48033*	3.02e+16*	53.78776*	60.05693	56.07064*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

3.2. Cointegration test

Cointegration test for the model states about three valid cointegration vectors in the model. The processes are gone through testing the number of cointegration vectors starting from 0:

- H0 : r = 0 is rejected at the 5% level (159.1416> 95.75366).
- Then the case of r = 1 is tested and since the trace statistic is greater than its critical value (91.62506> 69.81889), we reject the null hypothesis again.
- Then the case of r = 2 is tested and since the trace statistic is greater than its critical value (54.25090> 47.85613), we reject the null hypothesis again.
- Continuing with r = 3, it is found that the trace statistic is less than its critical value (24.45172< 29.79707). Thus, the null hypothesis is accepted. It results that there are three cointegration vectors in the model.

The presence of cointegration vectors (three cointegration in our model) is also explained as the existence of a long run relationship between the variables and hence, VECM (Vector Error Correction Model) methodology should be implemented for the model.

Table following on the next page

Table 2: Cointegration test (EViews econometric software)

Date: 12/01/18 Time: 23:55
Sample (adjusted): 2008Q3 2018Q2
Included observations: 40 after adjustments
Trend assumption: Linear deterministic trend
Series: AGRICULTURE_SHARE D_EXPORTS D_GDP D_REER IMPORTS INFLATION
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.815095	159.1416	95.75366	0.0000
At most 1 *	0.607161	91.62506	69.81889	0.0004
At most 2 *	0.525256	54.25090	47.85613	0.0111
At most 3	0.329765	24.45172	29.79707	0.1820
At most 4	0.124640	8.446639	15.49471	0.4189
At most 5	0.075078	3.121830	3.841466	0.0772

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

As the results of cointegration tests have been obtained, the VECM model may be built. Throughout the VECM estimation, the main points such as the short-run coefficients and long-run relationship between the variables are estimated.

3.3. Short run analysis

In order to conduct a short-run analysis, the VECM estimation has been established first. Since there are six variables included in the model, there have been six equations under the VECM estimation model. Out of them, the ones with dependent variables of the share of agriculture in GDP and non-oil real effective exchange rate (REER) is chosen to be studied, since the paper aims to analyze their relationship with other variables in order to explain the transmission channel empirically. Thus, chosen equations are estimated again with OLS method in order to interpret the short-run coefficients of the lagged variables on the dependent variables. There are also cointegration equations which help to identify the speed of adjustment terms. In other words, they are error correction terms. If there is a deviation from the long run equilibrium, it will be corrected gradually through short run adjustment:

1. CointEQ1 = AGRICULTURE_SHARE(-1) + 6.00E-06* IMPORTS(-1) -7.32E-06*INFLATION(-1) + 2.81E-06*D_GDP(-1) -0.065151
2. CointEQ2 = D_REER(-1) + 0.001901*IMPORTS(-1) + 0.157894*INFLATION(-1) - 0.002331*D_GDP(-1) -20.76314
3. CointEQ3 = D_EXPORTS(-1)+ 0.040540*IMPORTS(-1) + 4.735712*INFLATION(-1) - 0.181549*D_GDP(-1) - 521.6191

The Wald test also has been conducted in order to analyze the short-term effects of the chosen independent variables together with its lags on dependent variables. Considering that the quarterly data is used for the paper, then the analysis of 4 lags together may be considered as a short-run analysis as well.

Table 3 states about the short-run analysis of the VECM equations (the ones with dependent variables of the share of agriculture and non-oil real effective exchange rate). While conducting the analysis, the significance of the joint effects of the lagged coefficients of each including variable has been tested in each equation via the Wald test. From the first equation, it may be seen that the lags of the non-oil real effective exchange rate and share of agriculture have statistically significant short-term relationships with the share of agriculture variable. In the meantime, the second equation states that there are statistically significant short-term impacts of the lags of exports and imports variables on the non-oil real effective exchange rate.

Table 3: Short-run analysis of the model (EViews econometric software)

Variables:	Share of agriculture	Non-oil real effective exchange rate	Exports	Imports	Inflation (GDP deflator)	GDP
1st equation (dependent variable is share of agriculture)						
Wald test (p-value)	0.0000***	0.0888*	0.7707	0.2005	0.2129	0.5033
2nd equation (dependent variable is non-oil real effective exchange rate)						
Wald test (p-value)	0.2113	0.2862	0.0028***	0.0073***	0.1664	0.1049

**** - significant at 1% significance level;*
*** - significant at 5% significance level;*
** - significant at 10% significance level.*

The above mentioned short-run econometric values state about the short-run transmission channel of the relationship between non-oil real effective exchange rate and share of agriculture in GDP in Azerbaijan. Starting from the second equation the transmission channel from non-oil real effective exchange rate to the share of agriculture in GDP can be explained in detail. There are statistically significant short-run effects of exports and imports on the non-oil real effective exchange rate. The signs of these effects are negative for both variables. That means the more increase in the exports and imports is the less non-oil real effective exchange rate. Since the non-oil real effective exchange rate is the non-oil nominal effective exchange rate adjusted by inflation that shows the value of a currency against a basket of the currencies of the main trading partners, the increase in the imports decreases the nominal effective exchange rate (nominal exchange rate against the currencies of main trading partners) and hence the non-oil real effective exchange rate. The increase in exports also affects negatively to the non-oil real effective exchange rate. The changes in exports are mainly (more than 90%) about the oil and gas products. Thus, the increase in the exports of oil and gas products also increases the oil and gas production in the country and demotivates the production in non-oil sector directly. Since the non-oil real effective exchange rate determines the real exchange rates in non-oil sectors against the currencies of main trading partners, the significant increase in exports of goods make the non-oil real effective exchange rate to decrease as the focus of the trade is oil products in that case. The first equation states about the negative relationship between the non-oil real effective exchange rate and the share of agriculture in GDP - most of the non-oil products in the country are from the Agriculture sector. It is because the more valuable the non-oil products against its trade partners is the less competitive non-oil products both in the local and international market. Since the country is dependent on imported goods, expensive non-oil local products will be substituted with the imported non-oil products. It will also make it less competitive in the international market due to its value against the goods of its main trading

