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The Determinants of Exchange Rate Systems: An Empirical Analysis

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Since the breakdown of the Bretton Woods System, exchange arrangements of countries have become flexible. Several attempts have been made to determine whether the theories of optimum currency areas adequately explain the choice of an exchange rate system.

In this paper, the optimum currency area is retested. Using cross-section data, a regression analysis of the choice of an exchange rate system is performed, applying ordered and multinomial logit techniques. An important result of this analysis is the failure to reject the hypothesis that flexibility is the latent variable underlying the exchange rate system.

1. Introduction

Before 1971, under the Bretton Woods agreement, most countries had fixed exchange rates with an obligation of maintaining them, except for when there was a fundamental disequilibrium in the balance of payments. The breakdown of the Bretton Woods system created an opportunity for each country to adopt whatever exchange rate system suited it. Since then, the exchange rate arrangements of smaller industrial countries and developing countries have become more flexible.

What are the causes of this changing pattern of exchange rate

regimes? Do the theories of optimum currency areas explain the exchange rate regime choices after the breakdown of the Bretton Woods system?

Several attempts have been made to determine whether the theories of optimum currency area adequately explain the choice of an exchange rate system. Previous empirical studies have used various statistical techniques with cross-section data. Heller (1977, 1978) performed a discriminant analysis on the choice of exchange rate regimes. Dreyer (1978) used a probit model in his analysis. Holden, Holden, and Suss (HHS, 1979) defined an exchange rate flexibility index, and then applied ordinary least squares methods to cross sectional data for 75 countries. The explanatory variables used in these papers are generally drawn from the literature on optimum currency area. The studies cited generally provide empirical support for the optimum currency area theory.

In this paper, the optimum currency area hypothesis is retested using cross-country data for 1984. It is assumed that governments act in accordance with the policy conclusions of economists. Two new statistical techniques, ordered probability and multinomial logit models, are employed in this analysis. These techniques are appropriate since the dependent variable, the exchange rate system, is a qualitative variable. For this purpose, the International Monetary Fund's (IMF) classification of the exchange rate policies of member countries are used. Two new explanatory variables, "the source of disturbances" to the economy and "the level of international reserves" are added in this paper. These variables are relevant to the optimum currency area theory and have long been ignored by empirical analysts.

The paper is divided in seven sections. Section one is the introduction followed by section two which summarizes the major economic factors which may influence the choice of an exchange rate regime. Section three reviews previous empirical works. Section four presents the model used in this paper and outlines the ordered

probability and multinomial logit models and their relevance. In section five, the data set and its sources are explained. The estimation results of the ordered probability and multinomial logit procedures are discussed in section six. Finally, section seven summarizes the results with concluding remarks.

2. The Theory

Because the choice of an appropriate exchange rate regime for a country depends on its economic characteristics, the optimum exchange rate system will vary among countries. Factors which influence the choice of the exchange rate system have been outlined in the literature on optimum currency area. The theory of optimum currency area has provided theoretical insights for analysts searching for major factors that influence the relative desirability of alternative exchange rate regimes (Tower and Willett, 1976).

The exchange rate system (E) is the dependent variable in this empirical analysis and flexibility is the assumed continuous and latent variable underlying E. The flexibility of the exchange rate system, as discussed in the literature, is a function of a set of explanatory variables. In the following paragraph, I will briefly outline these variables, how they are related to flexibility, and how they are measured in this empirical analysis.

The explanatory variables which are used in this paper are the following:

1. The degree of openness (DO) is measured by the ratio of imports to gross national income. It is expected to be negatively related to the flexibility of E.

2. The degree of financial integration (DFK) is measured by the ratio of commercial bank holdings of foreign assets to the central bank holdings of foreign assets.[1] It may have a positive or negative relationship to the flexibility of E.

3. The degree of product diversification (DPD) is predicted to be positively related to the flexibility of E. The proxy for DPD is the ratio of the value of the largest export item to total value of exports. This ratio shows the degree of product concentration rather than product diversification. Thus, the proxy is the inverse of DPD (IDPD) and we expect a negative sign for IDPD.

4. The geographical pattern of trade (GPT) is expected to have a positive relationship to the flexibility of E. The inverse of GPT is IGPT measured by the share of the value of the largest trade partner in the total value of foreign trade. The higher this ratio, the higher the concentration of foreign trade. We should, therefore, expect a negative sign for IGPT.

5. The relative rate of inflation (RRF) is expected to be positively related to the flexibility of E. The inflation differential pertaining to a

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1.This measure is adopted from Black (1976). A higher ratio of commercial bank holdings of foreign assets to the central bank holdings of foreign assets indicates relatively higher involvement of the banking system in foreign trade and capital transactions. Other measures for DFK were used by different authors. Heller (1978) used the ratio of foreign assets to the broad money supply. A high ratio indicates a high degree of financial market integration and, therefore, a high degree of international capital movements. This proxy may not be applicable in countries with significant barriers to convertibility. HHS used a different measure, the ratio of the sum of private capital account debit and credit to gross domestic product.

specific country is measured as the absolute value of the difference between the inflation rate for that country and the average inflation rate for the world as a whole. The greater is the difference between a country's inflation rate and the world average, the more difficult it is to maintain a fixed exchange rate.

6. The size of the economy (GNP) is predicted to have a positive relationship to the flexibility of E. The GNP for all countries is measured by gross national product valued in dollars.

7. The source of disturbances (SD) is assumed to be internal to developing countries and external to developed countries. A dummy variable is employed for SD assigning one to developing countries and zero to developed countries. We should, thus, expect a positive sign for SD.

