NBER WORKING PAPER SERIES

MULTICOUNTRY MODELLING OF FINANCIAL MARKETS

Jon Cockerline
John F. Helliwell
Robert Lafrance

Working Paper No. 2736

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
October 1988

Department of Finance, University of British Columbia and Department of Finance, and Bank of Canada, respectively. This paper was prepared for the Federal Reserve Board Conference on Monetary Aggregates and Financial Sector Behaviour in Washington, May 26-27, and as part of the research program of the working group in international macroeconomics. We are grateful to members of that group, and to several other colleagues, for their advice and assistance. We are especially grateful to Hossein Rostami for his creative assistance in preparing the sections dealing with international financial linkages. We are also grateful to the model groups, and especially to Jaime Marquez, for the provision of data, model description, and advice. Our revisions have been aided by helpful comments from Ralph Bryant, Peter Hooper, Bill Poole, John Taylor and Simon Wren-Lewis. This research is part of the NBER's research program in International Studies. The views expressed are those of the authors. No responsibility for these views should be attributed to the Department of Finance, the Bank of Canada, or the National Bureau of Economic Research.

NBER Working Paper #2736
October 1988

MULTICOUNTRY MODELING OF FINANCIAL MARKETS

ABSTRACT

After a survey of alternative theoretical approaches to modelling financial markets, the domestic and international financial linkages of major multicountry models are examined and assessed. The properties of these models are compared by calculating the slopes of their LM and BP curves for the United States, Germany, and Japan. The BP curves (horizontal by assumption in several models) are almost always found to be flatter than the estimated LM curves. International differences in LM slopes are not generally greater than inter-model differences in the estimated slopes of LM curves for any given country. Models with rational or model-consistent expectations in their financial markets tend to show more appreciation of the U.S. dollar, in response to fiscal expansion, than do models with adaptive expectations, although in both types of model the induced nominal exchange rate changes play a modest role in the transmission linking domestic spending to the current account. Suggestions are made for modelling the increasing globalization of financial markets, and for more explicit treatment of learning behaviour in the modelling of expectations.

Jon Cockerline
Department of Finance
Ottawa, Ontario
K1A 0G5

John F. Helliwell
University of British Columbia
Vancouver, B.C.
V67 1Y2

Robert Lafrance
Bank of Canada
Ottawa, Ontario
K1A 0G9

Multicountry Modelling of Financial Markets

John F. Helliwell, Jon Cockerline and Robert Lafrance

1. Introduction

What theoretical approaches are available for the modelling of domestic and international financial markets in multicountry econometric models? What structures have been chosen and applied in the major models, and what are the main properties of the financial sectors that have been estimated? What do the models appear to reveal about the comparative behaviour of financial markets in the United States, Japan and Germany? Finally, what are the implications of these estimated financial models for the domestic and international effects of fiscal and monetary policies? These are the main questions that we shall be addressing in this paper.

Although the main emphasis of this paper is on the modelling of domestic financial sectors, and on the resulting implications for macroeconomic behaviour, there are three ways in which our focus has been made more international.

First, since the multicountry models that we are surveying include separate national blocks for (at least) the three largest industrial economies, we shall be comparing the treatment and properties of the monetary sectors of the United States, Japan and Germany. The stage for this comparison will be set in section 2, where we review some of the main questions of theory and model design that underlie the specification of domestic financial markets in multicountry models. We then present our empirical comparisons, looking across models and across countries, in section 3 and a related Appendix.

Second, we shall emphasize the modelling of the international linkages of financial markets, as captured by the modelling of international asset movements, interest rates, and exchange rates. This will be done in section 4.

Finally, since a primary purpose of the multicountry models is to show how the effects of national policies are transmitted to other countries, our review will emphasize those aspects of monetary structure that have the most important implications for international transmission. To do this, we shall present and discuss, in sections 5 and 6, a number of the key simulation results prepared for this and related earlier conferences. We shall be trying to assess the implications of alternative modelling strategies as well as of the apparent differences in financial structures in the largest industrial countries. Our comparison among national economies will be mainly limited to the United States, Japan, and Germany, since these countries are the focus of the simulations prepared for this conference.[1]

In our concluding section, we shall summarize our evidence about the character and properties of the modelling of financial markets in multicountry models, and make some suggestions for further work.

2. Domestic Financial Markets

2.1 Model Design

The design of a macroeconomic model is a compromise between a set of objectives (e.g. forecasting, policy simulations), theoretical inclinations, and data limitations including the evaluation of the empirical evidence. Multicountry models were built to focus mainly on spill-over effects of national policy settings and the effects of exogenous shocks.

