WP/04/142

IMF Working Paper

Choosing the Correct Currency Anchor for a Small Economy: The Case of Nepal

Sibel Yelten

INTERNATIONAL MONETARY FUND

 WP/04/142

IMF Working Paper

Asia and Pacific Department

Choosing the Correct Currency Anchor for a Small Economy: The Case of Nepal

Prepared by Sibel Yelten[1]

Authorized for distribution by Jerald Schiff

August 2004

Abstract

This paper uses the Sjaastad model to estimate the optimal currency area for the Nepalese rupee and concludes that, currently, Nepal may be reasonably well off with its peg to the Indian rupee. As its economy opens and its trade base and trading partners expand, it may want to reevaluate whether moving toward an exchange rate basket including the U.S. dollar may be a better policy choice. The regression results indicate that, currently, the prices of imported goods in Nepal are solely influenced by India, suggesting that with the peg to the Indian rupee, Nepal can isolate the import side of its economy completely from external shocks. On the export side, the regression results indicate that Nepalese export prices seem, to a large extent, to be influenced by U.S. prices. However, the export price index had to be constructed, and the construction methodology is likely to entail an overestimation of the impact of the U.S. dollar.

JEL Classification Numbers: E32, F31

Keywords: Optimum Currency Area, Asian Crisis, Exchange Rate Basket, Currency Peg

Author's E-Mail Address: syelten@imf.org

[1] I would like to thank Larry Sjaastad and participants at the IMF's Asia and Pacific Department seminar for valuable comments on this paper.

Contents Page

I. Introduction

Nepal is a small, agriculture-based, landlocked country that has had a fixed exchange rate regime since 1960. It has sustained the current level of its peg toward the Indian rupee since 1993. Nepal's narrow export base and its pegged exchange regime make the country vulnerable to price shocks in traded goods and to price pressures that arise from exchange rate fluctuations in major currencies. Despite its peg to the Indian rupee, fluctuations in the dollar and the euro do affect the Nepalese economy, since those shocks get transmitted to the local economy through the traded-goods sector.

Going forward, Nepal may become increasingly vulnerable to fluctuations in the world prices of its traded goods and exchange rate fluctuations. Currently, only 35–40 percent of Nepal's GDP consists of traded goods.[2] However, in September 2003, Nepal finalized WTO accession talks, which, in the near future, may lead to a significant opening of its economy. In addition, Nepal is expected to be at a disadvantage after the Multifiber Agreement (MFA) phase out in 2005, due to the lifting of quota restrictions on Indian and Chinese exports. Changes in the competitive structure and the opening of the Nepalese economy are likely to make Nepal's pegged exchange rate more sensitive to external shocks.

In light of these vulnerabilities, this paper attempts to answers the question whether the Indian rupee is the correct anchor currency for the Nepalese rupee. The paper does not analyze the costs and benefits of a fixed-versus-flexible regime for Nepal, or does it analyze the level of the current peg.

A caveat applicable to the paper is that the export price index for Nepal needed to be constructed. The construction methodology introduced a bias in favor of the U.S. dollar, leading to an overestimation of the influence of the U.S. dollar on export prices.

Nonetheless, the analysis suggests that, currently, Nepal may be reasonably well off with its choice to peg its currency to the Indian rupee. Import prices in Nepal are solely influenced by the Indian currency area. Fluctuations between third currencies (U.S. dollar/rupee, euro/rupee), do not lead to inflationary or deflationary pressures in the import prices of Nepal.
In contrast, the regression results suggest that Nepalese export prices do experience shocks from the U.S. dollar currency area. Therefore, when the U.S. dollar depreciates toward the Indian rupee, pressure builds up on export prices owing to the price-making power that the U.S. dollar has over the prices of Nepalese export goods.

The Indian rupee currently appears to be a reasonable anchor for the Nepalese rupee; but, going forward, as Nepal opens its economy and increases its exports, it may want to reevaluate

[2] Calculated as exports plus imports, excluding re-exports, divided by GDP.

whether pegging to a currency basket with a positive weight for the U.S. dollar may be a better policy option.[3]

Section II of this paper summarizes the traded-goods sector of Nepal, followed by a review of the optimal-currency-basket literature in Section III. Section IV summarizes the Sjaastad model. Section V explains the estimation method used in the paper and gives a detailed description of the data and of the construction of the export index. Section VI presents the estimation results, followed by conclusions in Section VII.

