In Search of a Dramatic Equilibrium:
Was the Armenian Dram Overvalued?

Nienke Oomes, Gohar Minasyan, and
Ara Stepanyan

IMF Working Paper

Middle East and Central Asia Department

In Search of a Dramatic Equilibrium: Was the Armenian Dram Overvalued?

Prepared by Nienke Oomes, Gohar Minasyan, and Ara Stepanyan[1]

Authorized for distribution by Mark Lewis

March 2009

Abstract

This papers estimates the equilibrium exchange rate for Armenia using three different approaches: the purchasing power parity (PPP) approach, the behavioral equilibrium exchange rate (BEER) approach, and the external sustainability (ES) approach. All three approaches suggest that the dram was overvalued by about 20–30 percent prior to the devaluation of the dram in March 2009.

---

[1] Nienke Oomes is the IMF Resident Representative in Armenia. Gohar Minasyan and Ara Stepanyan are former and current economists in the IMF Armenia Office. For useful comments, the authors are grateful to the IMF Armenia team and participants of the conference on "Global Competitiveness of the Armenian Economy," organized by the Armenian International Policy Research Group in May 2008 in Washington DC. The authors would also like to thank Fernando Gonçalves for useful contributions to this paper.

Contents   Page

I. INTRODUCTION

Armenia's real effective exchange rate has appreciated rapidly in recent years, which has led to concerns about a possible overvaluation of the dram. During 2005-2007, real appreciation was accompanied by nominal appreciation, and was mostly the result of large foreign exchange inflows, notably remittances and FDI, as well as high export prices, notably for copper and molybdenum. In 2008, however, the Central Bank of Armenia (CBA) changed its de facto exchange rate regime from a managed float without a predetermined path to a soft peg, and kept the nominal rate vis-à-vis the U.S. dollar within a very tight band until the recent dram devaluation in early March 2009. This was despite the facts that the U.S. dollar appreciated significantly against most other currencies, export prices fell significantly, and many of Armenia's trade partners (e.g., Russia, Ukraine, Georgia) had already devalued against the dollar.

This paper assesses the equilibrium real exchange rate level in Armenia by using three different approaches: the purchasing power parity (PPP) approach, the behavioral equilibrium exchange rate (BEER) approach, and the external sustainability (ES) approach.[2]

All three approaches suggest that the dram was overvalued by about 20–30 percent as of end-2008. The BEER estimate conducted by the Central Bank or Armenia (CBA) is in line with these estimates (Figure 1). While most approaches suggest that the dram was close to equilibrium (i.e., within a 10-percent band) most of the time during the 2000–07 period, some approaches suggest overvaluation in 2000, undervaluation in 2003, and overvaluation in 2007. The only year for which all approaches suggest a significant deviation from equilibrium is 2008.

Figure 1. Armenia: Estimated Real Exchange Rate Misalignment
(In percent)

---
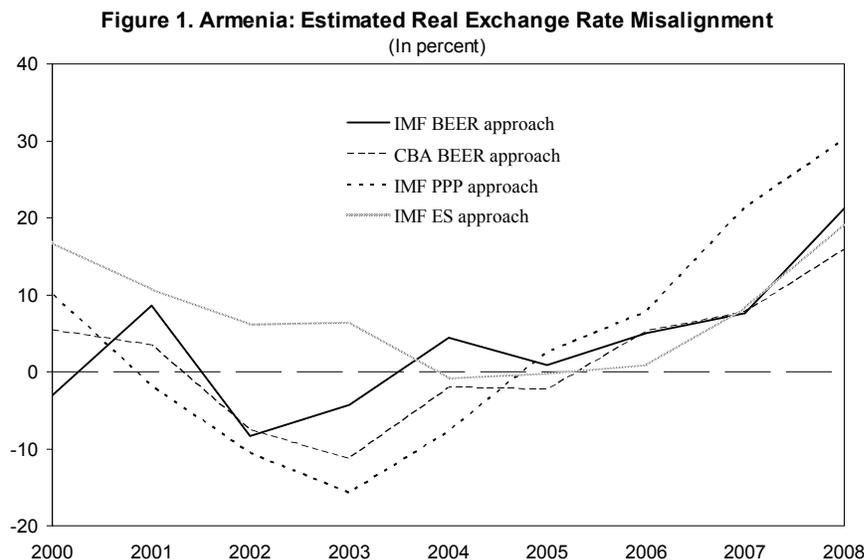
[2] Other equilibrium real exchange rate models not used in this paper include the Fundamental Equilibrium Exchange Rate (FEER) approach, the Desired Equilibrium Exchange Rate approach (DEER), and the Natural Rate of Exchange (NATREX) approach. For a survey, see Égert (2003).

II. PURCHASING POWER PARITY (PPP) APPROACH

One approach for estimating the equilibrium real exchange rate is by defining it as an equilibrium distance to Purchasing Power Parity (PPP). Armenia's PPP exchange rate is defined as the nominal exchange rate E at which the Armenian price level P equals the foreign price level P^*, that is, $PE=P^*$. Since the real exchange rate is defined as PE / P^*, the condition for PPP implies that the real exchange rate should equal one. While few people would want to maintain that the PPP real exchange rate itself is an "equilibrium" rate, it is nevertheless a useful benchmark.

The latest PPP estimates for Armenia (based on 2005 weights) suggest that Armenian prices in U.S. dollar terms have increased recently from about one third to almost two thirds of U.S. prices (Figure 2). In 1993, the Armenian price level was only about 10 percent of the U.S. price level. However, between 1993 and 1996, this relative price level increased gradually from roughly 10 to 30 percent, after which it remained approximately constant for almost 10 years. In recent years, however, the price level has increased significantly, to 63 percent in 2008, reflecting rapid nominal appreciation during 2005–07 and high inflation during 2008.