partners. These are enough reasons for agriculture share in GDP to decrease when the non-oil real effective exchange rate increases. Concluding above findings, there is a short-run statistical significant relationship between the non-oil real effective exchange rate and agriculture share in GDP in Azerbaijan getting its basis from the increasing trade in the country in a short-term. It is proved econometrically as shown above.

3.4. Long Run Analysis

The long-run relationship in the VECM model is analyzed through cointegration equations. The order of variables is set based on what to analyze due to the placement of the variables in the cointegration equations. Since the paper aims to analyze the long-run relationship between agriculture share in GDP and non-oil real effective exchange rate, the order of variables put in the model is as follows: Share of agriculture; non-oil REER; Exports; Imports; Inflation and GDP. In this chapter, the order of restrictions is set to analyze the impact of Exports; Imports; Inflation and GDP to the Share of agriculture and non-oil REER in a long run. Although there are three cointegration vectors, the first and the second cointegration equations are chosen to be analyzed. However, the Johansen test automatically restricts three restrictions in each cointegration equation.

Table 4: Johansen normalization restrictions imposed (EViews econometric software)

Cointegrating Eq:	CointEq1	CointEq2	CointEq3
AGRICULTURE_SHARE(-1)	1.000000	0.000000	0.000000
D_REER(-1)	0.000000	1.000000	0.000000
D_EXPORTS(-1)	0.000000	0.000000	1.000000
IMPORTS(-1)	6.00E-06	0.001901	0.040540
	(9.2E-07)	(0.00083)	(0.09861)
	[6.53096]	[2.29052]	[0.41111]
INFLATION(-1)	-7.32E-06	0.157894	4.735712
	(6.3E-05)	(0.05708)	(6.78308)
	[-0.11587]	[2.76638]	[0.69817]
D_GDP(-1)	2.81E-06	-0.002331	-0.181549
	(6.3E-07)	(0.00057)	(0.06720)
	[4.48601]	[-4.12322]	[-2.70169]
C	-0.065151	-20.76314	-521.6191

Considering the two short-run equations from previous paragraphs, the coefficients of the cointegration equations should be reviewed. In order to conclude for the long-run causality, the coefficients should be negative and statistically significant, since they are error corrections for the long run relationship. The analysis shows that coefficient of cointegration equation 1 in the short-run equation with the dependent variable of the share of agriculture and cointegration equation 2 in the short-run equation with the dependent variable of non-oil real effective exchange rate have negative and statistically significant (at 10% and 5% significance levels, respectively) values. So it states that there is a long-run causality running from Imports; Inflation and GDP to share of Agriculture in GDP, and from Imports; Inflation and GDP to non-oil real effective exchange rate. The coefficients of the cointegration equation show the speed of adjustment in case of any deviation from the long-run equilibrium.

4. CONCLUSION

By using the VECM model, the impact of exchange rate volatility on agriculture sphere in Azerbaijan and its transmission channel has been analyzed in the paper. Both long and short-run relationships among the variables have been considered during the analysis. The short-run findings states about the negative statistical significant relationship between the non-oil real effective exchange rate and agriculture share in GDP in Azerbaijan. Besides, the long-run causality running from Imports; Inflation and GDP to share of Agriculture in GDP, and from Imports; Inflation and GDP to non-oil real effective exchange rate are also found throughout the econometric analysis. In 2015 Azerbaijan national currency devaluated against the foreign currency and it had a positive impact on the share of non - oil share especially agricultural share in GDP. Based on academic literature the devaluation stimulates exports of the country. Thus, devaluation in Azerbaijan increased the country's export possibilities in a number of sectors, especially in the non-oil sector. At the same time, after the devaluation prices of the non-oil products in the country rose and led to an increase in local market prices. It also had a positive impact on the supply of local products, especially agricultural products. Besides, recent governmental regulations, especially Azerbaijan Republic President's decree on Strategic Road Map dated to 6th December 2016 played stimuli for the development of agriculture in Azerbaijan. The main strategic goals of Strategic Road Map have been directed to the development of agriculture in Azerbaijan Republic which covers sustainable provision of food security, increasing institutional base for the agricultural sector, building information and monitoring system of population's food availability, increasing agricultural production based on supply chain management, developing export and local agricultural products production. These objectives will result in the increase of the share of agriculture in GDP and reduction of dependence on imports. Furthermore, the paper opens a path for the future research of the focus area and use of applied econometric model in the countries with similar characteristics such as Khazakhistan, Nigeria. The economic linkage between the exchange rate volatility and agriculture sphere in those countries is believed to state some interesting findings that will let the authors investigate the relationship between exchange rate and agriculture in oil exporting countries much in detail.

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