Fakhri Hasanov[1]

THE IMPACT OF REAL EXCHANGE RATE ON NON-OIL EXPORTS. IS THERE AN ASYMMETRIC ADJUSTMENT TOWARDS THE EQUILIBRIUM?

This is a pioneer study in the area of oil-exporting economies, which investigates an asymmetric adjustment towards the equilibrium level in the impact of real exchange rate on non-oil exports by applying threshold and momentum-threshold autoregressive cointegration methods. The main finding of the study is that the real exchange rate has a statistically significant negative impact on the non-oil exports in the long run and the adjustment process towards the equilibrium is symmetric. The findings of this study have useful policy implications regarding the effects of the exchange rate on the non-oil exports and thereby the non-oil export-led growth strategy, one of the key policies in Azerbaijan.

Keywords: *asymmetric adjustment; threshold autoregressive; momentum-threshold autoregressive; exchange rate; non-oil export; Azerbaijan economy.*
JELClassification: C32, F47.

Фахрі Хасанов

ВПЛИВ РЕАЛЬНОГО ОБМІННОГО КУРСУ НА ПОЗАНАФТОВИЙ ЕКСПОРТ: ДОКАЗ АСИМЕТРИЧНОЇ АДАПТАЦІЇ ДО РІВНОВАГИ

У статті досліджено економіки країн-експортерів нафти і асиметричну адаптацію до рівноваги у впливі реального обмінного курсу на позанафтовий експорт. Для аналізу застосовано методи порогової і імпульсно-порогової авторегресійної коінтеграції. Основний висновок дослідження полягає в тому, що реальний обмінний курс має статистично значущий негативний вплив на позанафтовий експорт у довгостроковій перспективі, а процес адаптації до рівноваги симетричний. Результати цього дослідження можуть бути застосовані при корекції впливу обмінного курсу на позанафтовий експорт і тим самим стратегії економічного зростання, залежного від позанафтового експорту, що є одним з ключових напрямів політики в Азербайджані.

Ключові слова: *асиметрична адаптація, порогова авторегресія, імпульсно-порогова авторегресія, обмінний курс, позанафтовий експорт, економіка Азербайджану.*
Форм. 11. Табл. 11. Рис. 4. Літ. 42.

Фахри Хасанов

ВЛИЯНИЕ РЕАЛЬНОГО ОБМЕННОГО КУРСА НА ВНЕНЕФТЕВОЙ ЭКСПОРТ: ДОКАЗАТЕЛЬСТВО АСИММЕТРИЧНОЙ АДАПТАЦИИ К РАВНОВЕСИЮ

В статье исследованы экономики стран-экспортеров нефти и асимметричная адаптация к равновесию во влиянии реального обменного курса на вненефтевой экспорт. Для анализа применены методы пороговой и импульсно-пороговой авторегрессионной коинтеграции. Основной вывод исследования состоит в том, что реальный обменный курс оказывает статистически значимое негативное влияние на вненефтевой экспорт в долгосрочной перспективе, а процесс адаптации к равновесию симметричен. Результаты этого исследования могут быть применены при коррекции влияния обменного курса на вненефтевой экспорт и тем самым стратегии экономического роста, зависимого от вненефтевого экспорта, что является одним из ключевых направлений политики в Азербайджане.

[1] PhD, Associate Professor, Department of Economics, Qafqaz University, Baku, Azerbaijan; Senior Researcher, Department of Socio-Economic Modeling, Institute of Cybernetics, Azerbaijan National Academy of Sciences, Baku, Azerbaijan; Visiting Associate Professor, Department of Economics, George Washington University, USA.

Ключевые слова: *асимметричная адаптация, пороговая авторегрессия, импульсно-пороговая авторегрессия, обменный курс, вненефтевой экспорт, экономика Азербайджана.*

1. Introduction. The study investigates the impact of the real exchange rate on the non-oil exports and thereby implementing non-oil export-led growth (NELG hereafter) strategy in Azerbaijan in the framework of cointegration and asymmetric error correction by applying threshold and momentum-threshold autoregressive methods (hereafter TAR and M-TAR, respectively).

There is a number of motivations for conducting this research. The main motivation is that some seminal theoretical and empirical studies predict that the most natural resources rich countries experience with the negative consequences of the natural resources revenues and in this regard, these revenues are a curse rather than a blessing (Sachs and Warner, 1997; Auty, 2001; Gylfason, 2001). According to the Dutch Disease, one of the resource curse concepts, inflow of resource revenues into a country causes appreciation of the real exchange rate, undermining the competitiveness of the non-resource sector and leading to a higher demand for imports and services (Corden and Nearly, 1982; Corden, 1984). The number of empirical studies supports this prediction, especially the ultimate role of exchange rates in economic challenges of the natural resources rich countries (Wakeman-Linn et al., 2002; Sturm et al., 2009; Hasanov, 2011; Hasanov and Samadova, 2010).

Another motivation is that without conducting quantitative analyses it is quite difficult to implement effective international trade policy in a country.

One of the motivations would be to examine whether the general prediction of the international trade theory, assuming a negative impact of an appreciating real exchange rate on country's exports, holds in a certain economy.

Thus, because of the following reasons it is important to investigate the impact of the real exchange rate on the non-oil exports in the Republic of Azerbaijan. First, Azerbaijan is a natural resource (oil) rich country. Second, its real effective exchange rate has appreciated about 2 times during 2004–2008, while the share of the non-oil exports in the total export has decreased from 52.5% in 2004 to 4.7% in 2008 (Hasanov and Samadova, 2010).

In particular, policy related motivation of this research is based on the export-led growth concept (Emilio, 2001; Goldstein and Peevhouse, 2008; MacComby and Thirwall, 1994). So that, by relying on the concept, Azerbaijani government rightly considers that development of the non-oil sector, especially, its export capacity can become an engine for a sustainable economic growth in the country, especially in the future post oil boom period. A number of development programs are adopted and state agencies are established for this purpose. At the same time, the Central Bank of Azerbaijan (CBAR hereafter) is trying to keep the nominal value of domestic currency constant by conducting more fixed (peg to US dollar basically) than flexible exchange rate policy, but the real exchange rate is appreciating as mentioned above.

