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Fundamental Equilibrium Exchange Rates and Currency Boards: Evidence from Argentina and Estonia in the 90's

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Summary. Hard pegs and especially currency boards have been criticized as a policy tool for fighting inflation, as over the medium to long-run period they are thought to lead to an overvalued exchange rate and to a significant worsening of the current account. In order to verify this criticism we calculate historic fundamental equilibrium exchange rates (FEERs) for two countries which have introduced currency boards in the beginning of the 90's, namely Argentina and Estonia. Our analysis suggests that there were no severe misalignments of real exchange rates in currency board countries at least in the recent past. Overall, since the introduction of the currency board the Argentinian real exchange rate has had periods of relatively small undervaluation and overvaluations. These misalignments are in the order of 6%, which is far from the severe misalignments that might have been expected given the current economic problems in Argentina. In Estonia the size of the misalignments has been much larger than in the case of Argentina. The results of this analysis suggest that the parity at which Estonia entered the currency board was overvalued. However, the process of transformation has allowed Estonia to improve its competitiveness. At the end of the sample period (1999) the Estonian real exchange rate was undervalued by around 15%.

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I. Introduction

Over the last decade currency boards have regained popularity. Initially seen as a colonial monetary regime applicable only to very small, open and well integrated countries, currency boards have made a comeback becoming popular in both small and medium size economies. There are two different explanations of the revival of currency boards in the 90's.

First, proponents of currency boards argue that the revival of this monetary regime is part of a global tendency of hollowing out of the middle part of the distribution of exchange rate regimes. As intermediate regimes become unsustainable, countries move towards either flexible exchange rates or hard exchange rate commitments (*Hanke and Schuler*, 1999).[1] These authors regard currency boards as a permanent means of achieving a stable monetary standard. According to this view, currency boards ensure monetary discipline and instill confidence in the domestic currency and indeed provide important anti-inflationary benefits. In addition, currency boards are successful in maintaining high growth and low inflation. This explanation of revival of currency boards treats them as a permanent monetary regime.

The second explains the revival of currency boards with their ability to stabilize economies which have a long history of monetary instability or lack the institutions and expertise to conduct independent monetary policy. Indeed the adoption of a currency board is a solution for countries in transition from centrally planned to market economy (Estonia, Lithuania), countries which desperately need to import monetary stability due to the history of hyperinflation or absence of stable institutions (Argentina, Bulgaria); or countries in the process of postwar reconstruction (Bosnia and Herzegovina). This explanation views currency boards as a transitory monetary regime. Once the economy is stabilized and credibility in the national currency and monetary authorities is rebuilt, the country needs to find an exit strategy from the existing currency board arrangement. The reason for this is that currency board arrangements are very rigid. Since the nominal exchange rate is irrevocably fixed, changes in the real exchange rate can

[1] *Fischer, S.* (2001) states that empirical evidence shows that in the last decade there has been a tendency of hollowing out of the middle of the distribution of exchange rate regimes and moving toward either flexible exchange rates or hard exchange rate commitments ('two poles'). There is an opposite view that "intermediate solutions are more likely to be appropriate for many countries rather than corner solutions" *Frankel, J.* (1999). *Masson* (2001) rejects the hypothesis that there are only transitions toward the two poles (floating or firm fixed) using a wide set of countries. According to *Masson* (2001), the evidence of exchange rate regimes transitions suggests that intermediate regimes will continue to constitute an important fraction of actual exchange rate regimes.

only take place through differential price movements. Such adjustment is likely to be slow and partial (if prices and wages are sticky), which could lead to continuous overvaluation of the real exchange rate. This exchange rate misalignment implies a loss of competitiveness, a worsening current account balance and eventually speculative attacks and a collapse of the fixed exchange rate. Countries should therefore follow different exit strategies in order to avoid the collapse of the fixed exchange rate. Exit can be to a simple peg to the same or to a different currency, and at the same or different parity; to a floating rate; or to a different monetary standard including joining monetary union or adopting foreign currency as legal tender. For the Central and Eastern European countries with currency boards the path of exchange rate regime transition looks predetermined. These countries (Bulgaria, Estonia and Lithuania) have started negotiations for EU membership. Since new member countries cannot use an opt-out clause, eventually they will have to join EMU.

Joining EMU, currency board countries will need to decide at what parities to enter the monetary union (*Gulde, A. M., et al.,* 2000). One option is to stick to the current parity. This means that they will need to quantify their equilibrium exchange rate and the deviation from this rate to assess whether the current parity would be sustainable. If the current parity is undervalued inflation in the economy will be higher than in the other members of the monetary union (this is likely due to convergence). If it is overvalued, the country will have competitive problems, which in the case of a common monetary policy could cause lower output. The second option is to change the current parity in order to narrow the gap between the equilibrium real exchange rate and the current level of the real exchange rate. This change could be done when they enter ERM II. Since ERM II is a multilateral commitment to fix the exchange rate within a 15% band, the change in the parity might not lead to loss of credibility and currency crisis.

Currently there is intense discussion about whether Central and Eastern European countries should adopt the euro as legal tender before joining EU (euroization). Since euroization is practically irreversible, these countries have to choose very carefully the level of the exchange rate at which they adopt the euro as legal tender.

The collapse of the Argentinian currency board at the end of 2001 reopened the discussion on the sustainability of currency board arrangements and possible exit strategies from this monetary regime. In the case of Argentina prior to the collapse of the currency board there was some slight probability that they could form a monetary union with the United States or a re-

gional monetary union with MERCOSUR countries.[2] A widely recommended solution to Argentina's problems was the proposal to abolish the national currency and adopt the US dollar as legal tender (*Calvo*, 2000; *Hanke and Schuler*, 1999, 2002). If Argentina had chosen dollarization, the authorities would have had to decide the level of exchange rate at which to adopt the US dollar as legal tender. The authorities had an option to dollarize preserving the existing level of exchange rate or to devalue in order to correct any overvaluation of the real exchange rate. At the end the authorities floated the peso in order to compensate the accumulated real overvaluation of the exchange rate.

In this paper we estimate equilibrium exchange rates for Argentina and Estonia and calculate misalignments of the exchange rates in order to address the issue of sustainability of existing currency boards and a possible path of transition for exchange rate regimes.

The plan of the paper is as follows. Section II provides a short discussion of the appropriate methodology for estimating equilibrium exchange rates and the definition of the real exchange rate. Section III provides an explanation of the assumptions underlying the calculation of fundamental equilibrium exchange rates. The results are presented in Section IV. Section V offers some brief conclusions.

II. Which Measure of Equilibrium?

In this paper we try to address two related questions. *First*, does the adoption of a currency board arrangement lead to a prolonged appreciation of the real exchange rate and big misalignments, which affect the country's export competitiveness and growth performance? *Second*, we try to calculate quantitative measures of the deviation of real exchange rates from equilibrium, which will give us valuable information about possible channels of correction of accumulated misalignments.

To find answers to these questions we need a concept of equilibrium real exchange rates against which to measure actual exchange rate changes. Traditionally the purchasing power parity (*PPP*) doctrine is viewed as a model of the long-run real exchange rate. Under *PPP* the equilibrium real exchange rate is a constant. Recent studies, which emphasize purchasing power parity as a long-run concept, allow short-run deviation from the equilibrium rate. In this case the real exchange rate need only be stationary rather than a con-

[2] For a discussion of the possibility that Argentina forms a monetary union with other Latin American countries (MERCOSUR countries) see *Eichengreen, B.,* 1998; *Levy Yeyati, E., and Sturzenegger, F.,* 2000.

stant. Stationarity implies that the real exchange rate returns to its mean in the long-run. The mean is considered to be the long-run equilibrium real exchange rate, which is fixed. Thus the model of long-run PPP admits changes in the real exchange rate, but not in its mean.

Consensus estimates suggest that the speed of convergence of the real exchange rate to PPP is extremely slow with a half-life of three to five years. The long-run equilibrium real exchange rate delivered by PPP also gives no information about whether this equilibrium is desirable or not. The famous example is *Frenkel* (1978), which finds support for PPP during German hyperinflation period in the 1920's. Few would claim that the nominal and real exchange rates during this episode were the outcome of an underlying macroeconomic equilibrium.

There are number of reasons for the empirical failure of PPP.[3] Barriers to trade such as tariffs and transportation costs are obvious reasons why the same goods are not sold at the same price throughout the world. Different consumer preferences across countries lead consumers in each country to choose different baskets of goods. As price indices are constructed for a basket of goods designed to represent a particular country's consumption, an apparent failure of *PPP* could be due to different rates of inflation across two countries' distinctive baskets of consumption goods rather than different prices for the same goods across countries. The presence of nontraded goods in the consumer basket may cause a breakdown in *PPP* because these goods are not directly comparable across countries. Productivity differentials among economies and sectors within an economy might lead to long-run deviations of real exchange rate from *PPP* (Balassa-Samuelson effect). Differences in government spending and demographic profiles across countries may also affect equilibrium real exchange rates and cause deviation from purchasing power parity.

The underlying balance methodology addresses the issue of the relationship between equilibrium real exchange rates and macroeconomic fundamentals. This approach expresses the equilibrium exchange rate in terms of fundamental variables.[4] The most popular and widely applied in empirical work on the underlying balance model is the Fundamental Equilibrium Exchange Rate (*FEER*) approach. The concept of *FEER* was introduced by *Williamson* (1983). It is the real exchange rate, which is consistent with internal and external equilibrium of the economy. Within this framework inter-

[3] For review of *PPP* puzzle see *Rogoff*, 1996.

[4] For review of a wide variety of concepts and empirical approaches to estimating equilibrium exchange rates see *Driver, R. L., and Westaway, P.,* 2001.

nal equilibrium is a situation where demand for domestic output is equal to its supply. This implies that there will be no output gap either in the domestic economy or abroad. External balance is defined as a position where saving minus investment in the economy is at a sustainable level. The definition of external balance does not imply that the economy has to achieve full stock-flow equilibrium, where net foreign assets are constant and sustainable current account is equal to zero. The *FEER* is therefore a medium term rather than long-run concept of equilibrium exchange rates. The medium term nature of the *FEER* is consistent with a neutrality assumption that the real economy will be independent of nominal variables. Therefore the *FEER* is a real exchange rate, which is consistent with a range of combinations of nominal exchange rates and prices.

