Notes on the Shadow Exchange Rate

The shadow exchange rate (SER) is the economic price of foreign currency. Even with a floating exchange system, where the rate is market-determined, there is no guarantee that the SER is equal to the market or official exchange rate (OER). That would be the case only if there were no taxes and subsidies on the demand and supply of tradable goods, and the present exchange rate reflected the long-run equilibrium value of foreign currency over the life of a project.

Exchange rates are one of the key macro-prices affecting project performance. If the OER is overvalued (so the price of a unit of local currency relative to foreign currency is above its long-run equilibrium level), then projects producing non-tradables are favoured relative to projects producing tradables. On the other hand, if the OER is undervalued (so the price of local currency is too low), projects producing tradables are favoured relative to projects producing non-tradables.

Shadow exchange rate factor

In theory the SER should reflect the welfare change created by the availability of an additional unit of foreign exchange (in the case of a project which generates additional supply of foreign exchange) or by the use of an additional unit of foreign exchange (in the case of a project which generates a demand for foreign exchange) or by a combination of the two effects. The shadow exchange rate factor (SERF) is the ratio of the shadow exchange rate (SER) to the official or market exchange rate (OER), with both the SER and the OER expressed in the same base year prices used for the project calculations. In principle the value of the SER should be estimated for each year of a project's life and applied to the traded components of annual benefits and costs, although it is often adequate to use a single SERF for each year, on the assumption that the ratio of the SER to the OER is unchanged over the life of a project.

Under a set of restrictive conditions domestic market prices can be used to approximate the value of goods made available through additional imports or diverted from domestic use as additional exports as a result of a project. This allows a weighted average of the ratio of domestic to world prices for traded goods to approximate the SERF. With taxes and subsidies on trade taken to determine the difference between domestic and world prices this leads to a formula for the SERF as

$$SERF = OER.(\Sigma p_m.\Delta q_m.(1 + tm - sm) + \Sigma p_x.\Delta q_x.(1 - tx + sx)) / OER.(\Sigma p_m.\Delta q_m. + \Sigma p_x.\Delta q_x) \quad (1)$$

Where m and x are import and export products respectively, Δq_m and Δq_x are changes in import and export quantity respectively as result of a project, pm and px are the cif and fob world prices for goods m and x in foreign currency, OER is the prevailing official exchange rate to convert to local currency, tm and tx are rates of tax on imports m and exports x, respectively and sm and sx are rates of subsidy on m and x. Summation Σ covers are imports and all exports. The signs on taxes and subsidies are opposite since import taxes raise domestic prices above world levels and import subsidies reduce them below world levels. Similarly export taxes reduce domestic prices and export subsidies raise them.

In theory where a project's effect is large enough to change the OER the shares of different imports and exports in (1) will be determined by the size of the import elasticities of demand for individual imports m and export elasticities of supply for individual exports x and the share of m and x in total trade. Where detailed information on trade elasticities is not available, a common simplifying assumption is that all elasticities are equal to 1.0, so that existing average shares in foreign trade equal marginal shares in new trade created by a project. This allows (1) to be approximated by (2), which is a commonly used short cut expression for the SERF.

$$SERF = (M + Tm - Sm) + (X - Tx + Sx)/(M + X) \quad (2)$$

Where M and X are the total value of imports and exports in respectively in foreign currency converted to domestic currency at the OER, and Tm and Tx are total taxes on imports and

exports respectively and Sm and Sx are the total subsidies on imports and exports, respectively .

Equation (2) makes the SERF dependent solely on trade taxes and subsidies. This is a common adjustment in practical appraisal, but even accepting its assumptions on domestic prices, it is only correct where OER reflects the underlying or equilibrium real exchange rate (ERER) over the life of a project. This is generally defined as the rate which generates both external balance (a current account fundable by sustained long-run capital flows) and internal balance (where potential and actual output are equal). In theory like any other relative price change a change in the underlying real value of foreign exchange which operates over the life of a project should be incorporated in an appraisal.

Real exchange rate

The real exchange rate is the nominal rate adjusted for inflation differentials between a country and its trading partners. The real exchange should be an effective exchange rate so that price differentials with different trading partners are adjusted for the relative share of each partner in a country's foreign trade. Where the purchasing power parity explanation of exchange rate movements applies and the exchange rate is free to fluctuate, the rate in the market will move to offset any loss (or gain) in price competitiveness due to faster (or slower) inflation than in a country's trading partners. Under these conditions the real exchange rate will be constant and like any other constant price need not be allowed for in an appraisal. In many practical situations however real exchange rates do fluctuate in the long term and where there are either significant benefits or costs that are related to foreign currency values the impact of real exchange rate adjustments should be incorporated in appraisals, even if only as part of a sensitivity analysis.

In principle where the real exchange rate prevailing at the time of appraisal (RER) does not reflect the underlying real value of foreign exchange at the prices of the base year for the project calculations, that is the ERER, this should be incorporated in the formula for the SERF. Where an estimate is available for ERER the formula for the SER needs to be modified by introducing an additional premium (where ERER>RER) or discount (where ERER< OER).

Thus where ERER/RER = p, the SER formula becomes

SER/OER = p*((M + Tm - Sm) + (X- Tx+ Sx)/(M + X))   (3)

This version of the formula incorporates not just the standard rate of tax/subsidy on foreign trade but also an estimate of long-run exchange rate misalignment.

