The impact of real oil price on real effective exchange rate: The case of Azerbaijan

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The Impact of Real Oil Price on Real Effective Exchange Rate: The Case of Azerbaijan

Fakhri Hasanov [1]

Abstract:

Using quarterly data from 2000-2007 and applying Error Correction Model and Johansen Co-integration Approaches I estimate the impact of real oil price on the real exchange rate of Azerbaijani manat. Estimation outputs derived from these approaches are very close to each other and indicate that real oil price has statistically significant positive impact on real exchange rate in the long-run. Besides, revealed that relative price as a proxy for productivity has also explanatory power in explaining long-run behavior of real exchange rate. Estimated Error Correction Term indicates that half-life of adjustment toward long-run equilibrium level takes 3-4 quarters. Since findings of this study occur as results of high fiscal expansion my policy suggestions mainly related to Fiscal policy implementations.

Keywords:
Real effective exchange rate, Real oil price, Relative productivity, Azerbaijani manat, Dutch Disease, Oil-exporting Countries, Johansen Co-integration Approach, Error Correction Modeling, Half-life Speed.

JEL:
F31, F41, C32, P24, Q43

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Introduction

Azerbaijani economy has performed rapid economic development approximately since 2004. It is obvious that this economic development mainly sourced from oil sector of economy. Oil extraction and exportation, also increasing oil prices in the world markets cause huge inflow of oil revenues into countries. These oil revenues have certain effect on macroeconomic performance of Azerbaijan. For example, GDP growth rate was 34.5% in 2006 which made country a leader in the world in terms of growth rates; money supply has increased more than two times in 2006 and 2007 and one can observe high inflation rates starting from 2004. In parallel with above mentioned performance at the same time Azerbaijani economy faces sustainable appreciation of exchange rate, which undermines competitiveness of non-oil sector of economy. I assume that this permanent appreciation is tightly related to oil price and subsequently oil revenues. There are at least three reasons that allow us to think so.

First of all, resource curse concept, especially Dutch Disease phenomenon predicts certain link between appreciation of real exchange rate and resource price [Corden and Neary (1982), Corden (1984), Wijnbergen (1984), Buiter and Purvis (1982), Bruno and Sachs (1982), Enders and Herberg (1983), Edwards (1985)]. According to theoretical framework of Dutch Disease, there are three theoretical reasons why the relative price of non-tradable and therefore overall price level may rise [Egert (2009), Algozina (2006)]. The first reason is related to non-tradable prices raise due to leaves labour out of non-tradable sector. The second is that higher productivity in commodity sector that pushes up wages in the commodity sector which leads to higher wages in the non-tradable sector and, consequently, to higher non-tradable prices or consumer price level. Third, the relative price of non-tradable raises to the event that higher profits and wages in the non-tradable and the related tax revenues are spent on non-tradable goods and provided the income elasticity of demand for non-tradable is positive.

Secondly, there are number of empirical studies that investigate impact of oil price on real exchange rate and find positive relationship between them in the oil exporting countries Koranchelian (2005) in Algeria; Zalduendo (2006) in Venezuela; Issa et al. (2006) in Canada; Habib and Kalamova (2007) in Norway, Saudi Arabia and Russia, Oomes and Kalcheva (2007) in Russia; Korhonen and Juurikkala (2009) in nine OPEC countries; Jahan-Parvar and Mohammadi (2008) in fourteen oil-exporting countries.

Thirdly, if we look at spending mechanism of oil revenues we can observe that these revenues mainly oriented to non-tradable sector of economy as budget expenditures. These expenditures generate spending effect and result increase of relative price in non-tradable sector therefore, high inflation rates. On another side before spending, these revenues have to be converted into national currency which leads to excess supply of foreign currency and therefore, appreciation of nominal exchange rate. As a result, appreciation of real exchange rate sources from both channels, i.e. through rise in relative prices and appreciation in nominal exchange rate.

Since Azerbaijan is oil-exporting country and its economy experiences appreciation of real exchange rate it is important to analyze that whether this appreciation is mainly sourced from oil prices or not. Therefore, objective of this study is to investigate impact of real oil price on real exchange rate.

By conducting this study I can answer the following research question: Does real oil price play any role in formation of equilibrium path of real exchange rate?

Thus, based on theoretical framework of Dutch Disease [Corden and Neary (1982), Corden (1984)] and by following above mentioned empirical studies especially Jahan-Parvar and Mohammadi (2008), Koranchelian (2005), Zalduendo (2006), Habib and Kalamova (2007), Oomes and Kalcheva (2007), Korhonen and Juurikkala (2009) I analyze impact of real oil price on real exchange rate of Azerbaijani manat. I have found that there is statistically significant and positive relationship between the real oil price and real exchange rate over the research period. It is important to note that we cannot conclude that Azerbaijani economy has contracted Dutch Disease just by estimating impact of real oil prices on real exchange rates and in this regard we have to check all symptoms of Dutch Disease in parallel with carefully testing alternative explanations of observed processes.

Results of the study may be useful for policymakers in terms of policy implementation related to management of oil revenues and exchange rate policy. On another side this paper is the pioneer study in the area of investigation of relationship between oil price and real exchange rate in Azerbaijan.

The rest part of the paper is organized as below. Review of appropriate theoretical and empirical literatures are given in *Literature Review* section, while *Methodology and Data* section consists of employed econometric methodology and required data. *Estimation Outputs* section comprises results of econometric estimations and their interpretations are reflected in *Interpretation of Estimation Results* section. Main findings of the study and proposing policy recommendation are discussed in *Conclusion and Policy Suggestion* section. *Reference* section consists of list of reviewed literatures. Estimation outputs and graphic illustrations are presented in *Appendix*.

Literature review

Since my research direction is narrow, i.e. the investigation of impact of real oil price on real exchange rate I should mainly focus on such kinds of literatures rather than studies relating assessment of equilibrium real exchange rate in general. Therefore, I review some theoretical and empirical studies that investigate the impact of real oil price on real exchange rate in oil exporting countries. Theoretical base of such kinds of investigations come from Dutch Disease Theory, one of the resource curse concepts. According to Corden (1982) and Corden and Nearly (1984) Dutch Disease is the appreciation of a country's real exchange rate caused by an exogenous increase in resource price or sharp rise in resource export and the tendency of a booming resource sector to draw capital and labour away from a country's manufacturing and agricultural sectors, which can lead to a decline in exports of these sectors and inflate the cost of non-tradable goods[2]. Some theoretical aspects of Dutch Disease have been developed by also Wijnbergen (1984), Buiter and Purvis (1982), Bruno and Sachs (1982), Enders and Herberg (1983), Edwards (1985) and etc. According to theoretical framework of Dutch Disease, there are three theoretical reasons why the relative price of non-tradable, therefore, overall price level and subsequently real exchange rate may rise [Egert (2009), Algozina (2006)]. The first reason is related to non-tradable prices raise due to leaves labour out of non-tradable sector. The second higher productivity in commodity sector pushes up wages in the commodity sector which leads to higher wages in the non-tradable sector and, consequently, to higher non-tradable prices or consumer price level. Third, the relative price of non-tradable raises to the event that higher profits and wages in the non-tradable and the related tax revenues are spent on non-tradable goods and provided the income elasticity of demand for non-tradable is positive.

