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# Optimal Currency Basket Pegs for Developing and Emerging Economies

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*The exchange rate arrangement represents an important policy choice for emerging and transitional economies as they strive to become stable and market-driven. A wide variety of arrangements have emerged, ranging from currency boards, basket-currency pegs and single-currency pegs to floating rates. Recently the IMF has recommended that, if the exchange value of a currency is to be pegged, it is better to peg to a basket of currencies rather than a single currency. Nonetheless, there has been little theoretical research on the management and optimal design of basket-peg arrangements. In this paper we extend the small-country macroeconomic model of Turnovsky to show that an optimally designed basket-peg arrangement can minimize the variance in domestic consumer prices as well as the variance of foreign reserves. The model highlights the importance of the money and bond markets and, therefore, the importance of various interest rate channels. Additionally we show that a trade-weighted currency basket is not only suboptimal, it is at odds with increasing capital market integration. Further our solutions illustrate that the optimal weights will evolve as the domestic economy integrates with the global market for goods and services, and financial instruments.*

## I. Introduction

In the aftermath of the 1997 and 1998 currency crises, there arose a debate on the appropriate exchange rate arrangement for emerging and transitional economies. Some argued that to bring stability to global markets, a flexible exchange rate system should be adopted by all, while others pressed for fixed exchange rate arrangements. Hence, arrangements that lie between the ends of the spectrum currency basket pegs for example-appear to have fallen out of favor.

For emerging economies heavily dependent on exports the exchange rate is an important nominal price, and for these economies, there is a trade-off between domestic inflation performance and real growth that is dependent upon international price competitiveness. Frankel (1999, p.1) counters the claims above, arguing that no single regime a panacea, but more importantly, for an given country no regime is best for all time. Frankel maintains that intermediate regimes, as opposed to those at the end of the spectrum, are more likely to be appropriate for most countries. The fact remains that a large number of nations, as shown in

Table 1, continue to manage their currency against a basket as this arrangement provides a nominal guide for monetary policy as well as some limited flexibility against individual currencies.

The choice and management of the exchange rate arrangement typically plays an important role in a currency crisis, especially in an emerging or transitional economy. (See Sachs 1996 for a discussion on the importance of the exchange rate regime for transition to a market system.) Pegged- or heavily managed exchange rate arrangements result in relatively rigid nominal exchange values among involved currencies. During the period when the dollar was appreciating against the German mark and the Japanese yen, for example, the currencies of East Asian nations became overvalued relative to the currencies of other important trading partners. The inflexibility of the East Asian currencies caused by the exchange rate arrangements was a contributing factor to the crises.

After the crises forced Thailand, Indonesia, the Philippines, and Malaysia to float their currencies, traders began searching for technical floors and policy analysts began to call for new approaches to exchange rate management. In the aftermath, the International Monetary Fund (IMF) has been criticized, among other things, for not offering an alternative to a free float. Regarding the East Asian currency crises, however, Stanley Fischer (1997, p.6) , Deputy Managing Director of the IMF, stated:

> As more normal conditions return, the question of the optimal exchange rate system will be back on the agenda. There is no generally agreed answer to that question. Some conclusions are easy: if the exchange rate is to be pegged, it is almost certainly better to peg to a basket of currencies rather than a single currency.

It is important to recall that some of the crisis-stricken countries had a basket-peg system in place at the time of the crises. The heavy weight attached to the U.S. dollar, however, resulted in *de facto* single-currency-pegs rather than intermediate regimes. As nations continue to rely on currency-basket-peg arrangements, the appropriate weighting of currencies comprising the basket becomes an important research question.

Though an important and practical issue, optimally designed currency basket arrangements have received only limited theoretical treatment in the academic literature. In addition, these types of arrangements have not been studied in a manner that illuminates events such as the Central European and East Asian currency crises. This is because the literature on optimal currency weights tends to focus on the goods sector of the economy only (see Connolly and Yousef 1982, and Edison and Vrdal 1990, as examples), or focuses on developed economies, assuming perfect capital mobility and no currency substitution (Turnovsky 1982). Although these models generate interesting results, their assumptions are inconsistent with the conditions that exist in transitional and emerging economies. Fortunately this gap in the literature has spurred recent empirical research by Kotilainen (1995), Benassy-Quéré (1999), and Ito *et al*., (1998).