Before moving to the next section, which explains in detail the methodology applied to estimate equilibrium exchange rates, we need to clarify which measure of real exchange rate will be used as a basis for the *FEER* calculations. The measure needs to be a multilateral real exchange rate construction, as the *FEER* represents equilibrium in the whole economy. This choice implies that we will estimate multilateral equilibrium exchange rates and cannot derive bilateral equilibrium exchange rates directly. It is possible to back out the associated bilateral equilibrium exchange rates if estimates of equilibrium exchange rates are also available for the country's main trade partners.[5] Since we estimate *FEER*s only for two countries (Argentina and Estonia) this does not allow us to back out estimates of bilateral exchange rates. In terms of the price indices used for the construction of the real exchange rate we used indices which focus on traded goods prices.

The definition of real exchange rate used in this paper is given by:

$$R = \frac{WPXG * r}{PD}$$

where r is the nominal exchange rate (local currency per US dollar), *WPXG* is world export prices in US dollars and *PD* is domestic prices expressed in domestic currency, given by producer prices. An increase in *R* represents a depreciation. This is the definition of real exchange rate used in most of the existing work on fundamental equilibrium exchange rates.[6]

Using this definition of the real exchange rate allows us to abstract from the Balassa-Samuelson effect, which accounts for productivity differentials between traded and nontraded sectors of the economy. Since there is substantial empirical support for the Balassa-Samuelson effect, especially in

[5] See *Alberola et al.,* 1999; *Faruqee,* 1998.

[6] See for example *Barrell and Wren-Lewis,* 1989; *Wren-Lewis and Driver,* 1998.

comparisons between developed and developing countries, the choice of real exchange rate definition that excludes nontraded goods will significantly affect our estimation of *FEER*s for currency board countries.[7] In appendix C we provide graphs of the real effective exchange rates and *R* for Argentina and Estonia.

III. Calculating FEERs

There are two main approaches to estimating *FEER*s. The first uses a complete macroeconomic model and generates the *FEER* as a solution to that model. This can be done with a single country model, under given assumption about the rest of the world or a multicountry model.[8] The main advantage of this approach is that it derives estimates of the equilibrium exchange rate, which are consistent with all macroeconomic variables. However, sometimes it may lack transparency. The second and most widely used method to calculate *FEER*s takes a partial equilibrium approach. The approach estimates trend output and sustainable current accounts separately and solves for the real exchange rate which is consistent with these estimates. The main advantage of this approach is its simplicity and clarity. It allows to identify the factors that particularly affect the *FEER* estimation and permits different sensitivity tests.[9] The disadvantage of the partial equilibrium approach is that there is no model which ensures consistency between estimates of trend output and the sustainable current account. In addition, this approach does not allow for any feedback from the *FEER* to the inputs for trend output and saving minus investment relationships. This implies that trend output and saving minus investment influence *FEER*, but there is no feedback from the equilibrium exchange rate to the rest of the model.[10]

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[7] A definition of the real exchange rate that uses relative output or trade prices rather than consumer prices is also more appropriate when countries produce different goods. *Obstfeld and Rogoff*, 1996, show that *PPP* holds for relative consumer prices, but not for relative producer prices. This occurs even though all consumers are identical across countries, there is no home bias in consumption, no pricing to market and the law of one price holds for each individual good.

[8] *Wren-Lewis et al.* 1991 estimate *FFER* for the UK economy using a complete macroeconomic model. *Bayoumi et al.* 1994 calculate equilibrium real exchange rates for major industrial countries using IMF's multicountry macromodel MULTIMOD.

[9] For discussion how sensitive *FEER* estimation is to exogenous assumptions and weaknesses in the underlying structure see *Driver and Wren-Lewis,* 1999.

[10] *Barrell and Wren-Lewis*, 1989, and *Driver and Wren-Lewis*, 1999, investigate the impact of relaxing this assumption in the case of trend output. They allow trend GDP to vary with the real exchange rate. The results show that allowing for output endogeneity does not make substantial difference.

Since we do not have complete macroeconomic models for the countries of interest we are going to use the 'partial-equilibrium' model following the *Barrell and Wren-Lewis* (1989) and *Wren-Lewis and Driver* (1998) methodology to estimate FEERs.

The methodology applied in this paper for the calculation of *FEER*s can be broken down in three stages. Each of these stages illustrates the importance of the assumptions made about external and internal equilibrium of the economy. The first stage is to calculate the trend current account, which differs from actual current account. The difference between the actual and trend current account depends on the accuracy of the model of trade equations and *IPD* flows and estimation of the output gap. The difference between actual and predicted trade flows can be described as an outcome of shocks, which are viewed as temporary shocks and can be stripped out in calculations of the trend current account. Then we use the estimated trade equations to calculate what exports and imports would have been if output were equal to potential output (zero output gap). This allows us to derive a trend current account that is consistent with existence of internal balance within economy.[11] The first stage shows what the medium current account would be if the real exchange rate remained unchanged. However, the real exchange rate must move to clear the balance of payments, so the trend current account matches the medium-run sustainable current account. A critical element in estimating *FEER* is the assumption of the medium-term sustainable current account (also called structural capital flows if we look from the capital account point of view).[12] The second stage involves calculation of sustainable level of current account that corresponds to the external equilibrium of the economy. The final stage involves calculation of the real exchange rate that produces medium-term current account, which is equal to sustainable current account (structural capital flows). (See Appendix A for a full equation listing for the current account model.)

Modeling Aggregate Trade

Trade is disaggregated into eight components: prices and quantities of imports and exports of goods and services. Trade volumes are modeled in the traditional 'demand curve' approach. This approach has a long tradition in empirical macroeconomics and remains the standard way of modeling

[11] For simplicity we use actual *IPD* flows, smoothed using a four-quarter moving average.

[12] *Driver and Wren-Lewis*, 1999, show that *FEER* estimates are much more sensitive to sustainable current account norms and trade parameters than to estimates of trend output.

trade flows.[13] There are three arguments in trade volume equation: a measure of the total demand, a measure of competitiveness, and an exogenous time trend. The functional form is the traditional log-linear specification. We use domestic income as the variable, which captures the impact of activity for both goods and services imports. For goods exports we use world trade, while for services exports we use world income approximated by OECD real GDP. Export competitiveness is measured by the ratio of world trade prices converted in domestic currency and domestic export prices. Import competitiveness is measured by real exchange rate defined as a ratio of world trade prices expressed in domestic currency and domestic producer prices. Export and import competitiveness for services is captured by the real exchange rate for services defined as a ratio of world consumer prices (approximated by OECD consumer prices) and domestic consumer prices multiplied by nominal effective exchange rate.

The estimation technique, which we apply, is a simple error correction mechanism (*ECM*). As we are not interested in short-term dynamics (FEERs are a medium-term concept) it would be preferable to use also cointegration techniques. Since our sample is quite short (1993:Q1 – 1999:Q4) we do not test for cointegration for trade volumes. A crucial ingredient in the estimation of an *ECM* is the assumption that the term capturing the disequilibrium effect is correctly specified. If estimation of the *ECM* does not produce residuals that are stationary it might be because the levels of variables are not cointegrated, and this in turn may be because a variable had been inadvertently omitted. To control this we perform variety of diagnostic tests to check for misspecification in the equations. These tests are for serial correlation, functional form, normality, and heteroskedasticity.[14] Results from this estimation are reported in Appendix B.

Price elasticities have a big impact on the *FEER* calculations because their size determines how much the real exchange rate has to change in order to bring the economy into internal and external balance. Higher price elasticities mean that smaller changes in real exchange rate are needed in or-

[13] For a survey see *Goldstein and Kahn*, 1985. The demand curve specification has serious empirical and theoretical inadequacies. First, this approach does not account for nonprice competitiveness factors so the demand curve approach does not account for variety and quality of goods produced in the economy. Second, modelling trade volumes with demand curve equation neglects supply side factors, in particular decisions over the location of production.

[14] The test for serial correlation is Lagrange multiplier test; for functional form Ramsey's RESET test; for normality Jarque-Bera test, and for heteroskedasticity, White's Heteroskedasticity Test. The tests are all distributed as χ^2 and null is accepted when the test statistics is less than critical value.

der to correct disequilibrium. In the extreme case, where price elasticities are infinite, the equilibrium real exchange rate is a constant and *PPP* holds.

Theoretically the Marshall-Lerner condition is regarded as the dividing line for the size of price elasticities. It requires the sum of the price elasticities for imports and exports volumes (in absolute terms) to be greater than unity. Under this condition the nominal trade balance (in domestic currency) will improve following a depreciation of the real exchange rate.[15] For both countries the results for goods exports and imports show that Marshall-Lerner condition is satisfied (see Table 1). For Argentina we found higher goods imports and exports prices elasticities than for Estonia. These relatively high price elasticities imply that for a given change in saving-investment norm relatively small changes in the *FEER* will be needed to reach a new equilibrium.

In both cases the prices elasticities with respect to services exports and imports are relatively low. Exception is the price elasticity of Argentina's services export (see Table 2).

Table 1

NORMALIZED ELASTICITY ESTIMATES FOR GOODS EXPORTS AND IMPORTS

	Argentina	Estonia
Export		
Price elasticity	1.4	0.85
Income elasticity	3.3	3.8
Import		
Price elasticity	-3.9	-1.2
Income elasticity	2.3	3.5

Activity elasticities give the amount by which trade volumes respond to a change in output. If they are greater than unity, this implies that trade volumes will be rising as a proportion of associated activity variable. Activity elasticities play an important role in the determination of the *FEER* because they transmit changes in the potential output into changes of the equilibrium exchange rate. A change of the potential output at home will trigger changes

[15] This condition assumes that trade balance is initially zero. If the trade balance is in deficit, then for the nominal balance (expressed in domestic currency) to improve, the amount by which the sum of the trade price elasticities must exceed unity increases. The size of this increase will be determined by the relative size of export and import price elasticities (see for example *Goldstein and Kahn*, 1985; *Hooper and Marquez*, 1995).

in the *FEER* (for an unchanged level of sustainable current account) and the size of these changes will be determined by the size of the activity elasticities of trade volume. The higher the activity elasticities, the bigger the resulting change in the trend current account for a given change in potential output. In other words, the size of the change in the *FEER* associated with a change in trend output is an increasing function of the size of the activity elasticities.