So, in such macroeconomic conditions, the present research would answer the important question of whether the underlying real exchange rate, originating under the exchange rate policy (nominal exchange rate) and real shocks (the relative prices), is harmful for successfully implementing of the NELG strategy in Azerbaijan.

Theoretical and empirical studies indicate that some macroeconomic variables such as exchange rate, inflation, unemployment and interest rate should demonstrate non-linear behavior and thereby they may asymmetrically affect other variables (Neftci, 1984; Falk, 1986; Sichel, 1993; Balke and Fomby, 1997; Enders and Granger, 1998; Enders, 2010: 428). Asymmetric relationships between the variables may lead to asymmetric adjustment towards equilibrium level.

In this regard, one can expect asymmetric adjustment in the relationship between the real exchange rate and non-oil export in Azerbaijan. One of the main reasons for such adjustment would be that the CBAR has implemented floating, fixed, and then fixed-floating (basically peg to US dollar) exchange rate regimes during the studied period and, as Balke and Fomby (1997) emphasize, different exchange rate regimes may lead to an asymmetric behavior of the exchange rate. Moreover, a structural break in the time path of the non-oil exports over the period of investigation also can cause an asymmetric behavior.

The above-mentioned facts are the motivations for conducting this analysis in the framework of asymmetric adjustment. Thus, the study is trying to answer the following research questions:

- Is there any long-run impact of the real exchange rate on the non-oil exports and thereby the implementing NELG strategy in Azerbaijan?
- Is an adjustment process towards the equilibrium value asymmetric?

To this end, this study examines the impact of the real exchange rate on the non-oil exports in the framework of cointegration and asymmetric adjustment by applying TAR and MTAR cointegration models in Azerbaijan. By following Enders and Siklos (2001) first the Engle-Granger (1987) (EG hereafter) cointegration approach (a widely used method in analyzing asymmetric adjustment towards equilibrium) is employed and then TAR and M-TAR methods are applied in both versions of the threshold level is (a) zero and (b) unknown. The estimation results indicate that the real exchange rate has a statistically significant negative impact on the non-oil exports in the long run, which is harmful for successful implementation of NELG strategy and the adjustment process towards the equilibrium is symmetric.

To our best knowledge, this is the first study in the area of oil-exporting economies, investigating an asymmetric adjustment in the cointegrated relationship of real exchange rate and non-oil exports by applying TAR and M-TAR methods. Moreover, the findings of the study have useful policy implications regarding the effects of the exchange rate on the non-oil exports and thereby on the NELG strategy, one of the key policies in Azerbaijan. Additionally, since non-linear (asymmetric) analysis is a quite new direction in the time series econometrics (Enders, 2010: 428), the study would be a contribution to the empirical literature.

The rest of the paper is designed as follows. Section 2 briefly reviews the related literature. Section 3 describes the required data, while Section 4 discusses the theoretical model of exports, and TAR and M-TAR cointegration methods. This is followed by Section 5, which covers the estimation results and their brief interpretation. Section 6 summarizes the main findings of the study and possible policy implications.

2. Brief Literature Review. There is a number of empirical studies that investigated the impact of the exchange rate on non-oil exports. Some of them: Hasanov and Samadova (2010) for Azerbaijan; Egert and Morales-Zumaquero (2005), Bernardina

(2004) for Russia; Sabuhi and Piri (2008), Masoud and Rastegari (2008) for Iran; Sorsa (1999) for Algeria; Ogun (1998), Yusuf and Edom (2007), Abolagba et al. (2010) for Nigeria; Benbouziane and Benamar (2007) for Algeria, Bahrain, Iran, Kuwait, Libya, Saudi Arabia, and Sudan.

However, previous studies do not consider asymmetric relationship (adjustment) in their analyses. Therefore, to our best knowledge, the present research is the first one in the area of oil-exporting economies to investigate the impact of real exchange rate on non-oil exports in the framework of cointegration and asymmetric adjustment by applying TAR and M-TAR methods.

On the other side, analyses of the asymmetric effects of different economic processes are quite new and interested field in the empirical studies (Enders, 2010: 428; Chan, 1993). In particular, regarding investigation an impact of exchange rate on exports in the framework of cointegration and asymmetric adjustment for the oil-exporting economies, in fact we are aware of only one research, Duasa (2009). Therefore, the present study is a contribution to the empirical literature.

Duasa (2009) investigated the impact of the real effective exchange rate on trade variables in Malaysia over the monthly period 1999M1–2006M12. Following Ender and Siklos (2001), he conducted the cointegration and asymmetric adjustment analysis and found a long-run relationship between the real effective exchange rate and the export volume and adjustment towards the long-run is asymmetric in the case of TAR model. In the cointegrating relationship between balance of trade and real exchange rate, the author finds symmetric adjustment when TAR model is used and the asymmetric one when M-TAR model is applied.

The main shortcoming of this study is that the specifications used in the empirical analysis are misspecified due to the omitted variable problem. Precisely saying, (foreign income) income variable, one of the determinants of (export) import predicted by international trade theory is omitted.

3. Data. Table 1 provides the definition, description and the sources of the variables.

Table 1. **Definition, description and source of the variables**

Name	Notation	Description	Source
Real Non-oil Export	*RXN*	$RXN = \frac{XN \times AZN\_USD}{CPI}$, where *XN* is nominal non-oil export in US dollars; *AZN_USD* means manat value of US dollar; *CPI* denotes consumer price index of Azerbaijan.	CBAR: http://cbar.az/pages/publications-researches/statistic-bulletin.
Non-oil Trade based Real Effective Exchange Rate	*REERN*	It is a multilateral consumer price index based on the real effective exchange rate of the manat relative to the main trading partners of Azerbaijan in the non-oil trade turnover. *REERN* is defined in terms of foreign currency per unit of manat and therefore, its increase means appreciation of manat.	CBAR: http://cbar.az/pages/publications-researches/statistic-bulletin.
Real GDP	*RGDP*	This is a seasonally adjusted gross domestic product in billions of 2000 prices.	International Monetary Fund: http://elibrary-data.imf.org/FindDataReports.aspx?d=33061&e=169393.

Figure 1. **Graphs of the variables**

Since the quarterly data for the non-oil exports are not available prior to 2000Q1, the study covers the period 2000Q1—2010Q4.

Time profile of the variables is illustrated in Figure 1.