8. The level of international reserves (R) is expected to be negatively related to the flexibility of E.[2] R is the value of the country's international reserves minus gold, measured in dollar terms.

All determinants of the exchange rate system (1) through (8) originate from the optimum currency area literature. The foreign trade elasticity is another variable that can be added to this study. In this paper, however, this variable was dropped due to the difficulty of its calculation in the case of the developing countries. Another variable, the degree of economic development (DED) was added. This variable was used by Holden and Holden (1976) and again by Holden, Holden

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2.It is reasonable to argue that the causality may be the other way round, from exchange rate regime to reserves. However, the cost of adjustment to external imbalances in case of less developed countries is higher because of the importance of imports in fostering economic development. Under such circumstances, if foreign reserves are sufficient, the adoption of a less flexible exchange rate is more feasible.

and Suss (HHS, 1979). It is reasonable to argue that less developed economies are generally undiversified, open, and lack integrated financial markets. We should, therefore, expect a direct relationship between the desirable flexibility of E and DED.

3. A Brief Review of Previous Empirical Studies

The important empirical studies in this area are by Heller (1977,1978), Dreyer (1978), and Holden, Holden, and Suss (1979). In these studies the authors applied various statistical techniques to cross-sectional data. Heller analyzes cross-sectional data for 86 countries, including both developed and developing. The exchange arrangements in his 1976 data set include 9 floaters and 77 peggers. By using discriminant analysis, he discovers that DO, GPT, and GNP are the most important factors in distinguishing peggers and floaters. However, together their explanatory power is only slightly higher than the intercept.

From a theoretical point of view the appropriateness of discriminant analysis estimation critically depends on the distribution of the explanatory variables. If these are normally distributed, the discriminant analysis estimator is a maximum likelihood estimator and, therefore, should be asymptotically more efficient than the multinomial logit model. However, if the normality assumption is incorrect, discriminant analysis is generally inconsistent, whereas the multinomial logit model will retain its consistency (Amemiya,1981).

Dreyer uses the probit model to analyze cross-sectional data on 88 developing countries. There are three exchange rate regimes in his model: (i) pegged to a single intervention currency, (ii) more flexible,

i.e., pegged to a basket of currencies or a "gliding parity", and (iii) floating exchange rate. The prediction power of his model is poor. The basic problem with his study, as pointed out by the author, lies in the data. Dreyer uses data from different years. A cross-sectional analysis using data from different periods may be a major source of inconsistency in Dreyer's results.

Holden, Holden, and Suss define "an exchange rate flexibility index", denoted F^i, and use it as the dependent variable. F^i assumes values ranging from infinity for free floating to zero for a fixed exchange rate system. They carry out a cross-sectional analysis involving 76 developed and underdeveloped countries. Their data cover the years 1974 and 1975. They find that DO, IDPD, DED, and RRF are all statistically significant at the 95% confidence level.

In general, the above studies support the optimum currency area theory. In particular, the sign of the coefficients in the Heller and HHS studies are as theory predicts, although not all of the estimated parameters are statistically significant. However, these studies suffer from the shortcomings of the IMF's classification of members' exchange rate systems prior to 1982. Also, if the discriminant analysis and probit model are not used appropriately, results are biased.

A new study of this issue will be fruitful. There has been an improvement in the classification of members' exchange rate systems by the IMF which will help produce more consistent results. There is also more and better quality data available. Furthermore, there are new techniques that can be used, namely ordered and multinomial logit models.

4. The Empirical Model

The empirical model may be written as follows:

$$E = f(DO, DFK, IDPD, IGPT, RRF, DED, GNP, SD, IR) \qquad (1)$$

where E represents the exchange rate system. The expected signs of the coefficients are:

$$f_{DO}, f_{IDPD}, f_{IGPT}, f_{IR} < 0$$

$$f_{GNP}, f_{DED}, f_{RRF}, f_{SD} > 0$$

$$f_{DFK} \begin{matrix} < \\ > \end{matrix} 0$$

The model specified in equation 1 states that the exchange rate regime is a function of a set of specified economic characteristics of countries. The objective is to calculate the probability that a country with a given set of characteristics will choose a specific exchange rate regime.

Although it is not stated directly, optimum currency area theory implies that exchange rate flexibility is a function of the economic characteristic of a country. Indeed flexibility is the most important single theme discussed in the international finance literature in relation to exchange rate systems. Thus, in equation 1, E can be considered a continuous latent variable representing the degree of flexibility ranging from zero for fixed exchange rate systems to infinity for free floating systems. Exchange rate regimes can be ordered according to their degree of flexibility. If flexibility is the underlying variable determining exchange rate regimes, then the ordered probability model is appropriate. This model implies that if the desired flexibility rises above a critical point a country will choose a basket-peg exchange rate system over single-peg rates, and more flexible rates will be chosen if the desired flexibility rises further.

However, viewing the choice of the exchange rate system as a function of only desired flexibility may be too restrictive, in which case the multinomial logit model is appropriate. In the logit model alternative exchange rate regimes are assumed to be independent unordered options. Exchange rate regimes typically fall into four

possible categories: free floating, flexible exchange rates which are adjusted on the basis of some rules, pegged to a basket of currencies, and pegged to a single currency. Although flexibility is considered the most important issue in the choice of an exchange rate regime, any category of exchange rate regime is fundamentally different from the other. For example, a single currency peg is quite a different system from the free floating rate. The two systems will not affect decision-making in the economy proportionally according to their degree of flexibility. For example, the volume and direction of capital flows in an economy will be very different under the two systems. In order to satisfy some particular policy objective, one or the other exchange rate system must be adopted. Thus, any change in the characteristics of an economy will change the probability of the choice of an exchange rate regime. Here we assume that the alternative exchange rate regimes are independent, unordered options. Under such circumstances the multinomial logit model will be the appropriate procedure for estimating our model.

