Research Program on Forecasting

The impact of the real exchange rate on non-oil exports. Is there an asymmetric adjustment towards the equilibrium?

Fakhri Hasanov
Visiting Fulbright Scholar,
The George Washington University
Washington, DC 20052
USA

RPF Working Paper No. 2012-005
http://www.gwu.edu/~forcpgm/2012-005.pdf

May 29, 2012

RESEARCH PROGRAM ON FORECASTING
Center of Economic Research
Department of Economics
The George Washington University
Washington, DC 20052
http://www.gwu.edu/~forcpgm

The impact of the real exchange rate on non-oil exports. Is there an asymmetric adjustment towards the equilibrium?

Fakhri Hasanov[1]

Abstract

This study investigates the impact of the real exchange rate on the non-oil exports of the Republic of Azerbaijan in the framework of cointegration and an asymmetric error correction. Threshold and Momentum Threshold Autoregressive methods are applied over the quarterly period 2000Q1-2010Q4.

The main finding of the study is that there is a long-run relationship between the variables with symmetric rather than asymmetric adjustment towards the equilibrium level.

[1] Visiting Scholar at the George Washington University, fakhri.hasanov@gmail.com. I would like to thank Professor Tara Sinclair for her useful comments and suggestions. I am also thankful to the Economics Department of GWU and the Fulbright Scholar Program for their provision of the opportunity to conduct this research.

I. Introduction

The study investigates the impact of the real exchange rate on the non-oil exports of the Republic of Azerbaijan in the framework of cointegration and an asymmetric error correction by using Threshold and Momentum Threshold Autoregressive methods (hereafter TAR and M-TAR respectively).

There are some motivations for conducting this research. The main motivation is that some seminal theoretical and empirical studies predict that most natural resource rich countries suffer from serious socio-economic problems caused by their resource revenues and in this regard these natural revenues are a curse rather than a blessing for these countries (Sachs and Warner, 1997; Auty, 2001; Gylfason, 2001; Gylfason and Zoega, 2002 inter alia). One of these resource curses, the so called Dutch Disease, is mainly related to an appreciation of the real exchange rate, sourced from inflow of resource revenues into country, which undermines the competitiveness of the non-resource sector's (manufacturing and agriculture) export and therefore deteriorates this sector while leads to higher demand for imports and services (Corden and Nearly, 1982; Corden, 1984). This prediction, in particular the ultimate role of exchange rates in economic challenges of these countries, is supported by a number of empirical studies. For example, Wakeman-Linn et al. (2002) and Sturm and et al. (2009) inter alia conclude that the exchange rate is a key economic policy issue in oil exporting countries.

Another motivation would be to examine whether or not the predictions of the international trade theory holds in an economy such as Azerbaijan.

One of the motivations is that without conducting empirical analysis it is quite difficult or impossible to make effective policy measures for the international trade of a country.

Since Azerbaijan is also a resource rich country and its real 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 percent in 2004 to 4.7 percent in 2008 (Hasanov, 2011 a, b), and especially government thinks that the non-oil export based development can be an engine of sustainable economic growth for the country particularly in the future post-boom period, it would be useful to investigate the impact of the real exchange rate on the non-oil exports in the Republic of Azerbaijan.

Policy related motivation for carrying out this research is that, as mentioned above, development of the non-oil sector and, especially, its export capacity are rightly considered as the main strategic policy priority for the socio-economic development of the Azerbaijan Republic particularly, after the post boom period. Currently, a number of development programs are initiated and/or adopted by the government to prevent the negative trends in the non-oil sector and to improve the strategic environment for competitiveness and trade. So, this research would be useful in terms of clearly understating ongoing processes and therefore effective implementation various policy measures in the non-oil exports of Azerbaijan.

Economic theory suggests and empirical studies indicate that some macroeconomic variables such as the exchange rate, unemployment, inflation, and the interest rate should demonstrate non-linear behavior and therefore they may have asymmetric effect on other variables (Neftci, 1984; Falk, 1986; Terisvirta and Anderson, 1992; Sichel, 1993; Bradley and Jansen, 1997; Balke and Fomby, 1997; Enders and Granger, 1998; Enders and Siklos, 2001; Enders, 2010, p.428; inter alia). An asymmetric relationship between the variables may leads to an asymmetric adjustment process towards their 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 is that floating, fixed (managed), and then fixed-floating exchange rate regimes has been implemented by the Central Bank of Azerbaijan during the 1999-2010 and therefore different exchange rate regimes may have different kind of effects on the on-oil exports. Because as Balke and Fomby (1997, p. 3) emphasize, "exchange rate management and … are often characterized by discrete interventions. For exchange rate target zones, exchange rates are allowed to fluctuate freely within a given band, yet, when exchange rates exceed the target band, the central banks intervene in the foreign exchange market." Moreover time series of the non-oil export experienced a structural break in the period of investigation. These above mentioned facts motivate to conduct empirical analysis in the framework of asymmetric adjustment. For that purpose the present study uses TAR and M-TAR models which allow examining whether there is an asymmetric adjustment in the relationships between the real exchange rate and non-oil exports.

Thus, the study is trying to answer the following research questions:

- Is there any cointegration relationship between the real exchange rate and the non-oil exports?
- Is an adjustment process towards the equilibrium level asymmetric?

The impact of the real exchange rate on non-oil exports of Azerbaijan is investigated by using TAR and MTAR method, in the framework of cointegration and asymmetric adjustment. Regarding with the cointegration methods Engle-Granger (1987) approach is employed which is a widely used method in the case of analyzing asymmetric adjustment towards a long-run level. By following Enders and Siklos (2001), TAR and MTAR models are applied in both versions: when the threshold level was (a) zero or (b) unknown. Estimation results indicate that the real exchange rate has a statistically significant negative impact on the non-oil exports in the long-run. However the adjustment process towards the long-run is not found to be asymmetric.

To the best of our knowledge, this is the first study that investigates the impact of real exchange rate on export in the framework of asymmetric adjustment in the area of oil-based economies of the Commonwealth Independent States (CIS hereafter). Moreover, the findings of the study may be useful for policymakers of monetary and real sectors in Azerbaijan, especially in terms of implementing the exchange rate policy and its effect on the non-oil exports. Additionally the study is a contribution to the existing relevant literature of oil-based small open emerging economies.

The rest of the paper is designed as follows. Section 2 consists of required data and its description, while Section 3 discusses the theoretical model and econometric methodology of the research. This is followed by the Results section, which covers the long-and short-run estimation outputs and a brief interpretation. Section 5 reflects robustness checking issues and the Conclusion section summarized the main findings of the study and their possible practical contributions. The Reference section comprises a list of the reviewed literatures and some large estimation outputs in forms of tables and graphs are placed in Appendix.