Broadly speaking, three basic approaches were adopted in formulating these models: linkage, replication and standardization. In linkage models, independently developed national models are linked together via trade and international capital flows. Project LINK (Ball, ed., 1973) is the most comprehensive model in this category. For replication models, the designers set up a prototype model which is replicated over a number of countries with some allowance for differences in institutional characteristics and a common framework for international linkages. The Federal Reserve's Multicountry Model (MCM) is the archetype of this class of models. The World Economic Model of Japan's Economic Planning Agency (EPA) falls somewhere in between linkage and replication models. There is a discernible trend in recent multicountry models towards standardization of macroeconomic relationships. Countries of a comparable level of development share common specifications and in some instances common parameter estimates in these models. The OECD's INTERLINK model (Richardson 1988), the National Institute model (NIESR 1988), the IMF's MULTIMOD (Masson et al. 1988) and models developed by McKibbin and Sachs (1986) and Taylor (1988) are cast in this mold.

The trend towards standardization appears to be motivated by a desire to increase the transparency of large models and to ensure greater consistency between theory and application, in behaviour (of similar agents between markets), in accounting relationships (particularly between flows and stocks and wealth effects) and in transmission of information (e.g. by the application of model-

---

[1] The Federal Reserve Board Conference on Monetary Aggregates and Financial Sector Behaviour in Washington, May 26-27, 1988.

consistent[2] expectations). Smaller research groups and technological innovations (microcomputers) have also contributed to the process of simplifying and standardizing the national blocks of multicountry models.

The focus on international linkages and the trend towards standardization have meant that the contribution of multicountry models to the modelling of domestic financial sectors has been relatively modest. We will argue that the models that we have elected to examine share a common view as regards the representation of domestic financial markets and that they differ basically in terms of the level of aggregation of financial assets, and the way they treat expectations. In the treatment of expectations, the key difference is that between the model-consistent expectations used in the Taylor model, and the adaptive learning processes typically assumed in the other models.

2.2 A Framework

National balance sheet accounts provide a convenient framework to structure the financial block of a macroeconomic model. A stylized representation of these accounts is given in Table 2.1. The fundamental agents in the economy are identified by the column headings while the rows represent the various asset markets. The relevant sectors include persons (H), firms, both financial (FF) and non-financial (NFF), the public sector including the government (G) and the monetary authorities (CB),and foreign nationals or non-residents (NR). A typical, but not unique, configuration of asset demands (D) and supply of liabilities (S) is provided for illustrative purposes.

The accounts identify the nature and extent of financial claims among the various sectors of the economy. Financial claims can be categorized according to their basic characteristics such as currency of denomination, marketability, liquidity, maturity and the modality of payments (fixed or variable rates, contingent returns ...). Each type of claim when viewed over the set of identified economic agents defines a market whose rate of return may be determined endogenously from the equilibrium of market forces or exogenously by regulation or policy.

---

[2] Most of the macroeconomic literature, following Muth (1961), uses the term 'rational expectations' to define expectations that are consistent with the forecasts of the model used for analysis. Walters (1971) suggested that the term 'consistent' would be a more accurate description, and Masson et al (1988) further refine this to be 'model-consistent'. We shall generally use the latter term, to avoid possible later confusion when consideration is given to modelling learning behaviour in ways that assume rational behaviour under uncertainy and costly information, but where the resulting expectations may not be identical with specific forward solutions of the underlying model.

Table 2.1 Structure of Financial Claims

Sectors	H	NFF	FF	CB	G	NR
Claims						
Money	D	D	S	S		D
Credit	S	S	D			D
Bonds	D	S	S	D	S	D
Equity	D	S	S			D
Foreign sec.	D	D	D	D		S
For'n money	D	D	D	D		S

From the accounting framework it is relatively straightforward to derive a set of behavioural relationships whereby asset demands are defined in stock terms within the context of a portfolio according to risk/return characteristics of the various assets. The formulation of asset demands within the framework of a portfolio implies a common set of explanatory variables and cross-equation restrictions that are well known (Tobin/Brainard 1968, Christ 1971). The characterization of these restrictions in a dynamic context have also been thoroughly discussed (Purvis 1978, Owen 1981). The multicountry models in our survey have simplified, and sometimes ignored, important aspects of the portfolio approach. For instance, exclusion restrictions are typically the norm when it comes to interest rates on competing assets in the various portfolios. Furthermore, in the disaggregated models such as MCM and EPA, the wealth variable does not represent the sum of the components in the financial portfolio that is considered in these models.