Figure 2. Armenian Price Level Relative to U.S. Price Level
(In percent)

Sources: WEO (October 2008); IFS; and IMF staff estimates.

If a relative price of 100 percent (PPP exchange rate of one) were defined as the equilibrium real exchange rate, the above PPP estimates would suggest that the dram is undervalued by about one third, which seems unrealistic. Moreover, the same would then be true for almost all developing countries, which typically have exchange rates far below

PPP. As explained below, an important reason for this divergence from PPP is that countries with lower incomes and lower productivity have lower prices for nontradable goods and services, which do not converge to nontradables prices in partner countries precisely because of the absence of trade. It is more natural, therefore, to think of the equilibrium real exchange rate as an "equilibrium distance to PPP."

To estimate the "equilibrium distance to PPP," we need to correct for the fact that prices are generally lower in countries with lower incomes and lower productivity.[3] This hypothesis goes back to Balassa (1964) and Samuelson (1964), and is therefore referred to as the Balassa-Samuelson hypothesis. It is based on the following argument. First, lower productivity in the tradables sector implies lower wages in the tradables sector (under the assumption that wages depend on productivity). Second, lower wages in the tradables sector imply lower wages in the nontradables sector (under the assumption that labor and capital are sufficiently mobile). Third, lower wages in the nontradables sector imply lower prices of nontradables, both for supply-side reasons (lower input costs) and demand-side reasons (lower incomes, hence lower effective demand).[4] These nontradables prices are unlikely to converge to nontradables prices in neighboring countries because nontradables, by definition, cannot be easily traded.[5]

Strictly speaking, the Balassa-Samuelson hypothesis implies that the real exchange rate should appreciate in line with the "relative productivity differential." If Armenia experiences "relative productivity growth," this means that productivity growth in the tradables sector exceeds productivity growth in its nontradables sector. In other words, prices of Armenian nontradables will then rise over time, while prices of Armenian tradables, in theory, will not (assuming they are determined by PPP), implying a rise in the overall Armenian price level. This does not necessarily imply real appreciation: for example, if Armenia's trade partners were to experience the same relative productivity growth, trade partner prices would rise at the same rate as Armenian prices, and the real exchange rate would be unaffected. However, if trade partners experienced less relative productivity growth than Armenia, then Armenian prices would rise faster than trade partner prices, and the real

---

[3] Technically, what matters for the Balassa-Samuelson hypothesis is not absolute productivity, but *relative productivity*: the difference between productivity in the tradables sector and productivity in the nontradables sector. We will expand on this distinction further below.

[4] The argument here is that lower effective demand in Armenia reduces nontradables prices in Armenia, but does not necessarily reduce tradables prices to the extent that the latter are determined by global supply and demand.

[5] For example, even though haircuts may be cheaper in Armenia than in the US, it generally does not pay for Americans to travel to Armenia just to get a haircut, because of the high transportation costs and because haircuts cannot be stored. In addition, labor market restrictions prevent Armenian hairdressers from moving to the US, implying that wage differences will persist. Finally, even if education and health care are cheaper in Armenia than in the US, such public nonmarket services are typically not available to noncitizens.

exchange rate would appreciate. That is why what matters is the "relative productivity differential": Armenian relative productivity minus relative productivity growth in trade partner countries.

In the absence of reliable data on sectoral productivity, the Balassa-Samuelson hypothesis is usually tested by regressing the real exchange rate (or the relative price level) on the overall productivity differential.[6] Output and employment data for tradables and nontradables sectors tend to be unavailable for most developing countries and are of mixed quality for others, and in any case are difficult to compare across countries. In the absence of better data, a common proxy is, therefore, to regress relative price levels on the overall productivity differential, i.e., on relative GDP per capita.[7]

Figure 3. Relative Price Levels and Relative Incomes

Source: IMF (World Economic Outlook, 2004).
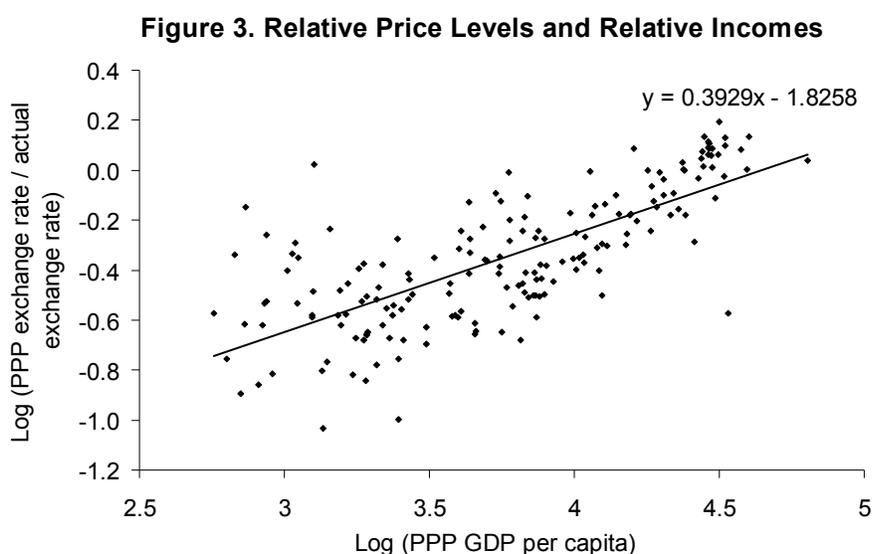
As predicted by the Balassa-Samuelson hypothesis, there exists indeed a clear positive relationship between the real exchange rate and productivity (Figure 3)**.** As before, the real exchange rate is measured as the relative price level PE / P^*, and productivity is measured as PPP GDP per capita.[8] The sample is taken from the IMF's World Economic

---

[6] See, e.g., De Gregorio and others (1994), Rogoff (1996), Kravis and Lipsey (1988), or Frankel (2005).

