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**Abstract:**
By using quarterly data from 2001-2007 and applying various approaches, we estimate real equilibrium exchange rate misalignment for Azerbaijani Manat (AZN) and find that AZN is slightly overvalued. Purchasing power parity approach does not explain the equilibrium exchange rate. However using behavioral and permanent equilibrium exchange rate approaches, we find that the relative productivity, terms of trade, trade openness, net foreign assets, government expenditures and oil prices are the main determinants of misalignment.

Key words: Real exchange rate, misalignment, Azerbaijan, Manat, exchange rate

JEL: F31

## Introduction

Economies with inflexible nominal exchange rate regimes without necessary policies usually face the real exchange rate misalignment. However, regardless of exchange rate regime, monetary policy makers desire to maintain the real exchange rate close to "equilibrium" in order to avoid negative consequences of exchange rate misalignment. Real exchange rate misalignment is the difference between the long-run equilibrium real exchange rate and the current real exchange rate. Consistent misalignment of the exchange rate results in serious macroeconomic discrepancies. Several emerging, as well as, post-Soviet countries have experienced a currency crisis because of a pegged or less flexible exchange rate regime. Exchange rate problems and banking crises in Asia and Latin America have been studied extensively[1]. In order to minimize this difference, public policy makers in transition economies first need to estimate the key determinants of exchange rate misalignment.

The economic literature has suggested several approaches to estimate the main determinants of misalignment. Purchasing Power Parity (*PPP*) approach is used as a basic model to estimate the misalignment. However, the characteristics of transition economies may

[1] Please refer to Aghion et al. (2000, 2001), Berg and Pattillo (1999a, b), Frankel and Rose (1996), Goldstein et al (2000), Krugman (2000), and Obstfeld (1996) among other studies.

undermine the applicability of this approach. Several studies that employed this approach had obtained inconsistent results. Furthermore other studies included variables, such as productivity growth differentials, inflation rates and capital inflows to determine potential factors influencing real exchange rates. By studying the determinants of real equilibrium exchange rates in various transition economies, Kemme and Teng (2000), Egert and Lahreche-Revil (2003), Kemme and Roy (2003), and Taylor and Sarno (2001) among others find that the interest rate and productivity differentials are the key determinants of the real exchange rate. Most of these studies use several approaches along with *PPP* approach, such as Macroeconomic Balance (foreign trade balance - *MB*) developed by Williamson (1983, 1994), Behavioral Equilibrium Exchange Rate (*BEER*) suggested by Clark and McDonald (1998, 2000), as well as Permanent Equilibrium Exchange Rate (*PEER*) developed by Beveridge and Nelson (1981) to measure the misalignment in exchange rates. These methods differ in factors they employ to estimate the misalignment. While *PPP* approach focus on the nominal rate that compensate the relative price differences, *MB* approach use the rate that equates domestic and foreign trade balance. However, *BEER* approach calculates the rate that is determined during the long run relationship between the exchange rate and its main determinants. The determinants can be both interest rate differentials and macroeconomic factors. *PEER* approach utilizes permanent components of these variables to predict the equilibrium real exchange rates.

To our best knowledge the previous literature has not studied the determinants of the equilibrium real exchange rate of Azerbaijani Manat (we use Manat throughout the study) and not identified the best approach among discussed above. Based on the findings of previous studies, we use several methods to determine the main factors affecting the real exchange rate in Azerbaijan. Using quarterly data from 2001-2007, we find that various *PPP* approaches are not appropriate for estimating equilibrium real exchange rates in Azerbaijan. This may be

caused by higher relative prices than those in main trade partners not compensated by nominal exchange rates in the country. *Macroeconomic Balance Approach* also is not appropriate tool for equilibrium exchange rate estimation, because estimated import equation (which is main part of this approach) is not consistent with the theory. Then we apply *BEER* approach and find that the main determinants of the long run *REER* are terms of trade index, relative productivity, trade openness and net foreign assets. We also find a significant Ballassa-Samuelson effect on real exchange rates with a size of 0.4 percent.

Furthermore, we find that the key determinants of the short run *REER* are its lagged values, terms of trade index, trade openness, net foreign assets, and administered prices index. The error correction approach estimates that 45 percent of misalignment in *REER* is restored during one quarter. Using *PEER* approach we conclude that the existence of permanent components in the long term determinants of *REER* increases the misalignment between actual and equilibrium exchange rates.

The rest of the paper is designed as follows: Section I describes monetary and exchange rate policy background for Azerbaijan. Section II estimates various *PPP* approaches and makes assessments for the best approach. Section III shows the results of Macroeconomic Balance Approach. Section IV introduces Behavioral Equilibrium Exchange Rate approach and its results. Section V estimates Permanent Equilibrium Exchange Rate approach. Section VI concludes.

## I. Monetary and Exchange Rate Policy Background for Azerbaijan

Transition to market economy in Azerbaijan accompanied with sharp reduction in production, hyperinflation, and depreciation of local currency. As a result, Azerbaijan experienced volatile monetary and exchange rate policies during 90s. Eight years of war that resulted in military occupation of 20 percent of country's territories by its neighbor, Armenia,

exacerbated these problems. However, highly volatile period was soon followed by the period of a stable economic development in 2000s. During 2004-2007, with the implementation of "Stability Program" supported by IMF, Azerbaijan has been able to reduce the inflationary pressures in the economy and reach stability in prices and exchange rates. International oil consortium linking country's rich oil reserves with international markets through world's second-largest oil pipeline, BTC, created a sustainable source of rich oil revenues. Consequently, Azerbaijan became the fastest growing country with GDP growth rate at 20-30 percent during 2005-2007. Although the oil revenues are collected in Oil Fund, the substantial amount is transferred to government budget every year to finance infrastructure projects. Banking industry has been country's one of the fastest growing industries fueled by oil revenues flown into the economy.

The developments in financial system affected foreign exchange markets in Azerbaijan. Currently, foreign currency is traded in three trading venues: *OpIFEM - Open Interbank Foreign Exchange Market, İBT – İnternal Bank Transactionns and BEST- Burse E-System of Trade*. About 40 percent of total volume is traded in *IBT* where firms and individual customers exchange their currency. Total volume of transactions increased from $6.1 billion to $15.1 billion, 50 percent of which were in dollars. Oil revenues created a large amount of trade balance surplus that caused manat to appreciate. During 2004-2007 manat appreciated 13 percent against dollar. Appreciation in manat has increased the confidence in local currency and manat denominated deposits grew from 20 to 50 percent of total deposits. However, manat would further appreciate, if the Central Bank of Azerbaijan (CBA) did not intervene to the foreign exchange markets. For example, the CBA spent $1.4 billion in 2007 (slightly less than 10 percent of total volume in dollars market) to intervene the foreign exchange markets.

The CBA officially states to use managed floating exchange rate regime. However, since 1995 the fixed exchange rate regime was actually implemented with different intermediate regimes. The CBA's exchange rate policies varying from managed appreciation of manat to its depreciation have been successful at attaining price and exchange rate stability. However, increasing oil revenues forced CBA to revise its exchange rate policies and sterilize dollar revenues. CBA's buy-side intervention into currency markets increased inflationary pressures. The CBA has been very flexible in its exchange rate policies recently. During 2008 the CBA pegged manat's value to dollar, later following depreciation in dollar's value against euro it switched to the euro-dollar basket. Following the peak of financial crisis in October 2008, the CBA effectively dropped euro from the basket and pegged its currency to dollar.

As an oil-producing country, Azerbaijan's macroeconomic stability is vulnerable to right choice of exchange rate policy. Consistent misalignment in exchange rates will cause unavoidable damages. Therefore, the aim of this study is to determine the main factors affecting real exchange rates in Azerbaijan. Our results will provide policymakers with effective tools to implement the right exchange rate policy.

## II. PPP Approaches

### *A. Simplified PPP Approach*

All *PPP* approaches suggest that the real exchange rates, $R$ is affected from the changes in relative price levels. These approaches estimate the real exchange rate as:

$$R = S * (P/P^*)$$

where, $S$ is nominal exchange rate, $P^*$ is the weighted average price level of trade partners and $P$ is the price level in domestic economy.