Regarding with empirical literatures, there are number of studies that investigate the impact of real oil price

[2] The term Dutch Disease refers to the adverse effects on Dutch manufacturing of the natural gas discoveries of the nineteen sixities, essentially through the subsequent appreciation of the Dutch real exchange rate. Dutch Disease is sometimes interpreted as exclusively resulting from the discovery of new natural resources, which characterized the original Dutch case that gave the disease its name. For example, the Rutherford Dictionary of Economics gives the following definition of Dutch Disease: "The harmful consequences for a national economy of discovering natural resources, especially the decline in traditional industries brought about by the rapid growth and prosperity of a new industry. The successful new industry has high exports, creating a foreign exchange surplus and raising the country's exchange rate with the consequence that other industries of the economy become internationally uncompetitive" (Rutherford, 1992). Buiter and Purvis (1983) distinguish between the case of oil price increases, which have a temporary effect, and the case of oil discoveries, which have permanent effects.According to the core model of Corden and Naery (1982) there are three sectors in the economy: The Booming Sector (this is the sector which observe high export revenues. For example oil sector.), the Lagging Sector (this is the sector which consists of tradable sector with excluding booming sector. For example, agriculture and manufacturing.) and the Non-tradable Sector. The first two sectors produce tradable facing given world prices, while the third sector produce only non-tradable goods, which is not depend on world prices.

on real exchange rate in oil exporting country or country groups.

Koranchelian (2005) investigates the impact of real oil price and Real GDP per capita relative to trading partners as a proxy for relative productivity on Algerian real effective exchange rate by employed VECM approach over the annual period of 1970-2003. Author reveals that real oil price together with relative productivity has statistically significant and positive impact on real effective exchange rate.

Zalduendo (2006) examines co-integration relationship between CPI-based real effective exchange rate and real oil price, relative productivity, government expenditure as a share of GDP and differential in real interest rates over the period of 1950-2007 by using VECM. His main findings are that (a) oil prices have indeed played a significant role in determining a time-varying equilibrium real exchange rate path; (b) oil prices are not the only important determinant of the real effective exchange rate: declining productivity is also a key factor; (c) appreciation pressures are rising; (d) the speed of convergence is higher.

Issa et al. (2006) revisits the relationship between energy prices and the Canadian dollar over the 1973–2005 in the Amano and van Norden (1995) equation, which shows a negative relationship such that higher real energy prices lead to a depreciation of the Canadian dollar. Based on structural break tests, the authors find a break point in the sign of this relationship, which changes from negative to positive in the early 1990s. The break in the effect between energy prices and the Canadian dollar is consistent with major changes in energy-related cross-border trade and in Canada's energy policies.

Habib and Kalamova (2007) investigate whether the real oil price and productivity differentials against 15 OECD countries have an impact on the real exchange rates of three main oil-exporting countries: Norway and Saudi Arabia (in the period of 1980-2006) and for Russia (in the period of 1995-2006). In the case of Russia it is possible to establish a positive long-run relationship between the real oil price and the real exchange rate. However, authors find virtually no impact of the real oil price on the real exchange rates of Norway and Saudi Arabia. The diverse exchange rate regimes cannot help in explaining the different empirical results on the impact of oil prices across countries, which instead might be due to other policy responses, namely the accumulation of net foreign assets and their sterilization, and specific institutional characteristics.

Kalcheva and Oomes (2007) test symptoms of Dutch Disease, i.e. (1) real exchange rate appreciation; (2) slower manufacturing growth; (3) faster service sector growth; and (4) higher overall wages while carefully controlling for other factors that could have led to similar symptoms over the monthly period of 1997-2005.

Main conclusion of this study is that Russia has all of the symptoms of which real oil price has statistically significant and positive impact on real effective exchange rate in the long run.

Korhonen and Juurikkala (2009) assess the determinants of equilibrium real exchange rates in OPEC countries over the period of 1975 to 2005. By utilizing pooled mean group and mean group estimators, authors find that the price of oil has a clear, statistically significant effect on real exchange rates in oil producing countries in the long-run. Higher oil price lead to appreciation of the real exchange rate. Elasticity of the real exchange rate with respect to the oil price is typically between 0.4 and 0.5, but may be even larger depending on the specification. Real per capita GDP, on the other hand, does not appear to have a clear effect on real exchange rate.

Jahan-Parvar and Mohammadi (2008) test the validity of the Dutch Disease hypothesis by examining the relationship between real oil prices and real exchange rates in a sample of fourteen oil exporting countries over the annual period of 1970-2007. Autoregressive distributed lag (ARDL) bounds tests of co-integration support the existence of a stable relationship between real exchange rates and real oil prices in all countries, suggesting a strong support for the Dutch Disease hypothesis.

By summarizing, all of these articles can be concluded that not depending on objective of the investigations, i.e. testing Dutch Disease Hypothesis, or just measurement the impact of real oil price on real exchange rate these studies reveal statistically significant positive impact of real oil prices on real exchange rate in oil-exporting countries.

Methodology and Data

Real Exchange Rate Equation

For the estimation of real exchange rate I am going to use behavioral equilibrium exchange rate (BEER) approach (Clark and MacDonald, 1998, 2000). This framework suggests looking for a long-run (co-integrating) relationship between the real exchange rate and its economical fundamentals. The theoretical underpinning of the BEER approach rests on the basic concept of uncovered interest rate parity (UIP):

$$q_t = E_t(q_{t+1}) - (R_t - R_t^*) \quad (1)$$

Where, q_t – is a observed real exchange rate at time t, $E_t(q_{t+1})$ – denotes the expected real exchange rate at time t, R_t and R_t*- are domestic and foreign real interest rates at time t respectively.

