Pegging the Exchange Rate and the Choice of a Standard by LDCs: A Joint Formulation*

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This paper employs the bivariate probit model to explore two aspects of exchange-rate policy in developing countries: the decision of whether to peg the currency or adopt a more flexible exchange-rate regime and whether to peg to a single currency or a basket. The results confirm that the two decisions are jointly determined; therefore models that treat them as separate are inappropriate. The paper identifies a number of variables that are important determinants of the two exchange-rate policy decisions.

I. Introduction

Since the advent of generalized floating, exchange-rate policy has become an important issue for policy makers because the choice of exchange-rate regime has significant repercussions on a country's economy. A large body of literature, surveyed by Edison and Melvin (1988), has investigated the volatility of exchange-rates under different exchange regimes and its effects on international trade. Another strand of the literature, also surveyed by Edison and Melvin (1988) and by Wickham (1985), has focused on the choice of the optimum exchange-rate regime by an individual nation. The papers surveyed differ as to the objective function being considered and the nature of the shocks experienced by an economy. In practice, while most industrial countries float their currencies, either singly or jointly, developing countries have adopted a number of exchange rate practices. A few empirical

papers[1] have investigated the choice of exchange rate regime and the economic factors relevant to that decision.

The literature has divided countries into a small number of exchange-rate categories and has employed discrete-choice estimation procedures. Several papers [e.g., Dreyer (1978) and Melvin (1985)] classified countries into three categories: those pegging their currency to a single currency, those pegging to a basket, and those adopting a flexible exchange rate. The estimation procedure employed by Dreyer and Melvin treat the three exchange rate regimes as three separate choices. This paper contends that policy makers do not face three distinct options but are, in fact, confronted with two jointly determined decisions: whether to peg their currency or to adopt a more flexible regime and whether to peg the currency to a single currency or a basket of currencies. Because the estimation procedures employed previously are unable to capture the joint determination of these decisions, in this paper I formulate and estimate a bivariate probit model. The model allows us to identify the economic factors relevant to both decisions, whereas the previous literature could only identify the factors making for a more or less flexible (fixed) exchange rate regime. In addition, the model provides an explicit test of the hypothesis that the two decisions are in fact jointly determined, a consideration ignored by the previous literature.

The organization of this paper is as follows. The next section introduces a model of exchange-rate regime determination and outlines the application of bivariate probit to the two decisions previously outlined. The following section presents the estimation results, and the final section contains a summary and concluding remarks.

II. A Bivariate Probit Model of Exchange-Rate Regime Choice

Previous research on the determinants of the choice of exchange rate regime has proceeded by defining a latent variable, Z, which reflects a continuum of exchange-regime choice. The latent variable, which is unobserved, is related to a number of country-specific characteristics hypothesized to be significant determinants of exchange-regime choice:

(1) $Z = \beta'X + u$

1 The papers include those by Dreyer (1978), Heller (1978), Holden, Holden and Suss (1979), Melvin (1985), Bosco (1987), Nascimento (1987), and Savvides (1990).

X is a matrix of determinants of regime choice, β a vector of parameters to be estimated, and u a random error term. The observed variable (Z_1) takes on a small number of discrete values. In Bosco (1987), it assumes two values:

$$Z_1 = 1 \text{ if } Z > 0 \text{ (pegged exchange regime)}$$
$$= 0 \text{ otherwise (flexible exchange regime).}$$

In Dryer (1978) and Melvin (1985), it assumes three values:

$$Z_1 = 2 \text{ if } Z > \mu_1 \text{ (currency pegged to a single currency)}$$
$$= 1 \text{ if } \mu_1 > Z > 0 \text{ (currency pegged to a basket)}$$
$$= 0 \text{ otherwise (flexible exchange regime).}[2]$$

The above formulations envisage policy makers facing a small number (two or three) distinct choices. Policy makers opt for one of these choices on the basis of an objective function.[3] The papers apply limited-dependent variable techniques to estimate the parameters of vector β.

This paper offers an alternative formulation that encompasses three attractive features. First, it views the choice of standard to peg to (single currency or basket) as an option available to policy makers at the time of the initial choice between pegging the currency or adopting a more flexible regime. Second, it relies on a joint model where the peg/flexible and peg single currency/peg basket decisions are interdependent. Finally, it allows a formal test of whether the choice of standard is part of an overall optimization procedure. The model we employ relies on the bivariate probit model (BPM) introduced by Tunali (1988) where the binary outcomes of the peg/flexible decision and the peg single currency/peg basket decision jointly determine the optimal choice.

Consider the choice of exchange rate system by policy makers, when their objective is to stabilize domestic prices.[4] There are three levels of stability associated with the three exchange regime choice: y_F^*

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[2] The papers cited have chosen an inverse classification scheme to the one presented in the text with larger values signifying a flexible exchange regime. The reason for the inversion of notation is that it accords with that of our model, to be presented shortly.