According to the relative *PPP* approach, we can write the nominal exchange rate as a fraction of relation in price levels; $S = k*(P*/P)$. Substituting this equation above we can write: $R = S * (P/P*) = k*(P*/P)* (P/P*) = k$.

Simplified *PPP* approach assumes that the real exchange rate remains stable over the period of time. If the rate is above the average for that period it is overvalued, otherwise the rate is undervalued.

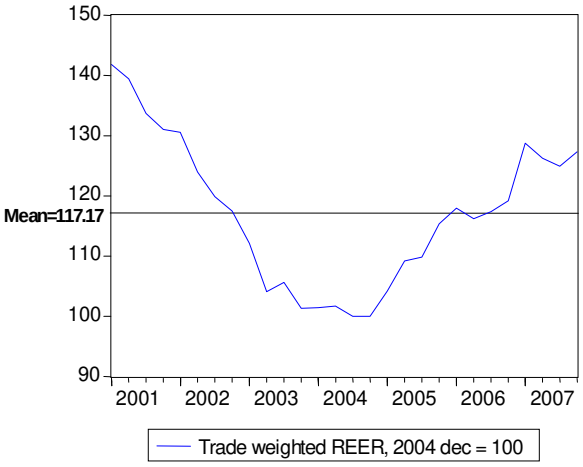


**Figure 1: Real exchange rate time series in Azerbaijan**

Figure 1 shows that the real exchange rate in Azerbaijan depreciated during 2001-2003 and appreciated since 2004. Although Central Bank of Azerbaijan (CBA) implements an appropriate exchange rate policy to prevent Manat from appreciating, because of the increase in oil revenues and trade balance surplus the appreciation has been inescapable since the end of 2006. According to the *Simplified APP* approach real exchange rate of Manat in 2007Q4 (127.34) is 8.7 percent higher than its equilibrium level (117.18) for the given period. However, the results should be considered with some caution, because they may be affected by the short sample size and may differ if one considers a longer period.

***B. Absolute PPP approach***

Another approach to test the deviations in real exchange rates is to use *Absolute PPP* approach. This approach assumes that the nominal exchange rate is equal to the ratio of price levels in domestic economy and in the main foreign trade partner:

$$S = P^*/P \qquad \text{or} \qquad Log\,(S)=Log(P^*) - Log(P)$$

We can write this equation in differences as below:

$$DLog(S) = DLog(P^*) - DLog(P)$$
or
$$DLog(S) – (DLog(P^*) - DLog(P)) = 0$$

Thus the change in the nominal effective exchange rates (*NEER*) should be equal to the difference in home and foreign price changes. We find that the actual *NEER* deviates from this definition. Figure 2 shows that changes in *NEER* in Azerbaijan are not equal to the differences in home and foreign price change.

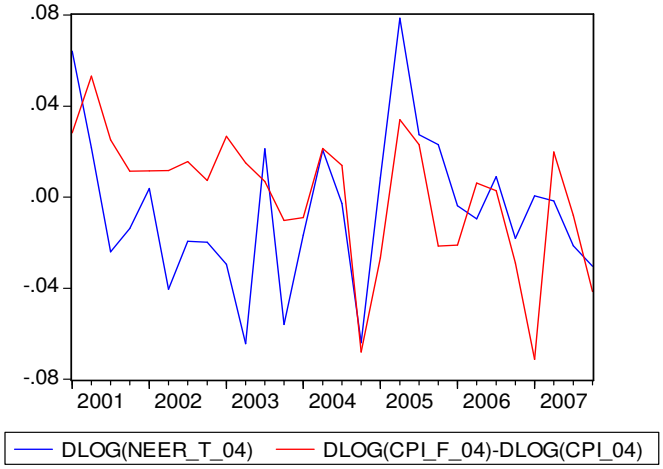


**Figure 2: NEER and differences in home and foreign prices**

Alternatively, one can test the strength of *Absolute PPP* approach to explain the real exchange rate misalignment by applying unit root test. This approach assumes that the difference between home and foreign prices is offset by nominal exchange rate and the real exchange rate remains stable or floats around that level in the long-run. This assumption will be valid if the time series of real exchange rate are stationary. In other words, if the test fails

to reject the unit root in series, then *Absolute PPP* approach does not hold and the real exchange rate significantly deviates from its equilibrium.

We use several methods to test for unit root in Table 1.1. The test results show that time-series of *REER* is not stationary during 2001-2007, therefore we can conclude that *Absolute PPP* approach cannot explain the behavior of exchange rates. In other words PPP approach does not hold in Azerbaijani economy. However we realize that the short period of time and the limited number of observations may affect our results and it is possible that this approach will better fit the longer period of data.

### *C. PPP Adjusted for the Balassa-Samuelson and Penn Effects*

In this section, we test Manat's real exchange rate misalignment with *PPP Adjusted for the Balassa-Samuelson and Penn* Effects.This approach assumes that the real exchange rate is the change in relative prices of tradable and non-tradable goods. It can be written as:

$$R = S * \frac{\left(\frac{P_N}{P_T}\right)^{\alpha}}{\left(\frac{P_N^*}{P_T^*}\right)^{\beta}} * \left(\frac{P_T}{P_T^*}\right) \quad \text{or} \quad \log(R) = \log(S) + \log\left(\frac{P_T}{P_T^*}\right) + \alpha * \log\left(\frac{P_N}{P_T}\right) - \beta * \log\left(\frac{P_N^*}{P_T^*}\right) \quad (1)$$

where $S$ and $R$ are the nominal and real exchange rates, respectively, $P_T$, $P_N$, $P^*_T$ and $P^*_N$ are the home and main foreign trade partner prices of tradable and non-tradable goods, while $\alpha$ and $\beta$ are the ratio of non-tradable goods price index to the consumer price index.

The last two terms in equation (1), the relative prices of non-tradables to tradables in home country and in the main trade partner, estimates the Balassa-Samuelson impact. This approach assumes that if tradables are more productive than nontradables, it will adversely affect their prices. In other words, the prices of non-tradables will be higher than that of tradables. This will lead to the appreciation of home currency. An increase in average productivity of tradables in main trade partners will lead to the depreciation of local currency.

Thus if the sum of the coefficients of the third and fourth terms on the right-hand-side of equation (1) equals to one, in other words differences in prices are offset by changing nominal exchange rates, it is considered that the *Absolute PPP* approach holds true in tradables and the real exchange rate in the country changes by relative productivity of tradables and nontradables (or by *Balassa-Samuelson effect*). To test this effect, we run a regression where the nominal effective exchange rate, relative tradables and nontradables price index in Azerbaijan and in main trade partners are the explanatory variables. We use CPI as a proxy for nontradables price index and PPI for tradables price index. The brief results are given below (Table 1.2):

$$LOG(REER\_T\_04)_{t\text{-}st:} = \underset{(4986.500)}{1.001} * LOG(NEER\_T\_04) + \underset{(45.694)}{0.900} * LOG\left(\frac{PPI\_04}{PPI\_MTP\_04}\right) + \underset{(41.530)}{0.973} * LOG\left(\frac{CPI\_04}{PPI\_04}\right) - \underset{(-28.537)}{1.048} * LOG\left(\frac{CPI\_MTP\_04}{PPI\_MTP\_0\ 4}\right) \quad (2)$$

where, *REER* is the real effective exchange rate, *NEER* is the nominal effective exchange rate, *PPI* (*CPI)* producers price index (consumers price index) in home country and *MTP* is the weighted *average* indices of main trade partners. *_04* means that base year for these variables is 2004. The numbers in brackets show the t-statistics of the coefficients.

By applying several tests, such as Durbin-Watson test, residuals test, and test for structural breaks (test results are available upon request), we find statistically significant results that are consistent with theoretical predictions. First, we find that there is a positive relationship between *NEER* and *REER.* One percent increase in *NEER* results in one percent increase in *REER*. Second, we find that tradable prices have a significant positive impact on *REER* in Azerbaijan. One percent increase in tradables price index relative to the main trade partners increases the *REER* by 0.9 percent. Third, the productivity, measured by the ratio of *CPI* to *PPI*, has a significant positive impact on *REER.* One percent increase in productivity

results in 1 percent increase in *REER*. Finally, we also find that one percent increase in productivity of tradables in main trade partners decrease *REER* by one percent.