As shown in Figure 1, *RXN* has quite large structural break in 2005Q1 and the slope of its drift becomes flatter after this break. There are 2 possible explanations for this break. First, starting from 2005 the CBAR has changed its methodology of calculating the balance of payment components. Second, due to huge inflow of the oil export revenues, *REERN* has appreciated 1.6 times over the 2004Q4—2010Q4 and therefore it led to a downward shift in *RXN*. Before the break the mean value of *RXN* was 254.25 mln manat, but it has decreased by 1.8 times and was 138.62 mln manat over the post break period. It is also observable from the graphs that the global recession has negatively influenced the variables.

4. Theoretical model and Econometric methods.

4.1. Theoretical framework of the study is the international trade theory (Leamer and Stern, 1970; Goldstein and Khan, 1995). Since this theory is well known and widely used in the empirical research and due to space constraint, it is not discussed here. According to this theory, our non-oil export function in the logarithm expression can be written as below:

$$rxn_t = c + \alpha \times reern_t + \beta \times rgdp_t + e_t, \quad (1)$$

where *rxn, reern, rgdp* are the logarithms of *RXN, REERN* and *RGDP* respectively; c, α, β are the coefficients to be estimated; e stands for error term; t denotes time. It is expected that $\alpha < 0$, $\beta > 0$.

4.2. Econometric methods. The TAR and M-TAR cointegration methods are employed in the empirical analysis. In case of (1), the methods can be illustrated as follows:

Step 1: Testing for stationarity of the variables by using the augmented Dickey-Fuller (ADF hereafter) test (Dickey and Fuller, 1981):

$$\Delta y_t = b_0 + b_1 y_{t-1} + \sum_{i=1}^{k} o_i \Delta y_{t-i} + \sum_{i=1}^{3} \pi_i CS_{it} + \theta trend + \varepsilon_t, \quad (2)$$

where Δ stands for the first difference operator; y is the vector of *rxn, reern, rgdp;* b_0 stands for a constant term; k is the number of lags of the dependent variable; CS_{it} and trend are the centered seasonal dummies and linear trend respectively; ε is the white noise.

The null hypothesis in ADF test is non-stationarity of a given series.

If all variables are integrated in the same order, one can move to Step 2.

Step2: Estimation of the relationship between the non-stationary variables in (1). One of the cointegration methods such as Johansen (1996), Stock and Watson (1988), EG can be used for this purpose. Note that the latter is widely used method in the analyses of asymmetric adjustments.

Step3: Testing stationarity for the residuals of (1) by allowing asymmetric adjustment:

$$\Delta \hat{e}_t = I_t p_1 \hat{e}_{t-1} + (1 - I_t) p_2 \hat{e}_{t-1} + \psi_t, \quad (3)$$

where $\hat{e}$ stands for the estimated residuals; p_1, p_2 are the coefficients; ψ stands for white noise residuals; I is an indicator function, which is defined as below:

$$I_t = \begin{cases} 1 \; if \; \hat{e}_{t-1} \geq \tau \\ 0 \; if \; \hat{e}_{t-1} < \tau \end{cases}; \tag{4}$$

where τ is the threshold level.

Ender and Siklos (2001) note that if the residuals of (3) are serially correlated, lagged values of $\Delta\hat{e}_t$ should be included into the equation. So, (3) will be:

$$\Delta\hat{e}_t = I_t p_1 \hat{e}_{t-1} + (1 - I_t) p_2 \hat{e}_{t-1} + \sum_{i=1}^{k} \mu_i \Delta\hat{e}_{t-i} + \psi_t, \tag{5}$$

where μ_i are the coefficients.

Various model selection criteria such as Akaike and Schwarz can be used to determine the appropriate number of lags. Further characteristics of (3) or (5) are discussed in Tong (1983; 1990).

A model comprising (1), (4), (3) or (5) called the TAR cointegration model. Note that in (4), I depends on $\hat{e}_{t-1}$. Caner and Hansen (1998) and Enders and Granger (1998) suggested an alternative way where the indicator function depends on $\Delta\hat{e}_{t-1}$:

$$M_t = \begin{cases} 1 \; if \; \Delta\hat{e}_{t-1} \geq \tau \\ 0 \; if \; \Delta\hat{e}_{t-1} < \tau \end{cases}. \tag{6}$$

In the case of new indicator function, (3) and (5) will be as (7) and (8) respectively:

$$\Delta\hat{e}_t = M_t p_1 \hat{e}_{t-1} + (1 - M_t) p_2 \hat{e}_{t-1} + \psi_t; \tag{7}$$

$$\Delta\hat{e}_t = M_t p_1 \hat{e}_{t-1} + (1 - M_t) p_2 \hat{e}_{t-1} + \sum_{i=1}^{k} \mu_i \Delta\hat{e}_{t-i} + \psi_t. \tag{8}$$

A model comprising (1), (6), (7) or (8) is the M-TAR cointegration model. In (4) and (6) it is assumed that the threshold level is zero, $\tau = 0$. In these cases, if $\hat{e}_{t-1}$ is above its long-run equilibrium of zero level, adjustment process is $p_1\hat{e}_{t-1}$, otherwise adjustment is $p_2\hat{e}_{t-1}$.

Enders and Siklos (2001) note that it is quite natural to set τ equal to zero in a number of economic applications. They also note that in general, the value of τ is unknown and needs to be estimated along with the values of p_1 and p_2. For that purpose, they suggest to use grid search procedure, proposed by Chan (1993) to derive a consistent estimate of τ. The procedure can be described as follows: (a) In the case of TAR (or M-TAR) cointegration model, the residuals or their changes are arranged in ascending order as $\{\hat{e}_1^0 < \hat{e}_2^0 < \ldots < \hat{e}_T^0\}$ (or $\{\Delta\hat{e}_1^0 < \Delta\hat{e}_2^0 < \ldots < \Delta\hat{e}_T^0\}$).(b) After discarding the largest and the smallest 15% of the $\hat{e}_t$ (or $\Delta\hat{e}_t$), the central 70% of the observations in this sequence are then considered in turn as thresholds in (3) or (5) (in (7) or (8)) as each of them could be a possible threshold. From the above given sequence the value providing the lowest sum of squared residuals (SSR hereafter) in (3) or (5) (in (7) or (8)) is considered a consistent threshold.