Under the BEER approach the unobservable expectation of real exchange ($E_t(q_{t+1})$) is assumed to be determined solely by a vector of long-run economic fundamentals Z_t (Siregar and Rajan, 2006). It is assumed that Z_t vector mainly consists of three long run fundamentals namely the relative price of non-traded to traded goods (NTT) as a proxy for relative productivity, net foreign assets (NFA) and terms of trade (TOT) [Faruqee, (1995), MacDonald (1997), Stein (1999), Clark and MacDonald, (1998), Clark and MacDonald, (2000)]. Thus, the BEER approach produces the estimates of equilibrium real exchange rate (q_t^{REER}) as a function of the long-run economic fundamentals and the short-run interest rate differentials:

$$q_t^{REER} = f\left(R_t - R_t*, NTT_t, NFA_t, TOT_t\right) \tag{2}$$

As state Korhonen and Juurikkala (2009) one of the privileges of BEER approach is that this approach can take into account country specific features. So, I should make some changes in Equation (2) on the based on Azerbaijani economy's stylized facts:

a) Since financial market is weakly developed the interest rate differential can be dropped;

b) The studies such as Koranchelian (2005), Zalduendo (2006), Issa et al. (2006), Kalcheva and Oomes (2007), Korhonen and Juurikkala (2007), Jahan-Parvar and Mohammadi (2008) examine relationship between oil price and real exchange rate and reveal that oil prices have a significant impact on the real exchange rates in the oil-exporting countries. Another side some determinants of real exchange rate such as terms of trade, net foreign asset, government spending mainly depend on oil price in the oil-exporting economies. When the oil price raises then terms of trade improves, net foreign assets increases, government expenditure expands and contrary as state Habib and Kalamova (2007). Indeed in the case of Azerbaijan can be observed that there is higher correlation between these above mentioned variables and oil price than real exchange rate. Hence I should exclude terms of trade, net foreign asset from the Equation (2) by including real oil price ($OILP^r$) here;

So, after taking into account above mentioned stylized facts of Azerbaijani economy Equation (2) becomes as following:

$$q_t^{BEER} = f\,(NTT_t, OILP_t^{\,r}) \tag{3}$$

Note that such kind of specification as Equation (3) meets my research objective and is in line with research specifications of Koranchelian (2005), Habib and Kalamova (2007), Korhonen and Juurikkala (2009). On another side as indicates Rautava (2002) given the small number of observations, there is a need to keep the system as small as possible in order to allow for the estimation of parameters.

Since the equilibrium rate is not an officially observable variable, a common empirical approach to estimate the BEER involves two steps. The first step involves estimating the long-run (co-integration) relationship between the prevailing real effective exchange rate (REER) and the economic fundamentals listed in Equation (4):

$$q_t^{REER} = \alpha + \beta_0 ntt_t + \beta_1 oilp_t^r \tag{4}$$

The second step uses the coefficient of these fundamental variables $\left(\hat{\alpha}, \hat{\beta}_0, \hat{\beta}_1\right)$ to compute the behavioral equilibrium exchange rate:

$$\hat{q}_t^{BEER} = \hat{\alpha} + \hat{\beta}_0 NTT_t + \hat{\beta}_1 OILP_t^r \tag{5}$$

Econometric Methodology

Since I have small number of observation (only 31 observations) I intend to employ Autoregressive Distributed Lag (ARDL) approach as main estimation methodology. At the same time in order to check robustness of the results and juxtapose them I am going also to employ Johansen Co-integration Approach in this study. ARDL approach has some advantages compared to other co-integration approaches [Pesaran et al. (2001); Oteng və Frimpong (2006); Sulayman və Muhammad (2010)]: (a) ARDL approach is simple and can be realized by using OLS; (b) There is no endogeneity problem in this method; (c) It is possible to estimate long- and short-run coefficients in one equation simultaneously; (d) It is not needed to Test for Unit Root of variables. In other words ARDL approach is irrespective whether variables in estimation are I(0) or I(1) or mixture of them; (e) this approach is more effective than others when we have small number of observations.

ARDL approach consists of following procedures:

The first stage covers construction of unrestricted Error Correction Model (ECM)

$$\Delta y_t = c_0 + \theta_1 y_{t-1} + \theta_{yxx} x_{t-1} + \sum_{k=1}^{n} \varpi_i \Delta y_{t-i} + \sum_{k=0}^{n} \varphi_i \Delta x_{t-i} + u_t \quad (6)$$

Where, y – is a depended variable; x – stands for explanatory variables; u - is a residuals of model, i.e. white noise errors; c_0 – is a drift coefficients; θ_i - indicate long-run coefficients, while ϖ_i and φ_i - reflect short-run coefficients; Δ - is a difference operator; k – is lag order.

Note that coefficient on y_{t-1}, i.e. θ_1 reflects error correction term. If θ_1 is statistically significant and falls interval of (-1:0) then can be considered that co-integration relationship between variables is stable. In other words short run fluctation of variables corrects toward long-run equilibrium level.

It is worth to note that one of the main points in ARDL estmation is to correctly define lag order of the first differenced variables. Because, finding co-integration relationship between variables is sensitive to lag order. Optimal lag order in ARDL is usually defined by minimising of Akaike and Schwarz criteria and at the same time removing serial autocorrelation of the residuals. Note that it is advisable to prefer Schwarz information criterion in the case of small number of observations (Pesaran and Shin, 1997, p.4; Fatai and et. al, 2003, p.89).

After constructing proper ECM, the second stage is to test for existence of co-integration between variables. In order to test for co-integration is used Wald-Test (or F-Test) on the θ_i coefficients of Equation (6). Hull hypothesis is that there is no co-integration between variables ($\theta_1 = \theta_2 = \theta_i = 0$), while alternative hypothesis is that there is co-integration between variables ($\theta_1 \neq \theta_2 \neq \theta_i \neq 0$)

Note that F-statistics have non-standard distribution in the case of ARDL. Critical values of F distribution are taken from specific table prepared by Pesaran and Pesaran and are reflected in Pesaran and Pesaran (1997) and also Pesaran et. al (2001). The two sets of critical values provide critical value bounds for all classifications of the regressors into purely I(1), purely I(0) or mutually cointegrated.

If the computed F statistics is higher than the upper bound of the critical values given significance level then the null hypothesis of no cointegration is rejected. If the computed F statistics is smaller than the lower bound of the critical values given significance level then the null hypothesis of no cointegration is accepted. The co-integration test result is inconclusive if computed F statistics falls between upper and lower bands.

If it is found that there is co-integration between variables, then long-run coefficients are estimated as a next step of ARDL approach. Long-run coefficients can be calculated based on estimated Equation (6) by setting $c_0 + \theta y_{t-1} + \theta_{yxx} x_{t-1}$ to zero and solving it for y as following way:

$$y = -\frac{c_0}{\theta} - \frac{\theta_{yxx}}{\theta} x + u \tag{7}$$

As I mentioned above in order to check robustness of the results and juxtapose them I am going also to employ Johansen Co-integration Approach in this study. Johansen (1988) and Johansen and Juselius (1990) full information maximum likelihood of a Vector Error Correction Model, which is as following:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta y_{t-i} + \mu + \varepsilon_t \tag{8}$$

Where, y_t is a (*n x 1*) vector of the *n* variables in interest, μ is a (*n x* 1) vector of constants, Γ represents a (*n x (k*-1*)*) matrix of short-run coefficients, ε_t denotes a (*n x 1*) vector of white noise residuals, and Π is a (*n x n*) coefficient matrix. If the matrix Π has reduced rank (*0 < r < n*), it can be split into a (*n x r*) matrix of loading coefficients α , and a (*n x r*) matrix of co-integrating vectors β . The former indicates the importance of the co-integration relationships in the individual equations of the system and of the speed of adjustment to disequilibrium, while the latter represents the long-term equilibrium relationship, so that $\Pi = \alpha\beta'$. *K* is number of lags; *t* denotes time and Δ is a difference operator.