Our findings suggest that Balassa-Samuelson effect has a significant impact on exchange rates in Azerbaijan. This effect is determined by the relative productivity that increases the competitiveness of goods and services produced in home country and the value of local currency. However, one needs to be somewhat cautious while interpreting these results. The increase in productivity observed in Azerbaijan is mostly caused by oil sector. It is well known that the productivity in oil industry in Azerbaijan is growing while that in non-oil sector tends to decline. However, the productivity growth in oil industry is mainly caused both by increase in total output and in oil prices. Although this type of productivity does not contribute to the competitiveness of the country and growing oil revenues cause manat to appreciate.

An alternative way to test the Balassa-Samuelson effect is to combine the first two variables – NEER and relative tradables price index – in the equation (1) as below:

$$\log(R) = \log\left(S * \frac{P_T}{P_T^*}\right) + \alpha * \log\left(\frac{P_N}{P_T}\right) - \beta * \log\left(\frac{P_N^*}{P_T^*}\right)$$

This approach states that if the coefficient of the first variable is not significantly different from zero, then REER in Azerbaijan is determined by the relative productivity in tradables and nontradables. Our test results are given in Table 1.3. The equation is as follows:

$$\underset{t\text{-}st:}{LOG(REER\_T\_\_04)} = \underset{(3515,193)}{1,001} * LOG\left(\left(NEER\_T\_04\right) * \left(\frac{PPI\_04}{PPI\_MTP\_04}\right)\right) + \tag{3}$$

$$+ \underset{(78,802)}{1,082} * LOG\left(\frac{CPI\_04}{PPI\_04}\right) - \underset{(-20,524)}{0,968} * LOG\left(\frac{CPI\_MTP\_04}{PPI\_MTP\_\_0\ \ 4}\right)$$

We find that the coefficient of combined effect of *NEER* with relative tradables price index is not insignificant. Particularly, t-statistics show that its coefficient is significantly different from zero. Using Wald test, we also test the null hypothesis that the coefficient of

the firm term is not different from zero. The Wald test results (Panel B in Table 3) reject the null hypothesis. We conclude that *REER* in Azerbaijan is affected not only by Balassa-Samuelson effect, but also by *NEER* and the relative tradables price index.

When we compare the differences between actual and fitted values (Panel C, Table 3), we find that the real exchange rate overvalued 0.1 percent during the last quarter of 2007 and 0.3 percent annual during 2007.

These results suggest that *Absolute PPP* approaches do not explain the real exchange rate misalignment, in other words deviation in exchange rates caused by relative price disparity is not offset by the changes in the nominal exchange rates in Azerbaijan. Indeed, Azerbaijan has experienced higher prices than its main trade partners and this difference has not been mitigated by manat's depreciation which undermines the impact of *Absolute PPP* approach. However, we understand that small sample size used in the study may affect our results.

**III. Macroeconomic Balance Approach**

Another approach to test the misalignment in real exchange rates is *Macroeconomic Balance Approach*. One of the main procedures in this approach is to estimate the import function. The theory suggests that there is a positive relationship between a country's imports and the real exchange rates. In other words, the elasticity of imports to the real exchange rates is expected to be positive. However, this is not the case for Azerbaijan. We use the real exchange rate as an independent and real GDP as a control variable to test the impact of the former on imports.

$$\underset{t\text{-}st:}{LOG(IM\_R)} = \underset{(6,806)}{7,154} - \underset{(-6,319)}{1,339} * LOG(REER\_T\_04) + \underset{(13,999)}{0,747} * LOG(GDP\_R) \quad (4)$$

The results (Table 4) are not consistent with theoretical predictions. As shown from the equation (4) the real exchange rate negatively affects imports, in other words, when home

currency appreciates, imports in Azerbaijan decreases. However, the economic intuition suggests the opposite. Therefore we can conclude that *Macroeconomic Balance Approach* is not appropriate to estimate *REER* misalignment in Azerbaijan due to the inconsistent results of import function.

## IV. Behavioral Equilibrium Exchange Rate (BEER)

Countries with higher risk will offer higher interest rates to attract capital flow which will affect exchange rates. To account for the risk premium, BEER approach includes the interest rates difference between countries and can be written as below:

$$BEER = F\left[(r - r^*), tot, tnt, nfa, \frac{gdebt}{gdebt^*}\right]$$

where *r-r** is the difference between home and foreign interest rates; *tot* is the terms of the trade; *tnt* is the productivity reflected by the ratio of tradables to non-tradables price indices (relative of the main trade partners); *nfa* is the net foreign assets; *gdebt/gdebt** is ratio of domestic government debt to GDP (relative to the main trade partner)

One of the advantages of the *BEER* is that this approach incorporates stylized facts of the country of interest. In this case the set of proxies for variables of interest may be affected by country specific factors. Therefore several issues need to be considered when this approach is applied to, particularly for Azerbaijan economy. First, net foreign assets divided by GDP may not accurately reveal the impact of capital inflow on the real exchange rates. Because GDP and net foreign assets are mainly consisted of oil revenues, we take the ratio of net foreign assets to the non-oil GDP. Thus we can prevent oil factor from "contaminating" test results. Second, interest rates will not have any significant impact on the real exchange rate due to the lack of well-developed financial markets in Azerbaijan. Third, due to the lack of data on government debt in main trade partners, we exclude this variable from our analysis.

Fourth, the strong dependence of Azerbaijani economy on oil revenues and its impact on exchange rates require that we include oil prices variable (*oil_p*) into our analysis. Fifth, the government expenditures in Azerbaijan have increasingly flown to non-oil sector. Therefore, we adjust our approach by including the ratio of government expenditures to non-oil GDP variable (*gov_exp_ngdp*) to control for this effect. Sixth, the previous studies show that it is essential to include price index for government regulated goods to estimate *BEER* approach in transition countries. We use administered prices index variable (*cpi_adm*) for this purposes. Finally, previous studies also find that when using *BEER* approach in small and open economies, the degree of trade openness which is calculated as the ratio of trade turnover to GDP is essential to determine the equilibrium level of real exchange rate.

Thus, we can re-write our set of determinants of real exchange rate in *BEER* approach as follows:

$$REER = f(tot, ntt, nfa\_ngdp, gov\_\exp\_ngdp, oil\_p, cpi\_adm, open)$$

We use the ratio of non-tradables to tradables price index for Azerbaijan and its main trading partners (CPI/PPI)/(CPI*/PPI*) as a proxy for relative productivity (*ntt*). We use quarterly data from 2001 to 2007 to test *BEER* approach. All variables, except oil prices, administered CPI and government expenditures ratio to non-oil GDP, were seasonally adjusted (*_SA*).

We can separate *REER* series in Azerbaijan into three different sub-periods: depreciation (2001-2003), relative stability (2003-2004) and appreciation (2004-2007) periods. We can refer to several reasons for this pattern. While the depreciation can be explained by decreasing in the terms of trade, relative productivity and net foreign assets position, the appreciation after 2004 may be caused by the increase in the administered prices index, in the degree of trade openness, in relative productivity, in net foreign assets and in government expenditures all together affected by rising oil revenues.

*BEER* estimates the long-term relation or *cointegration* between the real exchange rates and its macroeconomic determinants. The first step in this approach is to examine whether the dependent variable and its determinants integrate at the same order. Desirably, these variables must be non-stationary in level and stationary in differences. Our unit root tests conclude that these variables are non-stationary, I(1) in level and stationary, I(0), in differences (Table 5) at 5 percent significance level.