[7] Another approach is to use the overall productivity differential as a proxy for the relative productivity differential, which amounts to assuming that productivity growth in both the tradables and the nontradables sector are approximately a constant fraction of overall productivity growth.

[8] It is common to measure productivity as GDP per capita in PPP terms, because measuring it at actual exchange rates would imply that nominal exchange rate appreciation is equivalent to an increase in GDP per capita in U.S. dollar terms (i.e., this would implicitly assume that PPP holds).

Outlook database, and covers 180 countries (virtually the entire world). Based on a simple loglinear regression, we find the following equilibrium real exchange rate relationship:

Log (real exchange rate) = -1.83 + 0.39*Log (PPP GDP per capita).

This loglinear relationship, along with the 180 data points, is plotted in Figure 3.

Our estimates suggests that, on average, every 1 percent increase in PPP GDP per capita is associated with a real appreciation of 0.39 percent, which is surprisingly close to similar estimates conducted by others, and seems robust over time. For example, in his classic paper, Rogoff (1996) found a slope of 0.37 for a sample of 100 countries in 1990. De Broeck and Slok (2001) repeated this estimate for a sample of 149 countries in 1999, and found a slope of 0.41. Most recently, Frankel (2005) found a slope of 0.38 for a sample of 118 countries in 2000.

Based on the estimated equilibrium relationship between relative price levels and productivity differentials, we can obtain an estimate of the extent to which the dram has been undervalued or overvalued. The solid line in Figure 4 indicates our estimated equilibrium relationship between relative price levels (or the real exchange rate) and productivity, while the dashed line plots the actual evolution of Armenia's relative price level against Armenia's GDP per capita.[9] The difference between the dashed and dotted lines, plotted in Figure 5, can thus be interpreted as a measure of real exchange rate misalignment.

Figure 4. PPP Approach: Equilibrium and Actual Real Exchanges
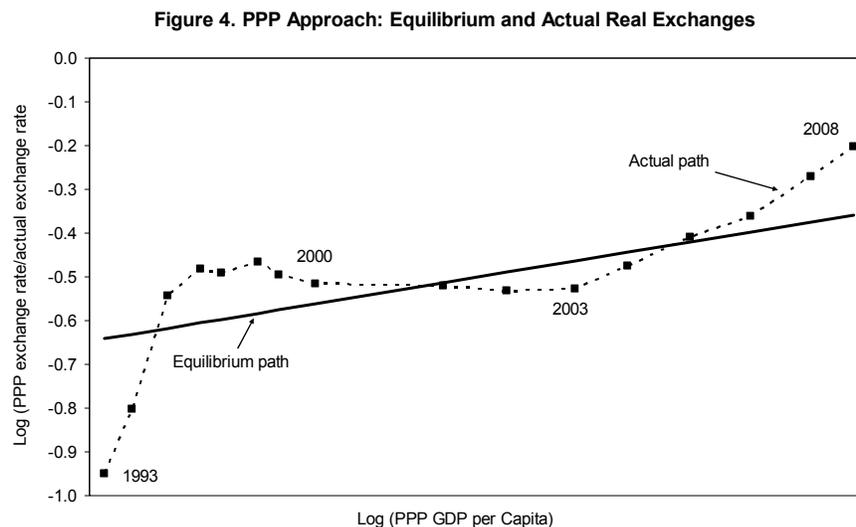
Sources: WEO (February 2009), IFS, and IMF staff estimates.

---

[9] Note that, since the data are in logs, a value of 0 on the y-axis corresponds to full PPP.

Figure 5. PPP Approach: Real Exchange Rate Misalignment
(In percent)
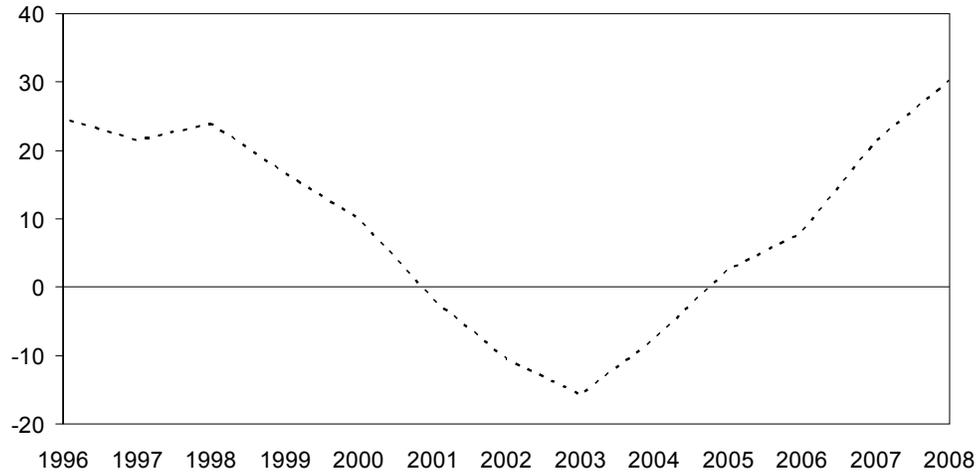
Sources: WEO (February 2009), IFS, and IMF staff estimates.