Therefore, if the choice of exchange rate system is ordered along a flexibility continuum, the ordered probability model is appropriate. By contrast, if the different regimes are independent and unordered, the multinomial logit model is appropriate. The ordered probability model is a special case of the multinomial logit model. We will test the null hypothesis that the true underlying model is an ordered probability model by using a likelihood ratio test. The multinomial logit model always provides consistent estimates. The estimates are inefficient if the ordered model is correct. The estimates from the ordered model are biased if the ordered model is incorrect. In what follows, the two alternative models are briefly explained and used in estimating equation 1.

Ordered Probability Model

Let Z be a categorical variable with 4 response categories R_1, R_2, R_3, and R_4. Define a set of five constants α_0, α_1, α_2, α_3 and α_4, with $\alpha_0 = -\infty$ and $\alpha_4 = +\infty$ and with $\alpha_0 < \alpha_1 < \ldots < \alpha_4$, such that:

$$Z_j \varepsilon R_i \Longleftrightarrow \alpha_{i-1} \leq Y_j \leq \alpha_i \qquad (2)$$

for i = 1, 2, 3, 4

Since Z is ordinal it can be represented as a series of dummy variables:

$$Z_{jK} = \begin{cases} 1 & \text{if } Z_j \varepsilon R_K \\ 0 & \text{otherwise} \end{cases} \qquad \text{for } j = 1, 2, \ldots, 121. \quad k = 1, 2, 3, 4.$$

where 121 is the number of observations in this analysis. The underlying response model is assumed to be a linear function of the regressors:

$$Y_j = X_j \beta + u_j \qquad (3)$$

Where Y is the degree of flexibility of the exchange rate system, X is the set of our explanatory variables and u is the residual. The residuals are assumed to have a multivariate normal or a Weibull distribution. Due to inadequate measurement techniques, Y is not observable: we only observe Z, an ordinal version of Y.

Given equations 2 and 3, the probability that regime k is chosen by country j is:

$$\text{Prob}(Z_{jk} = 1) = \text{prob}(Z_j \varepsilon R_K) = F(\alpha_k - X'_j\beta) - F(\alpha_{k-1} - X'_j\beta) \qquad (4)$$

where F can be logistic or cumulative normal. In order to make the estimations from the probability ordered model comparable to those from the multinomial logit model, the error terms in equation 3 are assumed to follow a Weibull distribution. The model includes five α values. α_0 and α_4 are the two extreme values and when α_1 is normalized to zero for identification purposes, we are left with the estimation of two threshold coefficients (α_2 and α_3).

The maximum likelihood method is used to obtain estimators for α and β. The likelihood function for the model given fixed values of the parameters is:

$$L = L(Z/\beta_0, ..., \beta_4, \alpha_2, \alpha_3)$$

$$L = \pi_{j=1}^{121} \pi_{k=1}^{4} [F (\alpha_k - X_j' \beta) - F (\alpha_{k-1} - X_j' \beta) Z_{jk}] \qquad (5)$$

and the log likelihood function, L^*, is:

$$L^* = \Sigma_{j=1}^{121} \quad \Sigma_{k=1}^{4} \quad Z_{jk} \log [F (\alpha_k - X_j' \beta) - F (\alpha_{k-1} - X_j' \beta)] \qquad (6)$$

The log likelihood function, L^*, is a function of (β_0, ..., β_4, α_2, α_3) and we want to maximize L^* subject to the constraint that $\alpha_1 \leq \alpha_2 \leq \alpha_3$.

Multinomial Logit Model

In this analysis, the exchange rate system is assumed to have three categories (see Table 2). Taking the case of three values for the dependent variable with probabilities P_0, P_1, P_2 the multinomial logit model can be written as:

$$\ln (P_{kj} / P_{1j}) = X_j \beta_k \qquad (7)$$

k = 1, 2 ; j = 1, 2,.....,121;

where j is the observation index, X_j is the j-th observation on a $1 \times q$ vector of explanatory variables, and β_k is a $q \times 1$ vector of coefficients.

The two equations in (7), plus the requirement that the probabilities for every j sum to one, determine the probabilities uniquely. The equations defined in (7) can be manipulated to yield:

$$P_{Oj} = 1 / [\, 1 + \Sigma_{k=1}^{2} \exp (X_j \beta_k) \,] \tag{8}$$

$$P_{kj} = \exp (X_j \beta_k) / [\, 1 + \Sigma_{k=1}^{2} \exp (X_j \beta_k) \,] \tag{9}$$

The multinomial logit model can be estimated by the maximization of the following likelihood function:

$$L = \pi_{j \,\varepsilon\, \theta_0} P_{jo} \, \pi_{j \,\varepsilon\, \theta_1} p_{j1} \, \pi_{j \,\varepsilon\, \theta_2} P_{j2} \tag{10}$$

where

$$\theta_k = \{\, j \mid \text{k-th response is observed} \,\}.$$

Hence

$$L = \pi_{j \,\varepsilon\, \theta} \{\, 1 / [\, 1 + \Sigma_{k=1}^{2} \exp (X_j \beta_k) \,] \,\} \, \pi_{i=1}^{2} \tag{11}$$

$$\pi_{j \,\varepsilon\, \theta} \{\, \exp (X_j \beta_k) / [\, 1 + \Sigma_{k=1}^{2} \exp (X_j \beta_k) \,] \,\}$$

5. The Data

This cross-sectional analysis is for all countries for which data is available in 1984. The total number of countries reported in the International Financial Statistics (IFS) is 138. Seventeen countries were eliminated from the sample because of the unavailability of several data. Therefore, the resulting sample consists of 121 countries, 20 developed and 101 developing. The information on actual exchange rate regimes

adopted by various countries in 1984 comes from the Annual Report on Exchange Arrangements and Exchange Restrictions (see Table 1).