[3] Several objectives have been offered in the literature including domestic relative price stability, internal and external balance, real absorption stability, minimization of real consumption shocks and minimization of domestic price shocks. For a discussion of this issue see Wickham (1985) and Williamson (1982).

[4] The choice of variable to stabilize is immaterial to the development of the model. Alternative objectives mentioned in endnote 3 would be equally applicable.

if a flexible exchange regime is chosen, y_{PB}^* if pegging to a basket is chosen, and y_{PS}^* if pegging to a single currency is chosen. Following Tunali (1988), $y_1^* = y_{PB}^* - y_F^*$ is the net anticipated increase in stability from pegging to a basket as compared to a flexible regime, and $y_2^* = y_{PS}^* - y_{PB}^*$ is the net anticipated increase from pegging to a single currency relative to a basket. Therefore, $y_1^* + y_2^*$ is the net anticipated increase from pegging to a single currency relative to a flexible exchange regime. Policy makers choose an exchange rate regime (C) from the three alternatives by comparing the associated stability levels.

Next we introduce two dichotomous variables (D_1 and D_2) defined as follows:

(2) $D_1 = 1$ if $y_1^* > 0$

         $= 0$ otherwise

(3) $D_2 = 1$ if $y_2^* > 0$

         $= 0$ otherwise

Therefore, the decision rule facing policy makers can be summarized as follows:

(4)   Flexible exchange regime (C = F), if $D_1 = 0$

         Peg to a basket (C = PB), if $D_1 = 1$ and $D_2 = 0$

         Peg to a single currency (C = PS), if $D_1 = 1$ and $D_2 = 1$.

A final condition necessary for the estimation of the model is that D_2 is observed if and only if $D_1 = 1$.[5]

Countries can be assigned to one of the three categories (F, PB, PS) based on the classification system of the International Monetary Fund (IMF). Therefore, we have data on D_1 and D_2, subject to the observability condition. Our objective is to explain the choice of exchange-rate regime through various economic determinants, contained in the matrix of explanatory variables X.

In order to capture the impact of the explanatory variables on exchange-regime choice, we specify the following system of structural equations:

5 This condition, known as the observability condition, precludes the possibility that pegging to a single currency is optimal when a flexible exchange regime is preferable to pegging to a basket. Further details can be found in Tunali (1988, pp. 7-8).

(5) $\quad y_F^* = \alpha_F' X + u_F$

(6) $\quad y_{PB}^* = \alpha_{PB}' X + u_{PB}$

(7) $\quad y_{PS}^* = \alpha_{PS}' X + u_{PS}$

where α_F, α_{PB}, and α_{PS} are vectors of unknown parameters and u_F, u_{PB}, and u_{PS} are random error terms. The reduced form of (5)-(7) is:

(8) $\quad y_1^* = \beta_1' X + u_1$

(9) $\quad y_2^* = \beta_2' X + u_2$

where $\beta_1 = \alpha_{PB} - \alpha_F$, $\beta_2 = \alpha_{PS} - \alpha_{PB}$, $u_1 = u_{PB} - u_F$, and $u_2 = u_{PS} - u_{PB}$ Summarizing, the dependent variables of (8) and (9) are unobservable. They capture the two exchange rate decisions confronting policy makers. The observed variables, D_1 and D_2, are defined by (4). Equation (8) determines the outcome of the peg/flexible regime decision through (2). Equation (9) determines the outcome of the peg basket/peg single currency decision through (3). Finally, the outcome of the second decision is not observed unless the decision to peg has been made, yielding the observability condition.

The probability P_c of a country belonging to one of the three regimes and therefore the likelihood function for the sample is

(10) $\quad L = \prod_{C=F} P_F \prod_{C=BP} P_{PB} \prod_{C=PS} P_{PS}.$

If the error terms in (8) and (9) follow the standard bivariate normal distribution, the probabilities are given by

(11) $\quad P_F = F(-\beta_1 X)$

(12) $\quad P_{PB} = G(\beta_1 X, -\beta_2 X; -\rho)$

(13) $\quad P_{PS} = G(\beta_1 X, \beta_2 X; \rho)$

where $F(X)$ and $G(.,.;.)$ are the standard univariate and bivariate normal distribution functions and ρ is the covariance between the error terms or $\rho = cov(u_1, u_2)$. The parameter vectors β_1 and β_2 as well as ρ can be estimated by maximization of the likelihood function in (10).[6]

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[6] As is well known, the parameter vectors (β_1, β_2) and the vairance of the error terms

In addition, maximization allows us to test for the independence of the peg/flexible and the peg to basket/peg single currency decisions ($\rho = 0$), and thus the appropriateness of the BPM. If the hypothesis $\rho = 0$ cannot be rejected, the parameter vector β_1 can be estimated by dividing the total sample into two categories (flexible regime and peggers) and applying binomial probit. Moreover, β_2 can be estimated by dividing the subsample of countries which maintain a pegged exchange regime into two categories (single currency peggers and basket peggers) and applying binomial probit to the subsample. This is known as the Independent Probit Model (IPM), and has been estimated by Bosco (1987).