II. Nepal's Traded-Goods Sector

Nepal's main export goods are readymade garments, carpets, and vegetable ghee. From the overseas exports (exports excluding India) approximately 30 percent consists of woolen carpets and 40 percent of readymade garments (Table 1).

Table 1. Share of Major Commodities in the Overseas Exports of Nepal in FY 2001/02 1/

	Value (In Nrs millions)	As a Percent of Overseas Exports
Readymade garments	7,752	42.0
Woolen carpet	6,109	33.2
Woolen and pashmina goods	1,852	10.1
Hides and goatskin	451	2.5
Other goods	2,245	12.2
Total	18,409	100.0

Source: Nepal Overseas Trade Statistics 2001–2002

1/ Overseas exports exclude India.

In addition to the narrow export base, its dependence on India, the United States, and Germany as its trading partners adds to the vulnerability from shocks through fluctuations in major exchange rates. Garments are exported almost exclusively to the U.S. market, carpets to Germany, and vegetable ghee to India. In recent years, India accounted on average for over 50 percent of Nepalese exports and 40 percent of its imports (Table 2). The United States, the second largest export destination for Nepalese goods, accounted on average for 20 percent of exports.

Table 2. Major Trading Partners of Nepal in FY 2001/02

(In millions of Nepalese rupees)

	Exports	In Percent		Imports	In Percent
India	28,865	60	India	45,364	43
United States	9,378	19	Singapore	7,846	7
Germany	4,043	8	Malaysia	4,818	5
United Kingdom	809	2	Saudi Arabia	4,573	4
Italy	567	1	China	4,316	4
Japan	492	1	Switzerland	4,206	4
Other countries	4,142	9	Other countries	34,380	33
Total	48,296	100	Total	105,503	100

Source: Nepal Overseas Trade Statistics 2001–2002

[3] Alternatively, Nepal can also evaluate the cost and benefits of moving toward a more flexible exchange rate regime.

III. THE OPTIMAL CURRENCY BASKET

In the current literature, authors have searched for an optimal basket starting with the assumption that a basket is the best exchange rate policy. Studies by Bhandari (1985a and 1985b), Flanders and Helpman (1979), Turnovsky (1982), Flanders and Tishler (1981), and Lipschitz and Sundararajan (1980) focused on an optimal basket based on *ad hoc* criteria such as minimizing the variance in the balance of payments, and found that trade weighted baskets are the optimal policy choice. Those solutions assumed that a basket is the optimal solution and, since most countries trade with more than one country, the optimal basket under those criteria includes the currencies of all trading partners. Therefore, those solutions are unlikely to lead to a corner solution (a basket that includes only one country).

In this paper, corner solutions that allow a pure U.S. dollar peg or a pure Indian rupee peg are acceptable solutions. This is possible because in the Sjaastad (2000) model the weights of the basket are chosen according to the relative price-making power that countries have over the prices of traded goods of a given country. Trade flows are a significant component in deciding which countries may have price-making power, but they are not the only determinants. For example, most Asian countries have significant trade with Singapore. In the case of Malaysia, 23.3 percent of total exports go to Singapore, and 15.4 percent of total imports come from Singapore; but Singapore obviously does not determine the world prices of Malaysia's traded goods, such as electrical machinery, crude petroleum, telecommunications, vegetable oil, etc. Since the price-making power of Singapore over Malaysia is likely to be low, the Singapore dollar does not need to be present in the Malaysian currency basket. If we were to follow the optimal currency basket literature described above, however, we would need to give a significant weight to the Singapore dollar in a basket for Malaysia.