2. Brief Literature Review

There are a number of studies that investigate the impact of the exchange rate on non-oil exports. Hasanov and Samadova (2010) for Azerbaijan; Egert and Morales-Zumaquero (2005) and Bernardina (2004) for Russia; Sabuhi and Piri (2008) and also Masoud and Rastegari (2008) for Iran; Sorsa (1999) for Algeria; Oyejide (1986), Ogun (1998), Yusuf and Edom (2007), Adubi and Okunmadewa (1999) and Abolagba et al. (2010) for Nigeria; Ros

(1993) for Mexico; Amin (1996) for Cameroon; Benbouziane and Benamar (2007) for Algeria, Bahrain, Iran, Kuwait, Libya, Saudi Arabia, and Sudan investigated the impact of real exchange rates on non-oil exports.

However, none of the above mentioned studies take asymmetric effects into account in their analyses. To the best of our knowledge, the present research which investigates the impact of the exchange rate on the non-oil export in the framework of cointegration and asymmetric adjustment will be the first study in the area of oil-based economies of the CIS. Moreover, it will be a contribution to the relevant studies in the case of oil-based economies.

Although investigation of the asymmetric effects of different economic processes is a widely addressed topic in the recent studies, as a matter of fact there are very limited studies that investigate an impact of exchange rate on export in the framework of cointegration and asymmetric adjustment in oil-based economies. In this regard only one study is found: The study, conducting by Duasa (2009), investigates the impact of the real effective exchange rate on the trade variables in Malaysia over the monthly period of 1999M1-2006M12. By following Ender and Siklos (2001), the author conducts cointegration and asymmetric adjustment analysis, and finds that there exists a long-run relationship among the real effective exchange rate and the export volume and adjustment towards the long-run is an asymmetric in the case of TAR model. He also concludes that there is an asymmetric adjustment in the relationship between the real effective exchange rate and the trade balance in the case of M-TAR model. The main shortcoming of this study is that equations in the empirical analysis are misspecified due to omitted variable problem. Precisely saying, the author in his analyses does not include (foreign) income variable as one of the determinants of (export) import predicted by international trade theory.

To the best of our knowledge, the impact of the real exchange rate on exports in the framework of asymmetric adjustment has not been investigated yet in the area of oil-based economies of the Commonwealth Independent States (CIS hereafter). Therefore the present study is the first research in this area. Moreover the outcomes of this research may be useful for the policymakers in the monetary and real sectors of Azerbaijan, especially regarding with implementing the exchange rate policy and its effect on the non-oil exports. Additionally the study is a contribution to the existing relevant literature of the oil-based small open emerging economies.

2. Data

The study uses quarterly data over the period of 1999Q1-2010Q4.

Real Non-oil Export (RXN). Nominal Non-oil Export (XN) in US dollars data are taken from the official web page of the Central Bank of Azerbaijan (hereafter CBAR): http://cbar.az/pages/statistics/external-sector-statistics/. In order to get real values, XN firstly converted to the national currency by using manat-USD bilateral exchange rate (AZN_USD) and then deflated by consumer price index with base period of 2000Q4 (CPI):

$$RXN = \frac{XN * AZN\_USD}{CPI}$$

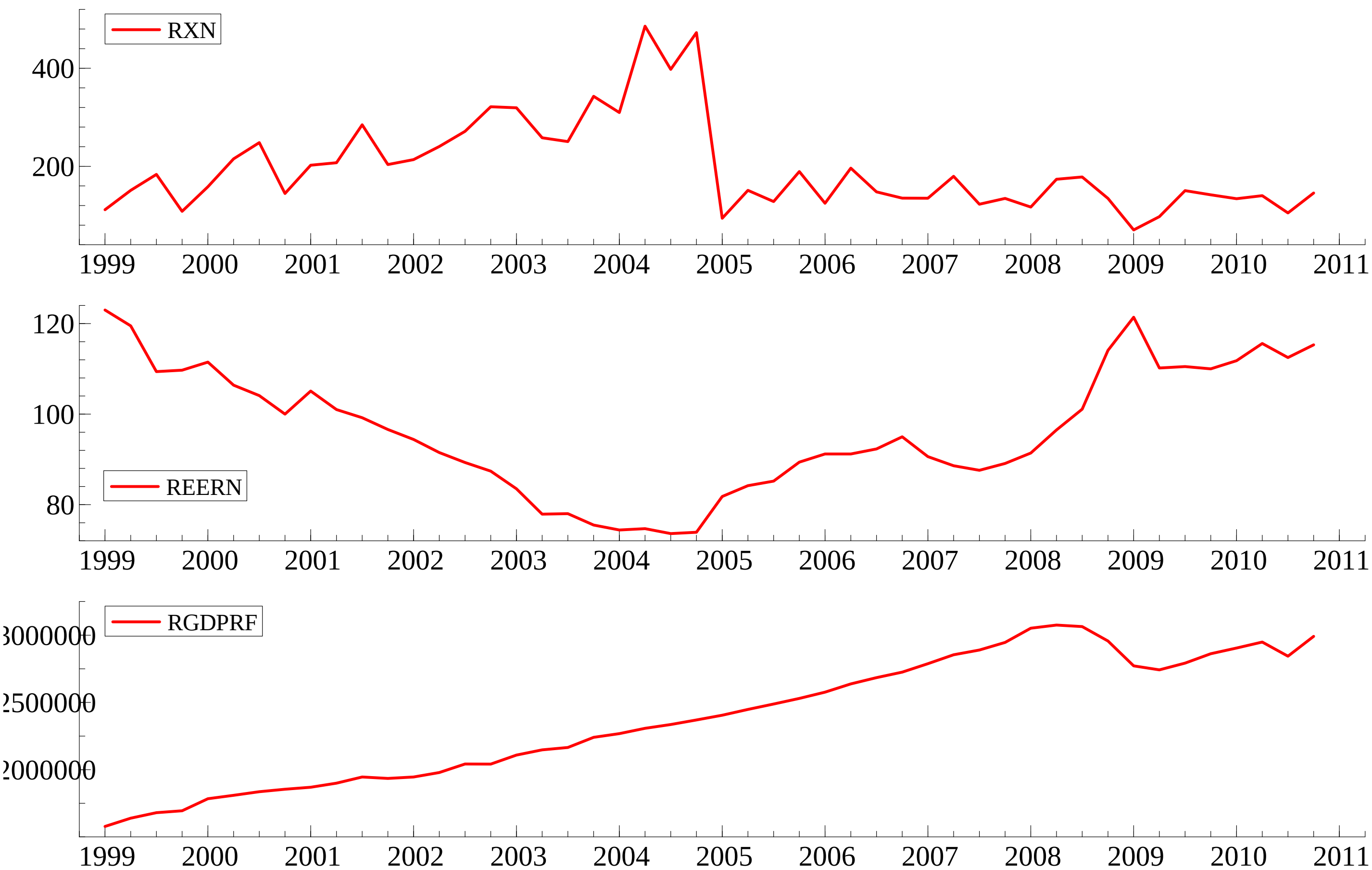
AZN_USD and CPI are collected from the statistical bulletin of CBAR (http://cbar.az/pages/publications-researches/statistic-bulletin/). Note that consumer price indexes given in the CBAR statistical bulletins are price changes according to the previous period. In other words, they report inflation. So, in order to make them useable in the study, price level is calculated using the above mentioned formula.