In this paper we consider the optimal design of the currency basket from a theoretical perspective. We take the choice of exchange rate regime as predetermined. In other words, we do not investigate the optimal regime here, rather we consider the optimal weights within a currency basket regime.[1] We then develop a small-country macroeconomic model to show that an optimally designed basket-peg arrangement can minimize the variance in domestic consumer prices as well as the variance of foreign reserves. Many nations, however, simply determine currency weights based on trade relationships. The small-country macroeconomic model we employ, highlights, in addition to the real sector, the importance of the money and bond markets and, thus, the importance of various interest rate channels. Additionally we show that a trade-weighted currency basket is not only suboptimal, it is at odds with increasing capital market integration. Further our solutions illustrate that the optimal weights will evolve along with the integration of the domestic economy into the global market for goods, services, and financial instruments. This final conclusion provides theoretical support to the claim made by Frankel (1999, p. 22) that exchange-rate arrangement parameters change over time, particularly "as governments deliberately change their economic structure, for example increasing regional trade integration..."

In Section 2 we present a small-country macroeconomic model suitable for the analysis of a developing or emerging nation and its choice of currency basket weights. In Section 3 we derive the optimal weights as an outcome of the minimization of a selected loss function, and the implications of the solutions are discussed in detail. Section 4 provides some relevant points for policymaking and a summary of our analysis.

## II. A Developing Country Model

Our analysis is derived from a model of a small open economy that is linked to two large economies through the goods, money, and bond markets. The currency of the small economy is pegged to a basket of two currencies. Much of the research on currency baskets focuses on the goods sector only. (See Edison and Vrdal, 1990, as an example). Turnovsky (1982), however, considers the currency basket in the context of a more general macroeconomic model, and the currency weights as outcomes of optimal policy-making. By assuming perfect capital mobility and no currency substitution, Turnovskys model applies to developed economies.

We add to the macro-model based analysis of currency basket pegs by including two important aspects of emerging and developing economies; currency substitution and imperfect capital substitution. Our approach is to extend Turnovsky's model by allowing domestic bonds to be imperfect substitutes in international bond markets. We also incorporate currency substitution, allowing private agents to hold and transact with foreign currencies, which, in some of the economies considered here, has been a significant concern (Sahay and Végh, 1995).

The various equations of the model are common in the literature and we draw directly from the model of Daniels (1997) for equations representing goods, money demand, output, and bond demand and balance of payments equations, and add to this Turnovsky's (1982) specification of the relationship among cross-exchange rates and exchange rate policy. Finally, we follow Benevie's (1983) approach to aggregating the balance of payments.

## A. Model Equations

The following six equations describe the home goods, money, and bonds markets for the small economy. These markets are linked to two large economies denoted as country 1 and country 2. The currencies of the large economies are those represented in the currency basket. The model equations are:

*Aggregate Demand*

$$y_t = a_0[r_t(E_t c_{t+1} - c_t)] + a_1(p_{1t} + e_{1t} - p_t) + a_2(p_{2t} + e_{2t} - p_t) + 0_t\eta_t; \quad a_{0,1,2} > 0, \quad (1)$$

*Consumer Prices*

$$c_t = \alpha_0 p_t + \alpha_1(p_{1t} + e_{1t}) + \alpha_2(p_{2t} + e_{2t}), \qquad \alpha_0 + \alpha_1 + \alpha_2 = 1, \qquad (2)$$

*Money Demand*

$$m_t - p_t = y_t - g_0 r_t - g_1[r_{1t} + (E_t e_{1t+1} - e_{lt})] - g_2[r_{2t} + (E_t e_{2t+1} - e_{2t})] + \xi_t; \qquad g_{0,1,2} > 0, \qquad (3)$$

*Output*

$$y_t = h(p_t - E_{t-1} p_t); \qquad h > 0, \qquad (4)$$

*Bond Demand*

$$b^f_t = -j_0 r_t + j_1[r_{1t} + (E_t e_{1t+1} - e_{1t})] + j_2[r_{2t} + (E_t e_{2t+1} - e_{2t})]; \qquad j_{0,1,2} > 0, \qquad (5)$$

$$b^d_t = q_0 r_t - q_1[r_{1t} + (E_t e_{1t+1} - e_{1t})] - q_2[r_{2t} + (E_t e_{2t+1} - e_{2t})]; \qquad q_{0,1,2} > 0, \qquad (6)$$

where the variables of countries 1 and 2 are indicated with a numbered subscript and home variables are not, and

$y_t$ log of real output,

$c_t$ consumer price index,

$p_t$ log of home output price level,

$p_{it}$ log of country is home output price level; $i$=1,2,

$e_{it}$ log of the exchange rate, defined as units of home currency to currency *i*;

*i*=1,2,

$m_t$ log of the nominal money stock,

$r_t$ nominal interest rate,

$E_{t+j}$ expectations operator, conditional on information dated time *t+j*,

$\eta_t$ home output demand disturbance, with $E(\eta t)=0$ and $E(ht^{2})=s^{2}h$ ,

$\xi_t$ home money demand disturbance, with $E(\xi t)=0$ and $E(xt^{2})=s^{2}x$,

$b^f_t$ end-of-period stock demand for foreign bonds, denominated in a common accounting standard,

and,

$b^d t$ end-of-period stock demand for home bonds, denominated in a common accounting standard.