Because of the short sample size (28 observations) and structural breaks during last years of sample period, we avoid using Johansen cointegration test. Instead, we use Engle-Granger cointegration test (Engle and Granger, 1987) to estimate the *BEER* for Manat. Our results (Table 6) are given below:

$$LOG(REER\_T\_04) = \underset{t\text{-}st:}{} 4{,}632 + \underset{(13{,}374)}{} 0{,}467 * LOG(TOT\_SA) + \underset{(3{,}107)}{} 0{,}563 * LOG(NTT\_SA) + \underset{(2{,}173)}{}$$

$$+ 0{,}163 * LOG(NFA\_NGDP\_SA) - \underset{(2{,}385)}{} 0{,}0004 * LOG(OIL\_P) + \underset{(0{,}006)}{} 0{,}009 * LOG(CPI\_ADM\_04) - \underset{(0{,}103)}{} \quad (5)$$

$$- 0{,}413 * LOG(OPEN\_SA) + \underset{(-3{,}731)}{} 0{,}072 * LOG(GOV\_EXP\_NGDP) \underset{(1{,}150)}{}$$

We find that the impact of oil prices, administered prices index and the ratio of government expenditures to non-oil GDP on the real exchange rate are not statistically significant. We check the robustness of our results as follows. First, by applying several tests, such as univariate regression, Granger-Causality test, and omitted variables test, we conclude that the relationship between administered prices index and the real exchange rates in Azerbaijan is not statistically significant. Test results are available upon request.

Second, oil prices become insignificant in *BEER* approach, because of possible interaction with other variables, such as net foreign assets and government expenditures[2]. In other words, these variables can be strongly correlated with each other, because oil revenues directly affect the net foreign assets acquisition and have a strong impact on government

[2]We also get statistically significant long-run and short run relationships between REER and its determinants, when we replace Net Foreign Assets Position with Oil Price or Government Expenditures.

revenues in Azerbaijan. Table 7 shows the correlation matrix for these variables. We find that all three dependent variables are strongly correlated with each other, however, only net foreign assets is somewhat strongly correlated (0.53) with *REER*[3].

Therefore we can exclude oil prices, administered prices index and government expenditures from equation (5). The results of revised specification are given below:

$$\underset{t\text{-}st:}{LOG(REER\_T\_04)} = \underset{(139,151)}{4,637} + \underset{(4,472)}{0,519} * LOG(TOT\_SA) + \underset{(2,432)}{0,423} * LOG(NTT\_SA) - \tag{6}$$

$$- \underset{(-4,023)}{0,411} * LOG(OPEN\_SA) + \underset{(4,576)}{0,223} * LOG(NFA\_NGDP\_SA)$$

We find that all dependent variables included in this specification are statistically significant and their signs are consistent with theoretical predictions. Terms of trade, relative price ratio of nontradables to tradables, and the ratio of net foreign assets to non-oil GDP have a positive, while trade openness has a negative impact on the real exchange rates. Our results also satisfy several robustness tests on coefficients, residuals and the stability tests (available at reader's request).

According to Engle-Granger approach (Engle and Granger, 1987) we need to test for stationarity of residuals to conclude that there is a cointegration between *REER* and its determinants. Figure 3 illustrates the time series of residuals.

Since residual series is not observable, we should not use standard critical values (based on MacKinnon (1996)) for Augmented Dickey Fuller Unit Root Test which E-views and other econometric packages usually perform. Therefore we use critical values of MacKinnon (1991) table for Unit Root Test on the residuals. As shown from Table 3.14 in Appendix 3, cointegration exists between REER and its determinants only at 90% significance level. This is maybe because of the small sample period, since we only have 28

[3] Although we do not report, Granger-Causality tests show that there is a statistically significant relation between REER and both oil prices and net foreign assets position.

observations. As stated in Engle and Granger (1987), we may also use Durbin-Watson statistics to test co-integration between variables in the Engle-Granger two-step cointegration approach. Test results indicate existence of cointegration between REER and its determinants[4].

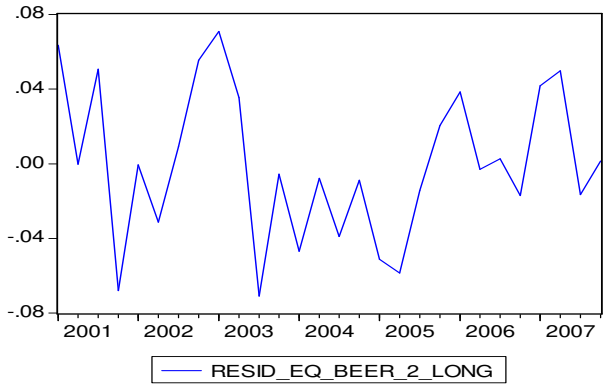


**Figure 3 Residuals from the BEER approach in equation (6)**

We can summarize the results of *BEER* approach in equation (6) as follows. First, the elasticity of *REER* regarding with terms of trade index is equal to 0.5 percent. This result is consistent with the theory of the positive relationship between trade environment and home currency. In other words, when trade environment improves, the home currency appreciates.

Second, the Balassa-Samuelson effect, indicated by the ratio of non-tradables price index to the tradables price index, has a positive impact (0.4 percent) on *REER* in Azerbaijan. In other words, rising productivity in tradables sector has led to the appreciation of home currency. However, when this effect is closely analyzed, we find that its mostly caused by oil sector. If we analyze oil and non-oil tradables separately, we find that non-oil sector in Azerbaijan has not been able to increase its productivity competitiveness. Indeed, agriculture and non-oil industrial production do not possess modern technology and high skilled human resources in order to claim for a higher productivity. Therefore, these sectors of economy are not able to provide foreign markets with competitive goods. On the other hand, oil production

[4]There is cointegration between variables, if actual number of Durbin-Watson greater than 0.386

is based on contractual agreements and not defined by the level of competitiveness. Considering these sides of Azerbaijani economy, we can conclude that the productivity effect defined in Balassa-Samuelson approach does not exist in Azerbaijan.

Third, we find that one percent increase in the degree of openness results in 0.4 percent depreciation in *REER* in Azerbaijan. This effect is common for transition economies. Indeed, when small and open transition countries diminish foreign trade barriers, their imports tend to rise and their home currency depreciates.

Fourth, we also find that when net foreign assets increase one percent, manat appreciates by 0.2 percent. This result is intuitive, because higher oil prices and larger production increase oil revenues (and net foreign assets) which leads to the appreciation of home currency.

Based on the equation (6) we also calculate contributions of each explanatory variable to *REER* during 2003-2007 (Table 10).

We can conclude that the main determinants of *REER* based on the *BEER* approach are terms of trade, relative productivity (the ratio of non-tradables to tradables price index), openness and net foreign asset position.

### *A. Short run modeling*

The next step in Engle-Granger approach is to construct a short-run model between key determinants and *REER*, including error correction mechanism (residuals derived from long-run approach with one lag). The main conditions for this stage are that variables have to be stationary in first difference, coefficient of one lagged residuals which derived from long-run model have to be statistically significant, and its value should fall between -1 and 0. In previous sections we concluded that the variables of interest are non-stationary in level, but stationary in first difference. In other words, variables are I (1).

We employ a general to specific approach for the short run modeling and obtain the specification as below:

$$DLOG(REER\_T\_04) = \underset{t\text{-}st:}{} -\underset{(-2,080)}{0,008} * C + \underset{(2,207)}{0,237} * DLOG(REER\_T\_04(-1)) + \underset{(3,724)}{0,240} * DLOG(TOT\_SA) +$$

$$-\underset{(-6,230)}{0,232} * DLOG(OPEN\_SA) + \underset{(3,615)}{0,075} * DLOG(NFA\_NGDP\_SA) + \quad (7)$$

$$+\underset{(3,427)}{0,164} * DLOG(CPI\_ADM\_04) - \underset{(4,981)}{0,450} * RESID\_EQ\_BEER\_2\_LONG(-1)$$

Equation (7) is also robust to tests for heteroscedasticity, autocorrelation and residuals test (Test results are available upon request). On the other hand Omitted Variables Test (Table 12) suggests that administered prices index variable should keep in the specification. The error correction coefficient is consistent with theory; therefore we can also conclude that there is a stable cointegration between *REER* and its key determinants.

Thus, short-term misalignment of *REER* is caused by its one period lagged values, terms of trade, trade openness, net foreign asset position and administered prices index. The error correction coefficient shows that misalignment from equilibrium is corrected by 45 percent during a quarter.

### *B. Misalignment in Real Effective Exchange Rates*

We compare the actual and fitted (obtained from equation (6)) values of *REER* during 2001-2007 in Azerbaijan as shown in Figure 4.