Recent optimal basket studies such as those derived by Ito, Ogawa, and Sasaki (1998) improve upon the earlier models by building a model based on micro-foundations. In their model the oligopolistic exporter maximizes his profits so that the export price is endogenously determined in response to the exchange rates. Therefore, price "stickiness" is a result of optimizing behavior and is not an assumption as in the earlier models. The optimal solution in their model is to minimize fluctuations in trade balances. Their result is also closely related to the trade pattern seen in a particular country.

IV. THE MODEL

This paper uses the Sjaastad (1998 and 2000) model to determine, which currency bloc(s) Nepal belongs to. The Sjaastad model demonstrates that, if the price level in a country is affected by more then one currency bloc, then this country can isolate itself from shocks to its inflation and real interest rates by choosing a peg to a currency basket. The optimal weights for that basket, according to Sjaastad's model, are the relative price-making powers that major currency countries have over that country.

In Sjaastad (1998 and 2000), the inflation and real interest rate of a small country x that pegs its currency to country k is determined by equation (1): (See appendix for derivation)

$$\Pi_x = \dot{E}_{x,k} + \Pi_k + \sum \Theta_x^j \dot{E}_{k,j}^R, \quad where \sum_j \Theta_x^j = 1 \tag{1}$$

$$r_x = r_k - \sum_j \Theta_x^j \dot{E}_{k,j}^R, \quad where \sum_j \Theta_x^j = 1$$

The term Θ_x^j, measures the share of power possessed by country *j* in the world market for the goods traded internationally by country *x*. For example, if the United States has the entire price-making power over country *x*'s traded goods, Θ_x^{US} would be equal to one and all other Θ_x^j's would be equal to zero. $\dot{E}_{k,j}^R$ are changes in the real exchange rate between country k and j. In the standard analysis of sources of external inflation, only the first two terms on the right hand side of equation (1) are taken into account. Indicating that the inflation in a small country is solely determined by the inflation in the anchor country (Π_k), and by changes to the exchange rate rule ($\dot{E}_{x,k}$). However, since the breakdown of the Bretton Woods system, real exchange rates have been very volatile, and the third term has been a quantitatively important source of external price shocks. In Sjaastad's model in addition to the inflation rate of the anchor country, the inflation and the real interest rate in the small country experiences shocks due to fluctuations in real exchange rates of the major currency countries. An important implication of equation (1) is that, while a credible exchange rate rule may result in interest rate parity, it is not sufficient to assure equality of real interest rates, and in the inflation rate.

Sjaastad shows that if the price making power Θ of major currency countries is large, a country can only isolate itself from shocks by pegging to a currency basket. Equation (2) is a general expression for the inflation rate in the small country *x* when that country pursues an exchange rate rule based on a basket of the three major currencies (see appendix for derivation):

$$\Pi_x = \Pi_W + \dot{E}_{x,B} + (\Theta_x^2 - \gamma_2) \cdot \dot{E}_{1,2} + (\Theta_x^3 - \gamma_3) \cdot \dot{E}_{1,3} \tag{2}$$

Since country *x* pegs its currency to the basket *B*, $\dot{E}_{x,B} = 0$, so it is clear that choosing the basket weights γ_j such that $\gamma = \Theta$ will eliminate external price shocks. The inflation rate in the small country is going to be the world inflation rate, which is represented here by a weighted average of the inflation rates of the three major currency countries: $\Pi_x = \Pi_W = \sum_{j=1}^{M} \Theta_x^j \Pi_j$. And the real interest rate will be a weighted average of the real interest rates of the three major currency countries.

The exception, in which a single exchange rate rule could eliminate shocks to the inflation rate, occurs when the Θ_x^j for the anchor country is one, and thus all other Θ_x^j's are zero. In that case, the inflation in the small country would be the same as the inflation in the anchor country. For example, if Nepal were in a U.S. dollar currency area (Θ_x^{usa} = 100%), then once it pegged its currency to the U.S. dollar, its inflation (and real interest rates) would be equivalent to that in the United States.