The results suggest that the Armenian real exchange rate was overvalued by as much as 30 percent in 2008. We plot the percentage difference between the actual and expected real exchange rate (i.e., the difference between the dashed and dotted lines), which we interpret as a measure of real exchange rate misalignment. These estimates suggest that the dram started out being highly undervalued in the early 1990s, then became slightly overvalued during 1995-2000, after which it moved back to equilibrium by 2001. Following that year, the dram became slightly undervalued again, as the equilibrium real exchange rate appreciated while the actual real exchange rate remained broadly constant. Since 2003, however, the actual real exchange rate appreciated more rapidly than the equilibrium exchange rate path, which has eliminated the undervaluation and has led to an estimated overvaluation of about 30 percent in 2008.

These results should be interpreted with caution, as the PPP approach is subject to a number of shortcomings. First, it only looks at the relationship between the real exchange and productivity, and does not look at other equilibrium exchange rate determinants. Second, the estimated equilibrium relationship between the real exchange rate and productivity is based on a large cross-section of countries that may not necessarily be representative of Armenia. Third, the estimated equilibrium relationship is a historical average for a large number of countries, which implicitly assumes that all exchange rates are on average in equilibrium. Finally, GDP per capita is a very rough proxy for the relative productivity differential variable suggested by Balassa-Samuelson.

III. Behavioral Equilibrium Real Exchange Rate (BEER) Approach

The next approach, the so-called Behavioral Equilibrium Exchange Rate or "BEER" approach, avoids some of the shortcomings of the PPP approach because it uses more precise definitions of productivity, includes other variables besides productivity, and is based on time-series data for Armenia alone. The methodology involves estimating the statistical long-run relationship between the real exchange rate and its fundamentals. In addition to productivity, we also include the terms of trade, net international reserves, and remittances as potential exchange rate determinants. The BEER approach suggests that the dram was overvalued by about 20 percent at end-2008.

A. Productivity Measures

As our productivity measure we use both "relative productivity" and the "relative productivity differential" suggested by Balassa-Samuelson. As explained above, "relative productivity" (sometimes called "dual productivity") is the difference between productivity in the tradable sector and productivity in the nontradable sector, and the "relative productivity differential" is the difference between relative productivity in Armenia and relative productivity in Armenia's trade partners. While industrial production is traditionally considered as tradable, and services as nontradable, the classification of other sectors, in particular construction and agriculture, is not straightforward.

We exclude the agricultural sector from our analysis. One rule of thumb suggested by the literature is to include agriculture in the tradable sector if its export share exceeds 10 percent, and include it in the nontradable sector otherwise. In Armenia, the export share of agriculture is significantly less than 10 percent, and has, in fact, been below two percent during the last five years, suggesting that it is mostly a nontradable sector. However, agriculture is typically characterized by relatively high state intervention, while the Balassa-Samuelson effect is essentially a market mechanism. Moreover, the data on agricultural output and employment are believed to be of particularly poor quality, as employment in agriculture is estimated based on land ownership by the household (all adult family members owing land are considered full-time employed, while only some of them may be working seasonally). Following other authors, we therefore exclude agriculture from our analysis altogether.

While the construction sector is usually considered as nontradable, we consider it as tradable for several reasons. The traditional reason for considering construction as nontradable is because the goods involved (particularly, real estate) cannot be physically moved across the border, while goods arbitrage is the main mechanism that ensures PPP (Égert, 2003). However, there are several arguments why one may wish to consider the construction sector in Armenia as largely tradable. First, the recent residential construction boom in Armenia is largely believed to be fueled by external demand, with anecdotal evidence suggesting that more than half of all real estate purchases in recent years (including corporate construction) are made by foreigners, mostly diasporan Armenians from Russia

and the Middle East. Second, Armenian construction workers are very mobile and many of them find temporary jobs in Russia, where wages are higher, which in turn drives up Armenian construction wages. Third, the Armenian construction sector in Armenia appears to have experienced significant productivity growth recently, as it increased by twelve times during the past nine years.[10] For these and other reasons, several other authors have also treated construction as a tradable sector in their panel analyses of Central and Eastern European economies (e.g., De Broeck and Slok, 2001; Coricelli and Jazbec, 2001).

To compute the relative productivity differential, we compare Armenia's relative productivity to that of the European Union (EU), using the same sectoral classification for the EU as for Armenia. We focus on the differential with the EU because the EU is Armenia's largest trade partner, accounting for 34 percent of Armenia's external trade. The next largest trade partner is Russia, accounting for 22 percent, followed by the United States, with 13 percent. While it would be preferable to take the relative productivity differential based on a weighted average of all or the major trade partners, this was not possible due to limited data availability and the fact that the sectoral classifications used by Russia and the U.S. are not comparable with that of Armenia and the EU. We therefore decided to focus on the productivity differential with the EU only.[11]

B. Other Equilibrium Exchange Rate Determinants

In addition to relative productivity, we include terms of trade, net international reserves (NIR) and remittances as potential equilibrium exchange rate determinants.

An improvement in the terms of trade is expected to give rise to real appreciation. The terms of trade are measured as the ratio of export prices to import prices. An improvement in the terms of trade thus leads to an improvement of the trade balance, which increases the supply of foreign currency, and, therefore, leads to real appreciation. In Armenia, the statistical relationship between the terms of trade and the real effective exchange rate does not appear to be very stable. In particular, it is difficult to detect the expected positive relationship in cointegration tests, unless enough lags are included. We believe that this could be due to the existence of trade contracts with pre-specified prices. In particular, commodity price changes in international markets may affect the trade flows with a lag. In addition, there can be inaccuracies in calculating the terms of trade, especially related to weights assigned to

---

[10] However, there are indications that official statistics underestimate construction prices and wages, and therefore are likely to overestimate real output growth and real productivity growth in construction. Moreover, productivity growth in construction started from a very low base, and the potential for productivity growth is much smaller than in conventional tradable sectors, such as manufacturing.