The activity variable associated with goods import volumes is given by domestic output. No restrictions are imposed on this elasticity. Export goods volumes are modeled as a function of world trade. Any prior belief in unit elasticity is not supported by the data. In both countries (Argentina and Estonia) the estimated activity elasticities are much bigger than unity. This makes *FEER* very sensitive to changes in trend output at home and abroad and to world trade. For Estonia the estimated activity elasticities are higher than for Argentina, which reflects the fact that Estonia is a smaller and more open economy.

In the case of services exports and imports the activity variables are given by domestic output and world output respectively. No restrictions are imposed on the associated activity elasticities.

Table 2

NORMALIZED ELASTICITY ESTIMATES FOR SERVICES EXPORTS AND IMPORTS

	Argentina	Estonia
Export		
Price elasticity	1.6	0.4
Income elasticity	4.8	3.8
Import		
Price elasticity	-0.1	-0.4
Income elasticity	2.4	3.0

Trade prices are modeled separately for goods and services. Goods prices are divided into two groups: commodity prices and manufacturing prices.

Commodity prices are broken down into four categories: oil prices, food prices, world agricultural nonfood prices and world metals and mineral prices. Commodity prices for imports and exports are defined as a weighted function of these four commodity prices groups, where country specific weights are based on the relevant shares of commodity exports and imports in total trade. Coefficients A_1 and B_1 give the share of all commodities within

total goods exports and imports, respectively. Data are derived from the UNCTAD Handbook of International Trade and Development Statistics and for each country the totals are for 1995.

Table 3

COEFFICIENTS ON COMMODITY PRICES

	Argentina	Estonia
Exports: B_1	0.66	0.32
Oil: b_1	0.16	0.18
Food: b_2	0.75	0.48
Nonfood: b_3	0.07	0.26
Metals: b_4	0.02	0.08
Imports: A_1	0.14	0.29
Oil: a_1	0.29	0.33
Food: a_2	0.40	0.54
Nonfood: a_3	0.14	0.09
Metals: a_4	0.17	0.04

Manufacturing export and import prices are modeled as a weighted average of world export prices and domestic producer prices. The elasticities for import and export prices to world trade prices are obtained using the error-correction mechanism model. In each case, the models are estimated using quarterly data from 1993:Q1 to 1999:Q4. Results of estimated and chosen price elasticities to world trade prices are presented in Table 4 (in Appendix B2 we present *ECM* and results). In the case of Argentina we found an estimate for the elasticity of import prices to world trade prices, which is not plausible. In this case we impose coefficient of 0.86, which is derived from a Johansen cointegration test.[16] The estimate for the elasticity of Estonian export prices to world trade prices is very low. This result implies that Estonian export is composed of goods whose prices are independent of world export prices. The evidence of the structure of Estonian export does not seem to support the view that the country's goods exports prices are independent of world trade prices. Taking into account the fact that Estonia is a very small and open economy we impose an export price elasticity to world trade prices of 1.

[16] Estimation period for this cointegration test is 1993:Q1 − 1999:Q4. We found one cointegration vector at 5% significance level. Due to short estimation period this result has to be accepted with caution.

Table 4

THE IMPACT OF WORLD PRICES WITHIN TRADE PRICE EQUATIONS

	Import prices		Export prices	
	Estimated A_2	Chosen A_2	Estimated B_2	Chosen B_2
Argentina	3.17	0.86	0.61	0.61
Estonia	0.55	0.55	0.08	1.0

For trade in services, export prices are assumed to be identical to domestic consumer prices and import prices to OECD consumer prices.

In addition to the trade price equations, we also assume simple relations between domestic GDP deflators and domestic producer prices; domestic consumer prices and domestic producer prices; and world consumer prices and world trade prices (specifications of these relationships are given in Appendix A3).

Since current account is not made up only of net trade flows we need to model interest, profit and dividend flows and net transfers.

In this paper we take *IPD* flows as exogenous because over the historical period, actual foreign assets and liabilities will determine *IPD* flows. If we assume that foreign assets are denominated in foreign currency then *IPD* credits will be in foreign currency (this is a plausible assumption for both Argentina and Estonia). On the other side, if foreign liabilities are denominated in domestic currency, then *IPD* debits will be in domestic currency. Here we assume that foreign liabilities are also denominated in foreign currency.[17] When these flows are denominated in foreign currency we need to allow for exchange rate revaluation effects since changes in real exchange rate will affect *IPD* flows. We also smooth the series for *IPD* flows using a four-quarter moving average.

The balance of *IPD* flows as a proportion of GDP for the historic period is given by:

$$bipd = \left[1 + \rho * \left(\frac{FEER - R}{R}\right)\right] * (ipdc - ipdd)$$

where:

[17] For example in the case of Argentina federal government debt is denominated 96 % in foreign currency (70% in US dollars, 20% in euro and 5% in Japanese yen) and only 4% in domestic currency – pesos (information from Argentinean Ministry of Economy, Undersecretariat of Financing).

bipd is balance of *IPD* flows as a percent of GDP,

ipdc is *IPD* credits as a percent of GDP,

ipdd is *IPD* debits as a percent of GDP,

ρ gives proportion of revaluation effect (in our case set to 1 for both Argentina and Estonia),

FEER is fundamental equilibrium exchange rate, and

R is actual real exchange rate.

Net transfers are modeled simply as an exogenous variable with trend, and are expressed as a proportion of GDP (in Appendix A4 we present equation for net transfers).

Estimating the Trend Current Account

An important element of *FEER* estimation is the calculation of trend output. Since the *FEER* is a concept which is compatible with exogenously determined values for internal balance, we need to model potential output in order to set output gaps (at home and abroad) to zero. In the literature three different methodologies are widely used for estimation of potential output and output gap.[18] The first two approaches are based on mechanical times series smoothing of GDP series. These are the time trend method and the Hodrick-Prescott filter. Estimates of potential output and output gaps derived by these two techniques use no information about the structure of the economy or economic relationships. The third approach is based on a Cobb-Douglas production function constructed by using a measure of equilibrium unemployment and the whole economy capital stock. This structural framework is less mechanical and reflects structural factors, which affects potential output. The disadvantage is that the production function estimation of potential output demands data for capital stock within the whole economy and a measure of potential employment, which are in most cases unavailable for developing countries.

In this paper we use the time series approach for estimation of the trend output and output gap. Trend output is modeled as exogenous with a time trend, and is given by:

$$Y = \lambda_0 e^{\lambda_1 T}$$

where λ_0 is a measure of trend GDP for a given period (in the case of this paper, 1995) and is equal to actual GDP plus output gap; λ_1 is a measure of

[18] For short review and comparison of the estimation properties of these methodologies see *Giorno et al.,* 1995.

potential output growth and *T* is time trend (1995:Q1 = 0).

As an alternative to the time trend method we use the *HP* filter to calculate trend output and the output gap. In general, the results produced by the *HP* filter method for trend output and the output gap are very similar to those produced by the time trend method. The difference is that at the end of the sample the *HP* filter method generates a level of trend output, which is slightly higher than that produced by the time trend method. In the calculation of the trend current account we prefer to use trend output estimations generated by the time trend method as the *HP* filter suffers from a well-known end point problem. We apply this method to calculate domestic trend output, world trend output and trend world trade.

Once we have estimates of trend output and trend world trade we use the estimated trade equations to calculate the levels of exports and imports when there is no output gap at home and abroad. The trend current account obtained is consistent with internal balance within economy.

Estimating Sustainable Current Account

In order to estimate *FEER*s, we need a measure of the sustainable level of the current account, or in other words the level of the current account that corresponds to external balance. Since the notion of sustainability in the *FEER*s calculation is associated with the medium run, assets stocks may still be adjusting over time towards a long-run steady state. This implies that our estimation of sustainable current account needs not to be zero (net foreign assets are not constant).

There are two different approaches applied in the empirical work to estimate sustainable current account. The first approach derives measures of sustainable (structural) capital flows, which finance current account imbalances (*Williamson and Mahar,* 1998). These structural capital inflows are not speculative flows which move from country to country in search of high short-term rates of return, but inflows or outflows that are likely to persist for a considerable period of time. This measure of sustainable capital flows is usually assumed to be a constant proportion of GDP. The second approach to estimating sustainable currents account is developed by *Masson*, 1998, and implemented by *Faruqee and Debelle,* 1998. Since saving minus investment in the economy and current account are by identity equal, this approach focuses on the determinants of net domestic savings. Saving minus investment norms provide an assessment of what might be the sustainable level of the current account in the medium term if the economy were in internal balance. This methodology does not aim to account for short-term cy-

clical movements in the current account. The estimates for long-run saving minus investment are calculated by setting the output gap equal to zero.