V. Estimation Method

To estimate the Θ's we start with equation (3). Assuming that excess demand for goods *q* is a function of their real price and that excess demand has to add up to zero, Sjaastad (2000) derives the following key equation (for derivation refer to Sjaastad 2000 or 1998):

$$PT_x = \sum_j \Theta_x^j \cdot (P_j + E_{x,j}), \quad where \ \sum_j \Theta_x^j = 1 \tag{3}$$

In this text, capital letters indicate natural logarithms. PT_x, P_j, $E_{x,j}$, represent the price index for traded goods in country *x*, and an index of the price level of country *j*, country *j*'s currency in terms of country *x*'s currency.

As indicated in equation (3) the sum of Θ_x^j over *j* is equal to one. An intuitive explanation for this is the following hypothetical experiment. Keeping all exchange rates constant, if the price levels of the countries of the world were to double, then the prices of country *x*'s traded goods would also have to double.

Using the identities $E_{x,j} = E_{x,i} + E_{i,j}$, $E_{x,i} = -E_{i,x}$, $\sum \Theta_x^j = 1$ and adding $E_{i,x}$ on both sides of the equation (3), we can rewrite the equation as:

$$PT_x + E_{i,x} = \sum_j \Theta_x^j \cdot (P_j + E_{i,j}) \tag{4}$$

The term $PT_x + E_{i,x}$ in equation (4) is the price of traded goods of country *x* converted to the currency of country *i*. For notational simplicity we define $PTF_x \equiv PT_x + E_{i,x}$, where the capital F after the variable indicates that the variable is expressed in the currency of country *i*. Similarly, the term $P_j + E_{i,j}$ is the price level of country *j* expressed in currency *i*. Again, to simplify the notation, we define $PF_j \equiv P_j + E_{i,j}$. Using these definitions equation (4) becomes:

$$PTF_x = \sum_{j=1}^{M} \Theta_x^j \cdot PF_j, \qquad where \sum_j \Theta_x^j = 1 \tag{5}$$

In the following estimations the U.S. dollar is used as currency *i*, and all variables are transformed to U.S. dollar terms using equation (4). Since price data is available as a monthly variable, monthly exchange rate averages are used for the conversion of the prices. Note that the derivation does not depend on what currency is chosen as currency *i*. As long as the left hand side and the right hand side variables in equation (5) are expressed in a common currency, the choice of currency *i* does not affect the estimation of the Θ_x^j's.

The Θ_x^j's can be estimated using equation (5). There are several ways this can be done. One way of doing it is to construct the traded goods index, PTF_x, as a weighted average of import price index IMP_x, and export price index EXP_x. In this paper another approach is used, equation (5) is estimated separately for imports and exports. First it is assumed that the import price index for Nepal is representative for the prices of traded goods of Nepal, estimating Θ^{import} for import goods (assumes IMPF=PTF). Afterwards the export price index is used assuming that it is representative for the prices of traded goods of Nepal, estimating Θ^{export} (assumes EXPF=PTF). The overall Θ for traded goods is going to be between those two estimates.

Equation (5) is parameterized using an autoregressive distributed lag (ARDL) model, which permits taking into account that price changes do not affect the economy instantaneously. Equation (5) is rewritten as:

$$\begin{aligned} &A_x(L)\cdot PTF_{x,t} = \sum_j [B_x^j(L)\cdot PF_{j,t}] \\ &\textit{where} \quad A_x(L) = \sum_{i=0}^{N} a_{x,i}\cdot L^i \ \textit{and}\ B_x^j(L) = \sum_{i=0}^{M} b_{x,i}^j L^i \end{aligned} \tag{6}$$

Writing out the details of equation (6) we get:

$$PTF_{x,t} = \tilde{a}_{x,1}\cdot PTF_{x,t-1}\ldots + \tilde{a}_{x,n}\cdot PTF_{x,t-N} + \sum_j [\tilde{B}_x^j(L)\cdot PF_{j,t}] \tag{7}$$

where we define: $-a_{x,i}/a_{x,0} \equiv \tilde{a}_{x,i}, -A_x(L)/a_{x,0} \equiv \tilde{A}_x(L), \textit{and}\ B_x^j(L)/a_{x,0} \equiv \tilde{B}_x^j(L)$. Using the estimation coefficients, we can calculate the Θ_x^j's as:

$$\begin{aligned} &\Theta_x^j = \frac{B_x^j(1)}{A_x(1)} = \frac{B_x^j(1)}{1-\sum_{i=1}^{N}\tilde{a}_{x,i}} \\ &\textit{where}\ \tilde{B}_x^j(1) = \sum_{i=0}^{M}\tilde{b}_{x,i}^j, \quad A_x(1) = \sum_{i=0}^{N} a_{x,i}, \quad B_x^j(1) = \sum_{i=0}^{M} b_{x,i}^j \end{aligned} \tag{8}$$