[11] As a robustness check, we also estimated a similar cointegrating vector using only Armenia's relative productivity, instead of the relative productivity differential. The results, which are available upon request from the authors, are very similar, but suggest slightly higher overvaluation, of about 29 percent at end-2008.

different trade partners, since the geographical structure of external trade of Armenia has changed significantly during the last ten years.

The relationship between NIR and the real exchange rate is generally ambiguous. On the one hand, NIR can be viewed as a summary measure of net balance of payments flows; as such, the relationship between NIR and real exchange rate is expected to be positive. On the other hand, purchases of foreign exchange by the monetary authority leads to an increase in NIR, but can limit real appreciation pressures in the short run, just as sales of foreign exchange can limit real depreciation pressures in the short run.[12] In this respect, it is difficult to detect a one-way causality between NIR and the real exchange rate. We find the relationship of NIR and exchange rate in most cases to be positive, although the results are somewhat sensitive to including other variables in the specification.

Remittances are believed to have been a significant factor contributing to recent real exchange rate appreciation in Armenia. Private transfers from temporary and resident workers experienced a surge in recent years, largely due to the economic boom in Russia. In a recent study on remittances to Armenia, Atoyan and Oomes (2006) found that a one percent of GDP increase in total remittance leads to a one percentage point increase in dram appreciation. Traditional remittances were found to have a positive impact on consumption, but not on GDP growth, while "other remittances," which are likely to be associated with investment into real estate, were found to have a positive effect on GDP growth as well. We found remittances to be positively related to the real effective exchange rate.

C. Results

The results show that a co-integrating vector exists between the real effective exchange rate, the terms of trade, remittances, NIR, and the relative productivity differential.[13] Augmented Dickey-Fuller (ADF) unit root tests, presented in Table 1, show that all series are nonstationary in levels and stationary in first differences, implying that it is legitimate to test for cointegration between these variables. The estimated cointegrating vector is presented in Table 2, which shows that all coefficients have the expected signs and reasonable magnitudes.[14] While the sign on NIR is theoretically ambiguous, as explained above, we

---

[12] Note that this would not be the case to the extent that foreign exchange interventions by the central bank are aimed at accommodating dollarization or dedollarization.

[13] Note that the cointegrating vector was estimated for data up to end-2007, and data for 2008 were used to project the equilibrium exchange rate for 2008.

[14] We obtained the best fit by including additional lags for relative productivity and the terms of trade. The reason for this could be that the mechanisms through which productivity changes affect the exchange rate involve adjustments in prices and wages, which take time. In the case of terms of trade, this could be due to the existence of trade contracts with pre-specified prices.

believe that the positive sign reflects the positive relationship between net BOP inflows and the REER.

The results from the BEER approach suggest that the real exchange rate was overvalued by about 20 percent at the end of 2008. The actual and estimated equilibrium real exchange rates are shown in Figure 6. Figure 7 shows the estimated misalignment, i.e., the deviation from the long-run equilibrium exchange rate (the error correction term), which was 21 percent at end-2008.

Our BEER results are broadly in line with results for other countries. Reviewing a number of time series and panel studies, Egert (2003) finds that an increase in relative productivity, or the relative productivity differential, is always associated with an appreciation of the real exchange rate. However, in the case of Armenia, an interesting aspect is the role of the construction sector: we could not find any evidence of a long-term relationship between the real effective exchange rate and alternative productivity measures that either exclude construction or treat it as a nontradable sector. This suggests that any evidence of the Balassa-Samuelson effect in Armenia is conditional on developments in the construction sector.

Just as the PPP-based approach for estimating the equilibrium exchange rate has a number of shortcomings, the BEER approach is subject to various shortcomings as well. The sample is quite short, therefore making it difficult to check the robustness of our results. Further, we could not find a unique cointegrating vector. Finally, cointegration techniques assume by definition that misalignment is zero on average, because the extent of misalignment is measured by the residual, which is zero by construction. This problem arises particularly in a short sample.[15]

---

[15] For a discussion of other shortcomings to this approach, see also Maeso-Fernandez, Chiara Osbat, and Bernd Schnatz (2005).

Table 1. BEER Approach: Augmented Dickey-Fuller Test Results

	Level		First Difference	
	t-Statistic	Prob.*	t-Statistic	Prob.*
Real effective exchange rate	0.28	0.97	-5.16	0.00
Terms of Trade (Exports deflator divided by imports deflator)	-2.34	0.40	-3.57	0.05
Net International Reserves (in US dollars)	-2.71	0.24	-4.35	0.01
Remittances including other transfers	-3.09	0.12	-7.14	0.00
Relative productivity differential (Armenian productivity in industry and construction, divided by productivity in transport and trade, divided by a similar measure of EU relative productivity)	-1.17	0.68	-2.99	0.05

*MacKinnon (1996) one-sided p-values.

Table 2. BEER Approach: Estimated Cointegrating Vector

Sample: 1998Q1:2007Q4

All variables are in logarithms

Dependent variable: real effective exchange rate

Terms of Trade	**0.09**
t-statistics	9.17
Remittances	**0.20**
t-statistics	20.25
Net International Reserves	**0.42**
t-statistics	49.82
Relative Productivity Differential	**0.07**
t-statistics	3.44
Trend	**-0.05**
t-statistics	-78.30
Constant	**1.86**
Number of lags	4
Log likelihood	447.6
Akaike information criterion	-20.1
Schwarz criterion	-14.8
Serial correlation LM (prob.)	0.71