Testing for co-integration, using the Johansen's reduced rank regression approach, centers on estimating the matrix Π in an unrestricted form, and then testing whether the restriction implied by the reduced rank of Π can be rejected. In particular, the number of the independent co-integrating vectors depends on the rank of Π which in turn is determined by the number of its characteristic roots that different from zero. The test for nonzero characteristic roots is conducted using Max and Trace [3] tests statistics.

While the ARDL bound testing approach does not require pre-testing order of integration, all variables need to be integrated of order one in order to apply the Johansen Co-integration method. Therefore, before estimating the co-integrated vector-error correction by Johansen's method, the stochastic properties of the data are

[3] Since Trace tests tend to reject the null hypothesis of no co-integration in small samples, Johansen (2002) shows that as long as the number of parameters per observation, *kn/T* (with *k* equal to the number of lags in VAR, *n* is the number of endogenous variables and *T* is the length of the sample), is less than 0.20, the Trace test will give robust results. It is useful to take this ratio into account for our co-integration relationships because of we also have small numbers of observations.

assessed by menas of Unit-Root Tests. I am going to employ Augmented Dickey-Fuller (1981) and Phillips-Perron (1988) unit root tests to assess the time-series properties of the data. The Augmented Dickey-Fuller and Phillips-Perron tests maintain the null hypothesis of non-stationarity of the time series.

Data

Research covers quarterly data over the period 2000-2007 and includes: real effective exchange rate ($REER$), domestic consumer price index (CPI), and domestic producer price index (PPI), trade-weighted average consumer price index of main trading partners (CPI^F), trade-weighted average producer price indices of main trading partners (PPI^F) and manat-US Dollar bilateral exchange rate and nominal oil price.

Real Effective Exchange Rate is a multilateral consumer price index based on real effective exchange rate of a currency of domestic economy relative to its main trading partners. It is defined in terms of foreign currency per unit of domestic currency, so that an increase in real effective exchange rate means appreciation of domestic currency. Real effective rates are calculated by Central Bank of Azerbaijan (CBA) and it can be retrieved from CBA official web-site (www.nba.az).

The Relative Price of Non-Traded to Traded Goods. This variable is used as a proxy for productivity differentials[4].

Productivity differentials are used to capture the Balassa-Samuelson effect[5] that is one of main determinants of real exchange rate. Ideally, direct measurements of productivity in the tradable and non-tradable sectors should be used. However, such kind of data I could not find for Azerbaijan and its main trading partners. So, two kinds of proxies can be used for measuring productivity differentials: The first one is the relative price of non-tradable to tradable; a measurement employed by Macdonald (1997a) Clark and MacDonald, (1998), Clark and MacDonald, (2000), Egert (2007), AlShehabi and Ding (2008), Egert (2009) and other researches. The second one is GDP per capita in PPP terms relative to trading partners, which was used by Chudik and Mongardini (2007). Because of two reasons I use the first proxy: a) The CPI/PPI ratio explicitly

[4] Note that to use the relative price of non-traded to traded goods as a proxy for productivity differentials and its definition is in line with the large number of studies, including Macdonald (1997a), Clark and MacDonald, (1998), Clark and MacDonald, (2000), Egert (2007), AlShehabi and Ding (2008), Egert (2009).

[5] The Balassa-Samuelson hypothesis postulates that increases in the productivity of the tradable sectors cause non-tradable prices to increase relative to tradable prices, leading to real exchange rate appreciation.

differentiates between the tradable and non-tradable sectors, a feature that is lacking in the second measurement; b) In order to calculate GDP per capita in PPP terms relevant variables over the required period and for all trading partner could not be found. Therefore, I decided to use relative price of non-traded to traded goods (NTT) as a proxy for relative productivity and it is defined as below:

$$NTT = \frac{\left(\frac{CPI}{PPI}\right)}{\left(\frac{CPI^F}{PPI^F}\right)} \tag{9}$$

Trade-weighted average consumer price index of the major trading partners is calculated as below:

$$CPI^F = \sum_{i=1}^{11}\left(CPI^i w^i\right) \tag{10}$$

$CPI^i -$ is a consumer price index of *i*-th trading partner, $w^i -$ is *i*-th trading partner's weight in overall trade volume of Azerbaijan.

Analogically trade-weighted average producer price index of the major trading partners is calculated as below:

$$PPI^F = \sum_{i=1}^{11}\left(PPI^i w^i\right) \tag{11}$$

$PPI^i -$ is a producer price index of *i*-th trading partner.

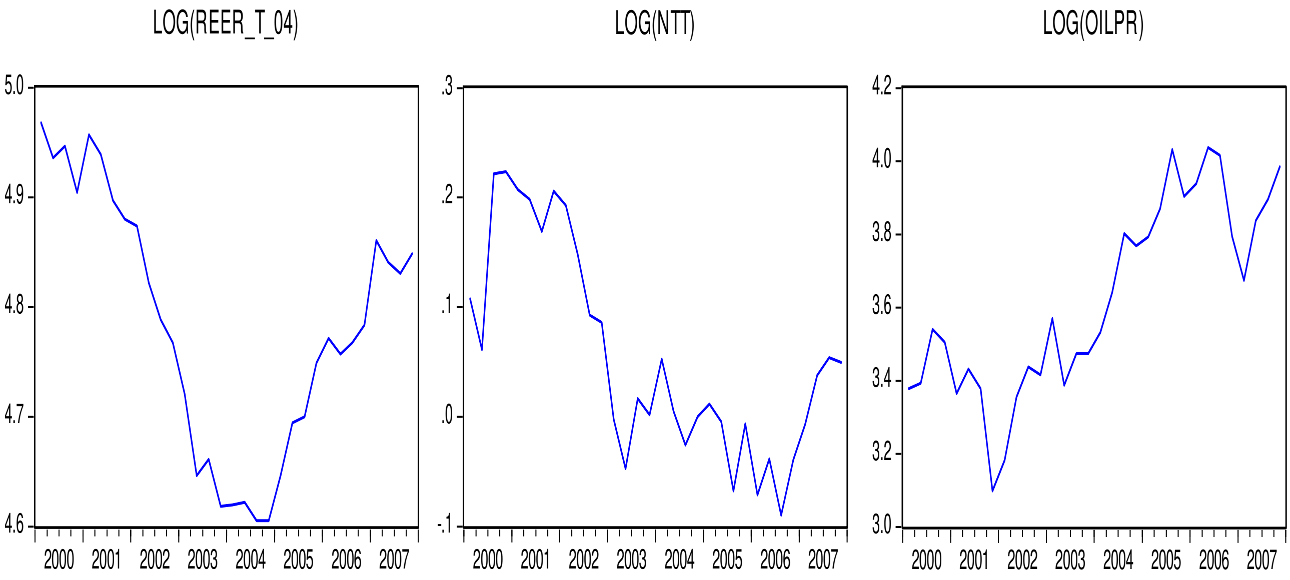
Required data in order to calculate CPI^F and PPI^F is taken from the International Financial Statistics (IFS) and official web page of CBA.