VI. Estimation Results

In this section, the regression results—the weights Θ_x^j for the currency basket—are presented. Table 3 summarizes the results of the augmented Dickey-Fuller test for all variables. The appropriate lag length for the augmented DF test was determined using AIC. According to the DF test all variables in levels are either I(2) or I(1); therefore, to achieve stationarity, the data is second differenced.

Table 3. Augmented Dickey-Fuller Test Results

(Sample: 01/2000–05/2003)

Variable	DF test w c & t 1/	Joint test t=0, r=1	DF test w c	Joint test c=0, r=1	DF test no c & t	Conclusion
$\Delta IMPF_{Nepal}$	-6.22					Unit root rejected
$\Delta EXPF_{Nepal}$	-6.13					Unit root rejected
ΔPF_{USA}	-2.23	2.66	-2.12	2.27	-0.48	Unit root with drift
$\Delta PF_{Euro\text{-}Area}$	-5.19					Unit root rejected
ΔPF_{India}	-2.51	3.44	-2.25	2.79	-2.25	Unit root rejected
Critical value	-3.41	6.25	-2.86	4.59	-1.95	

Source: Regression results.

1/ w=with, c=constant, t=trend, r=root.

The import price index used in this paper is the import goods component of the whole price index for Nepal, and therefore a reasonably good approximation for the import price index for Nepal.

The export index, as already mentioned was constructed. Nepalese total exports by export category were used as weights and were multiplied with the import price index for the corresponding SITC category for the United States.[4] Since carpets are exported almost exclusively to Germany, it would have made sense to use German carpet import prices as a proxy for Nepalese carpet export prices. Unfortunately, Germany does not publish their third level SITC category, therefore this data was not available. The United States provides a breakdown of prices up to the third SITC level. However, unfortunately according to the Bureau of Labor Statistics there is no good proxy in the United States import prices that would reflect export prices for Nepalese carpets. Not having a proxy for carpet prices is almost surely leading to an underestimation of the influence of the euro area. Further, using the U.S. import prices as a proxy for Nepalese export prices is almost certainly leading to an overestimation of the influence of the U.S. dollar on Nepalese goods.

A. Regression Results Using Import Prices of Nepal as a Proxy for Traded-Goods Prices

Equation (7) is estimated using IMP = PTF. The Akaike Information Criteria (AIC) was used to determine the appropriate lag length for the regressions. For this estimation, various countries are used as the right hand side variables including Japan, India, the euro area, the United

[4] The Bureau of Labor Statistics provided help regarding categorization. They indicated which subcategory in the United States import prices would be a good approximation for the export category of Nepal.

Kingdom, the United States, and various other countries. None of these countries except for India had a significant impact on the prices of import goods in Nepal.

Table 4 presents the regression results using the United States, India, and the euro area as explanatory variables. According to the model the basket weights Θ_x^j's for those three countries must add up to one. The hypothesis that the basket weights add up to one could not be rejected, with F = 0.86 and significance level of 0.36. Therefore, it was possible to impose the following unit sum restriction:

$$\Theta_x^{USA} + \Theta_x^{Euro} + \Theta_x^{India} = 1 = \frac{\widetilde{B}_x^{USA}(1) + \widetilde{B}_x^{Euro}(1) + \widetilde{B}_x^{India}(1)}{1 - \sum_{i=1}^{N} \widetilde{a}_{x,i}}, \tag{9}$$

The regression coefficients in Table 4 are used to calculate the Θ's, as in equation (8). The price making power of India in this regression is 106 percent and suggest that the Indian price level and the exchange rate dictate the import prices in Nepal—there are no shocks to the import price level of Nepal that arise from fluctuations between the exchange rate of the anchor country and other major currency countries.