Table 1.

Exchange Rate Arrangements (1984)

Single Currency peg	US $	French franc	British pound	total
	24	11	1	36
Composite Currency peg	SDR		Other Composites	total
	9		28	37
Flexibility Limited	Vis-a-Vis a Single Currency		Cooperative arrangements	total
	6		7	13
More Flexible	Adjusted according to a set of indicators	Managed Floating	Independently Floating	total
	6	17	12	35

Source: Annual Report on Exchange Arrangements and Exchange Restrictions (1985)

The classification of members' exchange arrangements is from the least flexible to the most flexible, and this factor is applied to subcategories within each of the broad headings. Accordingly, countries with a single peg allow zero fluctuation margins; and those with a basket-peg maintain their exchange rates within very narrow margins, seldom exceeding 1 percent about their basket-peg. All 6 countries in the "Limited Flexibility vis-a-vis a single currency" category allow their currency to fluctuate within 2(1/4) percent or less against other member's currency. The other "Limited Flexibility" category includes those European countries that maintain an arrangement within the European Monetary System (EMS). All of these countries except for Italy maintain 2(1/4) percent margins with respect to their cross rates

based on the central rates expressed in terms of the European Currency Unit (ECU). Countries with a more flexible currency, maintain their exchange rates within margins exceeding 2(1/4) percent of either their intervention currency or a composite of currencies. This category includes three groups of countries--those adjusting their exchange rate according to a set of indicators, those that have adopted managed floating, and, finally, those countries that have floated their currency independently (while reserving the discretionary power of the monetary authority to intervene in the foreign exchange market from time to time to maintain orderly conditions in that market).

For both estimation procedures the dependent variable is categorized according to the IMF's report on exchange rate arrangements in the order of increasing effective flexibility. I arrange the dependent variable in one category of E as shown in Table 2.

From Table 2 it can be seen that E is given three values (0,1,2). Under E, the degree of flexibility of (ii) and (iii) is considered to be close, so they are assigned to the same category. Category (iv) is a cooperative arrangement; the exchange rate system in this category is much more flexible than in category (ii). Therefore, category (iv) is combined with the category for the more flexible exchange rate systems.

For the explanatory variables of the model, data are needed on gross national product (GNP), gross domestic product (GDP), exports (X), imports (M), population (Pop), foreign assets of central banks (FAC), the foreign assets of the banking system (FAB), the largest export category (LX), the share of the largest trade partner in import and export (LTPX and LTPM), the amount of a country's international reserves minus gold (R), the rate of inflation (DP_c), and finally the exchange rate (EX).

Table 2.

Definitions of the Dependent Variable

		E
(i)	Single Currency peg	0
(ii)	Composite Currency peg (SDR and Other)	1
(iii)	Flexibility limited vis-a-vis a Single Currency	1
(iv)	Flexibility limited vis-a-vis a Group of Currencies	2
(v)	More Flexible: Adjusted according to a set of indicators	2
(vi)	More Flexible: Managed floating	2
(vii)	More Flexible: independently floating	2

exchange rate (EX)

The data for GNP are not available for many countries for 1984, so I replaced it with GDP, which is reported in IFS. The export and import data are taken from the Direction of Trade Statistic (DOT). The data for R together with FAB and MSUP are taken from IFS. The data for LX is reported in the Yearbook of International Trade Statistics. LX is accounted for by the largest export in terms of the three digit Standard International Trade Classification (SITC). For almost half of the countries involved in this investigation, the 1984 data for LX are not available. Therefore, I substituted the latest available data. For a few countries like Burma and Chad, the most recent data dates back to the late 1970's. For all other countries, data on LX are available for the early 1980s. This deficiency in LX data may not be serious because the

economic structure of developing countries is quite stable over a number of years. The data for LTPX and LTPM is found in the Direction of Trade Statistics. For DP_c, the data is collected from the IFS.

It may be the case that some of the independent variables are highly correlated. The correlation matrix for the variables used in the empirical analysis is presented in Table 3. The largest correlation is 0.438 (between R and DED). In any event, none of the correlation coefficients are large enough to significantly bias the estimation results.

Table 3.
Correlation Matrix, Exogenous Variables (E)

CORRB	DO	DFK	GNP	LDPD	IGPT	RRF	R	DED
DO	1.000							
DFK	0.101	1.000						
GNP	-0.125	-0.018	1.000					
IDPD	-0.095	-0.084	-0.167	1.000				
IGPT	-0.072	0.123	-0.057	0.130	1.000			
RRF	-0.064	-0.036	-0.0279	0.039	0.014	1.000		
R	-0.029	0.012	0.550	-0.216	-0.148	-0.036	1.000	
DED	-0.021	0.011	0.358	-0.058	0.076	-0.082	0.438	1.000

6. Estimation Procedure and Results

In this section, the estimation procedure and results from the estimation using ordered probability and multinomial logit models are described. In the first model, the dependent variable and the exchange

model, the dependent variable is assumed to be unordered. The hypothesis to be tested is that the underlying model is ordered. I first use six explanatory variables for both estimation procedures. These variables are derived from the literature on the optimum currency area and used in the previous empirical analysis.