All variables are normalized around trend and the stochastic disturbances $h_t$ and $x_t$ are assumed to be independent and uncorrelated.

Equation (1) represents the equilibrium condition for home output demand, where demand is positively related to domestic price competitiveness and negatively related to the domestic real interest rate. Equation (2) defines the relative consumer price index for the home economy, where $a_i$ represents the weights in the consumption basket of domestic and foreign goods.

Equation (3) is the demand function for real money balances of the home economy. Note that we assume the income elasticity of money demand to be unity.[2] The expected foreign interest yields are meant to capture currency substitution channels. Increases in the interest elasticities, $g_1$ and $g_2$, represent greater degrees of currency substitution.

Equation (4) is a typical price-innovation goods supply function. The supply conditions could be conditioned on consumer prices as opposed to home output prices, adding greater detail to the model, but would not change our general conclusions. A supply shock is not included here because its effect it similar to a combination of a goods demand and money demand shock which are already included.

Equations (5) and (6) are the demand functions for foreign and home bonds, where home (foreign) bond demand depends positively on the home (foreign) yield and negatively on the expected foreign (home) yield.

## B. Specification of Exchange Rates and Exchange Policy

The two exchange rates that the home economy faces imply a cross-rate between the currencies of countries 1 and 2. Currency arbitrage insures that

$$e_{1t} - e_{2t} = e_{3t}, \tag{7}$$

where $e_{3t}$ is the exchange rate of countries 1 and 2, defined as units of country 2's currency per unit of country 1's currency. Because the home country is assumed to be a small country, the cross-exchange rate, $e_3$, is considered to be exogenous to the small country.

To examine the exchange rate policy rule, we consider a regime in which the domestic currency is pegged to a two-currency basket, and where the basket is a weighted average of the value, $\varepsilon$, of the home currency relative to the currency of countries 1 and 2. Therefore the policy rule is described as

$$\lambda_1 e_{1t} + \lambda_2 e_{2t} = e; \qquad \lambda_1 + \lambda_2 = 1. \tag{8}$$

We normalize the value of basket, ε, at unity, and, therefore, the logged value of (8) is

$$\lambda_1 e_{1t} + \lambda_2 e_{2t} = 0. \tag{9}$$

Because $\lambda_1$ and $\lambda_2$ are linearly dependent policy instruments, there is only one unique weight as $\lambda_2$ can be expressed as $\lambda_2 = 1 - \lambda_1$. Equations (7) and (8) can be used to solve for the exchange rates $e_{1t}$ and $e_{2t}$ in terms of the cross rate, $e_{3t}$, yielding $e_1 = \lambda_2 e_{3t}$, and $e_2 = -\lambda_1 e_{3t}$

Given the exchange rate regime, foreign reserves are endogenous as they must adjust to maintain the pegged basket value. Because we assume that domestic authorities are unwilling or unable to sterilize foreign exchange transactions, changes in the money supply, $m_t$, are equivalent to changes in the foreign reserves component, $f_t$, which is denominated in a common accounting standard.[3]

The exchange rate $e_{3t}$ is determined by the interaction of countries 1 and 2. Therefore the international linkage of these economies must be characterized in order to specify the constraints on the cross rate. Following Turnovsky (1982) we consider these two large economies as being characterized by perfect capital mobility. Hence, uncovered interest parity holds. Internally, however, the relationship among interest rates and prices is given by the Fisher relation. These two relationships are expressed as, respectively:

$$r_{2t} - r_{1t} = E_t e_{3t+1} - e_{3t}, \tag{10}$$

and

$$r_{1t} = \rho_1 + (E_t p_{1t+1} - p_{1t}), \tag{11}$$

$$r_{2t} = \rho_2 + (E_t p_{2t+1} - p_{2t}). \tag{12}$$

Equation (10) implies that the anticipated depreciation of the currency of country 2 relative to country 1 is determined by the nominal interest rate differential. Equations (11) and (12) are the Fisher relation, in which the nominal interest rate is equal to the real interest rate, *ri*, plus expected inflation. In equations (11) and (12), the real interest rate is assumed to be constant. Equations (10) through (12) allow us to express the expected changes in the cross-exchange rate in terms of the real interest rates and expected price changes of country 1 and country 2.