Thus, cointegration and asymmetric adjustment in the framework of TAR and M-TAR methods are examined as below:

1. First, it is determined whether the variables are cointegrated in the TAR (or M-TAR) model. The null hypothesis is $p_1 = p_2 = 0$ in (3) (in (7) for the case of M-

TAR model). Note again that if ψ_t are serially correlated, then the null hypothesis should be tested in (5) (in (8) for the case of M-TAR model).

F-statistics of the null hypothesis has a non-standard distribution and therefore Enders and Siklos (2001) denoted it as Φ. If the obtained F-value is greater than appropriate Φ critical value, then the null hypothesis for non-stationarity of $\hat{e}$ can be rejected. Rejection of the null hypothesis means that $\hat{e}$ is stationary. In other words, the variables in (1) are cointegrated.

2. Once the null hypothesis of $p_1 = p_2 = 0$ is rejected, it is reasonable to test the nature of adjustment process. The null hypothesis of a symmetric adjustment is $p_1 = p_2$. Note that standard F-statistics can be used to test this hypothesis. If the obtained F-statistics is greater than that of appropriate standard critical value, then it can be concluded that adjustment to the long-run equilibrium level is asymmetric.

Given the existence of asymmetric adjustment, the asymmetric error-correction model for the variable of interest can be estimated:

$$\Delta rxn_t = \Omega_0 + \Omega_{11} I_t \hat{e}_{t-1} + \Omega_{12}(1 - I_t)\hat{e}_{t-1} + \sum_{i=1}^{k} \pi_{1i} \Delta rxn_{t-i} + \\ + \sum_{i=1}^{q} \pi_{2i} \Delta reern_{t-i} + \sum_{i=1}^{s} \pi_{3i} \Delta rgdp_{t-i} + \theta_{1t}. \quad (9)$$

5. Empirical Results and Discussion. According to the *ADF* test results reported in Table 2 in the Appendix[2], it can be concluded that *RXN, REERN* and *RGDP* are non-stationary in the log level and stationary in the first difference of the log, in other words, they are *I(1)*. As discussed in the data section, *RXN* has shifted in its mean since 2005Q1. Therefore, Perron (1989) unit root test in the presence of a structural break is also conducted and the results again indicate that this variable is *I(1)*. Because of space limitation, the test results are not reported here, but can be obtained from the author.

Table 2. **ADF Unit Root Test Results**

Variable	Log Level				First Difference in Logs			
	Deterministic variables	κ	$b_1 + 1$	Actual value	Deterministic variables	κ	$b_1 + 1$	Actual value
RXN	CTCS	3	0.59497	-2.668	CCS	0	-0.37183	-9.364**
RGDP	CT	1	0.88542	-1.703	C	0	0.25298	-4.782**
REERN	CTCS	0	0.94092	-1.343	CCS	0	0.32005	-4.476**

Notes: CTCS, CT, CCS, C refer to the inclusion of a constant, trend and seasonal dummy variables; constant and trend; constant and centered seasonal dummy variables; constant into (2) respectively. The sample is 2000(1)–2010(4); * and ** denote rejection of the null at the 5% and 1% significance levels.

Since the variables are integrated in the same order, a possible long-run relationship between them is estimated by using EG cointegration approach. Due to the structural break in our dependent variable, *rxn* by following Hendry and Juselius (2001) and Juselius (2006), a shift dummy variable, namely, *Dsh05Q1*, which takes unity after 2004Q4 and zero otherwise, is included into the cointegration analysis. According to the estimation results, the relationship between *rxn, reern, rgdp* and *Dsh05Q1* is as follows:

[2] All estimations are conducted in OxMetrics 6.2 and EViews 7.2 econometric packages.

$$rxn_t = -11.32 - 0.94 \times reern_t + 1.45 \times rgdp_t - 1.03 \times Dsh05Q1_t + e_t. \quad (10)$$

Table 3 reports the detailed estimation outputs. (10) is used to calculate the residuals:

$$\hat{e}_t = rxn_t + 11.32 + 0.94 \times reern_t - 1.45 \times rgdp_t + 1.03 \times Dsh05Q1_t. \quad (11)$$

Table 3. **Estimation of the relationship between the variables**

Modelling *rxn* by OLS				
	Coefficient	Std. Error	t-value	t-prob.
Constant	-11.319	6.350	-1.780	0.082
Rgdp	1.454	0.407	3.570	0.001
Reern	-0.942	0.250	-3.770	0.001
Dsh05Q1	-1.030	0.150	-6.860	0.000
Sigma = 0.203432; RSS = 1.65538121; R^2 = 0.796628; Adj.R^2 = 0.781375; F(3,40) = 52.23 [0.000]**; Log-likelihood = 9.73019; No. of observations = 44 (2000Q1-2010Q4); AR (1-3) test: F(3,37) = 2.6290 [0.0645]; ARCH (1-3) test: F(3,38) = 0.60960 [0.6129]; Normality test: χ^2 (2) = 0.70306 [0.7036]; Hetero test: F(5,38) = 0.83861 [0.5308]; Hetero-X test: F(6,37) = 0.68208 [0.6650]; RESET23 test: F(2,38) = 1.5916 [0.2169].				

Notes: Here and hereafter, the null hypotheses for AR, ARCH, Hetero and Hetero-X tests are that there are no autocorrelation, autoregressive conditioned heteroscedasticity, heteroscedasticity and crossed heteroscedasticity in the residuals respectively. The null hypotheses for the Normality and RESENT23 tests are that the residuals are normally distributed and there is no functional form misspecification respectively. Probabilities are in brackets. OLS means Ordinary Least Squares.

The calculated residuals are plotted at Figure 2.