In this paper we estimate sustainable current accounts based on saving-minus-investment norms. Within the saving-minus-investment framework the determinants of current account are given by:

- The fiscal position. An improving fiscal position (rising surplus or falling deficit) reduces investment and increases saving, which leads to an improvement in the current account. As we are interested in current accounts in medium term, we have to use a structural, cyclically adjusted measure of fiscal balance. In order to obtain such a measure we regress the actual fiscal position on the output gap and then subtract the estimated impact of output gap. There is also a study, which suggests that it is not only the size of fiscal surplus that matters but also its composition. To control this effect we follow *Bussiere and Driver* (2001) and include taxation as a proportion of GDP as an explanatory variable. This will also capture any effects due to the government share within the economy.
- The demographic structure, which affects saving behavior due to life cycle reasons. Countries where young and retired people dominate the population will have low level of savings. Countries with a big share of active population will have higher levels of saving. Demographic profile of countries is proxied by dependency ratio, defined as population younger than 14 and older than 65 as a proportion of the population aged between 14 and 65 years.
- The stage of development, proxied by GDP per head. This has implications on the amount of capital countries need to import. Poor countries (low levels of GDP per capita) have a low capital-labor ratio and high marginal return on capital. Countries with access to international capital markets borrow from abroad and over time the country builds up its capital stock and international debt. The higher level of capital increases output share which is diverted into servicing foreign debt. As countries developed intensively they started to export capital and to run current account surpluses. Income per capita is converted into US dollars using *PPP* exchange rates.
- The world real interest rate, which will equilibrate saving and investments in the world. As an approximation of world real interest rates we are using an US real interest rate.[19]

[19] US real interest rate is defined as treasury bill rate minus consumer price inflation.

We derive a sustainable current account level for Argentina and Estonia within a panel framework. In the case of Estonia the panel contains eleven Central and Eastern European transition countries for the 1993 to 1999 period.[20] The time span is chosen taking into account data availability for the countries within the panel. For most of them we have data since 1993.[21] Since all variables are relative to their sample average, estimation can be conducted only on a balanced panel. All the countries except Croatia are in the process of accessing the European Union, which means that these countries form a homogenous group. We do not include former Soviet Union countries in the panel (except Baltic countries), taking into account the fact that these countries lag behind Central and Eastern European countries in the process of economic transformation from centrally planned to market economies and differ significantly from accession countries in terms of macroeconomic variables development. In the case of Argentina we again use a regional panel, which consists of twelve Central and Latin American countries covering the 1985 to 1999 period.[22] The selection of the countries included in the panel and time span were based on available data.

All explanatory variables are measured relative to their sample averages, which give us two advantages. First is that any shock, which is common for all countries in the panel and hit them simultaneously will not affect the current account. Second, measuring explanatory variables relative to their sample averages allow the world real interest rate to be substituted out from the equation specification (see *Masson*, 1998). Dropping out of the world real interest rate is based on the assumption that position of transition countries included in the sample relative to the rest of the world does not change over time. The use of fixed effects does, however, imply that the current account position of each panel with respect to the rest of the world should not be zero. The disadvantage of applied panel data framework for estimation of sustainable current account is that this approach assumes homogeneous coefficients across countries. The preferred equation for sustainable current accounts for Argentina and Estonia are presented in Table 5:

[20] Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Republic, and Slovenia.

[21] Croatia and Slovenia gained independence from Yugoslavia in June 1991. Lithuania became independent from the Soviet Union in March 1990, Estonia in August 1991 and Latvia in September 1991. In January 1993 former Czechoslovakia has split into Czech and Slovak republics (EBRD, 2000).

[22] Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, Panama, Paraguay, Peru, Uruguay and Venezuela.

Table 5

PANEL ESTIMATES OF CURRENT ACCOUNT EQUATION

	Argentina	Estonia
c_i	-0.06	0.45
RDR	0.26	
	(2.18)	-
RYPC	-0.12	
	(-2.63)	-0.31
	(-2.89)	
RSFB	-	0.01
	(2.01)	
RTY	-	-0.25
	(-3.54)	
Adjusted R^2	0.29	0.38
DW	1.83	1.89
S.E.E.	0.039	0.041

Note: T-statistics are given in parentheses.

Here, CA_i is a dependent variable expressed as a ratio of current account to the GDP. *RDR* is a dependency ratio relative to sample average; *RYPC* is GDP per capita relative to sample average, *RSFB* is the structural fiscal surplus relative to sample average and *RTY* is taxation as a percentage of GDP relative to sample average. c_i is a constant which captures country specific effects (fixed effects).

In the transition countries panel demographic factors are omitted because the dependency ratio proves insignificant. World real interest rate approximated by US real interest rate also proves to be insignificant. As we mentioned above panel data methodology applied allows to drop out real interest rate from the model of saving-minus-investment norms. All explanatory variables are significant and the signs of the coefficients are consistent with those expected from the theory. The results show that stage-of-development variable proxied by GDP per capita relative to sample average plays the most important role in determining saving-minus-investment norms in transition countries. This result is expected, since all these countries need to import capital in order to finance the restructuring of their economies and to converge to developed countries. Fiscal policy development has a marginal effect, but its compositional effect is significant: increases in the fiscal surplus due to higher taxes result in a weaker contractionary effect than falls in

government spending.[23]

In the Latin American panel the results suggest that the relative dependency ratio and relative GDP per capital give the best model. Variables are significant and the signs of the coefficients are consistent with those predicted by the theory. Structural fiscal balance and taxation as a percentage of GDP proved to be insignificant and were not included in the model. As with the transition country panel the world real interest rate is also insignificant in the Latin America panel. This allows to exclude the real interest rate from the estimation of sustainable current accounts.

In the next section we present charts with actual, trend and estimated sustainable current accounts for Argentina and Estonia.

Since we have estimates for trend current accounts, which are compatible with internal balance of the economy and sustainable current account, we can now solve the model in order to get the level of real exchange rate that matches these two estimates. The next section provides an overview of the results of the historic *FEER*s for Argentina and Estonia, as well as a discussion on policy implications.

IV. Results and Discussion

This section presents results of our estimates of Fundamental Equilibrium Exchange Rates for Argentina and Estonia. We have estimated only historic *FEER*s covering the sample of 1993:Q1 – 1999:Q4.[24]

Essentially actual and trend current accounts may differ due to several reasons: domestic and international (OECD) outputs differ from trend output; world trade differs from the trend; commodity prices differ from trend prices; and existence of unexplained deviations (residuals) from the model's relationship for trade.

In the case of Argentina the difference between trend current account and actual current account represents mainly the effects of deviation of output from its trend (output gaps). Between 1993:Q3 and 1994:Q3 output growth exceeded the trend and output gap reached a positive 5%. This pushed the actual current account below the trend current account. At that time the trend current account stood below the sustainable current account, and therefore the real effective rate needed to be appreciated in order to reach the *FEER* (the real exchange rate was undervalued).

[23] In the long run one would expect supply effects which differed substantially from short-term demand effects of a Keynesian nature.

[24] The choice of the sample was based only on available data.

Between the last quarter of 1994 and the last quarter of 1995 contagion effects from the Mexican crisis resulted in negative growth and a negative output gap for Argentina. The result was a sharp reduction of imports and a significant improvement of actual current account during 1995. The trend current account was therefore below actual current account. However, it stood still higher than the sustainable current account. Consequently, the real exchange rate needed to be appreciated to reach the *FEER*.

Since the beginning of 1996 the Argentinian economy signaled a recovery from the crisis and accelerated. Higher growth combined with relatively high magnitudes of activity coefficients in the trade volume prompted a deterioration of the actual and trend current accounts. Concurrently, the current account deficit implied by savings-minus-investments norms tended to narrow. This lead to a depreciation in the *FEER* and an overvalued exchange rate by the end of the 1998. In the first quarter of 1998 Argentina's output growth subdued reflecting the effect of Asian crisis. Output decline during 1999 caused by the negative effect of the dramatic devaluation of the Argentina's main trade partner (in the beginning of 1999 Brazilian real devalued by 50%). Despite the negative impact on competitiveness as a result of Brazil's devaluation during this period the output effect dominated and

Chart 1.

ARGENTINA ACTUAL, TREND AND SUSTAINABLE CURRENT ACCOUNTS

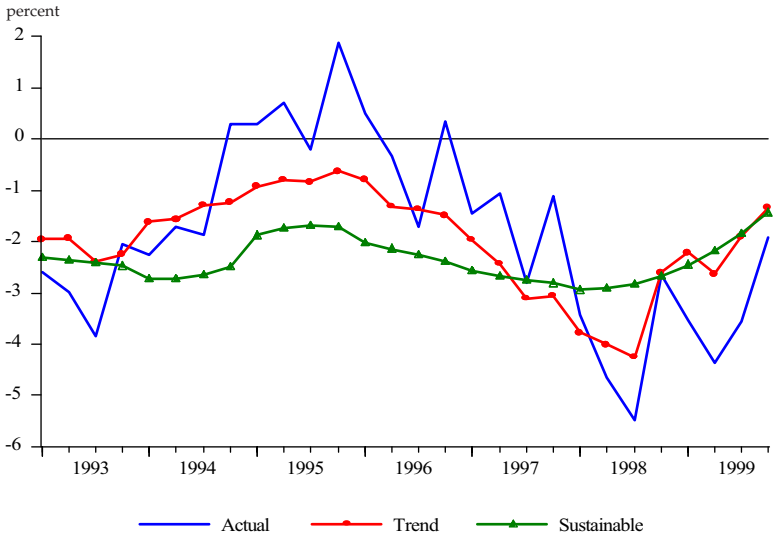
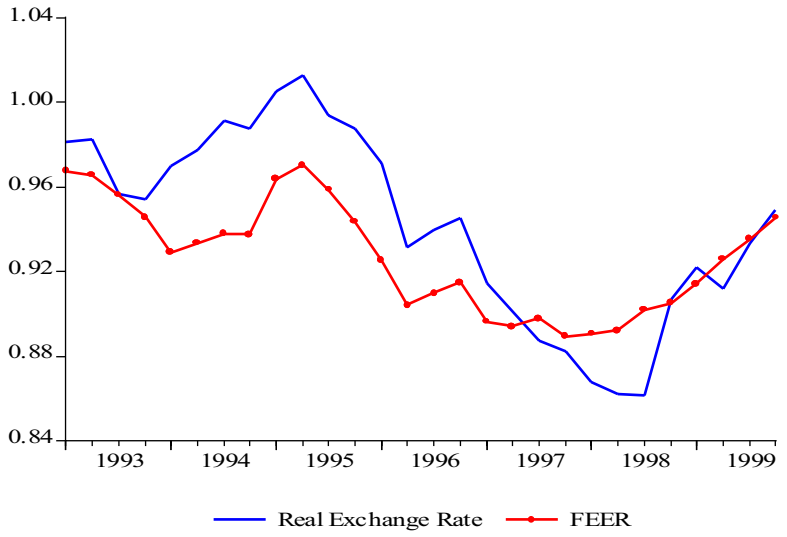


Chart 2.