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 domestic currency 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 domestic currency. So its increase means appreciation of the domestic currency. CBAR calculates the variable. Time series of the variable can be collected from the statistical bulletin of CBAR (http://cbar.az/pages/publications-researches/statistic-bulletin/).

Real GDP of Russian Federation (RGDPF). This is a seasonally adjusted millions of Gross Domestic Product of Russian Federation at 2000 prices, which is retrieved from International Monetary Fund's official web page: http://elibrary-data.imf.org/FindDataReports.aspx?d=33061&e=169393

Graphs of the above given variables are described in Figure 1.

Figure 1: Graphs of the variables



As shown in the top graph, RXN has quite large structural break in 2005Q1 and the slope of its drift becomes flatter after this break. There are two possible explanations for the break. The first one is that starting from 2005 the CBAR has changed its methodology for calculating the components of the balance of payment. The second one is that due to huge inflow of the oil export revenues, REERN has appreciated 1.6 times over the 2004Q4-2010Q4. Before the break the mean value of RXN was 254.25 million manat, but it has decreased by 1.8 times and was 138.62 million manat over the post break period. It is also observable from the graphs that all of three variables declined over the global recession period.

3. Model

3.1. Theoretical model. The study uses the standard international trade theory (Leamer and Stern 1970; Goldstein and Khan, 1995; Rose and Yellen, 1989; Rose, 1990). Since this theory is well-known and is widely used in the empirical research, it is not going to discuss it here. Note that according to this theory, our non-oil export function can be written as below.

$$RXN_t = C \cdot REERN_t^{\alpha} \cdot RGDPRF_t^{\beta} \cdot U_t \tag{1}$$

Where, $RXN, REERN, RGDPRF$ are defined as in the above Data section; C, α, β are the coefficients to be estimated; U stands for error term. It is expected that $\alpha < 0, \beta > 0$.

Equation (1) in the logarithmic expression can be written as below:

$$rxn_t = c + \alpha \cdot reern_t + \beta \cdot rgdprf_t + e_t \tag{2}$$

Note that small letter indicate logarithmic expressions of the variables, c is a logarithm of C and e_t stand for the residuals.

3.2. Econometric method. Since the objective of the study is to analyze the impact of the real exchange rate on the non-oil exports in the framework of cointegration and a possible asymmetric adjustment by following Enders and Siklos (2001) the Threshold Autoregressive (TAR hereafter) and Momentum Threshold Autoregressive (M-TAR hereafter) methods are employed in the empirical estimations. The methods can be illustrated in case of equation (1) as below:

Step 1: Testing for stationarity of the variables by using Augmented Dickey Fuller Test (Dickey and Fuller, 1981):

$$\Delta y_t = b_0 + b_1 y_{t-1} + \sum_{i=1}^{k} o_i \Delta y_{t-i} + \sum_{i=1}^{3} \pi_i CS_{it} + \psi trend + \varepsilon_t \tag{3}$$

Here, y is a vector of natural logarithmic expression of RXN, REERN and RGDPRF. κ is the number of the lags of the dependent variables, b_0 is a constant term, $CS_{it}, trend$ are centered seasonal dummies and liner trend respectively, ε_t is a white noise. t and Δ indicate time and first difference operator respectively. Note that the null hypothesis is that underlying series is non-stationary.

After concluding that all of the variables are integrated in the same order we can move to Step 2.

Step2: Estimation of relationship between non-stationary variables, i.e. estimation of equation (2):

Note that (2) can be estimated one of the cointegration methods such as Johansen (1988, 1996), Stock and Watson (1988) or Engle and Granger (1987).

Step3: Testing stationarity of the residuals of (2) by allowing asymmetric adjustment:

$$\Delta\hat{e}_t = I_t p_1 \hat{e}_{t-1} + (1 - I_t) p_2 \hat{e}_{t-1} + \psi_t \tag{4}$$

Here, $\hat{e}$ stands for estimated residuals, p_1, p_2 are coefficients, I_t is an indicator function, ψ stands for white noise residuals.

Indicator function is defined as below:

$$I_t = \begin{cases} 1\ if\ \hat{e}_{t-1} \geq \tau \\ 0\ if\ \hat{e}_{t-1} < \tau \end{cases} \tag{5}$$

Where, τ - is a threshold level.

Ender and Siklos (2001) further note that if (4) is not sufficient to capture dynamic adjustment of $\Delta\hat{e}_t$, in other words if ψ_t is not white-noise process then lagged values of $\Delta\hat{e}_t$ should be included into the equation. So, (4) will be:

$$\Delta\hat{e}_t = I_t p_1 \hat{e}_{t-1} + (1 - I_t) p_2 \hat{e}_{t-1} + \sum_{i=1}^{k} \mu_i \Delta\hat{e}_{t-i} + \psi_t \tag{6}$$

Here, μ_i are coefficients, k is a maximum number of lag length.

Various model selection criteria such as Akaike and Schwartz Bayesian can be used to determine appropriate number of lags. Tong (1983, 1990) showed that the least squares estimates of p_1 and p_2 have an asymptotic multivariate normal distribution. It is important to note that Lukkonen, Saikkonen, and Terisvirta (1988) showed that the usual asymptotic theory cannot be applied to derive ordinary Lagrange multiplier tests for nonlinearity. Moreover, Eitrheim and Terasvirta (1996) suggested that the Ljung-Box test for residual autocorrelation does not follow the χ^2 asymptotic distribution in nonlinear time series models.

A model comprising (3), (4) or (6) and (5) called the TAR cointegration model.