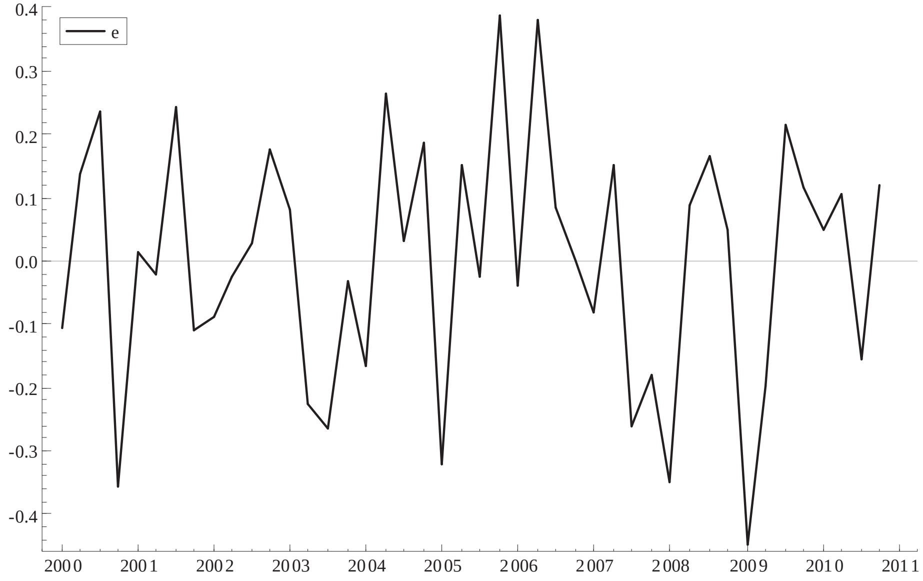

Figure 2. **Graph of the long-run residuals**

In order to know whether there is a cointegration between the variables and whether the adjustment process towards equilibrium value is asymmetric, by following Enders and Siklos (2001), TAR and M-TAR models are estimated in 2 versions: the threshold value is (a) zero and (b) unknown.

5.1. Threshold value is zero. Table 4 indicates that the residuals of the estimated (4) have not any problem, especially autocorrelation. Therefore, one does not need to estimate (6) and can continue with (4) to test for cointegration and then asymmetric adjustment. The null hypothesis of no cointegration i.e. $p_1 = p_2 = 0$ is tested. The calculated (sample) F-value of 25.151 reported in Panel A of Table 5 is greater than the corresponding Φ critical value of 8.78 at the 1% significance level (see Table 1 in Enders and Siklos, 2001). Hence, it can be concluded that there is a cointegrating relationship between *RXN, REERN* and *RGDP*.

Table 4. **Estimation results for (4) when the threshold value is zero**

Modelling $\Delta\hat{e}_t$ by OLS				
	Coefficient	Std. Error	t-value	t-prob.
$I_t\hat{e}_{t-1}$	-1.177	0.230	-5.130	0.000
$(1-I_t)\hat{e}_{t-1}$	-0.924	0.189	-4.900	0.000
Sigma = 0.19676; RSS = 1.62600245; log-likelihood = 10.1241; No. of observations = 44 (2000Q1-2010Q4); AR (1-3) test: F(3,39) = 1.9499 [0.1375]; ARCH (1-3) test: F(3,38) = 0.67857 [0.5706]; Normality test: χ^2 (2) = 1.2503 [0.5352]; Hetero test: F(4,39) = 0.66645 [0.6191]; Hetero-X test: F(4,39) = 0.66645 [0.6191]; RESET23 test: F(2,40) = 0.76650 [0.4713].				

Table 5. **Cointegration and Asymmetric Test Results**

Panel A: Test for cointegration ($p_1 = p_2 = 0$)	Panel B: Test for asymmetric adjustment ($p_1 = p_2$)
H_0: -1.177= -0.924 = 0	H_0: -1.177= -0.924
F(2,42) = 25.151 [0.000]**	F(1,42) = 0.727 [0.394]

According to (10), ceteris paribus, 1% appreciation of REERN leads to a decline in RXN by 0.94% in the long run. Note that this long-run elasticity is greater than that of estimated by Hasanov and Samadova (2010). The reasons of this difference would be that they (a) use the overall trade weighted real effective exchange rate and (b) their estimation sample of 2002Q3—2009Q3 does not contain 2000Q1—2002Q2 where the *REERN* has sharply depreciated.

All other things being equal, a 1% growth in RGDP causes a 1.45% rise in RXN.

It is noteworthy that these findings are consistent with the international trade theory and the results of other empirical studies.

As expected, the structural change in Dsh05Q1 has caused a significant negative shift in the level of RXN.

After having a cointegration between the variables, the nature of adjustment process is tested. Since the calculated F-value of 0.727, given in Panel B of Table 5, is smaller than the corresponding (with *numerator* = 2 and *denominator* = 41) critical value of 3.23 at the 5% significance level from the standard F-tables, the null hypothesis of $p_1 = p_2$ in other words, symmetric adjustment towards the long-run level cannot be rejected.

5.2. Threshold value is unknown: In subsection 5.1, the threshold value is assumed zero while it is considered unknown and searched using Chan (1993) procedure in this subsection. By doing so, (4) is estimated with each of 34 possible threshold values, and then *SSR* of the estimations are collected and compared. Since the estimations yield 34 estimated equations, in order to save space these outputs are not reported here, but can be obtained from the author. Figure 3 shows that (4) has the smallest *SSR* (1.556) in the threshold value of -0.166. As reported in Table 6, the residuals of (4), estimated in this consistent threshold value have no problem with the autocorrelation, normality, heteroscedasticity or functional form misspecification. Therefore, this specification is used for testing cointegration and asymmetric adjustment. The calculated F-value for the null hypothesis of $p_1 = p_2 = 0$ (Panel A of Table 7) is greater than the corresponding Φ* critical value of 9.90 at the 1% significance level (see Table 5 in Enders and Siklos, 2001). Therefore, it is again reasonable to consider a cointegrating relationship between the variables. By examining Panel B in Table 7, one cannot reject the null hypothesis of symmetric adjustment.