III. Empirical Estimation of the Bivariate Probit Model

A. The Determinants of Exchange Regime Choice

The bivariate probit model was estimated for a cross section of developing countries (LDCs) for the period 1979-86. The sample contains data from developing countries only because, while developed countries have floated their currencies (singly or jointly), developing countries have adopted a variety of exchange regime practices. The richness of the LDC sample allows the use of the joint-decision model in (10). Data on exchange-regime classification dictated the beginning year for the study: 1979 was the first year for which the International Financial Statistics (IFS) classification of the IMF was available. The availability of data on the explanatory variables dictated the final year of the study (1986). The sample contains 293 observations from 43 countries. A number of country-years had to be deleted from the sample due to unavailability of data for one or more of the explanatory variables.

In classifying countries into various exchange rate regimes, I relied on the IMF classification system published in the IFS. Despite various shortcomings, the IMF system is the only comprehensive and continuous system available. It has been used by all previous researchers, but one. The IMF classifies countries as single peg if they peg their currency to a single currency (in the majority of cases the U.S. dollar or the French franc), as basket peg if they peg their currency to a com-

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of the reduced forms (σ_1^2, σ_2^2) cannot be estimated separately. In fact what can be estimated by maximizing (10) is (β_1/σ_1, β_2/σ_2). It is standard procedure to assume that $\sigma_1^2 = \sigma_2^2 = 1$.

posite of their own choice or the Special Drawing Right (SDR), and as flexible regime if they adjust their currency according to a set of indicators or maintain other managed floating or (in a very small number of cases) independent floating arrangements. I chose the IMF classification at the midpoint of each year.

Next, we turn to a discussion of the determinants of exchange regime choice, the elements of X. The traditional literature draws on the optimum-currency areas approach. Based on feasibility and optimality considerations, it identifies a number of economic determinants of regime choice. Branson and Katseli (1981) argue that the two major feasibility conditions are the degree of openness of the economic system and integration of domestic asset markets into the international financial system. They find that the more open an economy the less likely that floating will be feasible and the greater the integration of domestic asset markets in the international capital market the greater the feasibility of a flexible exchange regime. This study follows tradition by measuring openness (OPEN) as the ratio of imports to gross domestic product. The ratio of gross international capital flows relative to the domestic money supply is the measure of the degree of asset market integration (AMI).[7]

Previous researchers, including Dreyer (1978), Heller (1978), Holden, Holden and Suss (1979), and Savvides (1990), have discussed at length a number of economic determinants of the optmality of various exchange rate practices. Thus, a brief discussion of these variables is sufficient here: (i) Size (SIZE). According to Heller (1978, p. 310), large countries, which have greater control of their trade prices, "will find flexible exchange rates more desirable than small ones, which might consider pegging a more attractive alternative." Size is measured by gross domestic product (GDP) in U.S. dollars; (ii) Inflation differential (INFLDIF). If a country's inflation rate diverges markedly from that of its trading partners, it will find maintaining a fixed exchange rate costly and should therefore opt for a more flexible exchange regime. The variable is measured as the difference beween the domestic inflation rate and a weighted average of the inflation rates of the country's ten most important trading partners. For each country, the ten most important trading partners are determined on the basis of average trade (import plus export) over the 1970-85 period, and the weights are the average trade shares. An average weight is chosen so as to avoid any bias from single-year weights; (iii) Trade concentration

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[7] The Appendix contains a detailed definition of all the variables employed in this study and the data sources.

(TRCON). If the majority of a country's exports are directed to a single or a small number of trading partners, it may be beneficial for the country to maintain a pegged exchange rate. All previous researchers have measured trade concentration as the share of total exports directed to the largest single trading partner. As Holden, Holden and Suss (1979, p. 332) state, this is a rather crude measure and "a better defined measure" needs to be developed. In this study we improve on previous studies by measuring trade concentration as a Gini-Hirschman coefficient of exports to the country's ten major trading partners. The ten major trading partners are determined as for INFLDIF.