Estimating the equilibrium real exchange rate

An estimate of the underlying real exchange rate is an important macro-economic parameter that should not be estimated ad hoc for individual projects. It should be estimated as part of macro-economic country assessments, updated as appropriate and made available to those working on projects in the country. Estimation of this parameter requires a good data set and specialist knowledge of econometrics.[1] Of the alternatives approaches available the closest to the theoretically desirable is the 'behavioural equation' approach. This requires setting up a regression model to explain trends in the real exchange rate by a set of fundamental variables based on macro-economic theory and a measure of the macro-economic balance of the economy.

In line with theory most specifications include at least the following as fundamental factors as determinants of ERER

- Net foreign assets (NFA)
  Debtor countries will be expected to require a more depreciated real exchange rate (that is a higher level of external competitiveness) in order to service their debts. Similarly creditor countries who receive foreign capital inflows will see their real

[1] Surveys of different approaches are in IMF (2006) " Methodology for CGER Exchange Rate Assessment" mimeo imf.org and Isard, P (2007) "Equilibrium exchange rates: an assessment of methodologies" *IMF Working Paper*, WP/07/296

exchange rate appreciate. The net foreign asset variable (NFA) is normally scaled relative to a country's size as measured either by total trade or GDP.

- Productivity (PROD)

   There is a well-established relationship between rising productivity and appreciating real exchange rates. Hence productivity levels in a country relative to its trading partners can be expected to influence the real exchange rate. The relative productivity effect can be approximated in different ways. The simplest is to use the ratio of GDP per capita in a country to a weighted average of GDP per capita in its trading partners (or one large partner), where rising relative productivity is expected to be associated with an appreciated real exchange rate as higher productivity can sustain competitiveness.

- Terms of trade (TOT)

   Improvement in the terms of trade of an economy increases income and wealth and raises foreign currency reserves. Other things being equal it will create a real exchange rate appreciation, as internal and external balance will require less competitiveness. Conversely, deterioration in the terms of trade will create a real depreciation as more competitiveness is required.

- Government consumption in GDP (GC)

   Insofar as the allocation of government consumption expenditure is biased towards non-traded activities (infrastructure and services) a rise in this ratio is expected to raise prices in non-traded as compared with traded activities. This will tend to appreciate the real exchange. Conversely a fall in the ratio will depreciate the real exchange rate as prices in traded activities will rise relative to those in traded ones.

- Restrictions on trade (RT)

   The extent to which trade is controlled can have a significant impact on the real exchange rate since it will restrict both imports and exports and does not put all of the strain on the exchange rate in managing the balance of trade with partner countries. In general the more trade is restricted the more will the real exchange rate appreciate, so that a relaxation of restrictions is normally associated with a real depreciation. Empirical work has used different proxies for the restrictiveness of trade including the share of imports and exports in GDP, tariff rates and subjective

judgements on the stance of trade policy.

Estimation requires a regression model of the form

$$RER_t = \alpha + \beta_1.NFA_t + \beta_2.PROD_t + \beta_3.TOT_t + \beta_4.GC_t + \beta_5.RT_t + \beta_6.X_t + \mu \quad (4)$$

Where RER is the real exchange rate in year t, α is a constant, μ is an error term and where X is any additional explanatory variable not included above (for example a measure of macro-economic imbalance such as the size of the budget deficit). Equation (4) can be applied to a single country if there are sufficient observations or across a set of countries in a panel analysis and is used to explain movements in actual real exchange rates. To determine the equilibrium real exchange rate (ERER) requires that the β coefficients from (4) are applied to the assumed long-run or equilibrium values of the explanatory variables. Thus the equilibrium real exchange rate can be derived in equation (5) as

$$ERER = \alpha + \beta_1.NFA^* + \beta_2.PROD^* + \beta_3.TOT^* + \beta_4.GC^* + \beta_5.RT^* + \mu \quad (5)$$

Where * denotes the long-run value for each variable.

In (5) the variable X has been omitted to illustrate that in equilibrium macro imbalance will be removed by definition, so variables to reflect this are omitted from the equilibrium equation.

RER and ERER will normally be derived as index numbers. The proportionate divergence of ERER from the actual RER thus gives the adjustment for exchange rate misalignment to be included in the formula for the SERF. Note however the trade controls assumed in the SERF calculation, and which are taken to apply over the life of a project, should be consistent with those used in the ERER estimation.

This approach has been applied in a number of studies with the broad conclusion that the main variables determining real exchange rates are relative productivity trends, changes in trade policy and the terms of trade, with productivity trends the major influence. Empirical estimation of the ERER is not straightforward however, since application of equation (5) requires both reliable β coefficients on key variables and projected long-run values for these variables. National regression studies are often ruled out by lack of key time series data. In this case an alternative approach is to use a panel data analysis across a sample of countries so that in combination sufficient observations are available to make the analysis meaningful. The β coefficients from the sample are then applied to individual country cases with projected country-specific figures for the explanatory variables. This approach assumes the countries in the sample share sufficient characteristics for common coefficients to be used. A unique constant term for an individual country can be derived by scaling the constants from the analysis of a group of countries by relative GDP per capita.

The projection of long-run underlying values for the key explanatory variables is the other major difficulty. There are at least three approaches in empirical work. One is to use values for a year where it is believed there was broadly internal and external balance, with these values adjusted to base year prices. A second is to take a long run average value such as over the past 5 years. A third is to use a genuine projection based on what is known about the general trend in the economy over the life of the project. Inevitably there will be uncertainty inherent in this type of calculation and ERER estimates from equation (5) will at best give an indication of direction of change should certain events occur in the future. For this reason, unless a detailed country-specific analysis is available, this addition to the SERF calculation is best treated as part of the sensitivity analysis to show how vulnerable a project is to macro-economic trends affecting competitiveness.