CPI and PPI for Azerbaijan are taken from State Statistical Committee's bulletins on monthly base. Weights of main trading partners in overall trade turnover of Azerbaijan are taken from CBA bulletins.

Real Oil Price ($OILP^r$) is calculated as nominal oil price is multiplied by nominal manat-US Dollar bilateral exchange rate and divided by CPI. As nominal oil price is taken crude oil price of United Kingdom Brent from IFS databases.

The time profile of real effective exchange rate, relative productivity and real oil price in their logarithm expressions are given Figure 1 below:

Figure 1: Time profile of variables



Estimation outputs

In order to know stochastic properties of variables first I perform Unit Root Test by employing Augmented Fickey Fuller and Phillip Perron Tests. Tests outputs are given Table A1 in the Appendix A and as shown from the test results all three variables are non-stationary in their level and stationary in the first difference. In other words they are I(1). Note that appropriate lag length for variables are selected by Schwarz information criterion.

Equation (6) in my case has following specification:

$$\Delta reer_t = c_0 + c_1 dum07Q1_t + \theta_1 reer_{t-1} + \theta_2 oilp^r{}_{t-1} + \theta_3 ntt_{t-1} + \sum_{i=1}^{n} \varpi_i \Delta reer_{t-i} + \sum_{i=0}^{n} \varphi_i \Delta oilp^r{}_{t-i} + \sum_{i=0}^{n} \beta_i \Delta ntt_{t-i} + u_t \quad (12)$$

Where, dum07Q1 – is a dummy variable which take one for the first quarter of 2007 and zero otherwise. This dummy is used for capturing sharp appreciation of real effective exchange rate in the first quarter of 2007 which may be tightly related to huge inflow of oil revenues and incresing in administrative price and therefore in CPI [6]. Also note that small letters indicate logarithmic expressions of variables in the estimations.

As the first step of ARDL approach, I estimate Equation (12) with maximum lag of the first differenced right-hand side variables and seven lags are maximum. Then I seek optimum lag for the first differenced

[6] An administrative price was increased 40% at the January of 2007 relative to previous month and it caused high inflation rate and therefore, high appreciation of real effective exchange rate.

right-hand side variables by minimizing value of Akaike and Schwarz criteria and at the same time by testing serial autocorrelation of residuals of Equation (12) in each lag order . According to to Schwarz criterion one lag is optimal while Akakike criterion indicates two lag. As mentioned in the Methodological section it is advisable to prefer Schwarz information ctiretion in case of small number of observations and therefore, I choose one lag as optimal order.

As a next step I perform Bound Test for checking existence of cointegration between level lagged variables of Equation (12) [7]. Since calculated F-statistics, **10.42** is higher than the **4.66**, upper bound of critical value[8] at the 99% significance level I can conclude that there is co-integration between real effective exchange rate, real oil price and relative productivity.

After getting co-integration between variables next step is to estimate long-run coefficients. Long-run coefficients is derived from Final ECM specification. Final ECM specification and long-run relationship between variables are given Equation (13) and Equation (14) respectively

$$\begin{aligned}\Delta reer_t &= 0{,}41 - 0{,}20 reer_{t-1} + 0{,}15 oilp^r{}_{t-1} + 0{,}39 ntt_{t-1} + \\ &+ 0{,}29 \Delta ntt_t - 0{,}15 \Delta ntt_{t-1} - 0{,}14 \Delta oilp^r{}_{t-1} + 0{,}06 dum07Q1_t\end{aligned} \tag{13}$$

Final ECM specification is satisfactory in terms of some test characteristics as shown Table A2 in the Appendix A[9].

$$reer = 2{,}02 + 0{,}75\, oilp^r + 1{,}95\, ntt \tag{14}$$

Now in order to check robustness of the results and juxtapose them I employ Johansen Co-integration Approach. First I look for optimum lag length relying on Lag Order Selection Criteria. The most of these criteria indicate that two lags are appropriate.

Thereby I estimate VAR model with two lags, three endogenous variables, namely real effective exchange rate, real oil price and relative productivity and exogenous variables such as constant and dummy variables namely dum07Q1. Note that this VAR model is satisfactory in terms of stability test, residuals serial autocorrelation, and normality and heteroskedasticity tests (Detailed information can be obtained from author).

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[7] Note that we found co-integration between variables also when we estimate equation (12) with two lags.
[8] Version: Restricted intercept and no trend [Pesaran et.al. (2001), page 12]
[9] In order to save space other test results (such as residuals tests, coefficients tests, misspecification tests and etc.) are not given in the paper and can be obtained from author under request.

Then I perform Co-integration Test based on this VAR and as shown from the Table B1 in Appendix B both Trace and Max-Eig Tests indicate existence of one co-integration relation between variables in four of Co-integration Test Specifications. Since there are four competing versions I should choose more relevant one among them. I estimate VECM in each of these four specifications and compare them with their properties. The results are given Table B 2 in Appendix B. As shown from the Table B 2 fourth specification, i.e. "Intercept and trend in CE–no trend in VAR" is not relevant one due to trend coefficient is not statistically significant. The first specification also is not appropriate because of weak exogeneity test of real oil price is not satisfactory here. Thus, I should choose relevant one among the second and the third specifications. One can prefer rather the third specification than second in terms of R-squared, Sum squared of residuals, Log Likelihood and highly significance of weak exogeneity Test. Thus, at the final I consider that the third specification is the most relevant one. So, long-run relationship between real effective exchange rate, real oil price and relative productivity derived from Johansen co-integration approach in given Equation (15)

$$reer = 2{,}00 + 0{,}74\,oilp^{r} + 2{,}10\,ntt \tag{15}$$

Note that this long-run equation is satisfactory in terms of autocorrelation, normality and heteroskedasticity tests of residuals (See: Table B2 in Appendix B).