Note that in (5) indicator function depends on $\hat{e}_{t-1}$. Caner and Hansen (1998) and Enders and Granger (1998) also suggested alternative way where indicator function depends on $\Delta\hat{e}_{t-1}$ and hence, (4), (5) and (6) become:

$$M_t = \begin{cases} 1\ if\ \Delta\hat{e}_{t-1} \geq \tau \\ 0\ if\ \Delta\hat{e}_{t-1} < \tau \end{cases} \tag{7}$$

$$\Delta\hat{e}_t = M_t p_1 \hat{e}_{t-1} + (1 - M_t) p_2 \hat{e}_{t-1} + \psi_t \tag{8}$$

$$\Delta\hat{e}_t = M_t p_1 \hat{e}_{t-1} + (1 - M_t) p_2 \hat{e}_{t-1} + \sum_{i=1}^{k} \mu_i \Delta\hat{e}_{t-i} + \psi_t \tag{9}$$

A model comprising (4), (7) and (8) or (9) called the M-TAR cointegration model.

In (5) and (7) it is assumed that the threshold level is zero, $\tau = 0$. In this case adjustment process is $p_1\hat{e}_{t-1}$ if $\hat{e}_{t-1}$ is above its long-run equilibrium level and adjustment is $p_2\hat{e}_{t-1}$ if $\hat{e}_{t-1}$ is below its long-run equilibrium level.

Enders and Siklos (2001) note that it is quite natural to set $\tau = 0$ in a number of economic applications. But 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 (Jarita, 2009). The procedure can be described as following:

(a) In the case of TAR (or M-TAR) cointegration model, the residual series $\hat{e}_t$ (or $\Delta\hat{e}_t$) is arranged in ascending order as $\{\hat{e}_1^0 < \hat{e}_2^0 < ... < \hat{e}_T^0\}$ $(or\ \{\Delta\hat{e}_1^0 < \Delta\hat{e}_2^0 < ... < \Delta\hat{e}_T^0\})$.

(b) After discarded the largest and smallest 15% of the $\hat{e}_t$ (or $\Delta\hat{e}_t$), the central 70% of observations of this sequence are then considered in turn as thresholds in (5) [or in (7) in the case of M-TAR model] as each of them could be a possible threshold. From the above given sequence the value providing the lowest residuals sum of squares in (4) or (6) [in (8) or (9) in the case of M-TAR model] defined as consistent threshold.

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

1. Firstly it is determined whether or not *rxn, reern* and *rgdprf* are cointegrated in the TAR (or M-TAR) model. The null hypothesis for that is: $p_1 = p_2 = 0$ in equation (4) [or in equation (8) in the case of M-TAR model]. It is important to note that if it is found out that ψ_t does not follow white-noise processes (especially they are correlated) then the null hypothesis should be tested in equation (6) [or equation (9) in the case of M-TAR model]. **F** statistics for the null hypothesis has non-standard distribution and therefore Enders and Siklos (2001) denoted it as Φ. If obtained **F**-value is greater than appropriate Φ critical value then the null hypothesis can be rejected.

Rejection of the null hypothesis means that $\hat{e}$ is stationary. In other words *rxn*, *reern* and *rgdprf* are cointegrated. Moreover, Petrucelli and Woolford (1984) showed that the necessary and sufficient conditions for the stationarity of $\hat{e}_t$ is $p_1 < 0,\ p_2 < 0$ and $(1+p_1)\cdot(1+p_2) < 1$.

2. After rejecting the null hypothesis of $p_1 = p_2 = 0$ it is possible to test for asymmetric adjustment. The null hypothesis is $p_1 = p_2$. Note that standard **F**-statistics can be used to test the null hypothesis. If obtained **F**-statistic is greater than that of appropriate standard critical value then it can be concluded that adjustment towards long-run equilibrium level is asymmetric. As mentioned above if $\hat{e}_{t-1}$ is above its long-run equilibrium level then adjustment process is $p_1\hat{e}_{t-1}$, otherwise adjustment is $p_2\hat{e}_{t-1}$.

Given the existence of asymmetric adjustment, the asymmetric error-correction model for *Lrxn* can be written as below:

$$\Delta rxn_t = \Omega_0 + \Omega_{11} I_t \hat{e}_{t-1} + \Omega_{12}(1 - I_t)\hat{e}_{t-1} + \sum_{i=1}^{k} \pi_{1i} \Delta rxn_{t-i} + \sum_{i=1}^{q} \pi_{2i} \Delta reern_{t-i} + \sum_{i=1}^{s} \pi_{3i} \Delta rgdprf_{t-i} + \theta_{1t} \qquad (10)$$

4. Results

Note that all of the estimations are conducted in OxMetrics 6.2 software package.

It can be expected that the adjustment process in the case of equation (2) is asymmetric. As mentioned in the Introduction, floating, fixed (managed), and then fixed-floating exchange rate regimes have been implemented by the CBAR during the 1999-2010, and different exchange rate regimes may have different kind of effects on the non-oil exports.

As indicated in the Econometric Methodology subsection, firstly a unit root ADF test on the *rxn*, *reern* and *gdprf* is conducted. The test outputs are given in Table 2 of the Appendix.

As shown in Table 2, it can be considered that all variables are I(1). In other words they are non-stationary in the log level and stationary in their first difference. After getting that all variables are integrated in the same order, the possible long-run relationship between them is estimated by using Engle-Granger cointegration approaches. As discussed in the Data section, our dependent variable, *rxn*, has shifted in its mean (a structural break) since

2005Q1. Therefore by following Hendry and Juselius (2001) and Juselius (2006), shift dummy (namely Dsh05Q1, which takes 1 after 2004Q4 and zero otherwise) is included into the cointegration estimation.

According to the estimation results, the relationship between *rxn*, *reern*, *rgdprf* and *Dsh05Q1* is as follows (Detailed estimation outputs are given in Table 3 in the Appendix.):

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

Then residuals ($\hat{e}_t$) are calculated from equation (11):

$$\hat{e}_t = rxn_t + 11.32 + 0.94 \cdot reern_t - 1.45 \cdot rgdprf_t + 1.03 \cdot Dsh05Q1_t \quad (12)$$

Graphs of the calculated residuals are given in Figure 2 in the Appendix.

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

4.1. Threshold value is zero: There is no any autocorrelation in the residuals when equation (4) is estimated. Estimation results are given in Table 4 in the Appendix. Then cointegration between the *rxn*, *reern* and *rgdprf* and asymmetric adjustment towards long-run value are tested. First the null hypothesis of no cointegration, i.e. $p_1 = p_2 = 0$ is tested. Since, sample F-value (25.151 in Panel A of Table 5 in the Appendix) is much greater than the corresponding Φ critical value of 8.78 at 1% significance level (Look at Table 1 in Enders and Siklos, 2001), it can be concluded that there is a cointegrating relationship between the real non-oil export, non-oil trade based real effective exchange rate and Russian GDP. In other words, the relationship between the variables is not spurious. Therefore coefficients in equation (11) can be interpreted as cointegration parameters (log-run elasticities). According to this equation, ceteris paribus, a 1% appreciation of REERN leads to a decline in RXN by 0.94% in the long-run. All other things being equal, however a 1% increase in RGDPRF causes a 1.45% rise in RXN. These findings are in line with international trade theory and the empirical results of other relevant empirical studies. As discussed earlier, the structural break in 2005Q1 negatively affects RXN in the long-run.