ARGENTINA REAL EXCHANGE RATE AND FEER



the actual current account started to recover. In effective terms the US dollar depreciated in 1999 and this also had a favorable effect on Argentina given the link between the two currencies. Argentina's trend current account therefore, also improved and the gap between the *FEER* and the actual real exchange rate diminished.

The model for Estonia produces results which are more volatile. This is due to the fact that Estonia's economy was changing very fast during the transition from a planned to a market economy. This was a period of price and trade liberalization, which affected the development of trade flows. The structural changes in the economic environment are also relevant and may cause permanent shifts in the real exchange rate level.

Between 1994 and 1996 Estonian output growth was below trend output growth, and correspondingly the trend current account was below actual current account. The exception to this reflects the existence of unexplained deviations (residuals) from the model's trade equations. However, the estimated sustainable current account was much higher, with the gap between the two reflecting a large overvaluation of the real exchange rate. The slight increase in the sustainable current account over this period resulted in a sharp appreciation in the *FEER*.

Between 1997 and first half of 1998 the Estonian economic growth was higher than trend output growth which resulted in a lower actual current account than the trend current account. The effect of Russian crisis reversed this trend pushing the actual current account back above the trend current account. By 1997 the sustainable current account tended to fall, causing a slight depreciation of *FEER*.

An analysis of the equilibrium real exchange rates indicates the degree of sustainability of the currency boards. Conventional criticism of the currency boards states that this monetary regime is associated with big misalignments, which eventually lead to the collapse of the fixed exchange rate (*Roubini*, 1998). Comparison of the *FEER* dynamics and the actual real exchange rate can give us an idea to what extend conventional criticism is supported by empirical evidences.

Chart 3.

ESTONIA ACTUAL, TREND AND SUSTAINABLE CURRENT ACCOUNTS

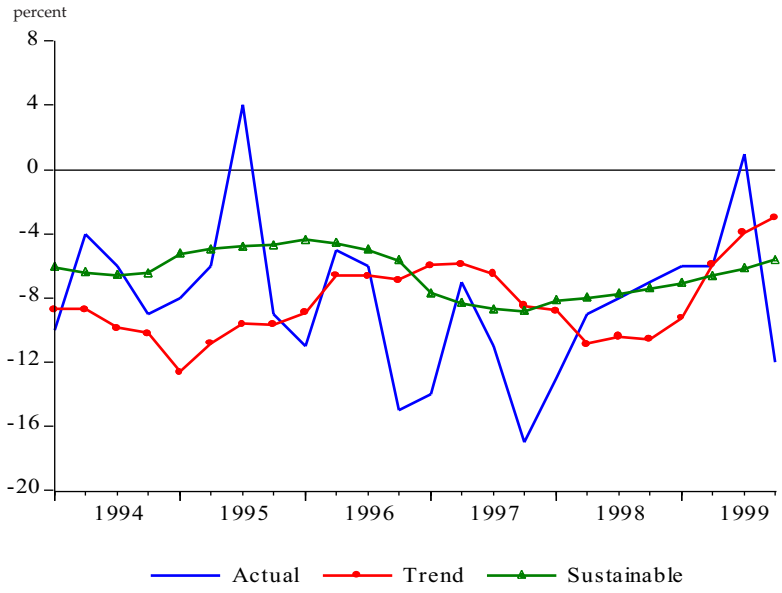
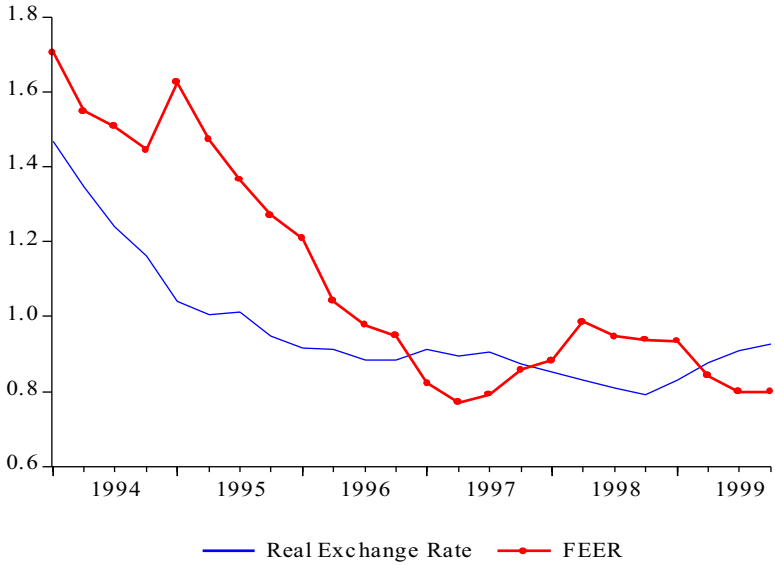


Chart 4.

ESTONIA REAL EXCHANGE RATE AND FEER



In the case of Argentina development of the actual real exchange rate/ *FEER* ratio can be broken down into three main periods: 1993:Q3 – 1997:Q2 (undervaluation); 1997:Q2 – 1998:Q3 (overvaluation) and 1998:Q3 – 1994:Q4 (equilibrium) (see Chart 5).[25]

[25] Measures the difference between actual real exchange rate and *FEER* as a percentage of the FEER $\left(\frac{FEER - R}{FEER}\right)$. A negative figure indicates an undervaluation, that is the real exchange rate needs to be appreciated to reach the *FEER*.

Chart 5.

ARGENTINA ACTUAL REAL EXCHANGE RATE AGAINST FEER

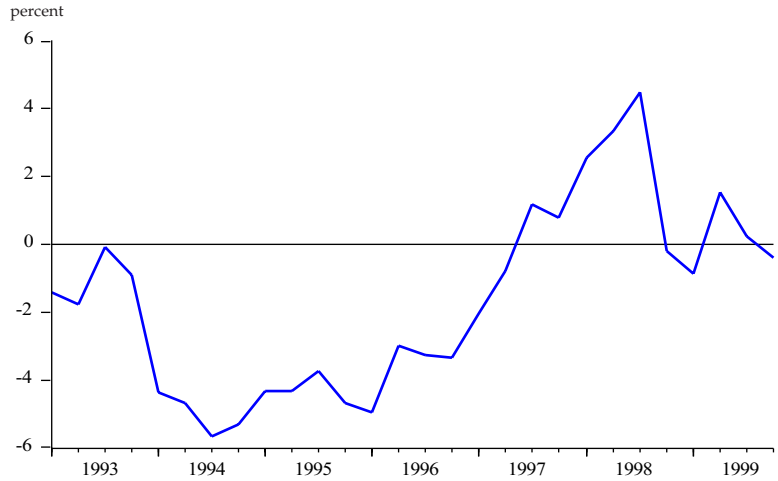
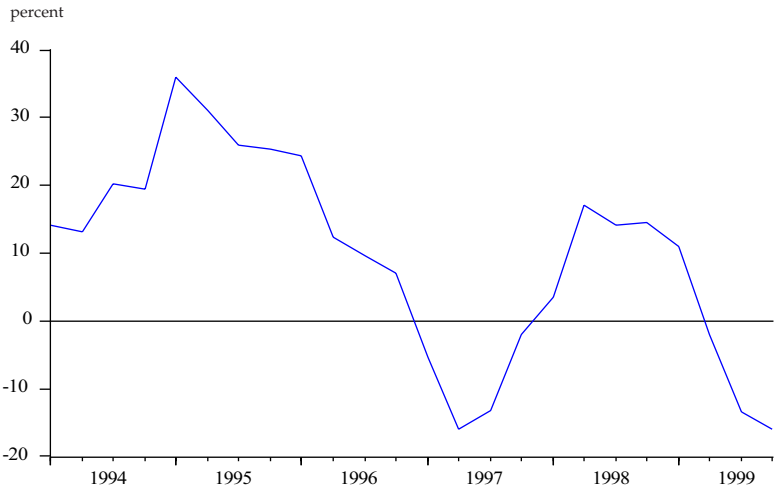


Chart 6.

ESTONIA ACTUAL REAL EXCHANGE RATE AGAINST FEER



Overall, the dynamics of the Argentinean real exchange rate and *FEER* during the period of the currency board arrangement does not show the persistent overvaluation of fixed exchange rates predicted. Indeed, the size of any misalignment is insignificant, below the 10% *Williamson* band (1983). *Williamson* assumes that this band guarantees that uncertainty of FEER calculations will not affect the assessment degree. Even in 1999 when Argentinean economic performance started to deteriorate, the real exchange rate was roughly at equilibrium. This was the period when severe economic problems in Argentina occurred. At that time there were proposals for the adoption of the US dollar as legal tender at the existing parity (*Calvo*, 2000; *Hanke and Schuler,* 1999). The main argument against official dollarization was that Argentinean real exchange rate was significantly overvalued and adoption of the US dollar would not solve the problems of poor competitiveness of Argentinean exports (*Sachs and Larrain,* 1999). Moreover, dollarization will aggravate the problems as it is an irreversible process, locking the country in the wrong exchange rate parity, which will have a permanent negative effect on Argentinean economy. Our results show that the Argentinean real exchange rare was not severely misaligned. At the end of 1999 real exchange rate was close to equilibrium exchange rate (*FEER*) with almost zero percent misalignment. Official dollarization at the beginning of 2000 might have helped to avoid the deeper crisis faced by Argentina at the end of 2001. Dollarization brings two big advantages:[26]

First, the establishment of a monetary union (symmetric or asymmetric) stimulates trade among member countries, which makes goods produced in different countries substitutable (*Rose and Van Wincoop*, 2001; *Rose*, 2001).[27] This would have an effect of rising the relative price elasticities in mutual trade relationships. The greater these elasticities, the less adjustment of real exchange rate required in respond to any shock of a particular size. Second and more important benefit for Argentina might be the reduction of interest rates since the devaluation premium will disappear with the adoption of the US dollar.