By using long-run coefficients of variables in Equation (15) I construct error correction term. ECM based on Johansen approach is as below:

$$\begin{aligned}\Delta reer_t = &-0{,}15ecm_{t-1} + 0{,}21\Delta reer_{t-2} + 0{,}25\Delta ntt_t - \\ &- 0{,}14\Delta oilp^{r}{}_{t-1} + 0{,}08\Delta oilp^{r}{}_{t-2} + 0{,}05dum07Q1_t\end{aligned} \tag{16}$$

Since coefficient of error correction term is statistically significant and with negative sign I can conclude that there is stabile long-run relationship between variables (See: Table B2, in Appendix B). Based on these error correction terms I can calculate half-life speed (HLS) of adjustments towards long-run equilibrium (i.e. how many quarter would need manat's real effective exchange rate to restore half of its equilibrium) and it is revealed that half-life speed of adjustments approximately takes 3-4 quarters in the case of Azerbaijani real effective exchange rate.

Interpretations of Estimation Results

Long-run coefficients derived from ARDL and Johansen approaches are very close to each-other as shown from Equation (14) Equation (15) respectively. According to these equation **one percent** increase (decrease) in real oil price leads to approximately **0.7 percent** appreciation (depreciation) of real effective exchange rate of manat. It is worth to note that this finding is in consistent with my research expectation and in line with findings in case of other oil-exporting countries. For example Cashin (2002) for 22 commodity exporting countries, Koranchelian (2005) for Algeria, Zalduendo (2006) for Venesuela, Issa et al. (2006) for Canada, Habib and Kalamova (2007) for Norway, Saudi Arabia and Russia, Oomes and Kalcheva (2007) for Russia, Jahan-Parvar and Mohammadi (2008) for 14 oil-exporting countries, Korhonen and Juurikkala (2009) for 9 OPEC countries. This finding has at least two important implications: the first one is that it supports the existence of a co-integration between real oil prices and real exchange rates, and the Dutch Disease hypothesis. Second one is that it indicates direction on causality, from real-oil price to real exchange rate.

It is important to note that we cannot conclude that Azerbaijani economy has contracted Dutch Disease just by estimating impact of real oil prices on real exchange rates and in this regard we have to check all symptoms of Dutch Disease in parallel with carefully testing alternative explanations of the observed processes.

One percent rise (decrease) in relative productivity causes approximately **2 percent** appreciations (depreciations) in real effective exchange rate of manat. This finding is also in line with my expectation and findings of other studies. For example, statistically significant and positive impact of relative productivity, i.e. Balassa-Samuelson Effect on real exchange rate also found by Halpern and Wyplosz (1997) for Transition countries of Eastern Europe and Former USSR; Egert and Lommatzsch (2004) for Transition countries of Eastern Europe; Egert (2005) for Bulgaria, Croatia, Romania, Russia, Ukraine, Turkey; Koranchelian (2005) for Algeria; Egert et al. (2007) for Central and Eastern European economies; Habib and Kalamova (2007) for Russia; Zalduendo (2006) for Venesuela; Oomes and Kalcheva (2007) for Russia and Korhonen and Juurikkala (2009) for 9 OPEC countries. However, we should be careful when we interpret relative productivity in case of Azerbaijan. The point is that increase in relative price of non-tradable is not sourced from productivity increase in tradable sector (i.e. in manufacturing and agriculture) as states Balassa-Samuelson Hypothesis. If we look at the productivity growth in tradable sector (manufacturing and agriculture) we can observe that there is downward trend here and on another side there are high Unit Labor Cost growth in tradable and non-tradable sectors, especially since 2004 (See:

Figure C1-C2 in Appendix C). Therefore, increasing in relative price of non-tradable can be explained by rather spending of oil revenues in non-tradable sector as budget expenditure than Balassa-Samuelson Effect. Indeed main part of oil revenues in form of government expenditure is oriented to non-oil sector of economy and this excess demand creates price increase in this sector (See: Figure C3-C4 in Appendix C). Thereby one can conclude that increasing in relative price of non-tradable, one of the main determinants of appreciation of real effective exchange rate mostly associates with high fiscal expansion, than Balassa-Samuelson Effect.

Study also reveals that according to coefficients of error correction terms derived from Johansen and ARDL approaches 15-20 percent of short-run disequilibrium can be corrected toward long-run equilibrium path within a quarter and half-life speed of adjustment approximately takes 3-4 quarters in the case of Azerbaijani real effective exchange rate.

Conclusion and Policy Suggestions

Study reveals that real oil price has statistically significant and positive effect on Azerbaijani real effective exchange rate which is similar to the experience of other oil-exporting countries. This finding provides us two kinds of conclusion: The first is that it supports significant role of oil price in formation of equilibrium path of real exchange rate of manat, therefore, Dutch Disease hypothesis. Second one is that it indicates direction on causality, from real-oil price to real exchange rate.

It is important to note that we cannot conclude that Azerbaijani economy has contracted Dutch Disease just by estimating impact of real oil prices on real exchange rates and in this regard we have to check all symptoms of Dutch Disease in parallel with carefully testing alternative explanations of observed processes.

Study also finds statistically significant and positive impact of relative prices on real exchange rate of manat which mostly associates with fiscal expansion than Balassa-Samuelson effect.

Since both of these determinants are tightly related to high fiscal expansion my policy suggestions mainly focused on rather fiscal policy implementations than monetary policy issues. I think that all these challenges particularly appreciation of real exchange rate which undermines competitiveness of economy mainly related to management of oil revenues that is mainly fiscal issue than monetary. The main point is that when government converts oil dollars into manats because of excess supply of foreign currency nominal exchange rate of manat faces appreciation pressure. This is one of the potential channels of real exchange rate appreciation. Then government spends these revenues mainly orienting into non-tradable sectors. This spending creates excess demand for non-tradable goods which causes increasing in relative price of non-tradable. That is the second potential channel of real exchange rate appreciation. Note that the second channel is more crucial than first one because of nominal appreciation of manat somehow is prevented by Central Bank of Azerbaijan.

I would suggest that in parallel with such kind of spending (expensive reconstruction works on administrative buildings, roads and bridges, construction of new buildings and etc.) government also should pay more attention to development of non-oil tradable sector (manufacture and agriculture) which can help diversification and sustainable development of economy. In this regard policy makers should focus on implementation of policy measures that cover issues below:

- Efficiently using oil revenues in favor of non-oil tradable sector developing;
- Establishment and support of domestic industries;
- Involving foreign direct investments into non-oil tradable sector, especially export oriented branches;
- Promotions (tax concessions, subsidies, soft line credits and etc) to non-oil industry and agriculture, especially to the export oriented and import substituting and also strategic branches;
- Elimination of institutional constraints, improvement of relevant legislation with a view to developing non-oil tradable sector;
- Development of education and investment in human capital.