After finding cointegration between variables, it is tested that whether or not adjustment process towards the long-run is asymmetric. Panel B of Table 5 in the Appendix indicates that one can fail to reject the null hypothesis of symmetric adjustment. Therefore it is concluded that adjustment process towards the long-run level is not asymmetric.

4.2. Threshold value is unknown: In the second version of the estimation of TAR model first a consistent threshold value is searched by using Chan (1993) procedure: (a) $\hat{e}_t$ sequence is arranged in ascending order, (b) discarded the smallest 15% and the largest 15% and therefore had 70% of the sequence (34 observations). Equation (4) is estimated with each of these 34 possible threshold values, and then Sum of Squared Residuals (SSR) of the estimations are collected and compared[2]. As shown in Figure 3 and Table 6 in the Appendix, equation (4) has the smallest SSR (1.556) in the threshold value of -0.165835. Then by using this equation, cointegration and asymmetric adjustment are tested. Sample F-value in Panel A of Table 7 in the Appendix is much greater than the corresponding Φ^* critical value of 9.90 at 1% significance level (See: Table 5 in Enders and Siklos, 2001). Therefore again it can be concluded that there is a cointegrating relationship between the variables. As a next test procedure, possibility of an asymmetric adjustment towards the equilibrium is checked. Since the null hypothesis of symmetric adjustment $p_1 = p_2$ cannot be rejected (See: Panel 3 in Table 7 in the Appendix), it is again concluded that adjustment process towards the long-run level is not asymmetric.

Thus, it is concluded that there is a cointegration between ***rxn, reern, rgdprf and Dsh05Q1****, but adjustment towards the equilibrium level is not asymmetric regardless of the threshold level is zero or unknown in the TAR model.*

Application of M-TAR Model: It is important to note that empirical studies show that in some cases TAR models are unable to detect an asymmetric adjustment towards the long-run value. This is especially the case when adjustment process exhibits more “momentum” in one direction rather than the other (Enders and Siklos, 2001). Therefore it is suggestive to use M-TAR model together with TAR model in the empirical applications. For example, Enders and Siklos (2001) cannot find cointegration between the federal funds rate and the 10-year yield on federal government securities and therefore asymmetric adjustment when they apply TAR model. However it is found that there is cointegration between the variables and asymmetric adjustment towards the long-run equilibrium when they employ M-TAR model. Similarly Duasa (2009) fails to find asymmetric adjustment in the

[2] Since these estimations yield 34 estimated equations in order to save space these outputs and also SSRs are not reported here. But these estimation outputs, their SSRs and also batch codes for estimations can be obtained under request.

cointegrating relationship between balance of trade and real exchange rate in Malaysia when he uses TAR model. However he finds that the adjustment process towards the long-run value is asymmetric when M-TAR model is used.

Thus in order to make clear inference about the adjustment process, it is decided to apply M-TAR in both cases, .i.e. when momentum threshold value is zero and unknown in the present study.

4.3. Momentum Threshold value is zero: Note that the diagnostic statistics indicate that residuals are correlated and this correlation disappear when two lags of the dependent variable ($\Delta\hat{e}_t$) are used. Therefore equation (9) is estimated with two lags of $\Delta\hat{e}_t$. The estimation results are reported in Table 8 of the Appendix. First as in case of TAR model an existence of a long-run relationship between the variables is tested. The sample F value in Panel A of Table 9 in the Appendix for the null hypothesis of $p_1 = p_2 = 0$ is greater than the corresponding Φ critical value (8.89) at 1% significance level (See: Table 1 in Enders and Siklos, 2001). Therefore the null hypothesis of no cointegration between the variables can be rejected. Since the variables are cointegrated, the nature of the adjustment process can be tested. Panel B of Table 9 indicates that the null hypothesis of $p_1 = p_2 = 0$ cannot be rejected and therefore adjustment process towards the long-run equilibrium is symmetric.

So, the results are similar to the findings from subsection 4.1. In other words there is cointegration between the variables and adjustment process towards the long-run level is symmetric.

4.4. Momentum Threshold value is unknown: By using Chan (1993) procedure, it is first tried to find a consistent threshold value. By doing so, equation (9) is estimated with each of 31 possible threshold values and then the SSRs[3] are compared. The graph of the SSRs is plotted in Figure 4 of the Appendix. Equation (9) has the smallest SSR (1.250645) when the threshold value is 0.266056 (See: Table 10 in the Appendix). This specification is used to test cointegration and asymmetric adjustment. According to Panel A of Table 11 in the Appendix, the sample F value (16.905) of the null hypothesis of no cointegration, i.e. $p_1 = p_2 = 0$ is greater than the corresponding Φ^* critical value of 9.79 at 1% significance level (See: Table 5 in Enders and Siklos, 2001). So, one can

[3] Since these estimations yield 34 estimated equations in order to save space these outputs and also SSRs are not reported. But these estimation outputs, their SSRs and also batch codes for estimations can be obtained under request.

again conclude that there is cointegration between the variables. As a final step, the nature of the adjustment process is checked. Panel B of Table 11 in the Appendix indicates that the null hypothesis of symmetric adjustment cannot be rejected.

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

5. Robustness checks

As mentioned before, due to a number of reasons, such as implemented different exchange rate policies by CBAR and a structural break in the time profile of the non-oil export during the period of analysis, one would expect an asymmetric adjustment in the relationship between the variables. However, results of empirical analysis do not support this expectation. One explanation for the evidence is that perhaps the adjustment process is indeed symmetric. Another explanation would be the small number of observations is used in the econometric estimations: 34 observations for the TAR model estimations and 31 in the M-TAR case (because of using two lags of the dependent variable). Maybe these small numbers of observations are not sufficient in order to discover asymmetric processes. The last possible explanation is that there is perhaps more than one threshold level in the relationship between the variables. This is shown by the graphs of the SSRs in Figures 3 and 4, especially in the case of TAR model estimations. As suggested by Enders and Siklos (2001) or Famby and Balke (1987), one should estimate TAR or M-TAR models with more than one threshold levels when there is more than one trough in the SSRs graph. In this regard, this study opens avenues for future investigations of asymmetric adjustment in the relationship between Azerbaijani real exchange rate and non-oil exports.