Figure 6. BEER Approach: Equilibrium and Actual REER
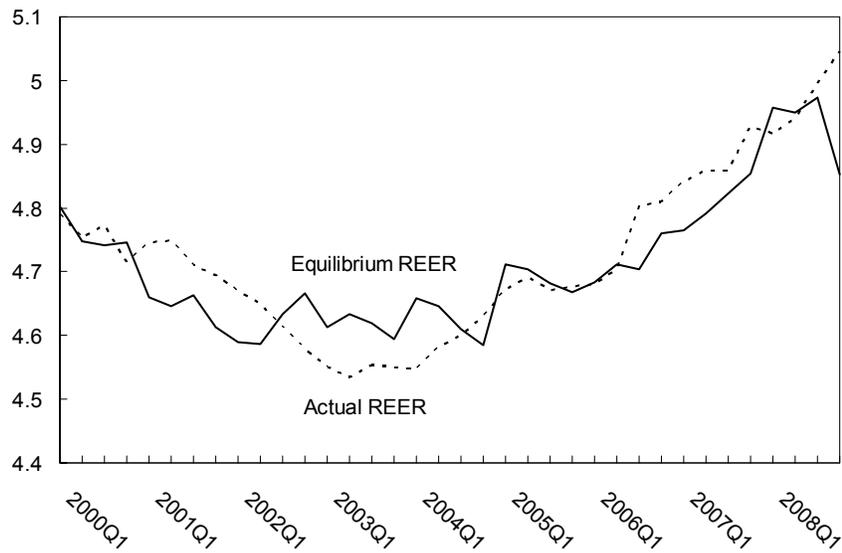
Figure 7. BEER Approach: Real Exchange Rate Misalignment
(In percent)
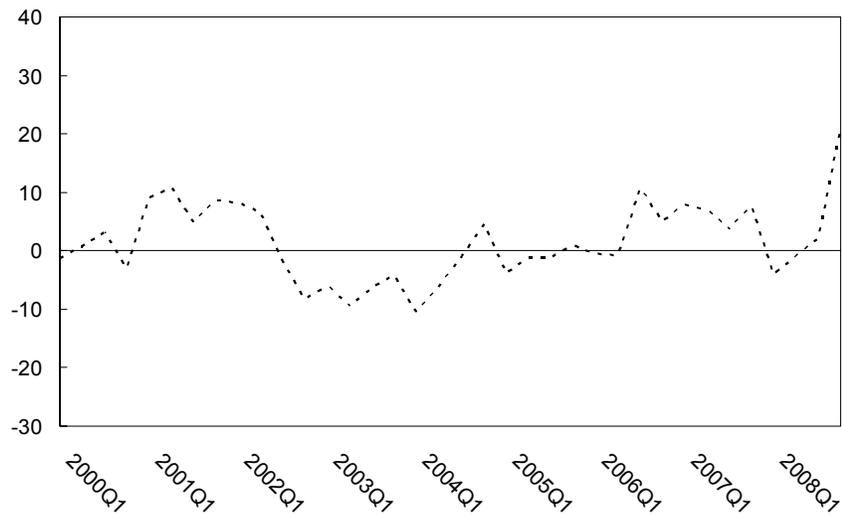
IV. EXTERNAL SUSTAINABILITY (ES) APPROACH[16]

The ES approach focuses on the relation between the sustainability of a country's foreign asset position, its current account position, and the real exchange rate. The approach consists of a simple calibration exercise that requires only a few assumptions about the economy's potential growth rate, inflation rate, and rates of return on external assets and liabilities.

---

[16] The authors would like to thank Fernando Gonçalves for significant contributions to this section.

The ES approach consists of three steps:

1.   Determine the trade or current account balance as ratios to GDP that stabilize the net foreign asset position at a given benchmark level;

2.   Compare these NFA-stabilizing trade or current account balance ratios with the level of a country's trade or current account balance expected to prevail over the medium term;

3.   Assess the adjustment in the real effective exchange rate that is needed to close the gap between medium-term balances and the NFA-stabilizing balances.

The external sustainability of an open economy requires that the intertemporal budget constraint of that economy is satisfied—i.e., the present value of future trade surpluses has to be sufficient to pay back all the outstanding external liabilities of the economy as a whole. One simple way to satisfy the intertemporal budget constraint is to have a stable ratio between net foreign assets and the size of the economy. This is analogous to approaches to debt sustainability which require the stabilization of the public debt-to-GDP ratio at a certain level.

To determine what is required to stabilize the NFA-to-GDP ratio at a benchmark level, the accumulation equation for NFA can be used:

(1) $NFA_t - NFA_{t-1} = CA_t + KG_t + KT_t + E_t$,

where CA_t is the current account balance, KG_t are capital gains from valuation changes, KT_t are capital transfers, and E_t errors and omissions. Denoting ratios to GDP by lower-case letters, equation (1) above becomes:

$$nfa_t - nfa_{t-1} = ca_t + kg_t + kt_t + e_t - \frac{g_t + \pi_t}{(1+g_t)(1+\pi_t)} nfa_{t-1},$$

where g_t is the growth rate of real GDP and π_t is the inflation rate of net foreign assets. Assuming that capital gains and errors and omissions have average zero over long periods, the stabilization of the NFA ratio to GDP at a benchmark level nfa^s implies

$$(2) \quad ca^s = \frac{g + \pi}{(1+g)(1+\pi)} nfa^s - kt^s$$

Equation (2) determines the current account balance as a ratio of GDP that stabilizes the NFA position. It is analogous to the determination of the primary surplus that stabilizes the public debt-to-GDP ratio.

Some important implications of the ES approach can be seen from equation (2). First, the faster a debtor economy ($nfa < 0$) grows the larger the current account deficit it can run without increasing the ratio of NFA to GDP. This observation is specially important for Armenia, which has been growing at double digits in recent years and therefore can afford having large current account deficits while keeping the sustainability of its external position.