As already mentioned, Nepal imports 43 percent of its goods from India (Table 2). The second largest major import partner is Singapore with 7 percent of total imports and the United States accounts for only 2 percent of total imports of Nepal. Considering the large percentage of imports from India, and the fact that there is no other country in the world that accounts for a major percentage of Nepalese imports it is not surprising that India has sole price making power over the prices of import goods.

It is important to notice that the coefficient in Table 4, for the euro area, and the United States are not significant. Therefore, these two can be dropped from the regression. To test whether India has 100 percent price making power over the import prices of Nepal, the unrestricted regression is run using only India as the right hand side variable. The test that Θ for India

Table 4. Import Prices: Restricted Regression Using India, United States, and Euro Area (Sample: 01/2000–05/2003)

Coefficients	Value	Standard Error	T-statistic	Significance
$\sum_{i=1}^{N} \widetilde{a}_{Nepal,i}$	-1.35	0.49	-2.77	0.01
$\widetilde{B}_{Nepal}^{USA}$	0.22	0.79	0.28	0.77
$\widetilde{B}_{Nepal}^{Euro}$	-0.36	0.26	-1.38	0.17
$\widetilde{B}_{Nepal}^{India}$	2.49	0.69	3.60	0.00

Source: Regression results.

is 1 cannot be rejected, with F = 0.00 and significance level 0.97. This confirms that India is the sole price maker for the prices of import goods of Nepal.

B. Regression Results Using Export Prices of Nepal as a Proxy for Traded-Goods Prices

The same approach was applied to estimate the Θ for export prices. The only countries with a significant impact on the prices of Nepalese exports prices were the United States and India. Table 5 summarizes the regression results. The price-making power of the United States over the export goods of Nepal is 71 percent, whereas India has a price-making power of 29 percent. It is important to note that the euro area was dropped in this regression, since the coefficient was not significant.

Table 5. Export Prices: Restricted Regression Using India, United States, and Euro Area

(Sample: 01/2000–05/2003)

Coefficients	Value	Standard Error	T-statistic	Significance
$\sum_{i=1}^{N} \tilde{a}_{Nepal,i}$	-2.43	1.30	-1.88	0.07
$\tilde{B}_{Nepal}^{USA}$	2.43	1.45	1.68	0.10
$\tilde{B}_{Nepal}^{India}$	1.00	0.50	2.02	0.05

Source: Regression results.

Sixty percent of Nepalese exports go to India and 19 percent go to the United States (Table 2). The Sjaastad model is concerned with the price-making power of countries. The United States, owing to the wide usage of dollar in trade transactions and the size of its economy, has a large impact on the world prices of traded goods. Therefore, even if only 19 percent of Nepalese exports go to the United States, the United States may still have a significant impact on Nepalese export prices, but the impact is likely to be less than is estimated in this paper.

VII. Conclusions

The analysis concludes that currently Nepal is reasonably well off with its choice to peg to the Indian rupee. Going forward, however, as Nepal opens its economy and increases its exports, it may want to reevaluate whether pegging to a currency basket with a positive weight for the U.S. dollar may be a better policy option. If Nepal had pegged its currency to a basket that included the U.S. dollar, then during the recent depreciation of the U.S. dollar against the Indian rupee, the Nepalese rupee would have automatically depreciated somewhat with the U.S. dollar.

One interesting aspect of the regression results was the asymmetry of shocks between the export and import sectors. Currently, import prices are solely determined by the Indian currency area; therefore, pegging to the Indian rupee eliminates shocks arising from the prices of imported goods. On the export side however, Nepal does experience large shocks. Currently imports make up 69 percent of the traded goods; however, as exports become a greater share of GDP, shocks that are transmitted to the local economy through the prices of export goods will become increasingly important.