Departing from the optimum currency areas literature, Melvin (1985) has argued that modern open-economy macro theories yield two testable hypotheses concerning the choice of exchange regime: (i) the greater the foreign price disturbance (FPRICSHK), the more likely a flexible exchange rate; and (ii) the greater the domestic money disturbances (M1SHK), the more likely a fixed exchange rate. To test these hypotheses, operationl measures of foreign price and domestic money shocks facing each country are necessary. Following Melvin (1985, p. 471), the foreign price shock facing a country is proxied by the standard error of residuals from a second-order autoregressive equation of the exchange-rate adjusted inflation rate(s) of the country's major trading partner(s). While Melvin considered the single most important trading partner, I constructed a weighted average of the exchange-rate adjusted inflation rates of the country's ten most important trading partners, on which I performed the autoregressive regressions.[8] Thus, my definition encompasses a more comprehensive measure of international price disturbances facing a particular nation.[9] The ten most important trading partners are the same as those for the calculation of INFLDIF. Finally, domestic money shocks were calculated in a manner identical to that of foreign price shocks. The M1 definition of money was employed in the autoregressive equations.

B. Empirical Results

[8] I constructed two foreign-price shock measures, one based on trading partners' wholesale price index, the other on consumer price index. The results reported below employ the wholesale price index. The choice of price index, however, is immaterial because almost identical results were obtained when the measure based on the consumer price index was used.

[9] Melvin appears to have recognized the limitations of his measure, because in subsequent regressions he employed each country's import price index as a proxy for the foreign price level.

Tunali (1988) has shown that, in order for the reduced form parameters (β_1 and β_2) to be identified, one of the coefficients of vector β_2 in (9) must be restricted to equal zero. Since equation (9) describes the choice of standard to peg to, I have chosen to restrict the coefficient of openness to equal zero. The reasoning is that, as stated earlier, this variable is more appropriate to the feasibility of a flexible versus a pegged exchange regime, rather than the choice of standard.[10]

The values of the parameter vectors β_1 and β_2 maximizing (10) were obtained using the Newton-Raphson method with a convergence criterion of 10^{-9}. The parameter estimates and their corresponding standard errors are shown in the second and third columns of Table 1. The likelihood ratio statistic is highly significant, indicating that the hypothesis that all parameters coefficients (except the intercepts) are jointly equal to zero can be rjected.

All estimated coefficients are of the correct *a priori* sign and significant at either the 0.05 or the 0.01 level (for a one-tail significance test) except for OPEN in the REGIME equation and AMI in the STANDARD equation, which are significant at the 0.10 level. Our results indicate that economies which are relatively open, less integrated in the international capital markets, smaller in size, lower in inflation differential and more highly concentrated in their external trade, tend to peg their currency. In addition, we find support in favor of the modern-open-economy approach variables: countries experiencing greater domestic money shocks and smaller foreign price shocks, tend to peg their currency.

In contrast to previous research, our methodology allows us also to identify the variables relevant to the decision of which standard to peg to.[11] Our results indicate that countries that are smaller in size, with lower inflation differential and greater concentration of their external trade, tend to peg to a single currency. Moreover, we find evidence that the modern approach variables influence significantly the decision

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[10] Restricting the other variable pertaining to feasibility (asset market integration) to equal zero does not alter the results significantly. The coefficients and standard errors of the variables in (8) are identical to those reported in the text. The coefficients and standard errors of the variables in (9) display minor changes relative to those in the text, while the coefficient of OPEN is negative and insignificant.

[11] The only previous attempt at this issue has been by Bosco (1987), who employed the independent probit model. As we shall argue presently, this model is inaproriate. Heller (1978) used discriminant analysis to investigate the determinants of the choice between three differrent sets of two standards: dollar-french franc, dollar-basket and french franc-basket.

Table 1

BIVARIATE PROBIT, INDEPENDENT PROBIT AND ORDERED PROBIT ESTIMATES

Dependent Variable	Bivariate Probit Model (BPM)		Independent Probit Model (IPM)		Ordered Probit Model
	REGIME	STANDARD	REGIME	STANDARD	CLASS
Explanatory Variables					
Constant	1.300359**	0.0642406	1.300367**	-1.774304**	0.994741**
	(0.460395)	(0.5483244)	(0.460392)	(0.465204)	(0.330257)
OPEN	1.080645+		1.080598+		-0.395357+
	(0.684507)		(0.684484)		(0.253960)
AMI	-0.6243287**	-0.3304614+	-0.6243249**	0.5908010**	-0.117012
	(0.1195368)	(0.2578697)	(0.1995364)	(0.2165399)	(0.133688)
SIZE	-0.3343756**	-0.3012724**	-0.3343747**	0.089398+	-0.241698**
	(0.0473356)	(0.0584802)	(0.0473355)	(0.068445)	(0.035185)
INFLDIF	-3.689776**	-4.522638**	-3.689773**	-2.487207**	-3.745088**
	(0.784382)	(0.864431)	(0.784381)	(1.035207)	(0.640889)
TRCON	1.631900*	1.950372*	1.631894*	1.283603+	1.278451*
	(0.882251)	(0.907135)	(0.882250)	(0.801680)	(0.613008)
MISHK	6.408039**	7.630281**	6.408002**	6.520892*	5.204479**
	(2.368456)	(2.549215)	(2.368452)	(3.054387)	(1.813140)
FPRICSHK	-6.622902**	-5.738931**	-6.622880**	2.998969+	-4.45381**
	(1.411467)	(1.646491)	(1.411466)	(2.055350)	(1.195653)
RHO(ρ)	0.9657069**				
	(0.0444161)				
Likelihood-Ratio Statistic	235.04**		174.44**	26.50**	157.94**
(d.f.)	(13)		(7)	(6)	(7)
Threshold Value (μ)					1.011059**
					(0.099192)