Because the home country considered here is a small country, and given that countries 1 and 2 are assumed to be large countries, the prices, interest rates, and cross-rate of countries 1 and 2 are taken as exogenous. In addition, these foreign exogenous variables are not correlated with the exogenous shocks of the small country. They are, however, correlated with each other. Thus, from the home country's perspective, $E(p_{1t})=E(p_{2t})=E(e_{3t})=0$, $E(p^2_{1t})=\sigma^2_{p1}$, $E(p^2_{2t})=\sigma^2_{p2}$, $E(e^2_{3t})=\sigma^2_{e3}$, $E(p_{1t}e_{3t})=\sigma^2_{p1e3}$, $E(p_{2t}e_{3t})=\sigma^2_{p2e3}$, and $E(p_{1t}p_{2t})=\sigma^2_{pp}$.

## C. External Equilibrium

A final set of assumptions is necessary to describe an external equilibrium condition. For the small nation, the current account surplus less capital outflows equals changes in official reserves. Aggregating the balance of payments equations and ignoring interest rate effects on trade balances [as in Benevie (1983)], the external equilibrium condition, or changes in official reserves, *ft*, can be expressed as:

$$f_t = a_1(p_{1t}+e_{1t}-p_t)+a_2(p_{2t}+e_{2t}-p_t)-(b^f_t-b^d_t). \qquad (13')$$

Through substitution, the condition is expressed as:

$$f_t=\Upsilon_1 p_{1t}+\gamma_2 p_{2t}-\gamma_3 p_t+\gamma_4 r_t+(\lambda_2\gamma_1-\lambda_1\gamma_2)e_{3t}, \qquad (13)$$

where $\gamma_1\equiv(a_1+q_1+j_1)$, $\gamma_2\equiv(a_2+q_2+j_2)$, $\gamma_3\equiv(a_1+a_2)$, $\gamma_4\equiv(q_0+j_0)$. If there is no goods market integration amongst the home country and countries 1 and 2, the parameters $a_1$ and $a_2$ equal 0. The more integrated are the goods markets, the larger these parameters become, approaching infinity and yielding purchasing power parity. Similarly, if there is no capital mobility, the parameters $j_0$, $j_1$, $j_2$, $q_0$, $q_1$, and $q_2$ equal zero. If there is perfect capital mobility, these parameters approach infinity and uncovered interest parity prevails.

## D. Model Solutions

To solve the model, equations (1), (2), (4), (7), (8), and (10) through (12) are used to derive an equilibrium condition for the goods market, equations (3), (4), and (7) through (12) an equilibrium condition for the money market, and equations (5) through (13) an equilibrium condition for the balance of payments. The three equilibrium conditions can be used to solve for the three endogenous variables, *pt*, *rt*, and *ft*. Solutions for these variables are proposed as functions of four exogenous variables, $p_{1t}$, $p_{2t}$, $\eta^t$, and $\xi_t$:

$$p_t = \pi_{10}+\pi_{11}\eta_t+\pi_{12}\xi_t+\pi_{13}p_{1t}+\pi_{14}p_{2t}, \tag{14}$$

$$r_t=\pi_{20}+\pi_{21}\eta_t+\pi_{22}\xi_t+\pi_{23}p_{1t}+\pi_{24}p_{2t}, \tag{15}$$

and,

$$f_t = \pi_{30}+\pi_{31}\eta_t+\pi_{32}\xi_t+\pi_{33}p_{1t}+\pi_{34}p_{2tt} \tag{16}$$

The solutions for the $\pi_{ij}$ coefficients are derived by the method of undetermined coefficients and are provided in the appendix.

## III. Policy Objectives and Optimal Instrument Settings

### A. The Objective Function

To derive the optimal values for the basket weights, we must first motivate a reasonable objective function. We assume that the objectives of the policymaker are domestic consumer price and exchange regime stabilization. The optimal basket weights can be derived as optimal outcomes by minimizing a loss function defined as a weighted average of the variance of unanticipated consumer price inflation and the variances of changes in foreign exchange reserves.[4] The loss function is expressed as:

$$L=\mu 1 Var(c_t-E_{t-1}c_t)+\mu_2 Var(f_t);\mu_1+\mu_2=1. \tag{17}$$

In other words, the policymaker seeks to smooth domestic consumer prices, but also desires to smooth the changes in foreign reserves that result from maintaining the exchange rate regime, perhaps to avoid speculative attacks on the currency. We choose this loss function because it is consistent with the stated objective of many of the transitional and emerging economies and the recommendations of the IMF (see Klacek 1995, p. 5, and Masson, *et al*., 1998). By substituting equation (2) in (17), the loss function can be expressed as:

$$L=\mu_1 Var[\alpha_0(p_t-E_{t-1}p_t)+\alpha_1 p_{1t}+\alpha_2 p_{2t}+(\alpha_1\lambda_2-\alpha_2\lambda_1)e_{3t}]+\mu_2 Var(ft). \tag{18}$$

Though the domestic authority is endowed with only one unique instrument, the loss function (18) indicates that, to achieve its goals, the domestic authority seeks to minimize the variance of domestic output price innovations, the impact of foreign price and cross-rate variances and covariances on the domestic economy, and the variance of changes in foreign reserves.