Second, larger capital transfers imply that further current account deficits can occur with a stable NFA-to-GDP ratio. The typical approach found in the literature is to assume that capital transfers as shares of GDP are null ($kt^s = 0$). Indeed, it is natural to assume that capital transfers will eventually converge to zero. But this convergence may be very slow implying that it is realistic to assume that current account deficits will be partly financed by capital transfers for the foreseeable future. In this paper we calibrate equation (2) first assuming $kt^s = 0$, and then assuming a value for kt^s that is consistent with medium term forecasts for capital transfers.

The choice of the NFA-to-GDP ratio benchmark is a key element of the ES approach but is, to some extent, arbitrary. One possibility is to use the most recent NFA position that was considered sustainable. A more elaborate approach could consider econometric evidence of the long-run relation between NFA and underlying fundamentals such as the relative level of development, fiscal policy and demographics (Lane and Milesi-Ferretti, 2005). For now, we use the NFA-to-GDP position as of end-2006, which was -24.2 percent.

Additional assumptions need to be made about the inflation rate of NFA and Armenia's long-term growth rate. The inflation rate of NFA is assumed to be 2.5 percent, consistent with long-term projections for inflation in advanced economies. Armenia's long-term GDP growth rate was calibrated at 3 percent. However, because results are somewhat sensitive to the growth rate assumption, we also assumed two alternative scenarios: low growth, with a growth rate of 2 percent; and high growth, with growth rate of 4 percent.

The last step of the ES approach is to derive the required medium-term real effective exchange rate adjustment that is needed to bring the current account balance to the NFA-stabilizing current account balance. The magnitude of the required exchange rate adjustment is obtained by first computing the elasticity of the current account balance to the real exchange rate,

$$\varepsilon_{CA} = \varepsilon_X \frac{X}{GDP} + (\varepsilon_M - 1)\frac{M}{GDP},$$

where ε_X and ε_M are the elasticities of exports and imports to the real exchange, and X/GDP and M/GDP are the ratios or exports and imports to GDP, respectively. Once ε_{CA} is computed, the required real exchange rate adjustment can be obtained as follows.

$$\varepsilon_{CA} = \frac{\Delta CA/CA}{\Delta RER/RER} \Rightarrow \frac{\Delta RER}{RER} = \frac{\Delta CA}{CA}\frac{1}{\varepsilon_{CA}}$$

The trade elasticities were calibrated at ε_X =-0.71 and ε_M =0.92, following the values used by the IMF's Consultative Group on Exchange Rate Issues (CGER). The export and import ratios to GDP were calibrated with both end-2006 and end-2007 figures. The results are depicted in Figure 8 below.

Figure 8. ES Approach: Real Exchange Rate Misalignment
(In percent)
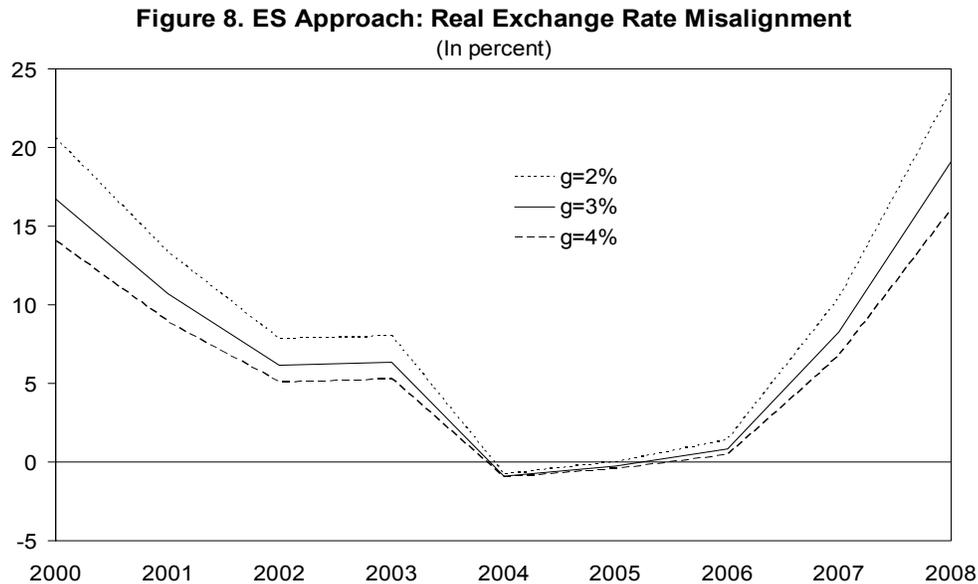
Like the BEER approach, the ES approach indicates that the real exchange rate was overvalued by about 20 percent as of end-2008. This estimate assumes a long-term growth rate of 3 percent. If long-term growth were 2 percent, the estimated overvaluation would be 24 percent, while if long-term growth were 4 percent, the estimated overvaluation would be 16 percent.

Like the other two approaches, the ES approach has shortcomings as well. In particular, the results are somewhat sensitive to the choice of parameter values, including the NFA-to-GDP ratio benchmark and the potential growth rate. However, while the exact misalignment estimates could be questioned on the grounds of their sensitivity to parameter choices, the trend is undeniable and is not affected much by the exact calibration choice.

The results are broadly consistent with the results of other approaches for recent years. Regardless of the growth rate assumption, the real exchange rate is estimated to have been around equilibrium during the years 2004–06, somewhat overvalued in 2007, and significantly overvalued by the end of 2008, which is broadly consistent with the findings of the PPP and BEER approaches. The main difference is that the other two approaches suggest

undervaluation during 2003, while the ES approach suggests overvaluation during that year (Figure 9).