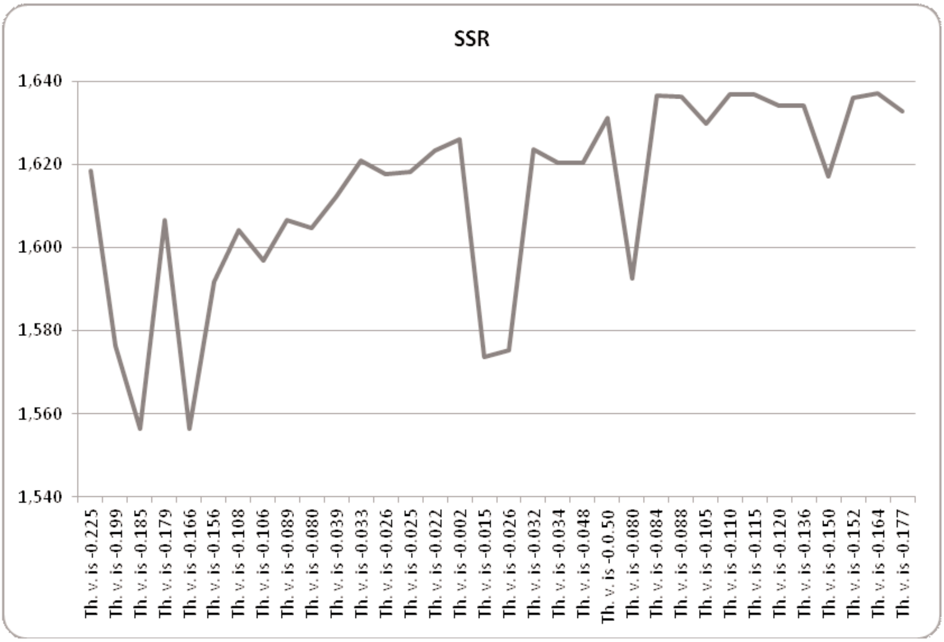

Figure 3. **Graph of the Sum of Squared Residuals in the case of TAR estimations**

Table 6. **Estimation results for (4) when the threshold value is -0.165835**

Modelling $\Delta\hat{e}_t$ by OLS				
	Coefficient	Std. Error	t-value	t-prob.
$I_t\hat{e}_{t-1}$	-1.280	0.212	-6.050	0.000
$(1-I_t)\hat{e}_{t-1}$	-0.815	0.193	-4.220	0.000
Sigma = 0.192499; RSS = 1.55634914; log-likelihood = 11.0873; No. of observations = 44 (2000Q1-2010Q4); AR (1-3) test: F(3,39) = 1.6519 [0.1932]; ARCH (1-3) test: F(3,38) = 0.82256 [0.4896]; Normality test: χ^2 (2) = 1.7347 [0.4201]; Hetero test: F(4,39) = 0.75754 [0.5592]; Hetero-X test: F(4,39) = 0.75754 [0.5592]; RESET23 test: F(2,40) = 1.0438 [0.3615].				

Table 7. **Cointegration and Asymmetric Tests Results**

Panel A: Test for cointegration ($p_1 = p_2 = 0$)	Panel B: Test for asymmetric adjustment ($p_1 = p_2$)
H_0: -1.280 = -0.815 = 0	**H_0:** -1.280 = -0.815
F(2,42) = 27.216 [0.0000]**	F(1,42) = 2.639 [0.1117]

Thus, it is concluded that there is a cointegration between the variables, but adjustment process towards the equilibrium is symmetric regardless of the threshold level is zero or unknown in the TAR model.

Application of M-TAR Model: It is important to note that the empirical studies show that TAR models are unable to detect an asymmetric adjustment in some cases, especially when adjustment process exhibits more "momentum" in one direction rather than the other (Enders and Siklos, 2001). Therefore, it is suggested to use M-TAR model together with TAR model in the empirical applications. For example, Enders and Siklos (2001) cannot find cointegration and asymmetric adjustment between the federal funds rate and the 10-year yield on federal government securities when they apply TAR model. However, they find evidences of the cointegration and asymmetric adjustment when M-TAR model is used. Similarly, Duasa (2009) fails to find asymmetric adjustment in the cointegrating relationship of trade balance and real exchange rate in Malaysia when he employs TAR model. However, he finds that the adjustment process towards the long-run value is asymmetric in case of M-TAR model.

Thus, in order to make clear inference about the nature of adjustment process, this study also applies M-TAR model in both cases when momentum threshold value is zero and unknown.

5.3. Momentum Threshold value is zero: Note that the diagnostic statistics indicate that the residuals of (8) are serially correlated and this problem disappears when (9) is estimated with two lags of the dependent variable $(\Delta\hat{e}_t)$. The estimation results reported in Table 8 indicate that the residuals are well behaved and have no problem. As in the case of the TAR model, an existence of a long-run relationship between the variables is tested first. The null hypothesis of no cointegration between the variables can be rejected. Because the sample F value of $p_1 = p_2 = 0$ given in Panel A of Table 9 is greater than the corresponding Φ critical value of 8.89 at the 1% significance level (See Table 1 in Enders and Siklos, 2001). The variables are cointegrated and therefore the nature of the adjustment process can be tested. The sample F-value of 0.127 in Panel B of Table 9 is smaller than the corresponding (with *numerator* = 2 and *denominator* = 38) critical value of 3.32 at the 5% significance level. Hence, the null hypothesis of $p_1 = p_2$ cannot be rejected.

Table 8. **Estimation results for (9) when the momentum threshold value is zero**

Modelling $\Delta\hat{e}_t$ by OLS				
	Coefficient	Std. Error	t-value	t-prob.
$\Delta\hat{e}_{t-1}$	0.380	0.215	1.770	0.085
$\Delta\hat{e}_{t-2}$	0.388	0.149	2.600	0.013
$M_t\hat{e}_{t-1}$	-1.505	0.299	-5.040	0.000
$(1-M_t)\hat{e}_{t-1}$	-1.399	0.307	-4.550	0.000
Sigma = 0.188251; RSS = 1.311227; log-likelihood = 12.397; No. of observations = 41 (2000Q4-2010Q4); AR (1-3) test: F(3,34) = 1.7824 [0.1691]; ARCH (1-3) test: F(3,35) = 0.41745 [0.7416]; Normality test: χ^2 (2) = 1.3706 [0.5040]; Hetero test: F(8,32) = 0.76168 [0.6382]; Hetero-X test: F(13,27) = 0.58617 [0.8437]; RESET23 test: F(2,35) = 2.2636 [0.1190].				