The complexity of these financial relationships can be reduced somewhat by adopting various modelling strategies. One possibility, is to group all the liabilities of a sector into one asset category. For example the government issues only bonds, firms only equity, money is non-interest bearing government debt etc.... This reduced set of claims may then be modelled according to the aforementioned principles.[3]

More typically, the size of the financial block is reduced by aggregating over sectors and omitting specific markets altogether. Credit and the equity markets are particularly susceptible to this treatment by aggregation over households, firms and the banking sector, or private financial intermediaries. Markets may be dropped if they are "internalized" when aggregating over agents. But this procedure is acceptable only if it assumed that the remaining sectors have no claims on each other that take the form of the omitted assets (eg. no bank

---

[3] The Bank of Canada's Small Annual Model adopts this strategy. See Rose and Selody (1985).

loans to foreigners; non-residents have no equity claims on the domestic capital stock).

Markets may be integrated by assuming that various financial assets are very close substitutes and therefore that their particular characteristics (risk, maturity...) are of secondary importance in a macroeconomic framework. As a consequence, multicountry models either focus on a restricted number of rates of return or, if they do consider a wide range of interest rates, assume that the interest rates move together according to "stable" historical relationships.

This may be viewed as a reduced-form approach to interest rate determination. The matrix of inter-sectoral claims in Table 2.1 suggests a more structural approach whereby sectoral asset demands and supplies are aggregated and the representative interest rate is determined by a market equilibrium condition. The structural approach is attractive because it uses the theory of portfolio behaviour to constrain the implied interest rate equation. However, the adoption of a structural approach does not require a highly disaggregated model. The structural versus reduced-form choice, and the aggregated versus disaggregated choice, are separate issues.[4]

2.3 Disaggregation: pros and cons

Microfoundations are potentially more transparent in a disaggregated framework but this assumes that the model identifies representative agents with specific motivations, market opportunities and constraints. The advantages of a detailed representation of a particular market segment (ie. disaggregation of monetary assets in EPA and MCM) may be less apparent when other financial markets are summarily described or ignored altogether.

There is a presumption that a more disaggregated approach might reduce potential simultaneity problems and help to identify the fundamental market equations (supply/demand) by using sector-specific characteristics as supplementary information. However, in most macroeconomic models disaggregation involves separate classes of assets rather than classes of agents, so that the equations tend to employ similar structures and variables.

As a practical matter disaggregation implies more potential sources for errors in specification and estimation. One reason for this is the sheer volume of coefficients and data involved, which limits the

---

4 Comparing the alternative approaches for U.S. long-term bond rates, Friedman (1980) concluded that "the structural modelling approach to interest rate determination...performs fairly well without sectoral disaggregation empirically [and]...in comparison with familiar unrestricted reduced-form term structure equations".

attention that can be given to ensure that each component of the disaggregated structure has sensible coefficients and properties. In particular, the pervasive use of partial adjustment processes and backward-looking expectations in a fairly disaggregated model structure could very well result in rather sluggish responses to policy shocks, thereby limiting the interest of policy makers in these models.

Models that derive their dynamic process from estimates based on low frequency data may be subject to problems of time aggregation bias. The adjustment path of the various economies in response to external or policy shocks may be misrepresented. Temporal aggregation can lead to lower precision in estimation and prediction, low power for tests and inability to make short-run forecasts (Zellner and Montmarquette (1971)). Empirical studies using temporally aggregated and disaggregated data document the sensitivity of inferences on lag structures to the level of temporal aggregation (Engle and Liu (1972), Wei (1978)).

2.4 The Demand for Money

The key behavioural relationship in the money market is the demand for money defined in terms of an aggregate or its components. Three motives are traditionally invoked for holding money balances: for transactions purposes, to speculate or to hold as a precautionary reserve. With each motive one could associate different explanatory variables: relative yields and transactions proxies, wealth and expected holding period yields, relative yields and measures of transactions uncertainties.

However, macro models typically eschew this complex set of motivations to focus on a narrow set of variables: one to represent transactions (GNP, GDP, absorption or consumption), another to express opportunity costs (short-term competing rates plus, where applicable, own rates for certain sub-components of monetary aggregates,) and, perhaps, a wealth variable (which in most models does not represent the aggregate of the financial portfolio).

The use of a single representative interest rate (opportunity cost) is most probably the outcome of multicollinearity in estimating asset demand equations. However, it may be justified either (1) by assuming that portfolio decisions are separable between broad types of financial claims (and that marginal allocative decisions are made between close substitutes), or (2) by considering that all non-monetary financial assets are perfect substitutes for each other such that their expected holding period yields would be equalized.