## B. Optimal Instrument Settings

The optimal instrument settings are determined through the unconstrained minimization of the loss function (18). First we use the constraint on the weights as given in equation (8) to express $\lambda_2$ in terms of $\lambda_1$. We then minimize (18) with respect to $\lambda_1$. The solutions are:

$$\lambda_1 = \frac{2\{\mu_1[\alpha_0(\beta_6+\beta_9)+(\alpha_1+\alpha_2)\Delta](\alpha_0\beta_6+\alpha_1\Delta)+\mu_2\beta_8(\beta_8+\beta_{11})\}\sigma_{e3}^2}{2\{\mu_1[\alpha_0(\beta_6+\beta_9)+(\alpha_1+\alpha_2)\Delta]^2+\mu_2(\beta_8+\beta_{11})^2\}\sigma_{e3}^2},$$

$$\frac{+\{\mu_1[\alpha_0(\beta_6+\beta_9)+(\alpha_1+\alpha_2)\Delta](\alpha_0\beta_6+\alpha_1\Delta)+\mu_2\beta_8(\beta_8+\beta_{11})\}\sigma_{p1e3}^2}{2\{\mu_1[\alpha_0(\beta_6+\beta_9)+(\alpha_1+\alpha_2)\Delta]^2+\mu_2(\beta_8+\beta_{11})^2\}\sigma_{e3}^2} \qquad (19a)$$

$$\frac{+\{\mu_1[\alpha_0(\beta_6+\beta_9)+(\alpha_1+\alpha_2)\Delta](\alpha_0\beta_9+\alpha_1\Delta)+\mu_2\beta_8(\beta_8+\beta_{11})\}\sigma_{p2e3}^2}{2\{\mu_1[\alpha_0(\beta_6+\beta_9)+(\alpha_1+\alpha_2)\Delta]^2+\mu_2(\beta_8+\beta_{11})^2\}\sigma_{e3}^2}$$

and

$$\lambda_2 = 1-\lambda_1, \qquad (19b)$$

where the $\beta_i$ and $\Delta$ identities are provided in the appendix. As has been noted in the literature, it is possible that one of the solutions exceed unity. That is, one weight is positive and one is negative. Though theoretically possible, we do not consider this outcome here.

## C. Importance of the Cross-Exchange Rate

Considering the exogenous shocks that appear in the solutions given in (19a) and (19b), it is apparent that the cross-exchange rate is most important. In fact, if foreign prices are not correlated with the cross-rate, then the covariance terms do not appear in the optimal solutions at all. This is not to say that foreign prices are not important to the domestic economy. They do indeed impact on the domestic consumer price and foreign reserves. Rather it is that a currency basket arrangement is managed by intervening in response to changes in the cross-rate's among the currencies included in the basket (see Daniels and VanHoose 1999, pp. 91-94). Hence, only shocks involving the cross-rate are important in determining the optimal basket weights.[5]

We also see that (see the solution for $\lambda_2$ provided in the appendix) the sign on the covariance terms are positive in the optimal solution for $\lambda_1$ and negative in the solution for $\lambda_2$. The intuition behind this is as follows. Given that, in Equation (7) the cross-rate is defined as units of country 2's currency to country 1's currency, then we would expect prices of country 2 to be positively correlated with the cross-rate. That is, as prices rise in country 2, ceterus paribus, the cross-rate rises, indicating a depreciation of the country 2's currency relative to country 1's currency. In a similar manner we would expect the prices of country 1 to be negatively correlated with the cross-rate.

Viewing the solution for $\lambda_1$ in (19a), $\sigma^2_{p1e3}<0$, implies that as this covariance rises, the weight assigned to the currency of country 1, $\lambda_1$, should be reduced whereas the weight assigned to the currency of country 2, $\lambda_2$, should be increased. Likewise, because $\sigma^2_{p2e3}>0$, as this covariance rises, the weight assigned to the currency of country 1, $\lambda_1$, should be increased whereas the weight assigned to the currency of country 2, $\lambda_2$, should be decreased.