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Appendix

Appendix A: Estimation Outputs of ARDL Approach

Table A1: ADF and PP Unit Root Test Results

Variables	Test Method	İn the level			İn the first difference		
		Constant	Trend	Actual value	Constant	Trend	Actual value
LOG(REER)	*ADF*	Yes	Yes	-0.264032	No	No	-4.800968***
	PP	Yes	Yes	-0.416001	No	No	-5.038039***
LOG($OILP^r$)	*ADF*	Yes	Yes	-2.398926	No	No	-5.549716***
	PP	Yes	Yes	-2.398926	No	No	-5.601480***
LOG(NTT)	*ADF*	No	No	-2.041835	No	No	-6.571813***
	PP	No	No	-2.018383	No	No	-6.720613***

Note that *, ** and *** asateriks above actual values indicate statistical significance of actual value at the 1%, 5% and 10% significance levels respectively. Number of observations are 31. Seven lags were used in ADF test automatically and appropriate lag length is selected by Schwarz criterion

Table A2: Final ECM Specification with legged level variables

Dependent Variable: DLOG(REER)
Method: Least Squares

Independent Variables	Coefficient	Std. Error	t-Statistic	Prob.
LOG(REER(-1))	-0.201001	0.052328	-3.841163	0.0008
LOG(NTT(-1))	0.389387	0.099174	3.926307	0.0007
LOG($OILP^r$ (-1))	0.147203	0.026386	5.578826	0.0000
C	0.405052	0.221021	1.832639	0.0798
DLOG(NTT)	0.288799	0.081645	3.537239	0.0018
DLOG(NTT(-1))	-0.146740	0.080938	-1.813003	0.0829
DLOG($OILP^r$ (-1))	-0.144408	0.036001	-4.011182	0.0005
DUM07Q1	0.056480	0.022799	2.477245	0.0210

R-squared	0.756533	Mean dependent var	-0.003850
Adjusted R-squared	0.682435	S.D. dependent var	0.034770
S.E. of regression	0.019594	Akaike info criterion	-4.809577
Sum squared resid	0.008830	Schwarz criterion	-4.439516
Log likelihood	82.54844	Hannan-Quinn criter.	-4.688946
F-statistic	10.20983	Durbin-Watson stat	2.010402
Prob(F-statistic)	0.000009		

Appendix B. Estimation Outputs of Johansen Approach

Table B1: VAR Co-integration Test Output

Series: LOG(REER_T_04) LOG(NTT) LOG($OILP^r$)
Exogenous series: DUM07Q1
Lags interval: 1 to 2

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	1	1	1	1	2
Max-Eig	1	1	1	1	2

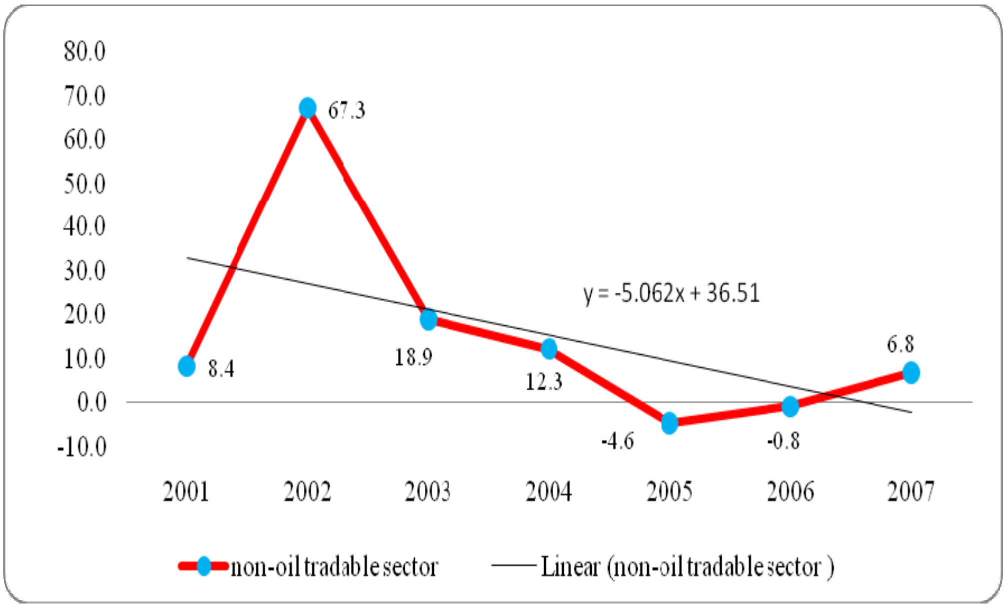
*Critical values based on MacKinnon-Haug-Michelis (1999)

Table B2: REER Co-integration Equations Specifications and Residuals Tests and Weak Exogeneity Tests

	Co-integration Equations Specifications			
	No intercept or trend in CE or VAR	Intercept (no trend) in CE–no intercept in VAR	Intercept (no trend) in CE and VAR	Intercept and trend in CE–no trend in VAR
reer	1.00000	1.00000	1.00000	1.00000
ntt	2.90963	2.22077	2.10013	2.15554
t-statistics:	[-9.68844]	[-6.05912]	[-5.99229]	[-4.20601]
$oilp^r$	1.26224	0.81671	0.73959	-1.27059
t-statistics:	[-138.025]	[-4.83501]	[-4.57890]	[-5.16496]
C		1.67033	-1.99530	-0.43342
t-statistics:		[-2.66689]		
@trend				-0.00995
t-statistics:				[1.64232]
ECM coefficient	-0.07534	-0.11437	-0.12334	-0.09191
t-statistics:	[-2.77808]	[-3.01422]	[-2.72339]	[-2.70577]
Statistical Properties				
R-squared	0.68279	0.69632	0.69818	0.69719
Sum squared residuals	0.01150	0.01101	0.01095	0.01098
Log Likelihood	78.44756	79.12283	79.21806	79.16756
Akaike AIC	-4.54500	-4.58857	-4.53020	-4.52694
Schwarz SC	-4.17494	-4.21851	-4.11388	-4.11062
Residuals Tests				
LM Test	OK	OK	OK	OK
Jarque-Bera	12.09927	3.71554	3.48120	2.07476
Prob.	0.05980	0.71510	0.74650	0.91270
White Heterosk. Test (Chi-sq)	93.19313	99.58763	95.95743	95.48142
Prob.	0.36790	0.22960	0.31420	0.32630
Weak Exogeneity Test				
$\alpha_{reer} = 0$	7.569794	8.58729	7.32987	6.12715
Prob.	0.00594	0.00339	0.00678	0.01331
$\alpha_{ntt} = 0$	0.79858	1.33686	1.77627	0.26029
Prob.	0.37152	0.24759	0.18261	0.60992
$\alpha_{oilp^r} = 0$	6.82660	2.90925	1.21983	2.68776
Prob.	0.00900	0.08807	0.26940	0.10112