The regression results suggest that on the export side, 71 percent of the price-making power belongs to the United States. As explained in detail previously, the construction of the export index introduces a bias in favor of the United States. Therefore, the regression results for exports overestimate the influence of the United States and underestimate the influence of the euro area and India. Nonetheless, the regression results can be used to put an upper boundary on the influence of the U.S. dollar on Nepal's economy. For example, since 69 percent of Nepal's total trade currently consists of imports, using that ratio as a weight, we can calculate the price-making power of the U.S. dollar on Nepalese traded goods. Accordingly, the overall price-making power of the United States on Nepal's traded goods is 22 percent.

$$\Theta_{Nepal}^{USA} = 31\% \cdot \Theta_{Imports} + 69\% \cdot \Theta_{Exports} = 22\%$$

These results indicate that even currently, Nepal experiences some pressure on its traded-goods sector during periods of strong U.S. dollar depreciation; however, if Nepal had a currency basket, these adjustments would take place automatically.

Derivation of Exchange Rate Basket

Equations (10) to (19) summarize the Sjaastad (2000) model. Defining $E^R_{x,j} \equiv P_j + E_{x,j} - P_x$ as the purchasing power parity (PPP) real exchange rate of country *x* with respect to that of country *j*, we can rewrite equation (3) as:

$$PT_x = P_x + \sum_j \Theta^j_x \cdot E^R_{x,j} \tag{10}$$

Assume now that a small country *x* has adopted a credible exchange rate rule with respect to currency *k*. After some manipulations and using the identity $E_{x,j} = E_{k,j} + E_{x,k}$, equation (10) can be written as:

$$PT_x = E_{x,k} + P_k + \sum_j \Theta^j_x \cdot E^R_{k,j} \tag{11}$$

Writing equation (11) in terms of changes, we get (12), where the notation is obvious.

$$\Pi^T_x = \dot{E}_{x,k} + \Pi_k + \sum_j \Theta^j_x \cdot \dot{E}^R_{k,j} \tag{12}$$

The price level of a country is a weighted average of the prices for its traded and nontraded goods $P_x = \alpha_x \cdot PNT_x + (1-\alpha_x) \cdot PT_x$. Therefore equation (12) can be extended to the overall price level of country *x*:

$$P_x = \alpha_x \cdot (PNT_x - PT_x) + (E_{x,k} + P_k) + \sum_j \Theta^j_x \cdot E^R_{k,j} \tag{13}$$

Ignoring the first term in equation (13) and writing it in terms of changes gives us:

$$\Pi_x = \dot{E}_{x,k} + \Pi_k + \sum_j \Theta^j_x \dot{E}^R_{k,j} \tag{14}$$

The interest rate in a small country following an exchange rate rule can be written as:

$$\begin{aligned} i_S &= i_X + \dot{E}_{S,X} + spread \\ r_S &= i_S - \Pi_S \end{aligned} \tag{15}$$

Using equation (14), we get:

$$\begin{aligned} r_S &= i_S - \dot{E}_{S,X} - \Pi_X - \sum_j \Theta^j_X \cdot \dot{E}^R_{X,j} \\ r_S &= r_X - \sum_j \Theta^j_X \cdot \dot{E}^R_{X,j} + spread \end{aligned} \tag{16}$$

As can be seen from the equation (16), movements in the real exchange rate in the *j* countries lead to shocks in the inflation rate of country *x* that has pegged its currency to country *k*. While a single-currency exchange rate rule cannot eliminate the shocks to the inflation rate arising from real exchange rate movements, a rule based on a basket of currencies—whereby a basket that is chosen such that the weights are equal to the Θ_x^j's—can eliminate those shocks. A single-currency exchange rate rule is a special case of a currency basket. As explained in Sjaastad (2000), a rule based on a basket allows yet another degree of freedom, namely the choice of the basket weights. Therefore, the basket weights can be chosen to eliminate deflationary and inflationary shocks to the inflation and the real interest rates.