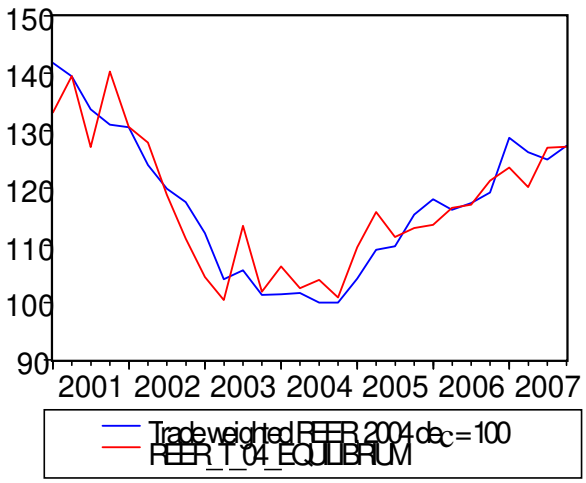


**Figure 4. Actual (blue line) and Fitted values of REER from Engle Granger approach (red line)**

We find that predicted values based on equation (6) and values of *REER* are very close each other at the end of period, 4th quarter of 2007. As shown in Table 13, REER is slightly overvalued by about 0.2 percent at the fourth quarter of 2007 and 1.9 percent annually base respectively. Thus we can summarize our conclusions based on BEER approach as below:

a) Based on Engle-Granger approach we find that there is a statistically significant and stable cointegration between real effective exchange rate and terms of trade, relative productivity, net foreign assets position, and trade openness in Azerbaijan.

b) Administered prices index and lagged values of *REER*, along with all variables mentioned above except relative productivity, have statistically significant impact on *REER* in the short run.

c) One quarter correction in *REER* misalignment is equal to 45 percent.

d) The equilibrium value of *REER* is approximately equal to its actual values at the fourth quarter of 2007.

## 5. Permanent Equilibrium Exchange Rate Approach

*PEER* approach studies the long-run relationship between actual exchange rates and permanent components (S) of its determinants. We can write this model as below:

$$q_t^{PEER} = \alpha + \beta_0 (r - r^*)_t^P + \beta_1 tot_t^P + \beta_2 tnt_t^P + \beta_3 nfa_t^P + \beta_3 (\frac{gdebt}{gdebt^*})_t^P$$

To estimate this model, first, we need to decompose permanent and transitory components of key independent variables for what we use Hodrick-Prescott values. The graphical illustration of *REER* and permanent components of key determinants over the period 2001-2007 is given in Figure 8.

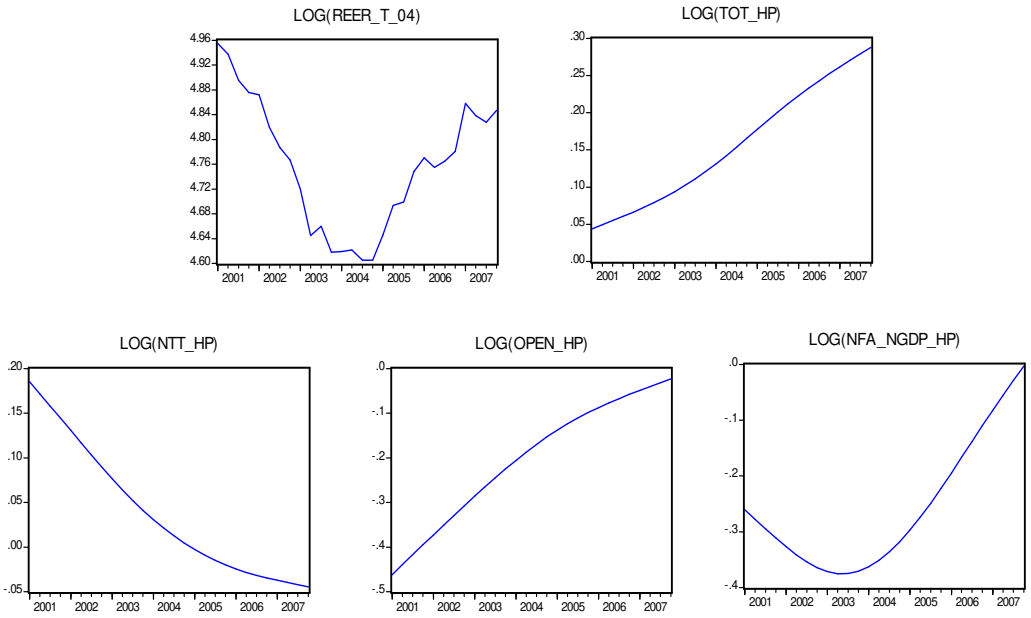


***Figure 8. REER and permanent components of its determinants***

Next, in order to estimate *PEER* model, we need two thing: a) the coefficients of key determinants obtained from *BEER* approach (equation (6)) and b) time series of permanent components of key determinanatsof .

Thus, we can specify our PEER approach specification as below:

$$PEER\_T\_04 = EXP \underset{t\text{-}st:}{\left( \begin{array}{l} 4{,}637 + 0{,}519^{*}\, LOG(TOT\_HP) + 0{,}423^{*}\, LOG(NTT\_HP) - \\ \quad\quad (139{,}151) \quad\quad (4{,}472) \quad\quad\quad\quad\quad\quad\quad\quad\quad\quad (2{,}432) \\ \\ - 0{,}411^{*}\, LOG(OPEN\_HP) + 0{,}223^{*}\, LOG(NFA\_NGDP\_HP) \\ \quad\quad (-4{,}023) \quad\quad\quad\quad\quad\quad\quad\quad\quad\quad (4{,}576) \end{array} \right)} \qquad (8)$$

Where, *EXP* is an exponential function.

Equilibrium series that derived from equation (8) and actual series of REER are illustrated in the Figure 9.

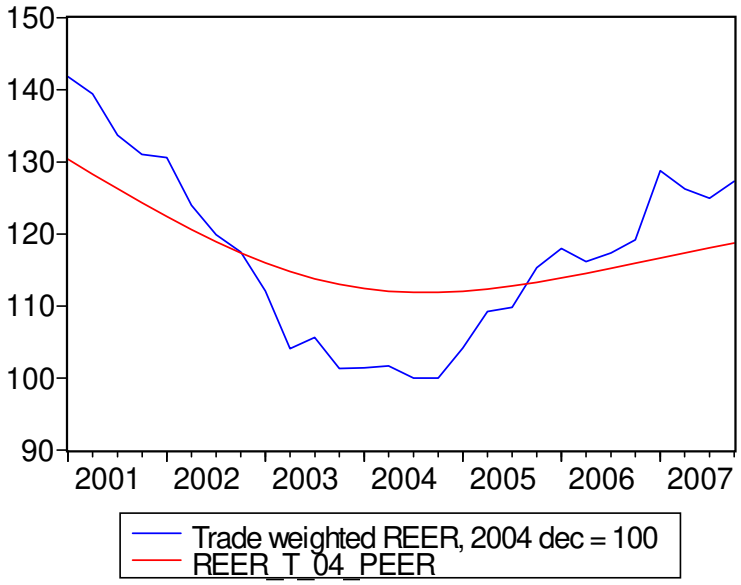


***Figure 9. Actual (blue line) and fitted (red line) values of REER***

As shown from Figure 9, the difference between blue and red lines suggest that *REER* in Azerbaijan is overvalued based on *PEER* model. We also show actual values and equilibrium values and the misalignments of REER based on PEER approach in Table 14.

We can conclude based on *PEER* approach that the size of permanent exchange rate misalignment is about 7.3 percent in the fourth quarter of 2007, and 4.3 percent annually.