6. Conclusion

This study investigates the impact of the real exchange rate on the non-oil exports of Azerbaijan Republic in the framework of cointegration and an asymmetric error correction, in order to answer two research questions: (1) Is there any cointegration relationship between the real exchange rate and the non-oil exports? and (2) Is an adjustment process towards the equilibrium level asymmetric? By following Enders and Siklos (2001), TAR and M-TAR models are estimated in two versions: when threshold level is (a) zero and (b) unknown.

The main finding of the study is that there is a cointegrated relationship between the non-oil exports, non-oil trade turnover based real exchange rate and foreign income, but adjustment process towards the equilibrium level is not asymmetric.

Possible explanations for failure in finding asymmetric adjustment are (a) maybe the adjustment process is indeed symmetric; (b) the small number of observations is not sufficient in order to discover asymmetric processes and (c) existence of more than one trough in the SSRs graphs put forward to use TAR or M-TAR models with more than one threshold levels. In this regard, this study opens avenues for future investigations of asymmetric adjustment in the relationship between Azerbaijani real exchange rate and non-oil exports.

To the best of our knowledge, this is the first study that investigates the impact of real exchange rates on export in the framework of asymmetric adjustment in the area of oil-based economies of the Commonwealth Independent States (CIS hereafter). In addition, the study is a contribution to the existing relevant literature of oil-based small open emerging economies. Moreover, finding of the long-run relationship between the real exchange rate and the non-oil exports may be useful for policymakers of monetary and real sectors in Azerbaijan, especially in terms of implementing different the exchange rate policies and their effects on the non-oil exports.

VI. Reference

Auty, R. (2001) “Natural Resources, Governance and the Transition in Energy-Rich Azerbaijan, Kazakhstan and Turkmenistan”. Working paper 0103, Lancaster University: Department of Geography.

Bradley, M., and Jansen, D. (1997), "Nonlinear Business Cycle Dynamics: Cross-Country Evidence on the Persistence of Aggregate Shocks, "Economic Inquiry, 35, 495-509.

Caner, M., and Hansen, B. (1998), "Threshold Autoregression with a Near Unit Root," working paper, University of Wisconsin, Dept. of Economics.

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.M. (1984) “Booming Sector and Dutch Disease Economics: Survey and Consolidation”. Oxford Economic Papers 36, pp. 359-380.

Corden W.M. and Neary J.P. (1982) “Booming Sector and De-Industrialization in a Small Open Economy”. Economic Journal 92, pp. 825-848.

Dickey D. and Fuller W. (1981) “Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root,” Econometrica, Vol. 49.

Duasa Jarita, (2009) “Asymmetric cointegration relationship between real exchange rate and trade variables: The case of Malaysia” International Islamic University Malaysia, MPRA Paper No. 14535.

Egert Balazs (2009) “Dutch disease in former Soviet Union: Witch-hunting?” BOFIT Discussion Papers 4.

Eitrheim, O. and Terisvirta, T. (1996), “Testing the Adequacy of Smooth Transition Autoregressive Models,” Journal of Econometrics, 74, 59-76.

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

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

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

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

Gylfason, Thorvaldur and Gylfi Zoega (2002) “Natural Resources and Economic Growth: The Role of Investment”. Working Paper No. 142, Central Bank of Chile.

Hasanov, F. (2010) “The Impact of Real Oil Price on Real Effective Exchange Rate: The Case of Azerbaijan” Discussion Paper Series 1041. DIW - Berlin German Institute for Economic Research. Berlin, August.

Hasanov, F. and Samadova I. (2010) “The Impact of Real Effective Exchange Rate on the Non-oil Export: The Case of Azerbaijan”, Forthcoming 2nd issue of ECO Economic Journal.

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

Hendry F.David and Juselius Katarina, (2000) “Explaining Cointegration Analysis: Part II” Discussion Papers, 00-20, Department of Economics, University of Copenhagen. November 12.

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

Johansen S. (1988) “Statistical analysis of cointegration vectors”. Journal of Economic Dynamics and Control 12, pp. 231-254.

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

Leamer E. Edward and Stern M. Robert (1970) “Quantitative International Economics” ALDINE Publishing Company, Chicago.

Lukkonen, R., Saikkonen, P., and Terisvirta, T. (1988), "Testing Linearity Against Smooth Transition Autoregressive Models," Biometrika, 75, 491-499.

Neftci, S. N. (1984), "Are Economic Time Series Asymmetric Over the Business Cycle?" Journal of Political Economy, 92, 307-328.

Petrucelli, J., and Woolford, S. (1984) "A Threshold AR(1) Model" Journal of Applied Probability, 21, pp. 270-286.

Rose, A.K. (1990). Exchange rates and the trade balance: Some evidence from developing countries. Economic Letters, 34: 271-275.

Rose, A.K. & Yellen, J.L. (1989). In there a J-curve?. Journal of Monetary Economics, 24: 53-68.

Sachs J.D. and Warner A.M. (1997) “Natural Resource Abundance and Economic Growth”. Center for International Development and Harvard Institute for International Development Harvard University Cambridge MA, November.

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

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

Sturm Michael, François Gurtner and Juan Gonzalez Alegre (2009) Fiscal policy challenges in oil-exporting countries a review of key issues. European central bank, occasional paper series no 104.

Terisvirta, T., and Anderson, H. M. (1992), "Characterizing Nonlinearities in Business Cycles Using Smooth Transition Autoregressive Models," Journal of Applied Econometrics, 7, S 119-S 139.

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, U.K.: Oxford University Press.

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

VII. Appendix

Table 2: ADF Unit Root Test Results

Variable	Log Level				First Difference in Logs			
	b_0	κ	b_1+1	**Actual value**	b_0	κ	b_1+1	**Actual value**
rxn	CTCS	3	0.59497	-2.668	CCS	0	-0.37183	-9.364**
rgdprf	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: For a variable y, the augmented Dickey-Fuller (1981) statistics $ADF(\kappa)$ is the t-ratio on b_1 from the regression:

$$\Delta y_t = b_0 + b_1 y_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta y_{t-i} + \sum_{i=1}^{3} \gamma_i CS_{it} + \psi trend + \varepsilon_t ,$$

here, Δ stands for first difference operator, κ is the number of the lags of the dependent variables, CTCS refers to inclusion of a constant, trend and seasonal dummy variables, CT includes only and constant and trend term, while CCS is a constant term with centered seasonal dummy variables and, C stand for a constant. ε_t is a white noise.

The sample is: 2000(1) - 2010(4); * and ** denote rejection at the 5% and 1% critical values.