Table 9. **Cointegration and Asymmetric Test Results**

Panel A: Test for cointegration ($p_1 = p_2 = 0$)	Panel B: Test for asymmetric adjustment ($p_1 = p_2$)
H_0: -1.505 = -1.399 = 0	**H_0:** -1.505 = -1.399
F(2,37) = 15.269 [0.000]**	F(1,37) = 0.127 [0.723]

5.4. Momentum Threshold value is unknown: By using Chan (1993) procedure, first a consistent threshold value among 31 possible threshold values is found. Because of space constraint, the 31 estimated equations are not reported, but can be obtained from the author. As Figure 4 illustrates, (9) has the smallest SSR (1.251) when the threshold value is 0.266. Table 10 indicates that this specification has not any problem, especially the residuals serially uncorrelated. Therefore, it is used for the further tests. The sample F-value for the null hypothesis of no cointegration, reported in Panel A of Table 11, is greater than the corresponding Φ* critical value of 9.79 at the 1% significance level given in Table 5 in Enders and Siklos, 2001. Therefore, it is again concluded that there is a cointegrating relationship between the variables. Finally, the nature of the adjustment process is tested and since the calculated F-value reported in Panel B in Table 11 is smaller than that of the critical value, it is again concluded that adjustment process is symmetric.

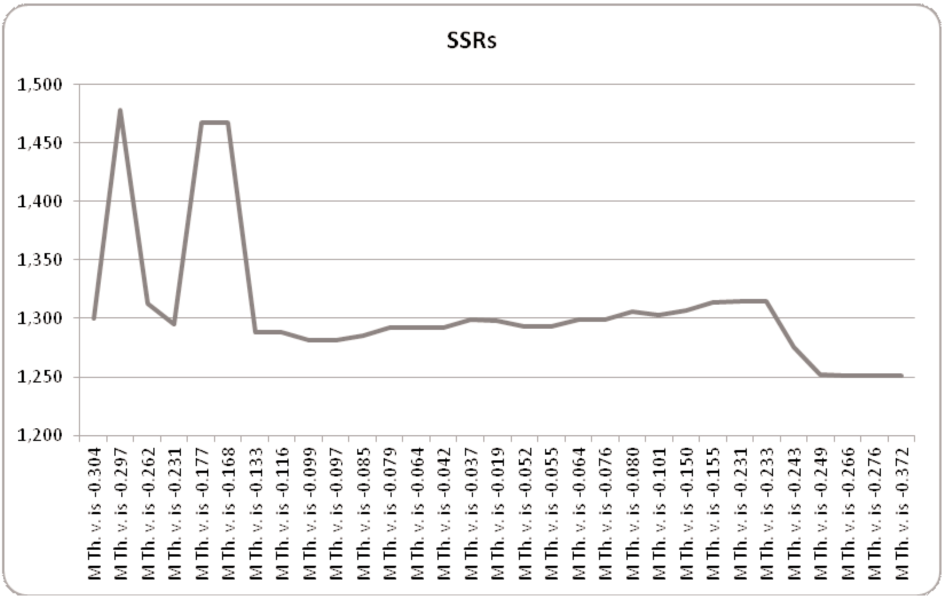

Figure 4. **Graph of the Sum Squared Residuals in the case of M-TAR model**

Thus, there is a cointegrating relationship between the variables, but adjustment process toward the long-run value is not asymmetric in case of the M-TAR model regardless of the momentum threshold level is zero or unknown.

6. Concluding Remarks. In the framework of cointegration and an asymmetric error correction, this study tries to answer two research questions: (a) Is there any long-run impact of the real exchange rate on the non-oil exports and therefore the implementing NELG strategy in Azerbaijan? and (2) Is an adjustment process towards the equilibrium level asymmetric? By following Enders and Siklos (2001), TAR and M-TAR cointegration models are applied in 2 versions: when threshold level is (a) zero and (b) unknown.

Table 10. **Estimation results for (9) when the momentum threshold value is 0.266056**

Modelling $\Delta\hat{e}_t$ by OLS				
	Coefficient	Std. Error	t-value	t-prob.
$\Delta\hat{e}_{t-1}$	0.455	0.215	2.120	0.041
$\Delta\hat{e}_{t-2}$	0.462	0.154	3.000	0.005
$\Delta\hat{e}_{t-2}$	-1.073	0.377	-2.850	0.007
$(1-M_t)\hat{e}_{t-1}$	-1.625	0.285	-5.700	0.000
Sigma = 0.183851; RSS = 1.250645; log-likelihood = 13.3667; No. of observations = 41 (2000Q4-2010Q4); AR (1-3) test: F(3,34) = 0.93779 [0.4331]; ARCH (1-3) test: F(3,35) = 0.64884 [0.5890]; Normality test: χ^2 (2) = 1.1228 [0.5704]; Hetero test: F(8,32) = 0.28061 [0.9676]; Hetero-X test: F(11,29) = 0.453 [0.9169]; RESET23 test: F(2,35) = 0.80157 [0.4567].				

Table 11. **Cointegration and Asymmetric Tests Results**

Panel A: Test for cointegration ($p_1 = p_2 = 0$)	Panel B: Test for asymmetric adjustment ($p_1 = p_2$)
H_0: -1.073 = -1.625 = 0	**H_0:** -1.073 = -1.625
F(2,37) = 16.905 [0.000]**	F(1,37) = 1.926 [0.173]

The study concludes that an appreciation of the real exchange rate has a negative impact of the non-oil exports in the long run. The current performance is that on the one side, the government is trying to implement the NELG policy successfully. On the other side, the CBAR is implementing mostly fixed than flexible exchange rate policy for keeping the nominal value of domestic currency on the constant level, but the real exchange rate appreciates by mainly sourcing from the increases in the relative prices, which undermines the competitiveness of the non-oil tradable goods. Under such circumstances, either the government should abandon the NELG policy or the CBAR should devaluate the national currency. However, both of them are extremely hard and debatable policy issues and require comprehensive studies. In this regard, the present study opens new avenues for indepth analyses in this direction.

As mentioned earlier, due to a number of reasons, such as implemented different exchange rate policies and a structural break in the time profile of the non-oil exports during the period of analysis, one would expect an asymmetric adjustment in the relationship between the variables. However, the key finding of the study is that adjustment process towards the equilibrium level is not asymmetric. Possible explanations of this finding are: (a) maybe the adjustment process is indeed symmetric; (b) the number of observations might not be sufficient to discover asymmetric processes and (c) possible existence of more than one threshold levels. Note that the last 2 points also open avenues for future investigations of asymmetric adjustment in the relationship between Azerbaijani real exchange rate and non-oil exports.

Acknowledgements. *This study was conducted during the post-doctoral study at the Economics Department, George Washington University. We would like to thank Prof. Tara Sinclair for her useful comments and suggestions. We are also indebted to the*

Economics Department of The George Washington University, the host institution and the Fulbright Scholar Program, the sponsor of the study for their provision of the opportunity to conduct this research.