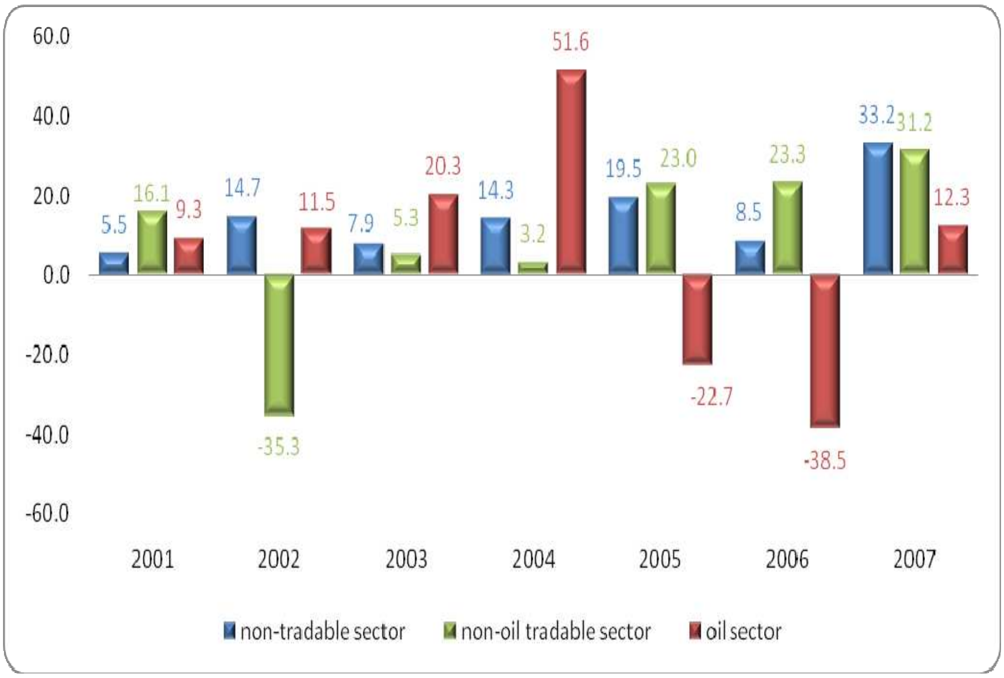
Appendix C: Graphic Illustrations

Figure C1: Productivity growth in non-oil tradable sector, %



Source: Author's own calculation based on SSCAR data.

Figure C2: ULC growth by sectors, %

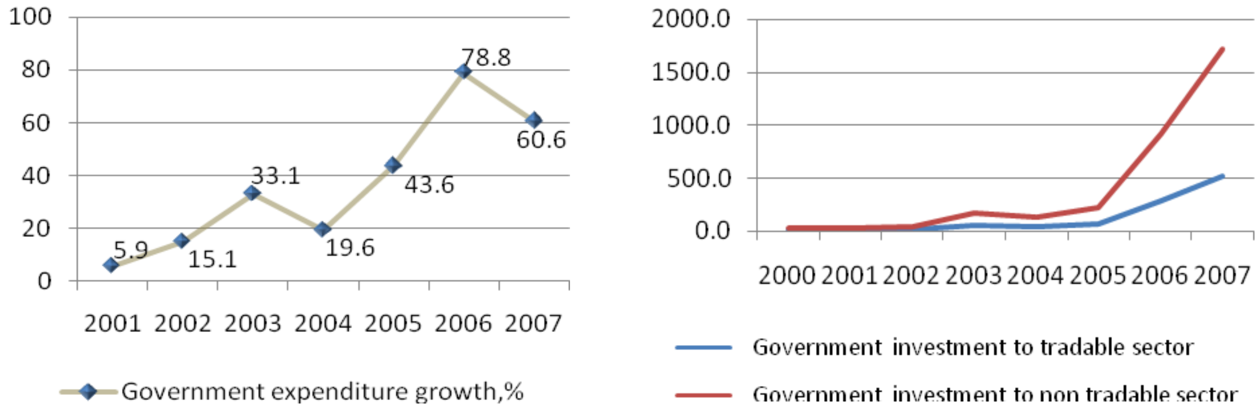


Source: Author's own calculation based on SSCAR data.

Figure C3: Government expenditures and government investments to non-oil tradable and non-tradable sectors

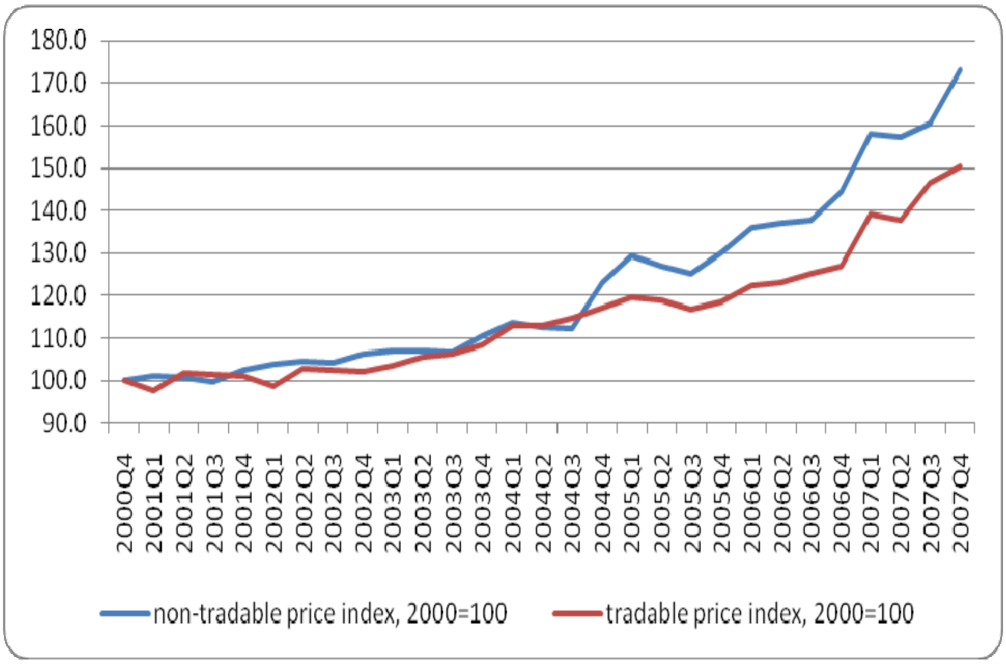
a) **Government Expediture Growth**

b) **Government investments, million AZN**



Source: Author's own calculation based on SSCAR data.

Figure C4: Tradable and non-tradable prices



Source: Author's own calculation based on SSCAR data.