**Conclusion**

We investigate the determinants of equilibrium level of Azerbaijani manat's real effective exchange rate and its misalignment in this paper. Our results can be summarized as below:

a) The Macroeconomic Balance Approach is not relevant to estimate REER equilibrium, due to fact thatimport function is not consistent with the theory, such that there is a negative relation between imports and manat's value.

b) After estimating various PPP approaches, we conclude that this group of approaches is not appropriate for estimating equilibrium exchange rates in Azerbaijan. In other words, deviations caused by relative prices are not completely compensated by nominal exchange rates. This may be a result of higher relative prices not compensated by nominal exchange rates in the country than those in main trade partners. Alternatively, this may be caused by the short sample size.

c) Using other approaches we find that Manat is close to its equilibrium level, or slightly overvalued such that;

d) Because of structural breaks in *REER* time series, we can separate it into three subsamples – 2001-2003 when rates are depreciating, 2003-2004 when rates are flat, and the period after 2004 when rates are appreciating. The behavior of exchange rates during the last two sub-periods can be explained by terms of trade , relative productivity, net foreign assets position increased by oil revenues, administered prices index, and by increase in government expenditures.

e) The main determinants of *REER* in the long run are terms of trade, relative productivity, trade openness and net foreign assets position;

    a. One percent increase in trade level increases *REER* by 0.5 percent.

b. The size of Ballassa-Samuelson effect measured by the ratio of nontradables to tradables price index is about 0.4 percent. In other words, the test results suggest that productivity increase in tradables sector caused appreciation in manat. However, one can easily realize that this is caused by recent developments and increase in productivity, mainly, in Azerbaijani oil industry.

c. One percent increase in trade openness lowers *REER* in Azerbaijan by 0.4 percent. This is consistent with the notion that when small and open transitional countries lower foreign trade barriers, they tend to import more and their home currency depreciates.

d. One percent increase in net foreign assets results in 0.2 percent appreciation in Manat's value. This result is straightforward, because along with rising oil prices and total output, oil revenues (and net foreign assets) of Azerbaijan increase. Thus, increasing oil revenues lead to the appreciation of home currency.

f) The key determinants of *REER* in the short run are its lagged values, terms of trade , trade openness, net foreign assets position, and administered prices index. The error correction coefficient indicates that 45 percent of deviation of *REER* from its equilibrium level is restored during one quarter.

g) We find that permanent misalignment (based on *PEER* approach) of REER is bigger than its current misalignment (based on *BEER* approach). The impact of permanent components increase misalignment between actual (prevailing) and equilibrium REER in long run.

h) Finally, we provide the results of various approaches for misalignment applied in this study in Table 8.

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**Table 1. Unit root test results for REER during 2001-2007**
**This table shows various test result for unit root in *REER*.**

| Null Hypothesis: REER_T_04 has a unit root<br>Exogenous: Constant, Linear Trend<br>Lag Length: 0 (Automatic based on SIC, MAXLAG=6) | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | **-0.526384** | **0.9759** |
| Test critical values: | 1% level | -4.323979 | |
| | 5% level | -3.580623 | |
| | 10% level | -3.225334 | |
| *MacKinnon (1996) one-sided p-values. | | | |

| Null Hypothesis: REER_T_04 has a unit root<br>Exogenous: Constant, Linear Trend<br>Bandwidth: 2 (Newey-West using Bartlett kernel) | | Adj. t-Stat | Prob.* |
|---|---|---|---|
| Phillips-Perron test statistic | | **-0.521219** | **0.9762** |
| Test critical values: | 1% level | -4.323979 | |
| | 5% level | -3.580623 | |
| | 10% level | -3.225334 | |
| *MacKinnon (1996) one-sided p-values. | | | |

| Null Hypothesis: REER_T_04 is stationary<br>Exogenous: Constant<br>Bandwidth: 4 (Newey-West using Bartlett kernel) | | LM-Stat. |
|---|---|---|
| Kwiatkowski-Phillips-Schmidt-Shin test statistic | | **0.200427** |
| Asymptotic critical values*: | 1% level | 0.739000 |
| | 5% level | 0.463000 |
| | 10% level | 0.347000 |
| *Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1) | | |

| Null Hypothesis: REER_T_04 has a unit root<br>Exogenous: Constant<br>Lag length: 0 (Spectral GLS-detrended AR based on SIC, MAXLAG=6)<br>Sample: 2001Q1 2007Q4<br>Included observations: 28 | | MZa | MZt | MSB | MPT |
|---|---|---|---|---|---|
| Ng-Perron test statistics | | -0.92920 | -0.67600 | 0.72751 | 26.0450 |
| Asymptotic critical values*: | 1% | -13.8000 | -2.58000 | 0.17400 | 1.78000 |
| | 5% | -8.10000 | -1.98000 | 0.23300 | 3.17000 |
| | 10% | -5.70000 | -1.62000 | 0.27500 | 4.45000 |
| *Ng-Perron (2001, Table 1) | | | | | |

**Table 2 Absolute PPP approach with Balassa Samuelson and Penn effect**
This table presents results of test for Balassa Samuelson and Penn effect in real exchange rates. *REER* is the real effective exchange rate, *NEER* is the nominal effective exchange rate, *PPI* (*CPI)* producers price index (consumers price index) in home country and *MTP* is the weighted *average* indices of main trade partners. *_04* means that base year for these variables is 2004.

Dependent Variable: LOG(REER_T_04)
Method: Least Squares
Date: 08/15/08 Time: 17:48
Sample (adjusted): 2001Q1 2007Q4
Included observations: 28 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| LOG(NEER_T_04) | 1.001289 | 0.000201 | 4986.500 | 0.0000 |
| LOG(PPI_04/PPI_MTP_04) | 0.900113 | 0.019699 | 45.69371 | 0.0000 |
| LOG(CPI_04/PPI_04) | 0.972709 | 0.023422 | 41.53031 | 0.0000 |
| LOG(CPI_MTP_04/PPI_MTP_04) | -1.048332 | 0.036736 | -28.53682 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.998315 | Mean dependent var | 4.758322 |
| Adjusted R-squared | 0.998104 | S.D. dependent var | 0.105322 |
| S.E. of regression | 0.004586 | Akaike info criterion | -7.799987 |
| Sum squared resid | 0.000505 | Schwarz criterion | -7.609672 |
| Log likelihood | 113.1998 | Durbin-Watson stat | 1.480687 |

**Table 3 Absolute PPP approach with Balassa Samuelson and Penn effect**

***Panel A***
Dependent Variable: LOG(REER_T_04)
Method: Least Squares
Sample (adjusted): 2001Q1 2007Q4
Included observations: 28 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| LOG((NEER_T_04)*(PPI_04/PPI_MTP_04)) | 1.001254 | 0.000285 | 3515.193 | 0.0000 |
| LOG(CPI_04/PPI_04) | 1.082228 | 0.013734 | 78.80155 | 0.0000 |
| LOG(CPI_MTP_04/PPI_MTP_04) | -0.967843 | 0.047156 | -20.52416 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.996463 | Mean dependent var | 4.758322 |
| Adjusted R-squared | 0.996180 | S.D. dependent var | 0.105322 |
| S.E. of regression | 0.006509 | Akaike info criterion | -7.130187 |
| Sum squared resid | 0.001059 | Schwarz criterion | -6.987451 |
| Log likelihood | 102.8226 | Durbin-Watson stat | 1.183969 |

***Panel B***
**Wald test results for REER approach in equation (3)**

| Test Statistic | Value | df | Probability |
|---|---|---|---|
| F-statistic | 12356578 | (1, 25) | **0.0000** |
| Chi-square | 12356578 | 1 | **0.0000** |

Null Hypothesis Summary:

| Normalized Restriction (= 0) | Value | Std. Err. |
|---|---|---|
| C(1) | 1.001254 | 0.000285 |

Restrictions are linear in coefficients.

***Panel C. Actual and fitted values of REER***

| Period | Actual REER, 2004m12=100 | Fitted REER, 2004m12=100 | Misalignment, % change |
|---|---|---|---|
| 2006Q4 | 119,185 | 119,454 | |
| 2007Q1 | 128,777 | 128,216 | |
| 2007Q2 | 126,259 | 126,335 | |
| 2007Q3 | 124,940 | 125,291 | |
| ***2007Q4*** | ***127.338*** | ***127.261*** | ***0.060*** |
| ***Annual*** | ***106.841*** | ***106.536*** | ***0.287*** |

**Table 4: Import as a Function of REER**
This table shows the relation between imports and *REER*. *IM* is the amount of imports, *GDP* is the amount of GDP for a given period. All values are in logged terms.