Note: The Likelihood-Ratio Statistic is (asymptotically) chi-square distributed with degrees of freedom (d.f.). The probit maximum-likelihood estimate divided by the corresponding standard error is asymptotically t-distributed. The standard error is shown in parentheses below each coefficient. All significance tests are one tail. The Appendix contains a detailed definition of all the variables and the data sources.
 ** Significant at the 0.01 level
  * Significant at the 0.05 level
  + Significant at the 0.10 level

of the standard of peg to: countries experiencing greater domestic money shocks and smaller foreign price shocks tend to peg to a single currency.

One important result of this model is the strong evidence in favor of the bivariate probit model: ρ is positive and highly significant. Our results indicate that the two decisions of whether to adopt a fixed/ flexible regime and the standard to peg to are jointly determined. The evidence presented rejects the independent probit in favor of the bivariate probit model. The economic interpretation of a positive ρ is straightforward: policy makers either perceive higher than average stability under both pegging regimes (single currency or basket) or lower than average stability under both regimes as compared to a flexible regime. For countries which have opted for a flexible regime, it suggests that policy makers do not view one of the pegging options they turned down as much inferior to the other; both pegging options are viewed as equally inferior to a flexible regime.

Next, we compare the BPM to models employed by previous researchers: the IPM estimated by Bosco (1987) and the ordered probit/ logit model estimated by Dreyer (1978) and Melvin (1985). The IPM parameters are estimated by maximizing the likelihood function

$$(14) \qquad L = \prod_{C=F} F(-\beta_1 X) \prod_{C=PB} F(\beta_1 X)(-\beta_2 X) \prod_{C=PS} F(\beta_1 X)(\beta_2 X)$$

instead of (10). The results of the IPM are in the fourth and fifth columns of Table 1, while those of the ordered probit are in the final column of Table 1. In addition to all previously defined terms, μ is a threshold value produced by ordered probit for classifying countries into various groups.[12] It should be noted that ordered probit cannot provide separate estimates for the two decisions, peg/flexible and standard to peg to. It provides one set of estimates concerning the impact of various economic variables on the decision to adopt various degrees of exchange rate flexibility (CLASS).

First we compare the BPM and IPM. Both IMP equations are highly significant, as evidenced by the likelihood-ratio statistic. The coefficient of the REGIME equation are virtually identical in the two

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[12] As stated in Section II, in the ordered probit model, the dependent variable assumes one of three discrete values. Therefore, there are two (non-infinity) threshold levels for classifying countries. By convention, the maximum likelihood procedure normalizes one threshold level to zero, and estimates the other threshold level (μ) and the parameter vector.

model specifications. This is the result of the near perfect positive correlation ($\rho = 0.9657$) between the two equations.[13] The IPM estimates of the STANDARD equation differ from those of BPM. In particular the signs of SIZE and AMI are positive. This would suggest that larger and more financially integrated countries should peg to a single currency rather than a basket. Previous research would identify these countries as opting for a greater degree of exchange rate flexibility, as does the bivariate model. The coefficient of TRCON, although still positive, is not significant (at the 0.05 level). Finally, there is a reversal in the sign of the coefficient of FPRICSHK: it is positive and (marginally) significant. Contrary to the precepts of the modern open-economy approach, the results indicate that countries experiencing greater foreign price shocks should opt for pegging to a single currency.

The ordered probit model is highly significant. The value of the threshold level is also highly significant revealing the model can successfully discriminate between classifications. The coefficient of OPEN is negative and (marginally) significant, whereas that of AMI is insignificant. This indicates that more open economies should opt for a more flexible regime, a result contrary to the BPM and previous research. The coefficients of the modern approach variables are of the appropriate sign and highly significant.