The dependent variable has already been defined in Table 2. The model estimated is :

$$E = f(DO, DFK, GNP, IDPD, IGPT, RRF) \qquad (12)$$

with signs as explained in the theory section.

Ordered Model

In estimating the ordered model, we have three choices of exchange rate systems. The probabilities arising from the logistic distribution can be expressed as $P_{ij} = \exp(X_i \beta_j) / \Sigma^{J}_{j=0} \exp(X_i \beta_j)$ where β is an unknown vector of parameters to be estimated, X_i is the vector of variables and J equals 2 or 3 depending on the number of the exchange rate category. For normalization, β_0 is set to zero. In the ordered model $\beta_1 = \beta_2 = \beta_3$. A positive coefficient indicates an increase in the probability of the choice of a more flexible exchange rate and a negative coefficient indicates otherwise.

The marginal probabilities for all variables are calculated and reported in all tables together with their t-values. When the dependent variable has three choices, these are given by: $\partial P_0 / \partial X_i = -\beta \bar{P}_0 (1 - \bar{P}_0)$, $\partial P_1 / \partial X_i = -\beta [\bar{P}_0 (1 - \bar{P}_0) + \bar{P}_2 (1 - \bar{P}_2)]$, and $\partial P_2 / \partial X_i = \beta \bar{P}_2 (1 - \bar{P}_2)$. The average values of probabilities from the sample are used to calculate the marginal probabilities. Thus, the variance for marginal probabilities are multiples of the variance of β.

Table 4, based on the E definition, shows the estimation results for equation (12). The coefficient of DO is positive which does not match

the predictions of the proponents of the óptimum currency area. Rather, the Kenen-Giersch hypothesis seems to prevail, which recommends a higher degree of flexibility for exchange rate systems as the degree of openness increases. This outcome is justified when we consider the composition of countries under the flexible-rate system. Twenty-five out of the forty-three countries in this group are developing countries with highly open economies. On the basis of the openness criterion, these countries should have chosen a less flexible exchange rate system. The coefficient for GNP has the expected sign and is highly significant. The coefficients related to IDPD, IGPT, and RRF are significant and their signs match predictions. Higher IDPD and IGPT, that is, lower DPD and GPT favor a less flexible exchange rate system and a higher deviation from the world average inflation rate favors a more flexible exchange rate as predicted by the theory.

Table 4.
Ordered Probability Model Estimation (E)

Order; lhs=E; rhs=One, LnDO, LnDFK, LnIGNP, LnIDPD, LnGPT, LnRRF; logit

	Expected Signs	Coefficient (t-Statistic)	Marginal Probabilities (×100)		
			0	1	2
Constant		-6.180 (4.869)			
LnDO	—	0.501** (1.703)	-10.30** (1.703)	5.50** (1.703)	4.80** (1.703)
LnDFK	?	-0.091 (0.950)	1.90 (0.950)	-1.00 (0.950)	-0.90 (0.950)
LnGNP	+	0.602* (4.073)	-12.40* (4.073)	6.61* (4.073)	6.78* (4.073)
LnIDPD	—	-0.286** (1.186)	5.90** (1.186)	-3.14** (1.186)	-2.70** (1.186)
LnIGPT	—	-0.791* (2.050)	16.30* (2.050)	-8.70* (2.050)	-7.60* (2.050)
LnRRF	+	0.538* (3.698)	-11.10* (3.698)	5.90* (3.698)	5.20* (3.698)
Thresh	1	2.248* (6.292)			

Log-likelihood ..... -101.72
Log-likelihood (β=0) -132.93
Log-Likelihood (Slopes=0)..... -164.27
Pseudo-R^2 .....0.24

Actual	Total	Predicted 0	1	2
Total	121	35	41	45
0	35	20	13	2
1	43	14	16	13
2	43	1	12	30

Note: The absolute t-values are in parentheses.
* Means significant at five percent level.
** Means significant at ten percent level.

Under E, 55 percent of the observations are correctly predicted. Categories 0, 1, and 2 are predicted well. The pseudo-$R^2 = 1 - (L_n / L_o)$ is reported for the model, where L_n is the value of the likelihood function when maximized with respect to all parameters and L_o is the value for the naive, equal-probability model. The R^2 is high by the standard of qualitative models.

Furthermore, it should be noted that the threshold coefficients in the estimation of the ordered model are highly significant. This indicates the ability of the model to successfully discriminate between groups.

Multinomial Logit Model

The model is estimated with six variables so that the results can be compared with those from the ordered estimation. In the multinomial logit model, there are (d-1) estimated regressions, where (d) is the number of values which the dependent variable can take. A positive coefficient indicates that an increase in a variable increases the probability of the choice of the exchange rate regime which is represented by the numerator of the log odds ratio relative to the base, the base being the single-peg regime.

The marginal probabilities for the logit model when there are three choices are given by: $\partial P_0 / \partial X_i = - \bar{P}_0 \bar{P}_1 \beta_1 - \bar{P}_0 \bar{P}_3 \beta_2$, $\partial P_1 / \partial X_i = \bar{P}_1 (1 - \bar{P}_1) \beta_1 - \bar{P}_1 \bar{P}_2 \beta_2$, and $\partial P_2 / \partial X_i = \bar{P}_2 (1 - \bar{P}_2) \beta_1 - \bar{P}_1 \bar{P}_2 \beta_1$. The average values of probabilities from the sample are used to calculate the marginal probabilities. Thus, the variance for marginal probabilties are multiples of the variance of β.