Dependent Variable: LOG(IM_R)
Method: Least Squares
Date: 08/16/08 Time: 17:19
Sample: 2001Q1 2007Q4
Included observations: 28

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 7.153921 | 1.051154 | 6.805781 | 0.0000 |
| **LOG(REER_T)** | **-1.338630** | 0.211844 | -6.318943 | 0.0000 |
| LOG(GDP_R) | 0.747009 | 0.053362 | 13.99897 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.903581 | Mean dependent var | 6.829817 |
| Adjusted R-squared | 0.895868 | S.D. dependent var | 0.359257 |
| S.E. of regression | 0.115931 | Akaike info criterion | -1.370691 |
| Sum squared resid | 0.335998 | Schwarz criterion | -1.227955 |
| Log likelihood | 22.18967 | F-statistic | 117.1428 |
| Durbin-Watson stat | 2.112738 | Prob(F-statistic) | 0.000000 |

## Table 5. Unit Root Test for Determinants of *BEER*

Group unit root test: Summary
Date: 09/23/08 Time: 12:25
Sample: 2001Q1 2007Q4
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic selection of lags based on SIC: 0 to 5
Newey-West bandwidth selection using Bartlett kernel

| Method | Statistic | Prob.** | Cross-sections | Obs |
|---|---|---|---|---|
| Null: Unit root (assumes common unit root process) | | | | |
| Levin, Lin & Chu t* | -0.35764 | ***0.3603*** | 8 | 215 |
| Breitung t-stat | 1.34201 | ***0.9102*** | 8 | 207 |
| Null: Unit root (assumes individual unit root process) | | | | |
| Im, Pesaran and Shin W-stat | 1.00426 | ***0.8424*** | 8 | 215 |
| ADF - Fisher Chi-square | 11.6990 | ***0.7644*** | 8 | 215 |
| PP - Fisher Chi-square | 21.6882 | ***0.1535*** | 8 | 220 |
| Null: No unit root (assumes common unit root process) | | | | |
| Hadri Z-stat | 6.43549 | ***0.0000*** | 8 | 224 |

** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality

## Table 6. Long-run BEER approach

Dependent Variable: LOG(REER_T_04)
Method: Least Squares
Date: 09/23/08 Time: 12:03
Sample: 2001Q1 2007Q4
Included observations: 28

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 4.631767 | 0.346337 | 13.37358 | 0.0000 |
| LOG(TOT_SA) | 0.466657 | 0.150189 | 3.107140 | 0.0056 |
| LOG(NTT_SA) | 0.562624 | 0.258912 | 2.173028 | 0.0420 |
| LOG(OPEN_SA) | -0.413067 | 0.110723 | -3.730617 | 0.0013 |
| LOG(NFA_NGDP_SA) | 0.163397 | 0.068510 | 2.385015 | 0.0271 |
| **LOG(OIL_P)** | **-0.000429** | **0.074993** | **-0.005714** | **0.9955** |
| **LOG(CPI_ADM_04)** | **0.009406** | **0.090906** | **0.103475** | **0.9186** |
| **LOG(GOV_EXP_NGDP)** | **0.072428** | **0.062979** | **1.150045** | **0.2637** |

| | | | |
|---|---|---|---|
| R-squared | 0.872107 | Mean dependent var | 4.758322 |
| Adjusted R-squared | 0.827345 | S.D. dependent var | 0.105322 |
| S.E. of regression | 0.043763 | Akaike info criterion | -3.185090 |
| Sum squared resid | 0.038304 | Schwarz criterion | -2.804460 |
| Log likelihood | 52.59126 | F-statistic | 19.48297 |
| Durbin-Watson stat | 1.646500 | Prob(F-statistic) | 0.000000 |

**Table 7. Correlation matrix of REER, oil prices, net foreign assets and the ratio of government debt to non-oil GDP**

| | LOG(REER_T_04) | LOG(NFA_NGDP_SA) | LOG(OIL_P) | LOG(GOV_EXP_NGDP) |
|---|---|---|---|---|
| LOG(REER_T_04) | 1.000000 | **0.534172** | -0.088907 | 0.053047 |
| LOG(OIL_P) | -0.088907 | 0.551969 | 1.000000 | 0.801295 |
| LOG(NFA_NGDP_SA) | 0.534172 | 1.000000 | **0.551969** | **0.606413** |
| LOG(GOV_EXP_NGDP) | 0.053047 | 0.606413 | **0.801295** | 1.000000 |

**Table 8. Long-run BEER approach**

Dependent Variable: LOG(REER_T_04)
Method: Least Squares
Date: 09/23/08 Time: 13:28
Sample: 2001Q1 2007Q4
Included observations: 28

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 4.637482 | 0.033327 | 139.1513 | 0.0000 |
| LOG(TOT_SA) | 0.518627 | 0.115966 | 4.472242 | 0.0002 |
| LOG(NTT_SA) | 0.422541 | 0.173712 | 2.432425 | 0.0232 |
| LOG(OPEN_SA) | -0.411059 | 0.102184 | -4.022734 | 0.0005 |
| LOG(NFA_NGDP_SA) | 0.222703 | 0.048664 | 4.576313 | 0.0001 |

| | | | |
|---|---|---|---|
| R-squared | 0.855142 | Mean dependent var | 4.758322 |
| Adjusted R-squared | 0.829950 | S.D. dependent var | 0.105322 |
| S.E. of regression | 0.043432 | Akaike info criterion | -3.274819 |
| Sum squared resid | 0.043385 | Schwarz criterion | -3.036925 |
| Log likelihood | 50.84746 | F-statistic | 33.94418 |
| Durbin-Watson stat | 1.560243 | Prob(F-statistic) | 0.000000 |

**Table 9 Unit root test for residuals derived from the BEER approach in equation (6)**

Null Hypothesis: RESID_EQ_BEER_2_LONG has a unit root
Exogenous: None
Lag Length: 0 (Automatic based on SIC, MAXLAG=6)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | ***-4.499190*** | ***0.0001*** |
| Test critical values: | 1% level | -5.82985 | |
| | 5% level | -4.95275 | |
| | 10% level | -4.53422 | |

*MacKinnon (1991) one-sided p-values.

**Table 10. Contributions of explanatory variables on REER from equation (6)**

| Variable / Year | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|
| BEER | 0,619 | 0,159 | -0,662 | 0,722 | 3,857 |
| TOT_SA | -5,891 | -12,592 | -4,679 | -3,303 | 2,322 |
| NTT_SA | -17,349 | 0,139 | 0,978 | -1,212 | -1,220 |
| OPEN_SA | 16,050 | -0,252 | -1,222 | -0,532 | 5,101 |
| NFA_NGDP_SA | -2,797 | -0,963 | -0,626 | 0,096 | -0,911 |

**Table 11. Short run REER approach**

Dependent Variable: DLOG(REER_T_04)
Method: Least Squares
Date: 09/23/08 Time: 15:07
Sample (adjusted): 2001Q2 2007Q4
Included observations: 27 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | -0.007606 | 0.003657 | -2.079672 | 0.0506 |
| DLOG(REER_T_04(-1)) | 0.237068 | 0.107438 | 2.206563 | 0.0392 |
| DLOG(TOT_SA) | 0.240157 | 0.064484 | 3.724309 | 0.0013 |
| DLOG(OPEN_SA) | -0.231871 | 0.037217 | -6.230186 | 0.0000 |
| DLOG(NFA_NGDP_SA) | 0.075308 | 0.020830 | 3.615261 | 0.0017 |
| DLOG(CPI_ADM_04) | 0.164316 | 0.047952 | 3.426697 | 0.0027 |
| RESID_EQ_BEER_2_LONG(-1) | -0.450472 | 0.090430 | -4.981440 | 0.0001 |

| | | | |
|---|---|---|---|
| R-squared | 0.807446 | Mean dependent var | -0.003996 |
| Adjusted R-squared | 0.749680 | S.D. dependent var | 0.034266 |
| S.E. of regression | 0.017144 | Akaike info criterion | -5.075912 |
| Sum squared resid | 0.005878 | Schwarz criterion | -4.739955 |
| Log likelihood | 75.52482 | F-statistic | 13.97782 |
| Durbin-Watson stat | 2.059254 | Prob(F-statistic) | 0.000003 |