Next, following Melvin (1985), I conducted a test of the modern open-economy versus the traditional optimum-currency areas approach by estimating two models. One includes only the modern approach variables, the other includes variables from both approaches. Melvin's test for the joint significance of all variables suggested by the optimum-currency areas approach showed that these variables added no significant explanatory power. The same likelihood ratio test for the bivariate probit model yielded a value of 95.56 with eight degrees of freedom. The joint hypothesis that the optimum-currency areas variables in the two equations are equal to zero can be rejected at the 0.005 level.[14] Similar tests for the two equations of the IPM yielded

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13 This finding can be verified by examining the likelihood functions in (10) and (14). Additionally, I explored the sensitivity of the parameter estimates of the BPM by restricting the value of ρ to equal 0.9, 0.8, 0.6, 0.4, and 0.2. Naturally the unrestricted model yielded the lowest value for the Akaike Information Criterion statistic. The parameter estimates showed little variation, the largest displayed by the coefficient of OPEN in the REGIME equation and the coefficients of AMI and FPRICSHK in the STANDARD equation.

14 In conducting the test, the identification restriction implies that in addition to the two modern approach variables, the REGIME equation must include one other, which is

values of 127.05 and 16.35 with five and four degrees of freedom respectively, while the test for the ordered probit model yielded a value of 111.11 with five degrees of freedom. In all cases, the joint hypothesis can be rejected at the 0.005 level. In order to test the explanatory power of the modern open-economy approach variables, a likelihood ratio test was conducted by dropping these variables from the model. In all cases, the joint hypothesis that all modern-approach variables are equal to zero can be rejected at the 0.01 level. In summary, in contrast to Melvin's work, our results indicate that variables from both the modern and the optimum-currency areas approaches merit inclusion in models of exchange-regime determination.

Finally, I turn to a comparison of the forecasting ability of the BPM and IPM models via two methods. First I employ the prediction scheme described in Tunali (1988). Second, I compute the Type I and Type II errors for the two models.

The maximum likelihood estimates of the parameters of the BPM and IPM models yield probability estimates of a country belonging to a specific classification. The estimated probability of pegging ($\hat{P}_P$) in the peg versus flexible decision is given by

$$(15) \qquad \hat{P}_P = 1 - \hat{P}_F = \hat{P}_{PB} + \hat{P}_{PS}.$$

Let $\overline{P}_P$ be the cutoff probability for discriminating correct predictions from incorrect ones. The predicted classification of the peg versus flexible decision is determined by

$$(16) \qquad D_1 = 1 \text{ ``peg'' if } \hat{P}_P \geqslant \overline{P}_P.$$
$$\qquad = 0 \text{ ``flexible'' if } \hat{P}_P < \overline{P}_P$$

According to Tunali (1988), $\overline{P}_P$ is computed as the ratio of the number of country-cases which peg their currency relative to the total sample. Similarly, the predicted classification for the other decision (peg to a basket versus peg to a single currency), which was confined to countries which pegged their currency, was determined by

$$(17) \qquad D_2 = 1 \text{ ``peg to a single currency'' if } \hat{P}_{PS}/\hat{P}_P \geqslant \overline{P}_{PS}/\overline{P}_P$$

restricted to equal zero in the STANDARD. I included each one of the traditional approach variables, in turn, and chose the model with the lowest (absolute) value for the log of the likelihood function. A comparison of this model with that containing both approaches yields the likelihood ratio statistic most biased against rejecting the null hypothesis.

$$= 0 \text{ ``peg to a basket'' if } \hat{P}_{PS}/\hat{P}_P < \overline{P}_{PS}/\overline{P}_P,$$

where $\overline{P}_{PS}$ is computed as the ratio of the number of country-cases which peg to a single currency relative to the total sample. By comparing the predicted to the actual classification, we compute the percentage of country-cases correctly classified by (16) and (17).

As was shown earlier, the maximum likelihood estimates of the parameters of the peg versus flexible decision were identical for the BPM and IPM. Therefore, the percentage of country-cases correctly classified by the two models was the same: 83.3 percent. When it comes to the other decision (peg to a single currency versus peg to a basket) the models yield very different results: the percentage correctly classified by the BPM is 73.4 percent while that by the IPM is 66.0. Therefore, the BPM performs significantly better than the IPM in terms of the prediction scheme outlined in (16)-(17).

Next, we compute the Type I and Type II error rates for the two decisions for the BPM and the IPM.[15] Since the maximum likelihood estimates of the peg versus flexible decision are identical for the BPM and IPM models, the error rates are identical and are shown in the first three columns of Table 2. As can be seen, the Type II error rates tend, in general, to be larger than the Type I error rates. The smallest total error rate occurs with a probability of 0.70. The other three columns of Table 2 show the error rates for the peg versus flexible decision for the ordered probit model. These rates tend to be higher than either the BPM or IPM model. In only six of twenty-seven cases does the ordered probit model yield a lower error rate than either the BPM or IPM model. Moreover, the total error rate for the ordered probit model is higher regardless of the probability cutoff being considered.