To illustrate this, consider three major currency blocs (the U.S. dollar, the German mark, and the yen) referred to as currencies *1*, *2*, and *3*, respectively. The number of units of currency *j* in the basket is referred to as x_j and $e_{1,j}$ denotes the value of currency *j* in terms of currency *1*, where ln(*e*) = *E*. The basket is labeled "*B*" and its value in terms of currency *1* is given by:

$$e_{1,B} = \sum_{j=1}^{M} e_{1,j} \cdot x_j = x_1 + e_{1,2} \cdot x_2 + e_{1,3} \cdot x_3 \tag{17}$$

To get the price of the basket in terms of the currency of the small country *x*, we multiply the two exchange rates.

$$\begin{aligned} e_{x,B} &= e_{x,1} \cdot e_{1,B} \\ &= e_{x,1} \cdot (x_1 + e_{1,2} \cdot x_2 + e_{1,3} \cdot x_3) \end{aligned} \tag{18}$$

And this also defines the exchange rate rule adopted by country *x*. By letting γ be the weight of the three *j* currencies in that basket and writing equation (18) in terms of logarithmic changes, we get:

$$\begin{aligned} &\dot{E}_{x,1} = \dot{E}_{x,B} - \gamma_2 \cdot \dot{E}_{1,2} - \gamma_3 \cdot \dot{E}_{1,3}, \\ &where: \gamma_j \equiv (e_{1,j} \cdot x_j)/(x_1 + e_{1,2} \cdot x_2 + e_{1,3} \cdot x_3) \end{aligned} \tag{19}$$

References

Bhandari, J. S., 1985a, "Experiments with the Optimal Currency Composite," *Southern Economic Journal,* Vol. 51, pp. 711–30.

_______, 1985b, "The Flexible Exchange Basket: A Macroeconomic Analysis," *Journal of International Money and Finance,* Vol. 4, pp. 19–41.

Flanders, M. J., and A. Tishler, 1981, "The Role of Elasticity Optimism in Choosing an Optimal Currency Basket with Applications to Israel," *Journal of International Economics,* Vol. 11, pp. 395–406.

Flanders, M. J., and E. Helpman, 1979, "An Optimal Exchange Rate Peg in a World of General Floating," *Review of Economic Studies,* Vol. 46, pp. 533–42.

Frankel, J., and S. Wei, 1994, "Yen Bloc or Dollar Bloc? Exchange Rate Policies of the Asian Economies," in T. Ito and A. Krueger, eds., *Macroeconomic Linkage: Savings, Exchange Rates and Capital Flows* (Chicago: University of Chicago Press).

Hamada, K., and H. Akiyoshi, 1987, "Monetary, Financial and Real Effects of Yen Internationalization," in S.W. Arndt and J.D. Richardson, eds., *Real-Financial Linkages among Open Economies*, (Cambridge, Massachusetts: MIT Press).

Ito, T., S. Ogawa, and S. Sasaki, 1998, "How did the Dollar peg fail in Asia," *National Bureau of Economic Review,* Vol. 6729, pp. 1–25.

Kaminsky, G., and C. Reinhart, 2002, "Financial Markets in Times of Stress," *Journal of Development Economics,* Vol. 69, pp. 451–70.

Kenen, P. B., 1969, "The Theory of Optimum Currency Areas: An Eclectic View," in R.A. Mundell and A.K. Swoboda, eds., *Monetary Problems of the International Economy* (Chicago: University of Chicago Press).

Lipschitz, L., and V. Sundararajan, 1980, "The Optimal Basket in a World of Generalized Floating," *Staff Papers*, International Monetary Fund, Vol. 27, pp. 80–100.

Mundell, R., 1961, "A Theory of Optimal Currency Areas," *American Economic Review,* Vol. 51, pp. 657–65.

Rats, 2002, *Rats Econometrics Software Package Version 5.02*, Evanston, IL: Estima.

Sjaastad, L., 1998, "Why PPP Real Exchange Rates Mislead," *Journal of Applied Economics,* Vol. 1, pp. 179–207.

_______, 2000, "Exchange Rate Strategies for Small Countries," *Zagreb Journal of Economics,* Vol. 4, pp. 3–33.

Turnovsky, S. J., 1982, "A Determination of the Optimal Currency Basket," *Journal of International Economics,* Vol. 12, pp. 333–54.