Table 5 presents the logit estimation results. In Table 5, all significant variables have the expected signs except DO in (I.2), which has an unexpected negative sign. The sign of the coefficient of

Table 5.
Logit Model Estimation (E)

Logit; lhs=E; rhs=One, LnDO, LnDFK, LnIGNP, LnIDPD, LnGPT, LnRRF

		(I.1) Log [prob (E = 1) / prob (E = 0)]		(I.2) Log [prob (E = 2) / prob (E = 0)]		
	Expected Signs	Coefficient (t-Statistic)		Marginal Probabilities (×100)		
		1	2	0	1	2
Constant		–5.450 (3.391)	–11.192 (5.266)			
LnDO	—	0.355 (0.855)	0.928** (1.772)	-13.20 (1.451)	-3.60 (0.448)	16.80** (1.673)
LnDFK	?	-0.273** (1.847)	-0.222 (1.355)	5.10** (1.723)	-3.50 (1.418)	-1.60 (0.586)
LnGNP	+	0.431* (2.476)	0.989* (4.560)	-14.6* (4.049)	-2.60 (0.826)	17.20* (4.266)
LnIDPD	—	0.026 (0.070)	-0.417 (1.065)	4.00 (0.574)	5.80 (0.903)	-9.90 (1.411)
LnIGPT	—	-1.406* (2.548)	-1.032 (1.585)	25.10* (2.277)	-19.20** (1.857)	-5.90 (0.479)
LnRRF	+	0.270 (1.098)	0.723* (2.505)	-10.20* (2.043)	-2.90 (0.683)	13.10* (2.544)

Log-likelihood ..... -97.00
Log-likelihood (β=0) -132.93
Log-Likelihood (Slopes=0)..... -132.39
Pseudo-R^2 .....0.27

		Predicted		
Actual	Total	0	1	2
Total	121	32	43	46
0	35	20	13	2
1	43	9	20	14
2	43	3	10	30

Note: The absolute t-values are in parentheses.
* Means significant at five percent level.
** Means significant at ten percent level.

indicates that as the degree of openness increases, the probability of adopting a flexible-rate system relative to the single-peg increases, but DO does not affect the relative probability of basket-peg and single-peg regimes. DFK is significant in (I.1) and has a negative sign implying that an increase in the financial integration of a country will increase the probability of a single-peg relative to a basket-peg regime. GNP is a significant factor, indicating that as an economy grows, the probability of adopting a more flexible exchange rate increases. IGPT is significant in (I.1), indicating that a higher geographical concentration of trade increases the probability of choosing the single-peg versus the basket-peg regimes. RRF is significant which means that a higher RRF increases the probability of choosing the flexible-rate relative to a single-peg.

The marginal probabilities support the results. The marginal probabilities for the three significant explanatory variables DO, GNP, and RRF show that higher values of these variables increase the probability of adopting a more flexible exchange rate system. The marginal probabilities for DFK and IGPT indicate that an increase in DFK or IGPT raises the probability of adopting category 0, and decreases that of adopting category 2 less than that of adopting category 1.

The results obtained from equation (12) by both ordered and multinomial logit techniques tend to confirm the view that larger countries tend to opt for a higher degree of exchange rate flexibility. The size of the economy and the deviation of the inflation rate from the world average, not the degree of openness, are the determining factors.

The percent correctly predicted by the multinomial logit model is 58%. The overall predictive power of this model is better than the ordered model. The pseudo-R^2 , for the logit model is higher than for the ordered model and are satisfactory by the standard of logit models.

We now test the null hypothesis that the underlying model is

ordered. The value of the test statistic is $-2(L_0 - L_1) \sim X_k^2$ where L_o is the likelihood from the ordered (logit) model and k is the number of parameters in the logit model minus one. Thus, the number of degrees of freedom is 13 in the case of three choices. The value of the test statistic is -2(-101.72 + 97.00) = 9.44, where the null hypothesis is not rejected. This outcome supports the generally accepted view that flexibility is the most important determinant of exchange rate systems.

INTRODUCING NEW VARIABLES

The hypothesis that the degree of flexibility is the latent variable underlying the exchange rate system was tested and not rejected. This implies that the ordered model is the more appropriate technique for estimating equation 12. I introduce new variables to the ordered model in order to study their significance in determining the choice of exchange rate systems. I am especially interested in the effects of international reserves (R) on the choice of the exchange rate regime. The expected sign for this variable is negative.

The estimation results show that the coefficient for R is not significant implying that the level of international reserves does not affect the choice of the exchange rate system. The addition of R also decreases the number of significant variables.

Next, I add the degree of economic development (DED) to the ordered model. The addition of DED does not increase the explanatory power of the model, nor does DED itself become a significant variable. The estimation results for the ordered model with an additional variable show that the source of the disturbance (SD) has the right sign but is not significant in the choice of exchange rate regime. The introduction of this variable has increased the R^2 of the ordered model from 0.24 in the previous case to 0.25 in this case, and has also improved the

this variable has increased the R^2 of the ordered model from 0.24 in the previous case to 0.25 in this case, and has also improved the predictive power of the model. The introduction of SD substantially increases the number of correctly predicted countries in category 1. One important aspect of introducing SD is its role as a dummy variable which discriminates between developed and developing countries by assigning one to the developing countries and zero to developed countries. SD turns out to be insignificant indicating that we are right in putting the two groups of countries together in this analysis.

7. Summary and Conclusion

In this paper, I tested the hypothesis that the choice of the exchange rate regime is determined by a demand for flexibility. In doing so, I used the ordered probability and multinomial logit models. The use of the ordered model is justified if the degree of flexibility is indeed the underlying response variable. On the other hand, different exchange rate regimes might be considered independent and unordered options since they are chosen according to the economic characteristics which differ among countries in which case the logit model is appropriate.