## D. Importance of Interest Rate Channels

Turning our attention to the $\beta_i$ identities, which are provided in the appendix, we see that these identities are complex combinations of the price and interest elasticities, the degree of indexation in the economy (h), and the weights in the consumption basket. In much of the previous literature, the various interest rate channels were ignored, while in the Turnovsky model they only affected the domestic economy through the demand for home output. As the more detailed model developed here shows, the interest rate channels are much broader than this. Hence, the impact of foreign interest rates (and therefore the cross-exchange rate) on money and bond demand must be considered in determining the optimal basket weights. This assertion receives additional support in the following sections.

## E. Are Trade Weights or a Single-Currency Peg Optimal?

Trade weights are often suggested as the appropriate weighting scheme for a currency basket arrangement. For example, *The Economist* (1997) claimed that:

> Southeast Asia needs something in-between, with more exchange rate flexibility than before, but without going all the way to a free float. At the very least, linking to a trade-weighted basket of currencies would provide more flexibility than a dollar peg.

Contrary to these assertions, trade weights are optimal only under very restrictive assumptions. First, trade weights, $\lambda_1=\alpha_1$ and $\lambda_2=\alpha_2$, are optimal only if the consumption share of home output is zero, $\alpha_0=0$. Practically speaking this is not plausible. Viewing the optimal solutions in (19a) and (19b), the only other case where trade weights are optimal are when the identities $\beta_6$ and $\beta_9$ equal zero. This would require that all foreign interest elasticities of the model equal zero. In words, a trade-weighted basket ignores foreign shocks to the money and bonds sectors as well as foreign interest rate shock effects on the demand for domestic output. Thus a trade-weighted currency basket would be inconsistent with calls for reductions in capital controls.

A single-currency peg is optimal if one of the optimal basket weight solutions equals unity. In the case of $\lambda_1$, the optimal solution equals unity only if the covariance terms, $\sigma^2_{p1e3}$ and $\sigma^2_{p2e3}$, are zero and if $\beta_{15}$ equals zero, i.e., if $\alpha_2$=$a_2$=$j_2$=$q_2$=$g_2$=0. Or in other words, if all the elasticity terms pertaining to country 2 equal zero, indicating no integration with country 2 whatsoever.

### F. Increasing Goods Market, Money Market, and Bond Market Integration

Another important conclusion we can draw from the solutions is that uneven integration or transition implies that the currency weights must change, and therefore periodic evaluation and changes are required. For example, if, in equation (19a), $\beta_6$ and $\alpha_1$ increase relative to $\beta_9$ and $\alpha_2$, then the weight on country 1's currency rises with the variance of the cross-rate but falls with the covariance of prices and the cross-rate. Depending on which terms are most important indicates which direction the weights should be adjusted.

The evidence of the previous section also implies that a low level of capital market integration, given by $g_1$, $g_2$, $j_1$, $j_2$, $q_1$, and $q_2$ in equations (3), (5), and (6), requires currency weights that approximate a trade-weighted scheme. Increasing capital market integration, however, requires an adjustment away from the trade-weights, with the appropriate adjustment depending on the relative importance of the two large countries and the relative importance of the various interest channels. Hence, a dynamic emerging or transitional economy must be prepared to adjust the basket weights periodically.

## IV. Policy Relevance and Conclusion

The exchange rate arrangement represents an important choice for emerging and transitional economies as they strive to become market-driven, stable economies. A wide variety of arrangements have emerged, ranging from currency boards, crawling pegs, exchange rate bands, basket-currency pegs, to floating rates. The IMF has suggested that, if the exchange value of a currency is to be pegged, it is better to peg to a basket of currencies rather than a single currency. Nonetheless, there has been little theoretical research on the management and optimal design of basket-peg arrangements.

In this paper we have shown that by pegging to a basket of currencies, the path of domestic prices is still subject to external shocks, including changes in the cross-exchange rates of the currencies in the basket arrangement. We also show, however, that an optimally designed basket-peg arrangement can be designed to minimize the variance in domestic consumer prices as well as the variance of the nations foreign reserves. In contrast to the previous literature, the small-country macroeconomic model developed here, highlights the importance of the money and bond markets and, thus, the importance of various interest rate channels. As a result, a trade-weighted currency basket is not only suboptimal, it is at odds with increasing capital market integration. Likewise our model illustrates that the optimal weights will evolve along with the integration of the domestic economy into the global market for goods and services, and financial instruments.

In summary, the relevant policymaking guidelines that emerge from our model is that:

1. Contrary to arguments offered by the media and the IMF, a trade-weighted basket is not likely to be optimal.
2. A through understanding of the macroeconomy is needed, particularly estimates of foreign price, interest, and exchange rate elasticities, for the determinations of optimal weights.
3. Exogenous cross-exchange-rates are an important consideration in the management of a basket-peg arrangement. For practical purposes, therefore, a basket that includes a small number of currencies is preferred.
4. Currency weights should be reviewed on a regular time schedule and adjustments made when deemed necessary.