Surveys of empirical research on the demand for money (Cooley and Leroy, Judd and Scadding, Laidler 1985, Podolski 1986) present evidence of unstable relationships.[5] One explanation of the instability of the relationship between monetary aggregates, interest rates, incomes and prices is that financial innovations have transformed the nature and attractiveness of monetary assets.[6] Various, and to a certain extent complementary, hypotheses have been offered to explain the process of financial innovation.

Silber (1975, 1983) argues that innovations in financial instruments and practices occur to remove or lessen the constraints that firms face. Innovations are most likely to appear when the nature of constraints change (i.e. modifications in the regulatory environment) or when the costs of adhering to the constraints are modified (e.g. circumventing deposit rate ceilings when market rates are high). Kane (1977) proposed the hypothesis of circumventive innovation or a "regulatory dialectic" in which the political process of regulation and the economic process of regulation avoidance interact by continuously adapting to each other. Wojnilower (1980) has observed that, according to the U.S. post-war experience, credit shortages at the peak of trade cycles were mainly responsible for financial innovation and regulatory change. Technology has provided a further impetus to financial innovation (Niehans), particularly in the sphere of information processing, as financial intermediaries have sought to lower transaction costs while providing more flexible financial instruments.

What are the implications of financial innovations? First, one would not expect to find very stable money demand functions and would not therefore be surprised if key parameter values differed between models for similar aggregates (different sample periods and/or conditioning variables). Secondly, one would favour broader aggregates or a more "aggregated" approach to the structure of the financial block in a model as substitutions between components due to innovations would tend to be internalized. However, there is some evidence indicating that broader aggregates are not necessarily more stable, in a functional sense, than are narrower aggregates.[7]

---

[5] In particular, functional instability may appear as the result of targeting a particular monetary aggregate, as financial innovations are developed to economize on scarce forms of money. Such an outcome illustrates "Goodhart's Law" - that any monetary aggregate chosen as a policy instrument will quickly see its financial significance change (Laidler 1985, p. 160).

[6] Laidler (1985, p. 120) states "..it does appear that institutional change is an important factor influencing the demand for money.... Such change turns out to have been important for a long time and rather wide variety of countries."

[7] See, e.g., Boughton (1981) and Blundell-Wignall et al. (1984).

Third, financial innovations could affect the properties of the macro model and in particular the slope of the LM curve. The conventional interpretation would be that greater substitution possibilities (new financial instruments) would make the monetary assets more responsive to interest rates changes. Conversely, financial innovations may leave money holdings in the hands of less market-sensitive agents or sharpen the "moneyness" of the monetary aggregates such that the interest rate elasticity of the demand for money decreases. The net effect could go either way, as noted much earlier by Marty (1961).

2.5 Monetary Policy Channels

The relative importance that is given to asset characteristics influences behavioural relationships in macro-models and the channels of transmission of monetary policy. For instance, Keynes focussed on the maturity of the asset and accentuated the relative illiquidity of long term assets (higher capital risk). Money and short-term bonds would be close substitutes at the short end of the maturity spectrum while long-term bonds and real capital were close substitutes at the long end. Tobin (1969) provided an alternative view whereby assets are classified according to the nature of their claims, either in nominal or real terms, thereby grouping money and bonds together. The buffer stock approach[8] identifies money as the residual asset in the portfolio and assumes temporary disequilibrium in the money market as a consequence of exogenous changes in the money supply with spill-over effects on goods and asset markets.

Each approach entails a different characterization of the transmission mechanism of monetary policy impulses to the real economy. The standard Keynesian version, which is favoured by all the multicountry models under review, establishes a money market equilibrium condition which solves out for a short-term interest rate.

Short-term interest rates are determined in the money market either in terms of the "narrow" institutional framework of managing bank (free) reserves (MCM, EPA), or as the result of equilibrating supply and demand for a conventional monetary aggregate. The detailed framework which characterizes the MCM and EPA models broadens the range of monetary policy instruments (setting discount or equivalent rates, reserve ratios or the monetary base via open market or foreign exchange operations). For the highly aggregated "standardized" models (OECD, NIESR, TAYLOR) the money supply becomes the policy variable without specific reference to the setting of policy instruments to achieve monetary targets. Alternatively the key short-term interest rate may

---

[8] For an exposition of the buffer stock approach, see Laidler (1983), Cuthbertson and Taylor (1987) and Davidson and Ireland (1987). Milbourne (1987) provides a critical assessment.

be determined exogenously, or as the dependent variable in a monetary policy reaction function.