References:

Abolagba, E., Onyekwere, N., Agbonkpolor, B., Umar, H. (2010). Determinants of Agricultural Exports. Kamla-Raj J Hum Ecol, 29(3): 181–184.

Auty, R. (2001). Natural Resources, Governance and the Transition in Energy-Rich Azerbaijan, Kazakhstan and Turkmenistan. Working Paper 0103, Lancaster University.

Balke, N.S., Fomby, T. (1997). Threshold Cointegration. International Economic Review, 38: 627–643.

Benbouziane, M., Benamar, A. (2007). The Impact of Exchange Rate Regime on the Real Sector In Mena Countries. 27th Annual Meeting of the Middle East Economic Association.

Bernardina, A. (2004). Price and Income Elasticities of Russian Exports. The European Journal of Comparative Economics, 1(2): 175–193.

Caner, M., Hansen, B. (1998). Threshold Autoregression with a Near Unit Root. Working paper, Universityof Wisconsin.

Chan, K.S. (1993). Consistency and Limiting Distribution of the Least Squares Estimator of a Threshold Autoregressive Model. The Annals of Statistics, 21: 520–533.

Corden, W. (1984). Booming Sector and Dutch Disease Economics: Survey and Consolidation. Oxford Economic Papers, 36: 359–380.

Corden, W., Neary, J. (1982). Booming Sector and De-Industrialization in a Small Open Economy. Economic Journal, 92: 825–848.

Dickey, D., Fuller, W. (1981). Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. Econometrica, 49: 1057–1072.

Duasa, J. (2009). Asymmetric cointegration relationship between real exchange rate and trade variables: The case of Malaysia. MPRA Paper No. 14535.

Egert, B., Morales-Zumaquero, A. (2005). Exchange Rate Regimes, Foreign Exchange Volatility and Export Performance in Central and Eastern Europe.

Enders, W. (2010). Applied Econometrics Time Series. Fourth edition. University of Alabama.

Enders, W., Granger, C. (1998). Unit-root tests and asymmetric adjustment with an example using the term structure of interest rates. Journal of Business and Economic Statistics, 16: 304–311.

Enders, W., Siklos, P.L. (2001). Cointegration and threshold adjustment. Journal of Business and Economic Statistics, 19: 166–176.

Engle, R., Granger, C. (1987). Cointegration and Error Correction: Representation, Estimation and Testing. Econometrica, 55: 251–276.

Falk, B. (1986). Further Evidence on the Asymmetric Behavior of Economic Time Series over the Business Cycle. Journal of Political Economy, 94: 1096–1109.

Goldstein, M., Khan, M. (1985). Income and price effects, in foreign trade. In: R.W. Jones and P.B. Kenen (eds.). Handbook of international economics. North-Holland, Amsterdam.

Goldstein, M., Pevehouse, J. (2008). International Relations. 8th ed. New York: Pearson Longman.

Gylfason, T. (2001). Lessons from the Dutch Disease Causes, Treatment, and Cures. Institute of economic studies. Working paper series, W01:06.

Hasanov, F. (2011). Dutch Disease and Azerbaijan Economy. Economics and Educational Research Consortium, Working Paper Series, No 11/03E.

Hasanov, F., Samadova, I. (2010). The Impact of Real Effective Exchange Rate on the Non-oil Export: The Case of Azerbaijan. ECO Economic Journal, 2: 23–39.

Hendry, D., Juselius, K. (2000). Explaining Cointegration Analysis: Part II. Discussion Papers, 00-20, Department of Economics, University of Copenhagen.

Johansen, S. (1996). Likelihood-Based Inference in Cointegrated Vector Auto-Regressive Models. Oxford, U.K.: Oxford University Press.

Juselius, K. (2006). The Cointegrated VAR Model: Methodology and Applications. Oxford University Press.

Leamer E., Stern, M. (1970). Quantitative International Economics. ALDINE Publishing Company, Chicago.

Masoud, H., Rastegari, F. (2008). Analysis of Economic-Political Factors affecting Non-oil Export of Iran. IDOSI Publications.

McCombie, J.S.L., Thirlwall A. (1994). Economic Growth and the Balance-of-Payments Constraint. London, St. Martins' Press.

Medina-Smith, E.C. (2001). Is the export-led growth hypothesis valid for developing countries? A case study of Costa Rica. In: Policy Issues on International Trade and Goods. Research Series No. 7, United Nations.

Neftci, S. (1984). Are Economic Time Series Asymmetric over the Business Cycle? Journal of Political Economy, 92: 307–328.

Ogun, O. (1998). Real exchange rate movements and export growth: Nigeria, 1960–1990. African Economic Research Consortium.

Perron, P. (1989). The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis. Econometrica, 57: 1361–1401.

Sabuhi, M., Piri, M. (2008). Consideration the Effect of Exchange Rate Volatility on Agricultural Products Export Price, the Case Study of Iran's Saffron. IDOSI Publications.

Sachs, J., Warner, A. (1997). Natural Resource Abundance and Economic Growth. Center for International Development and Harvard Institute for International Development.

Sichel, D. (1993). Business Cycle Asymmetry: A Deeper Look. Economic Inquiry, 31: 224–236.

Sorsa, P. (1999). Algeria – The Real Exchange Rate, Export Diversification, and Trade Protection. International Monetary Fund.

Stock, J., Watson, M. (1988). Testing for Common Trends. Journal of the American Statistical Association, 83: 1097–1107.

Sturm, M., Francois, G., Gonzalez, J. (2009). Fiscal policy challenges in oil-exporting countries a review of key issues. European central bank, occasional paper series no 104.

Tong, H. (1983). Threshold Models in Non-Linear Time Series Analysis. New York: Springer-Verlag.

Tong, H. (1990). Non-Linear Time-Series: A Dynamical Approach. Oxford University Press, Oxford, U.K.

Wakeman-Linn, J., Mathieu, P., Selm, B. (2002). Oil funds and revenue management in transition economies: the cases of Azerbaijan and Kazakhstan.

Yusuf, A., Edom, C. (2007). Determinants of timber exports in Nigeria: an error correction modeling approach. Department of Agricultural Economics, University of Ibadan, Nigeria.

Стаття надійшла до редакції 9.10.2012.