Though the following do not flow from the results of our analysis here, we also suggest that:

5. The currency composition, and optimally determined currency weights, and intervention bands should be announced as should the level of foreign currency reserves and intervention activities. Any adjustments made to weights should be announced as should the rational for their change so that market participants perceive the changes and the new weights and intervention bands to be credible.

The first is consistent with the recommendations found in the target zone literature, which shows that a credible band influences expectations and may have a stabilizing effect on the exchange rate (see Girardin and Marimoutou, 1997, for a summary). The remainder is consistent with the recommendations of the IMF who claim that crises, such as that experienced by Mexico, are worsened by the “poor quality to information supplied to both the official sector (including the IMF) and the markets” (Fischer, 1997, p. 8), and by Frankel (1999, p. 6) who states that “governments can reclaim confidence only by proclaiming policies that are so simple and so transparent that investors can verify instantly that the government is in fact doing what it claims to be doing."

## Notes

1. Savvides (1993) suggests that the decision to peg the currency or to allow it to be flexible, and whether to peg to a single currency or a basket of currencies are jointly determined choices.
2. This simplifying assumption has no impact on the general results of interest to us.
3. If foreign exchange intervention actions can be partially or fully sterilized, then the domestic money supply does not necessarily move one-to-one with changes in foreign reserves. Sterilization, however, is beyond the scope of this paper.
4. It can ppe shown that minimization of the variance of consumer prices is equivalent to minimizing the real exchange rate.
5. Because Turnovsky (1982) uses various identities to substitute out the cross-rate, the importance of the cross-rate is unseen.

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## Mathematical Appendix

### Model Solutions

$p_t = \pi_{10}+\pi_{11}\eta_t+\pi_{12}\xi_t+\pi_{13}p_{1t}+\pi_{14}p_{2t}+\pi_{15}e_{3t}$

$r_t = \pi_{20}+\pi_{21}\eta_t+p_{22}\xi_t+\pi_{23}p_{1t}+\pi_{24}p_{2t}+\pi_{25}e_{3t}$

$f_t = p_{30}+p_{31}\eta_t+\pi_{32}\xi_t+\pi_{33}p_{1t}+\pi_{34}p_{2t}+\pi_{35}e_{3t}$

$\Pi_{11}=\beta_2\Delta^{-1}$ $\qquad$ $\Pi_{12}=-a_0\Delta^{-1}$

$\Pi_{13}=\beta_6\Delta^{-1}$ $\qquad$ $\Pi_{14}=\beta_9\Delta^{-1}$

$\Pi_{15} =(\beta_6\lambda_2-\beta_9\lambda_1)\}\Delta^{-1}$

$\Pi_{21}=\beta_3\Delta^{-1}$ $\qquad$ $\Pi_{22}=\beta_1\Delta^{-1}$

$\Pi_{23}=\beta_7\Delta^{-1}$ $\qquad$ $\Pi_{24}=\beta_{10}\Delta^{-1}$

$\Pi_{25} =(\beta_7\lambda_2-\beta_{10}\lambda_1)\}\Delta^{-1}$

$\Pi_{31}=\beta_4\Delta^{-1}$ $\Pi_{32}=\beta_5\Delta^{-1}$

$\Pi_{33}=\beta_8\Delta^{-1}$ $\Pi_{34}=\beta_{11}\Delta^{-1}$

$\Pi_{35}=(\beta_8\lambda_2-\beta_{11}\lambda_1)\Delta^{-1}$

$\Pi_{10}=a_0[(g_1-j_1-q_1)\rho_1+(g_2-j_2-q_2)\rho_2][(a_1+a_2)(g_0+j_0)+q_0)+a_0(1+a_1+a_2)]^{-1}$

$\Pi_{20}=-(a_1+a_2)[(g_1-j_1-q_1)\rho_1+(g_2-j_2-q_2)\rho_2][(\alpha_1+\alpha_2)(\gamma_0+j_0)+q_0)+a_0(1+a_1+a_2)]^{-1}$

$\Pi_{30}=-\{[(a_1+a_2)g_0+a_0][(g_1-j_1-q_1)\rho_1$
$+(g_2-j_2-q_2)\rho_2]+(a_1+a_2)(a_0+j_0+q_0)(g_1r_1+g_2r_2)\}[(a_1+a_2)(g_0+j_0+q_0)+$
$a_0(1+a_1+a_2)]^{-1}$