Table 3: Estimation of the relationship between the variables

Modelling *rxn* by OLS

	Coefficient	Std. Error	t-value	t-prob.	Part.R^2
Constant	-11.319	6.350	-1.780	0.082	0.074
rgdprf	1.454	0.407	3.570	0.001	0.242
reern	-0.942	0.250	-3.770	0.001	0.262
Dsh05Q1	-1.030	0.150	-6.860	0.000	0.540

Sigma = 0.203432; RSS = 1.65538121; R^2 = 0.796628; F(3,40) = 52.23 [0.000]**; Adj.R^2 = 0.781375; 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]

Table 4: Threshold level, τ =0

Modelling *De* by OLS

	Coefficient	Std. Error	t-value	t-prob.	Part.R^2
$I*e_{t-1}$	-1.178	0.230	-5.130	0.000	0.385
$(1-I)*e_{t-1}$	-0.924	0.189	-4.900	0.000	0.364

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: -1.51981= -1.50827 = 0	H_0: -1.51981 = -1.50827
F(2,42) = 25.151 [0.0000]**	χ^2 (1) = 0.72722 [0.3938]

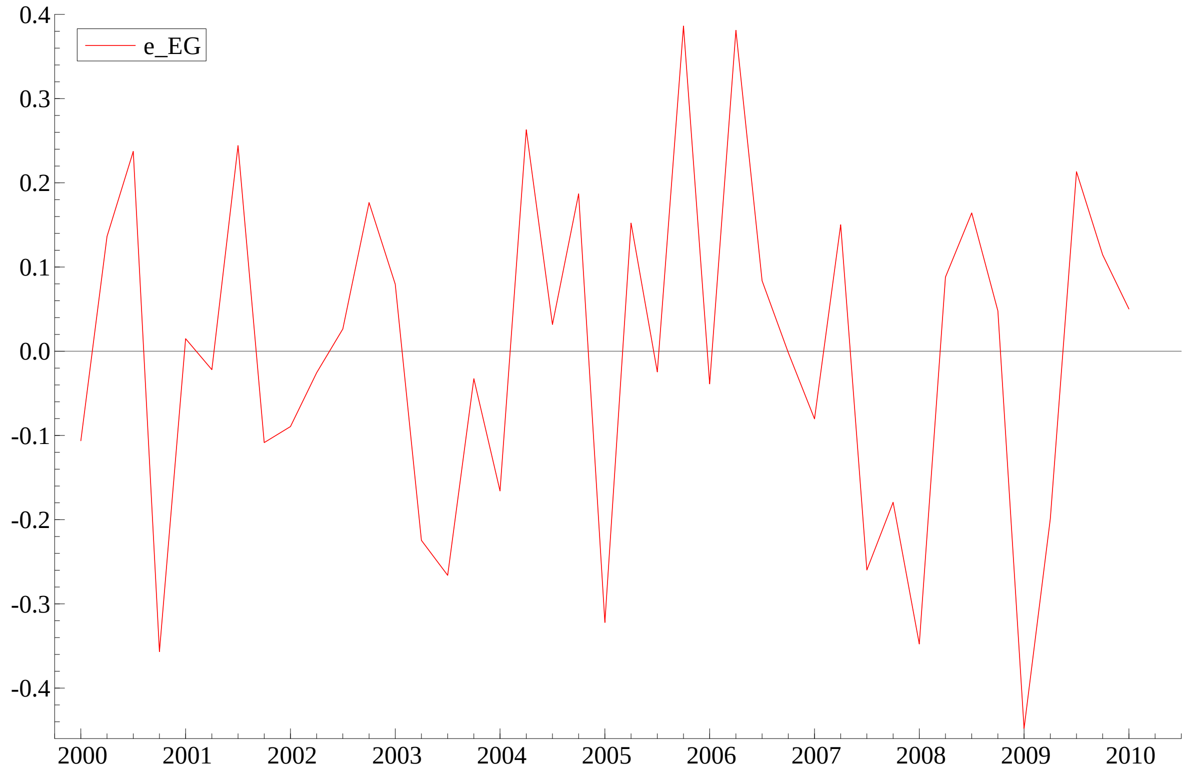


Figure 2: Graph of the long-run residuals

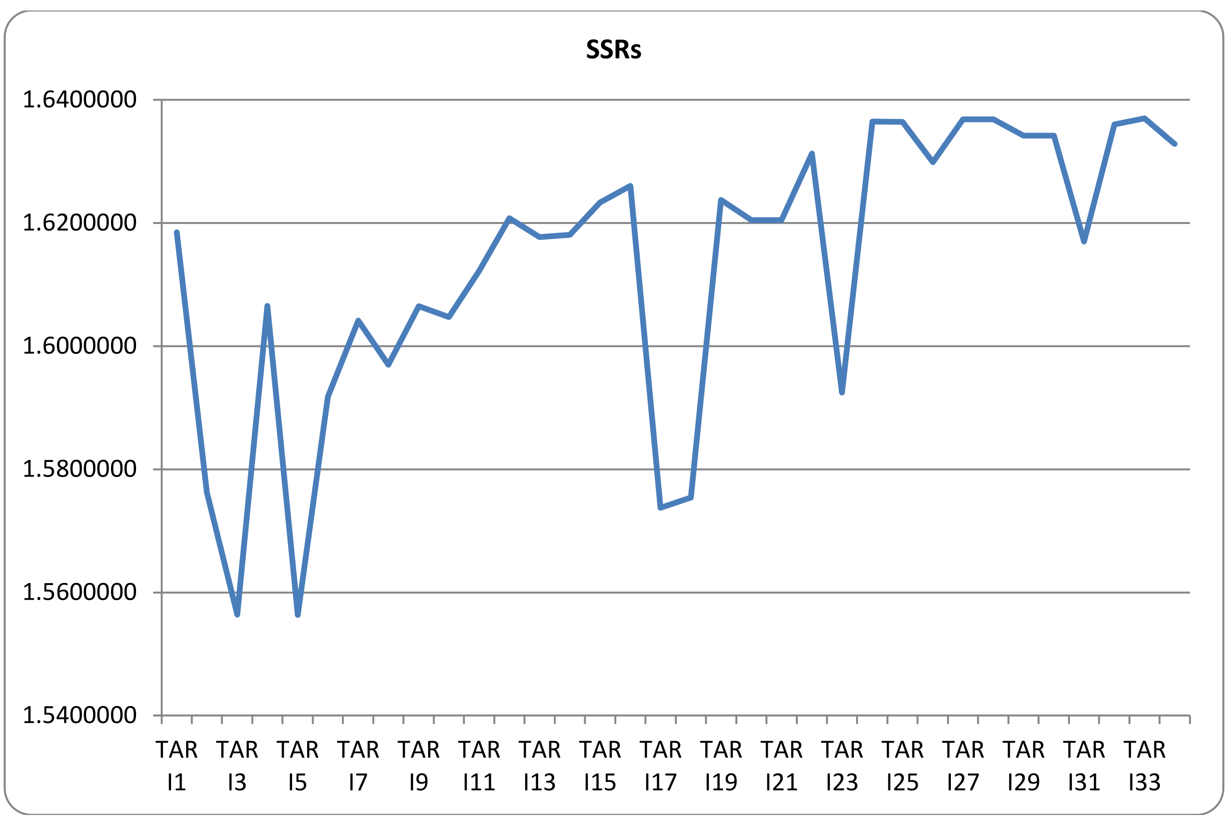


Figure 3: Graph of the SSRs in the case of TAR model

Table 6: Threshold level is -0.165835

Modelling *De* by OLS

	Coefficient	Std. Error	t-value	t-prob.	Part.R^2
$I5*e_{t-1}$	-1.280	0.212	-6.050	0.000	0.466
$(1-I5)*e_{t-1}$	-0.815	0.193	-4.220	0.000	0.298

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: $\chi^2(2)$ = 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 ($p_1=p_2$):**