Six variables DO, DFK, GNP, IDPD, IGPT, and RRF are used in both the ordered logit and multinomial logit models. DO, DFK and GNP are the feasibility conditions in the choice of the exchange rate regime. DO has received the most attention in theoretical studies, and these empirical results indicate that the higher levels of openness are associated with the adoption of more exchange-rate flexibility. These results do not support the orthodox views of optimum currency areas. Rather the Kenen-Giersch hypothesis, that flexibility of the exchange rate system increases as DO increases, is supported. DFK is significant only in the logit estimation. An increase in DFK increases the

probability of a single-peg system and decreases the probability of a flexible-rate system less than a basket-peg regime. GNP is significant and has the expected sign in both models.

The three variables IDPD, IGPT, and RRF are optimality conditions. IDPD is significant in the ordered model, while IGPT is significant in both the ordered and logit models. Both variables have the expected sign. Considering the significance and the expected sign of GNP and RRF together with their monotonically increasing marginal probabilities, we conclude that these two variables are determining factors in adopting the appropriate flexibility of the exchange rate system for the economy.

The explanatory power of both models is good. An important hypothesis in this paper is that the flexibility is the latent variable underlying the exchange rate system. The test-statistic failed to reject the null hypothesis that the true underlying model is ordered.

Next, the analysis is extended by introducing new variables R, DED, and SD. None of the variables is significant in explaining the choice of exchange rate regimes. SD also has the role of a dummy variable in distinguishing between developed and underdeveloped countries. It indicates that it is appropriate to bring developed and developing countries together in this analysis.

The results of this paper confirm some of the results already pointed out by theoretical analyses and previous empirical works. This analysis showed stronger roles for GPT, GNP and RRF relative to the previous analyses done by Dreyer, Heller, and HHS.

References:

[1] Aghevli, Bijan B., "Experiences of Asian Countries with Various Exchange Rate Policies," in John Williamson (ed.), *Exchange Rate Rules: The Theory, Performance & Prospects of the Crawling Peg*, (New York; St Martin's 1981), 298-318.

[2] Amemiya, T., "Qualitative Response Models: A Survey," *Journal of Economic Literature* 19 (December 1981), 1483-1538.

[3] Artus, J. R., and Young, J.H., "Fixed and Flexible Exchange Rates: A Renewal of the Debate," *IMF Staff Papers* 26 (December 1979), 654-698.

[4] Black, Stanley W., Exchange Policies for Less Developed Countries in a World of Floating Rates, Essays in International Finance No, 119 (Princeton. New Jersey: Princeton University, 1976).

[5] _____, *Floating Exchange Rates and National Economic Policy* (New Haven: Yale University Press, 1977).

[6] Branson, William H., and Louka, T.Latseli-Papafstralion, "Income Instability, Terms of Trade, and Choice of an Exchange Rate Regime," *Journal of Development Economics* 7 (March 1980), 49-69.

[7] _____, "Exchange Rate Policy in Developing Countries," in S. Grossman and E. Lunbery (eds.), *The World Economic Order: Past and Prospects* (London: Macmillan, 1981), 391-419.

[8] Brodsky, David A., and Gray P. Sampson, "The Sources of Exchange Rate Instability in Developing Countries: Dollar, French Francs and SDR Pegging Countries," *Weltwirtschaftliches* 13 (March 1983), 133-154.

[9] Connolly, Michael, "The Choice of an Optimum Currency Peg for a Small, Open Country," *Journal of International Money and*

Finance 1 (1982), 153-164.

[10] _____, "On the Optimal Currency Peg for Developing Countries", *Journal of Development Economics* 18 (1985), 555-59.

[11] Corden, Max W., "Monetary Integration", Essays in International Finance No. 93 (Princeton, New Jersey: Princeton University, 1972).

[12] Crockett, Andrew D., and Saleh M. Nsouli, "Exchange Rate Policies for Developing Countries," *Journal of Development Studies* 13 (January 1977), 125-143.

[13] Dornbusch, R., "Expectations and Exchange Rate Dynamics," *Journal of Political Economy* 84 (1976), 1161-1176.

[14] Dreyer, Jacob S., "Determinants of Exchange Rate Regimes for Currencies of Developing Countries: Some Preliminary Results," *World Development* 6 (April 1978), 437-445.

[15] Edwards, Sebastian, "Exchange Rate Misalignment in Developing Countries", World Bank Occasional Papers, New Series No. 2 (1988).

[16] Flanders, M. June, and E. Helpman, "On Exchange Policies for a Small Country," *The Economic Journal* 46 (March 1978), 44-58.

[17] _____, "An Optimal Exchange Rate Peg in a World of General Floating," *Review of Economic Studies* 46 (July 1979), 533-542.

[18] Friedman, M., "The Case for Flexible Exchange Rates," in Milton Friedman (ed.), *Essays in Positive Economics* (University of Chicago Press, Sixth Impression 1969), 157-203.

[19] _____, "Comments," in George P. Shultz and Robert Z. Aliber (eds.), *Guidelines, Informal Controls and the Market Place: Policy Choices in a Full Employment Economy* (University of

Chicago Press, 1966), 55-61.

[20] Giersch, Herbert, "On the Desirable Degree of Flexibility of Exchange Rates," *Weltwirtschaftliches* 3 (1973), 191-213.

[21] Goldstein, Morris, "Have Flexible Exchange Rates Handicapped Macroeconomic Policy?", Special Papers in International Economics No. 14 (Princeton, N.J. Princeton University, International Finance Section, June 1980).