$\Delta\equiv\beta_1\beta_2+a_0\beta_3$

## Identities

$\beta_1\equiv[(a_1+a_2)+(h+a_0\alpha_0)]$ $\beta_2\equiv(g_0+j_0+q_0)$

$\beta_3\equiv[(1+h)+(a_1+a_2)]$ $\beta_4\equiv[(1+h)(j_0+q_0)-g_0(a_1+a_2)]$

$\beta_5\equiv\beta_1(j_0+q_0)+a_0(a_1+a_2)$ $\beta_6\equiv(a_1-a_0\alpha_1)\beta_2+a_0(a_1+j_1+q_1-g_1)$

$\beta_7\equiv(a_1-a_0a_1)\beta_3-\beta_1\beta_{12}$

$\beta_8\equiv\beta_1[g_0(a_1+j_1+q_1)+g_1(j_0+q_0)]+a_0[(1+h)(a_1+j_1+q_1)+g_1(a_1+a_2)]+(a_1-a_0a_1)\beta_4$

$\beta_9\equiv(a_2-a_0a_2)\beta_2+a_0\beta_{13}$ $\beta_{10}\equiv(a_2-a_0\alpha_2)\beta_3-\beta_1\beta_{13}$

$\beta_{11}\equiv\beta_1[g_0(a_2+j_2+q_2)+g_2(j_0+q_0)]+a_0[(1+h)(a_2+j_2+q_2)+g_2(a_1+a_2)]+(a_2-a_0a_2)\beta_4$

## Appendix

### Table 1: IMF Member Nations Pegging or Managing Against a Currency Basket

| Country | Classification | Currency | Basket |
|---|---|---|---|
| Bangaladesh | Conventional Peg | taka | Weighted basket comprised of the currencies of Bangaladeshs major trading partners. |
| Botswana | Conventional Peg | pula | Weighted basket comprised of the SDR and the South African rand. |
| Burundi | Conventional Peg | franc | Weighted basket comprised of the currencies of Burundis main trading partners. |
| Chile | Crawling Bend | peso | Reference rate for band is a weighted basket consisting of the US dollar, the euro, and the Japanese yen. |
| Figi | Conventional Peg | dollar | Weighted basket of currencies comprised of the Australian dollar, the Japanese yen, the New Zeland dollar, the euro, and the US dollar. |
| Hungary | Crawling Band | forint | Reference rate for band is a weighted basket comprised of the euro and the US dollar. |
| Iceland | Exchange Rate Band | krna | Reference rate for band is a weighted basket comprised of the Canadian dollar, Danish krona, Norwegian krone, UK pound, Swedish krona, Swiss franc, and the US dollar. |
| Israel | Crawling Band | sheqel | Reference rate for band is a weighted basket comprised of the euro, UK pound, Japanese yen, and the US dollar. |
| Kuwait | Conventional Peg | dinar | Weighted basket of currencies comprised of the currencies of Kuwaits trade and financial partners. |
| Latvia | Conventional Peg | lats | SDR |
| Socialist Peoples Libyan Arab Jamahiriya | Exchange Rate Band | dinar | SDR |
| Maldives | Conventional Peg | rufiyaa | Weighted basket of currencies comprised of Maldives trade partners. |
| Malta | Conventional Peg | lira | Weighted basket of currencies comprised of the UK pound, the US dollar, and the euro. |
| Myanmar | Conventional Peg | kyat | SDR |
| Poland | Crawling Band | zloty | Central rate is a weighted basket of currencies comprised of the euro and the US dollar. |
| Qatar | Exchange Rate Band | riyal | SDR |
| Samoa | Conventional Peg | tala | Central rate is a weighted basket of currencies comprised of the currencies of Samoas trade partners. |
| Saudi Arabia | Exchange Rate Band | riyal | SDR |

**Table 1 (continued)**

| Country | Classification | Currency | Basket |
|---|---|---|---|
| Seychelles | Conventional Peg | rupee | Weighted basket comprised of the US dollar, UK pound, French franc, South African rand, Singapore dollar, German mark, Italian lira, and the Japanese yen. |
| Slovak Republic | Managed float | koruna | Managed against a basket comprised of the German mark and US dollar |
| Solomon Islands | Conventional Peg | dollar | Central rate is a weighted basket of currencies comprised of the currencies of the Solomon Islands trade partners. |
| Tonga | Conventional Peg | paanga | Weighted basket of currencies comprised of the US dollar, the Australian dollar, and the New Zealand dollar. |
| United Arab Emirates | Exchange Rate Band | dirham | SDR |
| Vanuatu | Conventional Peg | vatu | Central rate is a weighted basket of currencies comprised of the currencies of Vanuatus trade partners. |

Source: IMF Annual Report on Exchange Rate Arrangements and Exchange Restrictions, 1999.