$\mathbf{H_0}$: -1.27979 = -0.814640 = 0	$\mathbf{H_0}$: -1.27979 = -0.814640
F(2,42) = 27.216 [0.0000]**	χ^2 (1) = 2.6394 [0.1042]

Table 8: Momentum Threshold level, τ =0

Modelling *De* by OLS

	Coefficient	Std. Error	t-value	t-prob.	Part.R^2
De_1	0.380	0.215	1.770	0.085	0.078
De_2	0.388	0.149	2.600	0.013	0.155
$M*e_{t-1}$	-1.505	0.299	-5.040	0.000	0.407
$(1-M)*e_{t-1}$	-1.399	0.307	-4.550	0.000	0.359

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: $\chi^2(2)$ = 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 ($p_1=p_2$):**
$\mathbf{H_0}$: -1.50528 = -1.39906 = 0	$\mathbf{H_0}$: -1.50528 = -1.39906
F(2,37) = 15.269 [0.0000]**	χ^2 (1) = 0.12722 [0.7213]

Figure 4: Graph of the SSRs in the case of M-TAR model

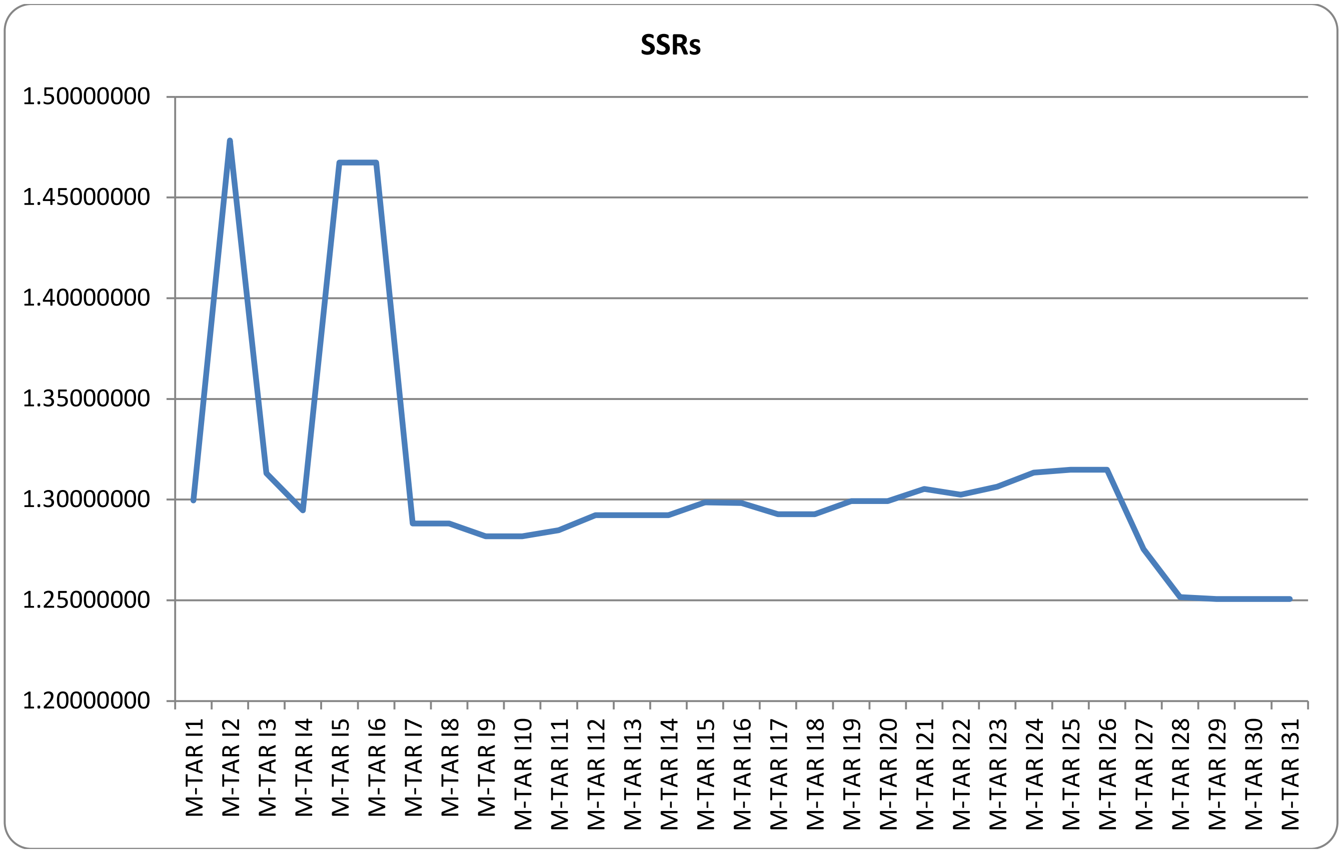


Table 10: Momentum Threshold level is 0.266056

Modelling *De* by OLS

	Coefficient	Std. Error	t-value	t-prob.	Part.R^2
De_1	0.455	0.215	2.120	0.041	0.108
De_2	0.462	0.154	3.000	0.005	0.196
M^*e_{t-1}	-1.073	0.377	-2.850	0.007	0.180
$(1-M)^*e_{t-1}$	-1.625	0.285	-5.700	0.000	0.467

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: $\chi^2(2)$ = 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: -1.07338 = -1.62483 = 0	H_0: -1.07338 = -1.62483
F(2,37) = 16.905 [0.0000]**	$\chi^2(1)$ = 1.9257 [0.1652]