In the case of Estonia development of the actual real exchange rate/ *FEER* ratio can be broken down into two main periods: 1994:Q1 – 1997:Q1 (overvaluation) and 1997:Q1 – 1999:Q4 (overvaluation and undervaluation) (see Chart 6).

[26] For a discussion of pros and cons of dollarization, see for example *Berg and Borensztein*, 2000; and *Bogetic*, 2000.

[27] *Rose and Van Wincoop*, 2001; and *Rose*, 2001; estimate that a common currency can boost trade among countries participating in a monetary union by a factor of three.

In general the size of misalignments have been much larger than in the case of Argentina. Consequently, the uncertainties surrounding the calculation of equilibrium exchange rates for Estonia will also be higher. The results of this analysis suggest that the parity at which Estonia entered the currency board was overvalued.[28] However, the process of transformation allowed Estonia to improve its competitiveness.

During the early period the trend current account was far below sustainable levels, which produced a big overvaluation. Over time the gap between the trend current account and sustainable current account narrowed bringing the real exchange rate close to equilibrium (*FEER*).

In early 1997 the continuous improvement of the trend current account and decline of the sustainable current account produced an undervaluation of the real exchange rate of about 15 percent. The real exchange rate needed to be appreciated in order to reach *FEER*. Appreciation started in the first quarter of 1998 as a result of the sharp deterioration of the trend current account. Over 1998 the real exchange rate was overvalued relative to the equilibrium level by 15 percent. The gap between the real exchange rate and *FEER* was eliminated in the middle of 1999 due to a sharp improvement in the trend current account which offset the slight rise in the sustainable current account. At the end of 1999 the Estonian real exchange rate was undervalued by 15 percent relative to equilibrium level. It is generally thought that the euro is currently undervalued. Therefore, recent movements in the degree of misalignment experienced in Estonia may also reflect movements in the anchor currency.

Real exchange rate misalignments can be an important determinant and indicator of a currency crisis. Our estimates of misalignments in the Estonian real exchange rate accounting for about 15% are far from the misalignment expected by the critics of fixed exchange rates and currency boards.

In contrast to Argentina, the end point of exchange rate regime path for Estonia is clear − the adoption of the euro. The main issue here is whether a currency board can be instrumental for Estonia through the process leading up to adoption of the euro. New entrants are envisaged to undergo three stages: EU accession, participation in ERM II and joining the Euro zone. For countries with a currency board the main question is whether this regime is

[28] K. Schuler states that Estonia started in 1992 with an exchange rate that deliberately undervalued the kroon. As a result they had higher inflation in 1992 than would otherwise have. According to calculations in this paper by 1994 the kroon was already overvalued versus *FEER*, so the gains from deliberate undervaluation did not last long. This result might suggest how quickly the advantage from a deliberate undervaluation disappears.

compatible with participation in ERM II.[29] On this stage it is important that the exchange rate regime fulfils several objectives: facilitating nominal convergence; allowing a market test for exchange rate stability; ensuring countries' entry in the Euro zone at an appropriate exchange rate and preparing central banks for operating within the Euro zone (European Commission). Perhaps the most important of these is to ensure that countries enter the Euro zone at an appropriate exchange rate.

It is known that Estonia, which has started negotiations for EU membership and is expected to join EU in early 2004, prefers to preserve the currency board. The Estonian authorities state that a currency board is compatible with ERM II and they wish to maintain it until full membership in EMU. This implies that Estonia will enter the monetary union at the existing parity. Since entry in the monetary union is practically irreversible, entry at the wrong level of the nominal exchange rate could have a permanent negative effect on the country's economic performance (*Barrell and In't Velt,* 1991). Entry at an overvalued exchange rate will result in losses of both export markets and foreign direct investment. Such losses may not be reversible and the country may be permanently affected if it chooses the wrong entry level of the exchange rate.

Our results show that the Estonian real exchange rate is not severely overvalued relative to equilibrium level. Indeed, at the end of the sample period it is undervalued by 15 percent. Based on these results we might expect that Estonia could sustain the existing nominal parity and preserve its currency board during the second stage of the accession process. Taking into account relatively short sample of our work and the fact that any decision about the Estonian entry rate into EMU will be taken around 2006, we can not answer the question whether the current parity is appropriate for entering EMU.

[29] When a country with a currency board pegged to the euro wishes to join ERM II, the decision on the compatibility of a particular currency board arrangement with ERM II could only be taken on the basis of a profound assessment of the appropriateness and sustainability of the said currency board. This conclusion logically follows from the procedure foreseen in the ERM II Resolution concerning the adoption of central rates. Although currency board arrangements cannot be regarded as an acceptable substitute for participation in ERM II, they may in particular circumstances constitute an appropriate unilateral commitment within ERM II. Such unilateral commitment would not impose any additional obligations on the ECB beyond those deriving from the ERM II resolution and the Central Bank Agreement.

V. Conclusions

Hard pegs and especially currency boards have been criticized as a policy tool for fighting inflation, as in the medium to long run they are thought to lead to an overvalued exchange rate and a significant worsening of the current account. Locking a country's exchange rate for a too long period to a misaligned nominal parity is bound to lead to a speculative attack and the collapse of the currency board (currency boards carry seeds of their own destruction).

In order to verify this criticism we calculate historic Fundamental Equilibrium Exchange Rates (*FEER*s) for two countries which introduced currency boards in the beginning of 90's: Argentina and Estonia. *FEER*s are measures of medium-term equilibrium real exchange rates and they are not intended to explain short-term movements in exchange rates. Rather, we use the calculated *FEER*s to assess medium and long-term movements in real exchange rates and sustainability of currency board arrangements.

Our analysis suggests that there were no severe misalignments of the real exchange rates in currency board countries at least in the recent past. Overall, since the introduction of the currency board the Argentinean real exchange rate has had periods of relatively small undervaluation and overvaluations. These misalignments varied within 6%, which is far from the severe misalignments that might have been expected given the current economic problems in Argentina. At the end of the sample period (1999) the Argentinean real exchange rate was virtually equal to the equilibrium rate (*FEER*). The analysis suggests that neither currency board arrangement nor the overvaluation of real exchange rate are at the root of the economic problems in Argentina. Based on this result we could expect that official dollarization in early 2000 might have helped to prevent the deeper crisis faced by Argentina at the end of 2001.

In Estonia the size of misalignments were much larger than in Argentina. Uncertainties surrounding the calculation of equilibrium exchange rate for Estonia will also be bigger. The results of this analysis suggest that the parity at which Estonia entered the currency board was overvalued. However, the transformation helped Estonia to improve its competitiveness. At the end of the sample period (1999) the Estonian real exchange rate was undervalued by around 15%. Based on these results we might expect that Estonia could sustain the existing nominal parity and preserve its currency board during the second stage of the accession process. Taking into account the relatively short sample of our work and the fact that any decision about Estonian entry rate into EMU will be taken around 2006, we can not certainly

answer the question of whether the current parity is appropriate for the entering EMU.

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Appendices

Appendix A: The model.

This appendix presents the structure of the model used to estimate *FEER* for Argentina and Estonia. It is based on *Barrell and Wren-Lewis*, 1989, and Wren-Lewis and Driver, 1998.

A1 Trade Volumes

Exports

Goods: $XGI = \gamma_0 RX^{-\gamma_1} S^{\gamma_2} e^{\gamma_3 T}$

Services: $XS = \theta_0 RS^{-\theta_1} YW^{\theta_2} e^{\theta_3 T}$

Imports

Goods: $MGI = \delta_0 R^{\delta_1} Y^{\delta_2} e^{\delta_3 T}$

Services: $MS = \psi_0 RS^{\Psi_1} Y^{\Psi_2} e^{\Psi_3 T}$

Where:

RX is export competitiveness given by: $RX = \frac{WPXG * r}{PXG}$

r − the nominal exchange rate (local currency per US dollar)

WPXG − world export prices expressed in US dollars

RS − the real exchange rate for services given by: $RS = \frac{PCW}{PC * NEER}$

PCW − world consumer prices, approximated by OECD consumer prices

PC − domestic consumer prices expressed in domestic currency

NEER − the nominal effective exchange rate

S − the world trade volume

YW − world real GDP, approximated by OECD real GDP

R − the real exchange rate given by: $R = \frac{WPXG * r}{PD}$

PD − domestic prices, approximated by producer prices expressed in domestic currency

Y − domestic real GDP

T − time trend (1995:Q1 = 0)

A2 Trade Prices

Exports

All goods: $PXGA = (PCOMX * r)^{B_1} PXG^{1-B_1}$

Manufacturing: $PXG = (WPXG * r)^{B_2} PD^{1-B_2}$

Commodities: $PCOMX = WPO^{b_1} WPFD^{b_2} WPANF^{b_3} WPMM^{b_4}$

Services: $PXS = PC$

Imports

All goods: $PMGA = (PCOMM * r)^{A_1} PMG^{1-A_1}$

Manufacturing: $PMG = (WPXG * r)^{A_2} PD^{1-A_2}$

Commodities: $PCOMM = WPO^{a_1} WPFD^{a_2} WPANF^{a_3} WPMM^{a_4}$

Services: $PMS = PCW * r$

Where:

$PCOMX$ − country's commodity export prices

PXG − country's manufacturing export prices

WPO − oil prices, in US dollars

$WPFD$ − world food prices, in US dollars

$WPANF$ − world agricultural nonfood prices, in US dollars

$WPMM$ − world metals and minerals prices, in US dollars

A3 Price Equations

Domestic GDP deflator: $PY = \omega_0 PDe^{\omega_1 T}$

Domestic consumer prices: $PC = \omega_2 PDe^{\omega_3 T}$

Foreign consumer prices: $PCW = \omega_4 WPXGe^{\omega_5 T}$

Where: PY is the domestic GDP deflator and all other variables are previously defined.