[22] Haberler, Gottfried, "The International Monetary System: Some Recent Developments and Discussions," in George H. N. (ed.), *Approaches to Greater Flexibility of Exchange Rates* (Princeton University Press, 1970).

[23] Heller, H. Robert, "Choosing an Exchange Rate System," *Finance and Development* 14 (June 1977), 23-26.

[24] _____, "Determinants of Exchange Rate Practices," *Journal of Money, Credit and Banking* 10 (Aug. 1978), 308-321.

[25] Holden, Paul, Merle Holden, and Esther C. Suss, "The Determinants of Exchange Rate Flexibility: An Empirical Investigation, "*The Review of Economics and Statistics* 61 (Aug. 1979), 327-333.

[26] Ingram. James C., "Comment: The Currency Area Problem", in Robert A. Mundell and Alexander K. Swoboda (eds.), *Monetary Problems of the International Economy*, (University of Chicago Press, 1969), 95-100.

[27] International Monetary Fund, *Annual Report of the Executive Board for the Financial Year Ending April 30, 1982* (IMF, Washington, 1982).

[28] _____, *Annual Report on Exchange Arrangements and Exchange Restrictions*, (IMF, Washington, 1985).

[29] _____, *International Finance Statistics*, Annual Report (IMF, Washington, 1985), and monthly reports.

[30] _____, *Direction of Trade Statistics*, (IMF, Washington, 1985).

[31] Ishiyama, Yoshide, "The Theory of Optimum Currency Areas: A survey," *IMF Staff Papers* 22 (July 1979), 344-83.

[32] Johnson, Harry G., "The Case for Flexible Exchange Rates, 1969," in Harry G. Johnson (ed.), *Further essays in Monetary Economics* (Harvard University Press, Cambridge, Massachusetts, 1973), 198-228.

[33] Judge, George G., William E. Griffiths, R. Carter Hill, H. Lutkepohl, and T. Chao Lee., *The Theory and Practice of Econometrics* (2nd. ed) (John Wiley and Sons, Inc., 1985).

[34] Kenen, Peter B., "The Theory of Optimum Currency Areas: An Eclectic View," in Robert A. Mundell and Alexander Swoboda (eds.), *Monetary Problems of the International Economy* (Chicago: University of Chicago Press (1969), 41-60.

[35] Lipschitz, Leslie, "Exchange Rate Policies for Developing Countries: Some Simple Arguments for Intervention," *IMF Staff Papers* 25 (Sept. 1978), 650-449.

[36] _____, "Exchange Rate Policy for a Small Developing Country, and the Selection of an Appropriate Standard," *IMF Staff Papers* 26 (Sept. 1979), 423-449.

[37] Lipschitz, Leslie, and V. Sundararajan, "The Optimal Basket in a World of Generalized Floating," *IMF Staff Papers* 27 (March 1980), 80-100.

[38] Maddala G.S., *Limited-dependent and Qualitative Variables in Econometrics* (Cambridge University Press, 1987).

[39] Mckelvey, R.D. and William Zavoina, "A Statistical Model for the Analysis of Ordinal Level Dependent Variables," *Journal of Mathematical Sociology* 4 (1976), 103-120.

[40] Mckinnon, Ronald I., "Optimum Currency Areas," *American Economic Review* 53 (Sept. 1963), 17-25.

[41] _____, "Optimum Currency Areas" *American Economic Review* 53 (Sept. 1963), 423-449.

[42] _____, "Monetary Control and the Crawling Peg," in John Williamson (ed.), *Exchange Rate Rules* (New York: St. Martin's, 1981), 38-40.

[43] Mundell, Robert A., "A Theory of Optimum Currency Areas," *American Economic Review* 51 (Sept. 1961), 657-65.

[44] _____, "The Appropriate Use of Monetary and Fiscal Policy for International and External Stability," *IMF Staff Papers* 9 (March 1962), 70-79.

[45] Orcutt, Guy H., "Exchange Rate Adjustment and the Relative Size of the Depreciating Bloc," *Review of Economics and Statistics* 37 (February 1955), 1-11.

[46] Putnam, Bluford H., and Sykes D. Wilford, "The Evolution of the Flexible Exchange Rate Debate" in B. H. Putnam and D. S. Wilford (eds.), *The Monetary Approach to International Adjustment* (Praeger Special Studies, Praeger Scientific, 1986), 123-138.

[47] Scitovsky, Tibor, *Economic Theory and Western European Integration* (Stanford, Cal., Stanford University Press, 1958).

[48] _____, "The Theory of Balance-of-Payments Adjustment," *Journal of Political Economy* 75 (August 1967), 523-531.

[49] Sohman, Egon, *Flexible Exchange Rates, Theory and*

Controversy (Chicago, III 1969).

[50] Tower, E., and Willett T.D., "The Theory of Optimum Currency Areas and Exchange Rate Flexibility," Special Papers in International Economics No. 11 (Princeton, N.J. Princeton University, International Finance Section, 1976).

[51] Wickham, P., "The Choice of Exchange Rate Regime in Developing Countries," *IMF Staff Papers* 32 (June 1985), 248-88.

[52] Williamson, John, (ed.), *The Crawling Peg in Historical Perspective, Exchange Rate Ruler* (New York: St. Martin's. 1981), 3-30.

[53] _____, "A Survey of the Literature on the Optimal Peg," *Journal of Development Economics* 11 (August 1982), 39-61.

[54] _____, "On the Optimal Currency Peg for Developing Countries," *Journal of Development Economics* 18 (1985), 561-62.