The error rates for the BPM and IPM models for the peg to a basket versus peg to a single currency decision are quite different.[16]

15 The maximum likelihood estimates yield implied probabilities corresponding to each country-case as described in (15). It is assumed that for each of the observations, the predicted probability is known *a priori*, whereas it is not known whether (for instance in the peg versus flexible decision) a country will peg its currency or not. Therefore, given a critical probability P*, all observations with predicted probabilities higher than P* are classified as "pegging" whereas those with predicted probabilities below P* are classified as "flexible." For any given P*, two possible types of error can be distinguished. A Type I error occurs when for a particular year a country is classified as flexible, when pegging did take place. Conversely, a Type II error occurs when a country is classified as pegging, when pegging did not take place. The error rate can be calculated as the ratio of the number of errors of each type to the maximum theoretical number of errors (180 and 105 for Type I and Type II, respectively, for the peg vs flexible decision).

16 Due to the nature of the ordered probit model, it is not possible to calculate error

Table 2
ERROR RATES FOR THE BPM AND IPM AND ORDERED PROBIT FOR THE PEG VS FLEXIBLE DECISION
(Percentage)

P*	BPM and IPM			Ordered Probit		
	Type I	Type II	Total	Type I	Type II	Total
0.10	1.1	63.8	23.5	1.1	78.1	28.7
0.20	2.1	56.2	21.5	1.6	65.7	24.6
0.30	3.7	50.5	20.5	3.2	56.2	22.2
0.40	6.9	41.9	19.5	4.3	51.4	21.2
0.50	12.2	31.4	19.1	10.6	38.1	20.5
0.60	17.0	17.1	17.1	18.1	28.6	21.8
0.70	19.7	11.4	16.7	26.6	9.5	20.5
0.80	26.6	7.6	19.8	36.2	1.9	23.9
0.90	40.4	1.0	26.3	59.6	1.0	38.6

They are shown in Table 3. It is immediately apparent that, out of eighteen critical probability levels, for only four (0.3 and 0.4 for Type I and 0.8 and 0.9 for Type II) does the BPM yield larger error rates than the IPM. Moreover, the BPM yields a lower total error rate for all nine critical probability levels. The lowest total error rate is generated by the BPM with critical probability level 0.50. In conclusion, the BPM is superior to the IPM in terms of its forecasting ability.[17]

IV. Concluding Remarks

This paper investigates the formulation of a country's exchange rate policy. It presents estimates of a bivariate probit model that captures the joint determination of a country's decision to peg its currency or adopt a flexible exchange regime and the decision of which standard

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rates for the peg to a basket versus peg to a single currency decision.

[17] It should be noted that Type I and Type II error rates are misleading in evaluating the structural models. In applications for forecasting purposes, the choice of critical probability level will depend on the relative cost associated with Type I and Type II errors.

Table 3

ERROR RATES FOR THE IPM AND BPM FOR THE PEG
TO A BASKET VS SINGLE CURRENCY DECISION
(Percentage)

P*	IPM			BPM		
	Type I	Type II	Total	Type I	Type II	Total
0.10	0.0	100.0	42.6	0.0	87.5	37.2
0.20	0.9	97.5	42.0	0.9	80.0	34.6
0.30	0.9	88.8	38.3	1.9	63.8	28.2
0.40	5.6	72.5	34.0	9.3	52.5	27.7
0.50	19.4	37.5	27.1	16.7	32.5	23.4
0.60	43.5	27.5	36.7	32.4	20.0	27.1
0.70	73.1	18.8	50.0	46.3	16.3	33.5
0.80	86.1	5.0	51.6	67.6	8.8	42.6
0.90	91.7	0.0	52.7	85.2	1.3	49.5

to pet to: a single currency or a basket. The paper shows that models which threat these decisions as independent are inappropriate because the two decisions are significantly positively correlated. It also demonstrates the superiority of the forecasting ability of the bivariate probit model relative to previously estimated models in the literature.

The research presented here contributes to policy making in several ways. First, it confirms the joint nature of exchange regime choice outlined above. Second, it sheds light into the economic determinants of exchange regime choice by developing countries. It demonstrates that variables from both the optimum-currency areas approach and the modern open-economy approach are relevant determinants of regime choice. Finally, it investigates separately the determinants of the two choices: peg versus flexible and peg to a single currency versus peg to a basket. Our results indicate that the same set of variables, from both the modern and optimum-currency areas approaches are significant determinants of the two choices.

Appendix

I. Countries Included in the Sample

Algeria, Bolivia, Burma, Cameroon, Colombia, Costa Rica,

Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Gabon, Ghana, Guatemala, Honduras, India, Indonesia, Ivory Coast, Kenya, Korea, Malawi, Malaysia, Mauritius, Mexico, Morocco, Nigeria, Pakistan, Paraguay, Peru, Philippines, Senegal, Sierra Leone, Singapore, Sri Lanka, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Uruguay, Venezuela, Zaire, Zambia.