A4 Trade Balance

The equations above can be combined to give a single expression for the trade balance as a proportion of t nominal output:

$$bgs = \frac{BGS}{PY * Y} = \frac{\gamma_0 RX^{-\gamma_1} S^{\gamma_2} e^{\gamma_3 T} (PCOMX * r)^{B_1} PXG^{(1-B_1)}}{PY * Y} + \frac{\theta_0 RS^{-\theta_1} YW^{\theta_2} e^{\theta_3 T} PC}{PY * Y}$$
$$- \frac{\delta_0 R^{\delta_1} Y^{\delta_2} e^{\delta_3 T} (PCOMM * r)^{A_1} PMG^{(1-A_1)}}{PY * Y} - \frac{\psi_0 RS^{\psi_1} Y^{\psi_2} e^{\psi_3 T} (PCW * r)}{PY * Y}$$

The number of relative price measures in this expression can be reduced to three: our measure of real exchange rate and two terms in real commodity

prices using information on trend in relative pricing behavior between different sectors. These pricing trends are given by equations in section A3 price equations. The balance of goods and services as a proportion of nominal GDP can therefore be simplified to:

$$bgs = c_0 RCOMX^{c_1} R^{c_2} S^{c_3} Y^{-1} e^{c_4 T} + c_5 R^{c_6} YW^{c_7} Y^{-1} e^{c_8 T}$$
$$- c_9 RCOMM^{c_{10}} R^{c_{11}} Y^{c_{12}} e^{c_{13} T} - c_{14} R^{c_{15}} Y^{c_{16}} e^{c_{17} T}$$

Where:

$$RCOMX = \frac{PCOMX}{WPXG} \quad \text{and} \quad RCOMM = \frac{PCOMM}{WPXG}$$

A5 Net Transfers

$$NTRAN = \eta_0 e^{\eta_1 T}$$

A6 IPD Flows

The balance of IPD flows as a proportion of GDP for the historic period can therefore be given as:

$$bipd = \left[1 + \rho * \left(\frac{FEER - R}{R}\right)\right] * (ipdc - ipdd)$$

Where:

$ipdc$ − IPD credits as a percentage of GDP

$ipdd$ − IPD debits as a percentage of GDP

ρ − the proportion of the revaluation effect (1 for both Argentina and Estonia)

A7 The Current Account

The full model of the current account in domestic currency, and as a proportion of nominal GDP, can therefore be given by:

$$cbs = \frac{CA}{PY * Y} = bgs + bipd + ntran$$

Where:

cbs − current account balance (proportion of GDP)

$ntran = \frac{NTRAN}{Y}$ is the balance of net transfers (proportion of GDP)

Appendix B: Estimation Results.

B1. Trade Volumes

This appendix presents the results of the error correction estimations (ECM) of the elasticities for the trade volume equations discussed in Section III. We also present here the results of ECM for the impact of world prices on country's trade prices. The definition of the variables is given in Appendix A. *L* indicates the variable which is presented in natural logarithms and *D* indicates the first difference. See Appendix D for the data sources.

Table B1

ERROR CORRECTION ESTIMATION OF GOODS EXPORT VOLUME ELASTICITIES (DEPENDENT VARIABLE DLXGI)

	Argentina	Estonia
DLRX	-0.55	
	(-0.90)	0.24
	(0.38)	
DLS	2.53	
	(1.73)	2.95
	(1.77)	
Constant	-11.8	
	(-1.86)	-17.9
	(-1.99)	
LXGI-1	-0.31	
	(-1.99)	-0.37
	(-2.39)	
LRX-1	0.37	
	(1.87)	0.32
	(1.75)	
LS-1	1.01	
	(1.83)	1.45
	(2.05)	
SQ1	0.37	
	(1.81)	-0.10
	(-.47)	
SQ2	0.72	
	(9.57)	-0.01
	(-0.09)	
SQ3	0.23	
	(1.58)	0.01
	(0.03)	
Adjusted R2	0.91	0.75
Serial correlation	0.75	2.70
Functional form	0.86	0.79
Normality	0.39	1.81
Heteroskedasticity	1.02	0.89

Note: T-statistics are given in parentheses.

Table B2

ERROR CORRECTION ESTIMATION OF SERVICES EXPORT VOLUME ELASTICITIES (DEPENDENT VARIABLE DLXS)

	Argentina	Estonia
DLRS	-0.42	
	(-0.67)	1.11
	(2.65)	
DLYW	0.96	
	(0.28)	-7.98
	(-1.12)	
Constant	-23.9	
	(-1.86)	-20.0
	(-1.18)	
LXS-1	-0.31	
	(-1.75)	-0.33
	(-1.92)	
LRS-1	-0.48	
	(-1.86)	0.13
	(1.46)	
LYW-1	1.69	
	(1.95)	1.26
	(1.26)	
SQ1	0.14	
	(5.29)	-0.09
	(-2.17)	
SQ2	-0.24	
	(-5.25)	0.24
	(3.91)	
SQ3	0.03	
	(0.93)	0.13
	(3.20)	
Adjusted R2	0.94	0.88
Serial correlation	0.99	0.97
Functional form	2.67	0.37
Normality	0.83	10.19
Heteroskedasticity	0.69	1.19

Note: T-statistics are given in parentheses.

Table B3

ERROR CORRECTION ESTIMATION OF GOODS IMPORT VOLUME ELASTICITIES (DEPENDENT VARIABLE DLMGI)

	Argentina	Estonia
DLR	-2.75	
	(-2.36)	-0.54
	(-0.73)	
DLY	2.72	
	(2.68)	3.37
	(4.14)	
Constant	8.64	
	(0.66)	-12.9
	(-2.86)	
LMGI-1	-0.32	
	(-3.46)	-0.34
	(-2.75)	
LR-1	-1.26	
	(-2.28)	-0.14
	(-1.55)	
LY-1	0.69	
	(2.63)	1.81
	(2.80)	
SQ1	-0.02	
	(-0.32)	-0.01
	(-0.01)	
SQ2	-0.14	
	(-1.51)	-0.10
	(-1.95)	
SQ3	0.14	
	(2.42)	-0.01
	(-0.02)	
Adjusted R2	0.77	0.87
Serial correlation	1.42	2.50
Functional form	1.23	3.47
Normality	0.44	1.09
Heteroskedasticity	1.20	0.54

Note: T-statistics are given in parentheses.

Table B4

ERROR CORRECTION ESTIMATION OF SERVICES IMPORT VOLUME ELASTICITIES (DEPENDENT VARIABLE DLMS)

	Argentina	Estonia
DLRS	1.02	
	(1.58)	0.62
	(1.15)	
DLY	1.11	
	(2.38)	0.66
	(0.77)	
Constant	-3.84	
	(-1.12)	-6.61
	(-1.48)	
LMS-1	-0.42	
	(-2.03)	-0.29
	(-1.87)	
LRS-1	-0.06	
	(-1.27)	0.11
	(1.74)	
LY-1	0.58	
	(1.76)	0.88
	(1.87)	
SQ1	0.33	
	(8.84)	-0.16
	(-1.12)	
SQ2	-0.32	
	(-3.90)	0.02
	(0.41)	
SQ3	0.04	
	(1.18)	-0.01
	(-0.03)	
Adjusted R2	0.97	0.59
Serial correlation	2.40	0.52
Functional form	1.20	0.86
Normality	0.93	0.74
Heteroskedasticity	3.72	3.97

Note: T-statistics are given in parentheses.

Appendix C: Charts

Chart 1:

ARGENTINA REAL EFFECTIVE EXCHANGE RATE AND *R*

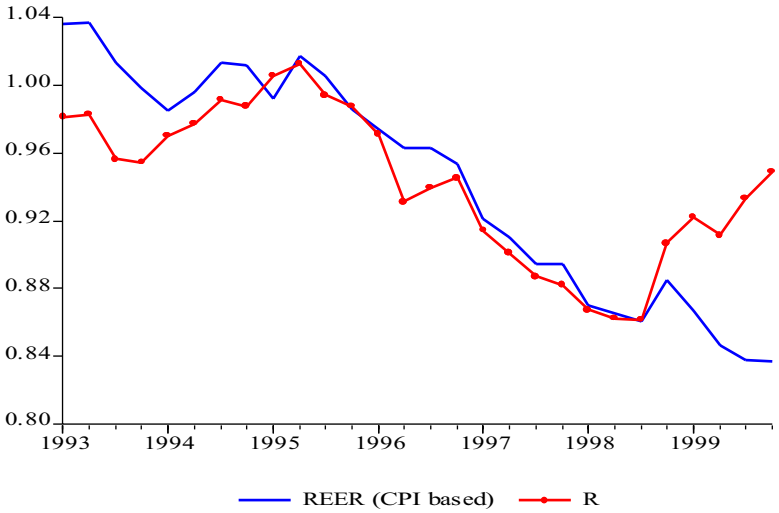


Chart 2

ESTONIA REAL EFFECTIVE EXCHANGE RATE AND *R*

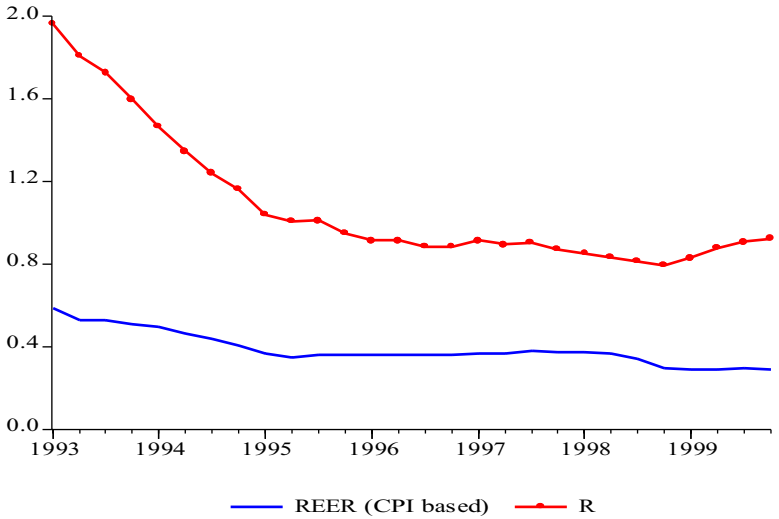


Chart 3

ARGENTINA OUTPUT GAP

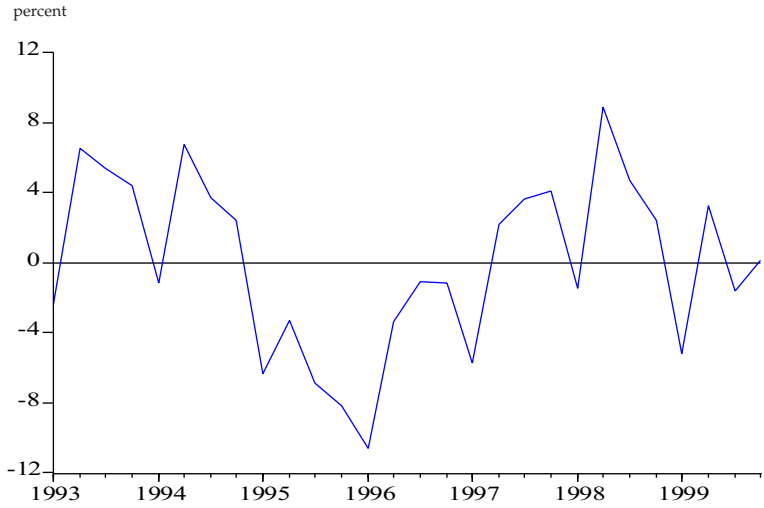
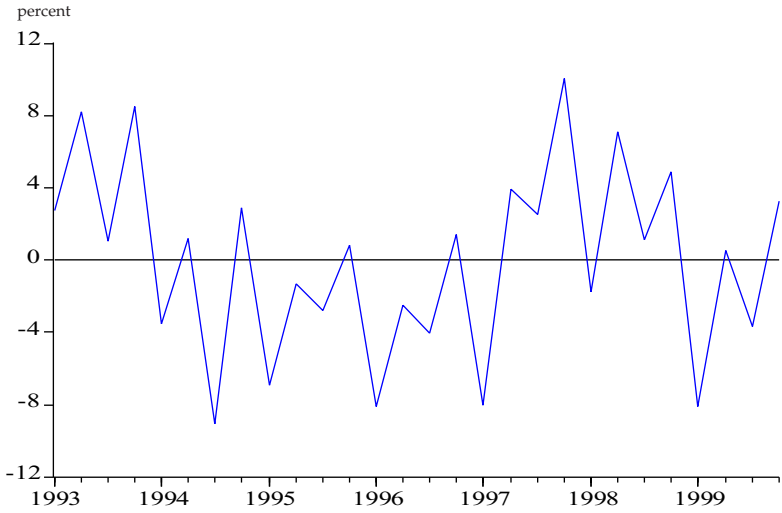


Chart 3

ESTONIA OUTPUT GAP



Appendix D: Data and Data Sources.

Most of the data is obtained from International Financial Statistics (IFS) published by IMF, World Development Indicators 2001 published by the World Bank, and the Quarterly National Accounts (QNA) and Monthly Economic Indicators (MEI) published by OECD. Additional source of information for Argentina is provided by the Ministry of the Economy, Secretariat of Economic Policy (http://www.mecon.gov.ar/prgmacri.htm) and Secretariat of Finance (http://www.mecon.gov.ar/finance/). For Estonia additional data sources used are the Bank of Estonia (http://www.ee/epbe/) and the Statistical Office of Estonia (www.stat.ee). The base period for the constant price series is 1995 and all indices are for 1995 = 100.

XGI: Domestic Goods Export Volume

- IFS line 72, volume of exports for Argentina. For Estonia data is obtained from the Statistical Office of Estonia. Turned from an index into constant price series using 1990 average for merchandise exports in US dollars (IFS line 78aa) converted into domestic currency using 1990 average for *r*. Sample period is 1993:Q1 to 1999:Q4 both for Argentina and Estonia.

WPXG: World Export Prices in US Dollars

- IFS line 74, unit value of world exports in US dollars (1993:Q1 to 1999:Q4).

r: Nominal Dollar Exchange Rate (Local Currency/US Dollars)

- IFS line *rf*, average exchange rate, national currency units per US dollar. For both countries the sample period is 1993:Q1 to 1999:Q4.

S: World Trade Volume

- IFS line 70, total world exports, US dollars current prices (1993:Q1 to 1999:Q4). Deflated using WPXG.

XS: Domestic Export Services Volume

- IFS line 78ad, services credits in US dollars. Converted into domestic currency using *r* and into a volume series by deflating by PC. For both countries the sample period is 1993:Q1 to 1999:Q4.

PCW: World Consumer Prices

- MEI, OECD consumer price index (1993:Q1 to 1999:Q4).

PC: Domestic Consumer Prices, Domestic Currency

- IFS line 64, consumer price index. For both countries the sample period is 1993:Q1 to 1999:Q4.

NEER: Nominal Effective Exchange Rate

- Nominal effective exchange rate index. For Argentina data is obtained from the Ministry of the Economy, Secretariat of Economic Policy. For Estonia data is provided by the Bank of Estonia. For both countries the sample period is 1993:Q1 to 1999:Q4.

YW: World (OECD) Real GDP

- QNA, total OECD GDP at constant market prices in US dollars (adjusted from annual to quarterly rate) (1993:Q1 to 1999:Q4).

MGI: Domestic Import Goods Volume

- IFS line 73, volume of imports, FOB (for Argentina). For Estonia data is obtained from the Statistical Office of Estonia. Turned from an index into constant price series using 1990 average for merchandise imports in US dollars (IFS line 78ab) converted into domestic currency using 1990 average for *r*. For both countries the sample period is 1993:Q1 to 1999:Q4.

PD: Domestic Prices, Domestic Currency

- IFS line 63, producer prices. For both countries the sample period is 1993:Q1 to 1999:Q4.

Y: Domestic Real GDP

- IFS line 69b. For Estonia GDP at 1995 prices in national currency. For Argentina GDP at 1993 prices in national currency. Adjusted from base year 1993 to 1995. For both countries the sample period is 1993:Q1 to 1999:Q4.

MS: Import Services Volume

- IFS line 78ae, services debits in US dollars. Converted into domestic currency using *r* and into a volume series by deflating by PCW converted into domestic currency terms using NEER. For both countries the sample period is 1993:Q1 to 1999:Q4.

WPO: Oil Prices, Dollars

- IFS, index constructed from Saudi Arabian light oil spot price (US dollars/barrel), end period (1993:Q1 to 1999:Q4).

WPFD: World Food Prices, Dollars

- IFS, food commodity price index, market prices, US dollars (1993:Q1 to 1999:Q4).

WPANF: World Agricultural Nonfood Prices, Dollars

- IFS, agricultural raw materials commodity price index, market prices, US dollars (1993:Q1 to 1999:Q4).

WPMM: World Metals and Minerals Prices, Dollars

- IFS, base metals commodity price index, market prices, US dollars (1993:Q1 to 1999:Q4).

PY: domestic GDP Deflator

- For Argentina the source used is the Ministry of the Economy, Secretariat of Economic Policy. Implicit price index calculated as a relation between GDP at current prices and at 1995 prices. For Estonia implicit price index calculated from ***Y*** and GDP at current market prices. For both countries the sample period is 1993:Q1 to 1999:Q4.

NTRAN: Net Transfers, Domestic Currency

- IFS, lines 78aj and 78ak, current transfers credits and current transfers debits, both in US dollars, converted into domestic currency using *r* and into real terms using *PY*. For both countries the sample period is 1993:Q1 to 1999:Q4.

CA: Current Account, Domestic Currency

- IFS line 78al, current account, current prices in US dollars. Converted into domestic currency using *r*. For both countries the sample period is 1993:Q1 to 1999:Q4.

IPDC: Interest, Profits and Dividends Credits

- IFS line 78ag, income credit in US dollars. Converted into domestic currency using *r*, and into real terms using *PY*. For both countries the sample period is 1993:Q1 to 1999:Q4.

IPDD: Interest, Profits and Dividends Debits

- IFS line 78ah, income debit in US dollars. Converted into domestic currency using *r*, and into real terms using *PY*. For both countries the sample period is 1993:Q1 to 1999:Q4.

PXG: Domestic Export Prices

- IFS line 74. Unit value of all exports (for Argentina). For Estonia data is obtained from Statistical Office of Estonia. For both countries the sample period is 1993:Q1 to 1999:Q4.

PMG: Domestic Import Prices

- IFS line 75. Unit value of all imports (for Argentina). For Estonia data is obtained from Statistical Office of Estonia. For both countries the sample period is 1993:Q1 to 1999:Q4.

REER: Real Effective Exchange Rate

- Real effective exchange rate index. For Argentina data is obtained from the Ministry of the Economy, Secretariat of Economic Policy. For Estonia data is provided by the Bank of Estonia. For both countries the sample period is 1993:Q1 to 1999:Q4.

DR: Dependency Ration

- Dependency ratio defined as population younger than 14 and older than 65 as a proportion of the population aged between 14 and 65. Data is obtained from World Bank World Development Indicators 2001.

YPC: GDP per Capita

- GDP per capita, PPP current international US dollars. Data is obtained from World Bank World Development Indicators 2001.

FB: Fiscal Balance

- Fiscal position as a proportion of GDP. Data is obtained from World Bank World Development Indicators 2001.

TY: Taxation

- Taxation as a proportion of GDP. Data is obtained from World Bank World Development Indicators 2001.

WR: US Real Interest Rate

- US real interest rate defined as treasury bill rate minus consumer price inflation. Data for US treasury bill rate and consumer price inflation is obtained from IFS. IFS line 60c treasury bill rate, and IFS line 64 consumer price inflation.

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