Figure 9. Armenia: Estimated Real Exchange Rate Misalignment
(In percent)
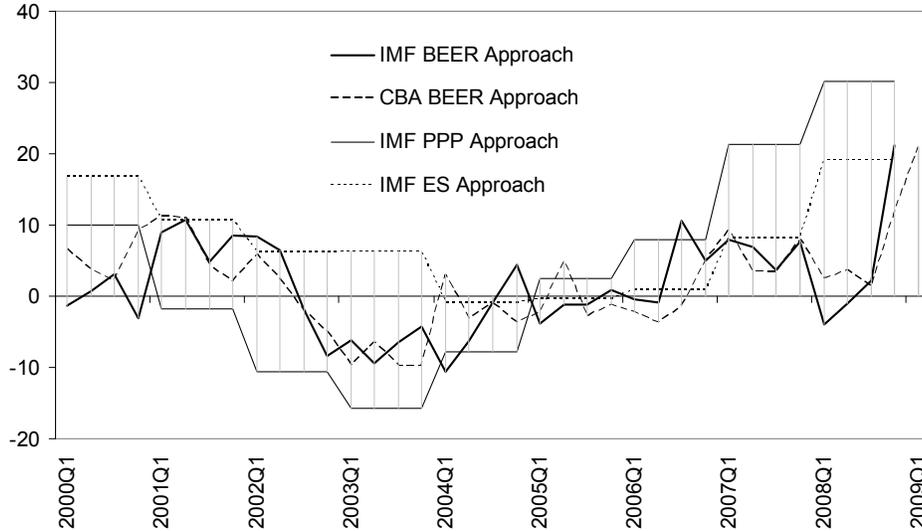
V. CONCLUSION

The main finding of this paper is that the real exchange rate in Armenia was overvalued by an estimated 20–30 percent prior to the devaluation of the dram in March 2009. This finding was confirmed by three different approaches for estimating the equilibrium real exchange rate: the purchasing power parity (PPP) approach, the behavioral equilibrium exchange rate (BEER) approach, and the external sustainability (ES) approach. Moreover, the BEER estimates conducted by the Central Bank of Armenia yielded similar results.

The overall findings are broadly consistent for all three approaches. In particular, all approaches suggest that the Armenian real exchange rate has been close to equilibrium (i.e., within a 10-percent band) during the years 2001, 2002, 2004, 2005, and 2006. Most approaches suggest that the real exchange rate was close to equilibrium in 2000, 2003, and 2007 as well, but the ES approach suggests overvaluation in 2000, while the PPP approach suggests undervaluation in 2003 and overvaluation in 2007. The only year from 2000 for which all approaches suggest a significant deviation from equilibrium is 2008.

Our estimates should be interpreted with some caution, due to the fact that each of the approaches has certain drawbacks and is based on certain assumptions. However, to the extent that all approaches point in the same direction, we can be fairly confident that overvaluation at end-2008 was indeed significant.

REFERENCES

Atoyan, Ruben, and Nienke Oomes, 2006, "Remittances to Armenia: Size, Sources, and Macroeconomic Implications," in: *Republic of Armenia: Selected Issues*, IMF Country Report No. 06/434, December 2006.

Balassa, Béla, 1964, "The Purchasing Power Parity Doctrine: A Reappraisal," *Journal of Political Economy*, Vol. 72, No. 6, pp. 584–96.

Coricelli, Fabrizio, and Bostjan Jazbec, 2001, "Real Exchange Rate Dynamics in Transition Economies," CEPR Discussion Paper No. 2869 (London: Center for Economic Policy Research). Available via the Internet: http://ssrn.com/abstract=278558

De Broeck, Mark, and Torsten Slok, 2001, Interpreting Real Exchange Rate Movements in Transition Countries, IMF Working Paper No. 01/56 (Washington DC: International Monetary Fund).

De Gregorio, Jose, Alberto Giovannini, and Holger Wolf, 1994, "International Evidence on Tradables and Nontradables Inflation," *European Economic Review*, Vol. 38, No. 6, pp. 1225–44.

Égert, Balázs, 2002, "Investigating the Balassa-Samuelson Hypothesis in the Transition: Do We Understand What We See? A Panel Study," *Economics of Transition*, Vol. 10, No. 2, pp. 273–309.

———, 2003, "Assessing Equilibrium Exchange Rates in CEE Acceding Countries: Can We Have DEER with BEER without FEER? A Critical Survey of the Literature," *Focus on Transition* Vol. 2, pp. 38–106. Available via the Internet: http://www.oenb.at/en/img/egert_ftr_203_tcm16-10369.pdf

Frankel, Jeffrey, 2005, "On the Renminbi: The Choice Between Adjustment Under a Fixed Exchange Rate and Adjustment Under a Flexible Rate," NBER Working Paper No. 11274 (Cambridge, MA: National Bureau of Economic Research). Available via the Internet: http://www.nber.org/papers/w11274

Kravis, Irving, and Richard Lipsey, 1988, "National Price Levels and the Prices of Tradables and Nontradables," *American Economic Review*, Papers and Proceedings, Vol 78, No. 2 (May) pp. 474–78.

Lane, Philip and Gian Maria Milesi-Ferretti, 2001, "Long-term capital movements," NBER Macroeconomics Annual 2001.

Maeso-Fernandez, Francisco, Chiara Osbat, and Bernd Schnatz, 2005, "Pitfalls in Estimating Equilibrium Exchange Rates for Transition Economies," *Economic Systems* Vol, 29, pp. 130–43.

Rogoff, Kenneth, 1996, "The Purchasing Power Puzzle," *Journal of Economic Literature*, Vol. 34, No. 2, June, pp. 647–68.

Samuelson, Paul A., 1964, "Theoretical Notes on Trade Problems," *Review of Economics and Statistics*, Vol. 46, No. 2, pp. 145–54.