II. Definition of Variables and Data Sources

1. Openness (OPEN): Calculated as the ratio of imports to gross domestic product (GDP). All data are from the International Financial Statistics (IFS) of the International Monetary Fund (IMF).

2. Asset Market Integration (AMI): Defined as the ratio of gross international capital flows to internal capital flows. Gross international capital flows include all flows (regardless of sign) recorded in the capital account of the Balance of Payments. Detailed data on international capital flows are obtained from the Balance of Payments Statistics Yearbook of the IMF. Internal flows are proxied by the money supply (M1).

3. Size (SIZE): Measured by GDP in U.S. dollars. All data are from the IFS.

4. Inflation Differential (INFLDIF): Calculated as the difference between the domestic inflation rate and a weighted average of the inflation rates of the country's ten most important trading partners. We determined the ten most important trading partners on the basis of average trade (export plus import) weights over the 1970-85 period. We constructed average weights so as ~~to reduce any bias from the choice of single-year trade weights.~~ For most countries in our sample, the ten most important trading partners represent over three fourths of total trade. Data for the weights are from the Direction of Trade Statistics of the IMF. The inflation rate was calculated as the percentage change in the consumer price index (CPI). All CPI data are from the IFS.

5. Trade Concentration (TRCON): Concentration is measured by the Gini-Hirschman coefficient defined as $C_j \sqrt{\sum_i (X_{ij}/X_j)^2}$ where C_j is the concentration coefficient for country j, X_{ij} is exports to market i by country j, and X_j is total exports of j.

In calculating C_j we included only the ten most improtant markets, which are the same as those for the calculation of INFLDIF. Data on exports classified by destination are from the Direction of Trade Statistics of the IMF.

6. Domestic Money Shocks (M1SHK): Calculated as the standard error of residuals from second-order autoregressive equations on the percentage change in the money stock. Due to limitations on the length of the time series available for each country, only twelve years were included in each autoregressive equation. The definition of money used is M1 and all data are from the IFS.

7. Foreign Price Shocks (FPRICSHK): Created in a manner similar to M1SHK, as the standard errors of residuals from second-order autoregressive equations of the weighted average of the exchange-rate adjusted inflation rates of a country's ten most important trading partners. The ten most important trading partners are the same as for the calculation of INFLDIF. Two alternative definitions of foreign inflation are employed: the percentage change in the consumer prie index (CPI) and in the wholesale price index (WPI). All CPI and WPI data are from the IFS.

References

Bosco, L., "Determinants of the Exchange Rate Regimes in LDCs: Some Empirical Evidence," *Economic Notes,* 1, 1987, 110-143.

Branson, W. and L. Katseli, "Exchange Rate Policy for Developing Countries," in: S. Grassman and E. Lundberg (eds.), *The World Economic Order: Past and Prospects,* New York: St. Martin's Press, 1981, 391-419.

Dreyer, J.S., "Determinants of Exchange-Rate Regimes for Currencies of Developing Countries:

Some Preliminary Results," *World Development,* 6, 1978, 437-445.

Edison, H. and M. Melvin, "The Determinants and Implications of the Choice of an Exchange Rate System," Working Paper No. 89-1, Center for Financial System Research, Arizona State University, December 1988.

Heller, H.R., "Determinants of Exchange Rate Practices," *Journal of Money Credit and Banking,* 10, 1978, 308-321.

Holden, P., M. Holden and E.C. Suss, "The Determinants of Exchange Rate Flexibility: An Empirical Investigation," *The Review of Economics and Statistics,* 61, 1979, 327-333.

Melvin, M., "The Choice of an Exchange Rate System and Macroeconomic Stability," *Journal of Money Credit and Banking,* 17, 1985, 467-478.

Nascimento, J.C., "The Choice of an Optimum Exchange Currency Regime for a Small Economy: An Econometric Analysis," *Journal of Development Economics,* 25, 1987, 149-165.

Savvides, A., "Real Exchange Rate Variability and the Choice of Exchange Rate Regime by Developing Countries," *Journal of International Money and Finance,* 9, 1990, 440-454.

Tunali, I., "Migration and Remigration as Interdependent Decisions: A Bivariate Probit Formulation," Working Paper No. 408, Cornell University, May 1988.

Wickham, P., "The Choice of Exchange Rate Regime in Developing Countries," *International Monetary Fund Staff Papers,* 32, 1985, 248-288.

Williamson, J., "A Survey of the Literature on the Optimal Peg," *Journal of Development Economics,* 11, 1982, 39-61.