**Table 12. Omitted variables test on Administered Prices index**

Redundant Variables: DLOG(CPI_ADM_04)

| | | | |
|---|---|---|---|
| F-statistic | 11.74225 | Probability | ***0.002672*** |
| Log likelihood ratio | 12.47175 | Probability | ***0.000413*** |

**Table 13. Manat's REER misalignment based on BEER approach**

| Period | Actual REER, 2004Q4=100 | Fitted values of BEER model, 2004Q4=100 | Misalignment, % |
|---|---|---|---|
| 2006Q4 | 119.185 | 121.238 | |
| 2007Q1 | 128.777 | 123.520 | |
| 2007Q2 | 126.259 | 120.141 | |
| 2007Q3 | 124.940 | 127.015 | |
| ***2007Q4*** | ***127.338*** | ***127.146*** | ***0.151*** |
| ***Annual*** | ***106.841*** | ***104.874*** | ***1.876*** |

**Table 14. Actual and Fitted values of REER based on PEER approach**

| Period | Actual REER, 2004Q4=100 | Fitted REER, 2004Q4=100 | Misalignment, % |
|---|---|---|---|
| 2006Q4 | 119,185 | 115,931 | |
| 2007Q1 | 128,777 | 116,643 | |
| 2007Q2 | 126,259 | 117,350 | |
| 2007Q3 | 124,940 | 118,046 | |
| ***2007Q4*** | ***127,338*** | ***118,728*** | ***7,252*** |
| ***Annual*** | ***106,841*** | ***102,413*** | ***4,324*** |

**Table 15. Results of approaches for misalignment of REER**

| | Exchange rate misalignments, % | | | |
|---|---|---|---|---|
| Period | Simple PPP approach | Modified PPP approach with Balassa-Samuelson and Penn effect | Behavioral EER approach | Permanent EER approach |
| 2007Q4 | ***8.7*** | ***0.1*** | ***0.2*** | ***7.3*** |
| Annual | ***- 8.8*** | ***0.3*** | ***1.9*** | ***4.3*** |

*Table 3.20 Long run BEER approach with Oil Prices*

Dependent Variable: LOG(REER_T_04)
Method: Least Squares
Date: 11/24/08 Time: 14:48
Sample: 2001Q1 2007Q4
Included observations: 28

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 4.125316 | 0.229246 | 17.99511 | 0.0000 |
| LOG(TOT_SA) | 0.451740 | 0.185885 | 2.430209 | 0.0233 |
| LOG(NTT_SA) | 0.942498 | 0.183213 | 5.144264 | 0.0000 |
| LOG(OIL_P) | 0.123465 | 0.061814 | 1.997354 | 0.0578 |
| LOG(OPEN_SA) | -0.331821 | 0.135684 | -2.445533 | 0.0225 |

| | | | |
|---|---|---|---|
| R-squared | 0.764151 | Mean dependent var | 4.758322 |
| Adjusted R-squared | 0.723134 | S.D. dependent var | 0.105322 |
| S.E. of regression | 0.055418 | Akaike info criterion | -2.787379 |
| Sum squared resid | 0.070638 | Schwarz criterion | -2.549485 |
| Log likelihood | 44.02330 | F-statistic | 18.63003 |
| Durbin-Watson stat | 1.302177 | Prob(F-statistic) | 0.000001 |

*Table 3.21 Short run BEER approach with Oil Prices*

Dependent Variable: DLOG(REER_T_04)
Method: Least Squares

Date: 09/23/08 Time: 18:19
Sample (adjusted): 2002Q1 2007Q4
Included observations: 24 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| DLOG(TOT_SA) | 0.193562 | 0.046386 | 4.172865 | 0.0011 |
| DLOG(TOT_SA(-1)) | 0.121457 | 0.054850 | 2.214349 | 0.0453 |
| DLOG(TOT_SA(-3)) | 0.120462 | 0.049496 | 2.433741 | 0.0301 |
| DLOG(NTT_SA(-2)) | 0.284080 | 0.071894 | 3.951353 | 0.0017 |
| DLOG(OIL_P(-2)) | 0.098160 | 0.029800 | 3.294019 | 0.0058 |
| DLOG(OPEN_SA) | -0.231970 | 0.034398 | -6.743718 | 0.0000 |
| DLOG(OPEN_SA(-1)) | -0.196696 | 0.034563 | -5.690973 | 0.0001 |
| DLOG(OPEN_SA(-2)) | -0.164158 | 0.035169 | -4.667675 | 0.0004 |
| DLOG(OPEN_SA(-3)) | -0.102350 | 0.031187 | -3.281834 | 0.0060 |
| DLOG(CPI_ADM_04) | 0.207539 | 0.031425 | 6.604190 | 0.0000 |
| RESID_EQ_BEER_3_LONG(-1) | -0.197440 | 0.075814 | -2.604289 | 0.0218 |

| | | | |
|---|---|---|---|
| R-squared | 0.934127 | Mean dependent var | -0.001199 |
| Adjusted R-squared | 0.883455 | S.D. dependent var | 0.035177 |
| S.E. of regression | 0.012009 | Akaike info criterion | -5.702757 |
| Sum squared resid | 0.001875 | Schwarz criterion | -5.162815 |
| Log likelihood | 79.43308 | Durbin-Watson stat | 2.080111 |

*Table 3.22 Long run BEER approach with Government Expenditures*

Dependent Variable: LOG(REER_T_04)
Method: Least Squares
Date: 09/24/08 Time: 11:32
Sample: 2001Q1 2007Q4
Included observations: 28

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 4.686698 | 0.044875 | 104.4390 | 0.0000 |
| LOG(TOT_SA) | 0.509953 | 0.130014 | 3.922289 | 0.0007 |
| LOG(NTT_SA) | 0.936164 | 0.155910 | 6.004518 | 0.0000 |
| LOG(OPEN_SA) | -0.305104 | 0.103319 | -2.953028 | 0.0071 |
| LOG(GOV_EXP_NGDP) | 0.152867 | 0.041465 | 3.686607 | 0.0012 |

| | | | |
|---|---|---|---|
| R-squared | 0.826039 | Mean dependent var | 4.758322 |
| Adjusted R-squared | 0.795785 | S.D. dependent var | 0.105322 |
| S.E. of regression | 0.047595 | Akaike info criterion | -3.091738 |
| Sum squared resid | 0.052102 | Schwarz criterion | -2.853844 |
| Log likelihood | 48.28433 | F-statistic | 27.30337 |
| Durbin-Watson stat | 1.537426 | Prob(F-statistic) | 0.000000 |

*Table 3.23 Short run BEER approach with Government Expenditures*

Dependent Variable: DLOG(REER_T_04)
Method: Least Squares
Date: 09/23/08 Time: 18:22
Sample (adjusted): 2001Q2 2007Q4
Included observations: 27 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| DLOG(TOT_SA) | 0.164324 | 0.079683 | 2.062206 | 0.0518 |
| DLOG(NTT_SA) | 0.294531 | 0.116007 | 2.538898 | 0.0191 |
| DLOG(OPEN_SA) | -0.220678 | 0.043338 | -5.091993 | 0.0000 |
| DLOG(GOV_EXP_NGDP) | 0.088679 | 0.022209 | 3.992925 | 0.0007 |
| DLOG(REER_T_04(-1)) | 0.376182 | 0.121796 | 3.088633 | 0.0056 |
| RESID_EQ_BEER_4_LONG(-1) | -0.357312 | 0.111984 | -3.190747 | 0.0044 |

| | | | |
|---|---|---|---|
| R-squared | 0.702513 | Mean dependent var | -0.003996 |
| Adjusted R-squared | 0.631683 | S.D. dependent var | 0.034266 |
| S.E. of regression | 0.020796 | Akaike info criterion | -4.714993 |
| Sum squared resid | 0.009082 | Schwarz criterion | -4.427029 |
| Log likelihood | 69.65240 | Durbin-Watson stat | 1.836392 |