As capital markets are assumed not to be segmented over the maturity spectrum, arbitrage conditions ensure that expected holding period yields of assets of varying maturities are equalized and a representative long term interest rate is derived from a term structure equation that reflects expectations of future short rates. Risk premia are typically ignored or subsumed in a constant term. Long rates, with or without due consideration for expectations of inflation, then affect core intertemporal decisions (investment and savings).

The Tobin model (supply price of capital) puts more emphasis on the effects of monetary policy shocks on the stock market and the market valuation of real capital assets. Stock market booms favour investment in capital goods as their market price exceeds their replacement cost.

The buffer stock approach adds a notion of temporary equilibrium in its treatment of market clearing in the short run for the money market. In this approach, holders of money balances are assumed to absorb unexpected short-term changes in the money supply, without the very large swings in interest rates that are implied by conventional money demand equations estimated with lagged response to interest rates. The buffer-stock model reflects the basic monetarist (Friedman and Schwartz 1963) interpretation of the transmission of monetary policy. The nominal money stock is supply determined and controlled by the monetary authorities. Real balances are demand determined. Excess supply positions in the money market are liquidated by additional purchases of assets and goods such that a money market disequilibrium term may be included in some aggregate expenditure functions. The long-run equilibrium between money supply and demand may then be achieved by some combination of changes in interest rates (Artis and Lewis 1976), output (Jonson 1976) and the price level (Laidler 1983). In the short run interest rates are determined in the bond market and the interest rate response to monetary policy shocks, such as an open market operation, is weaker than in the conventional Keynesian approach.

In the conventional approach, which is adopted in all of the multicountry models, short-run interest rates may overshoot following a monetary shock. The interest rate bears all the burden of the adjustment and overshooting may occur if the short-run interest elasticity of the demand for money is substantially below its long-run value.

3. Model Properties: Domestic Financial Sectors

This section provides a summary overview of the financial sectors of five multicountry models providing simulation results and analysis for this conference. They are the Federal Reserve Board's multicountry model, the world model of the Japanese Economic Planning Agency, the INTERLINK model of the OECD, the global economic model of the U.K. National Institute for Economic and Social Research (NIESR), and the Taylor model. With the exception of INTERLINK, which is semi-annual, all of the models have a quarterly frequency.

In the text of this section, we present summary evidence about the LM curves and term structure relations in each of the models, while the Appendix gives the underlying evidence about the structure and estimated equations of the individual models.

Table 3.1 provides estimates of the slopes of the LM curve in the each of the different models, for each of the G-3 countries. The slope of the LM curve has implications for crowding out of fiscal policy actions when money supplies are fixed. Furthermore, as discussed below in section 5, when combined with a representation of external equilibrium (a BP curve), the money market equilibrium condition can be used to make inferences about the exchange rate response to aggregate demand shocks in the short run.

Table 3.1 Inter-model comparisons: Slope of the LM curve.

(Interest rate response, in basis points, to 1% change in GNP or other activity variable in the short/long run; for OECD and Taylor, ratio of income elasticity to interest rate semi-elasticity, multiplied by 100).

Country/aggregate		MODEL				
		MCM	EPA	OECD	NIESR	TAYLOR
US	M1			36/36		18/18
	M2	87/71	56/74	51/51	54/70	
JAPAN	M1					29/29
	M2	36/36	44/40*	106/106	41/60	
GERMANY	CBM	31/9			46/40	
	M1		0/13			62/62
	M3			89/89		

* with bank debenture rate endogenous; 93/90 if exogenous.

Source: Partial simulations for MCM, EPA and NIESR; results for other models based on structural parameters, as reported in Appendix tables. For MCM, the short and long runs refer to the 4th quarters of the first and sixth years of partial simulations; for EPA and NIESR they are averages over the first and sixth years, respectively.

Exact comparisons between models for all major monetary aggregates are not possible due either to limitations in the documentation or model design. Nevertheless, a few observations are warranted. First, it is apparent that estimates of the respective LM slopes differ greatly between models for a similar aggregate and country thus indicating some uncertainty about the precise magnitudes. Second, when considering the key aggregate for each country that may be used in policy simulations, there are no firm conclusions about the relative steepness of the LM curves in different countries. For instance, there is no general consensus that the LM curve is steeper in the U.S. than in Japan or Germany.

In Table 3.2 we report estimates of the impact and long-run response of the representative long-term interest rate to the short-term money market rate. The OECD and Taylor models impose a long-run proportional adjustment of long-term rates to changes in short-term rates, as required by the pure expectations term-structure hypothesis. Long-run homogeneity is not imposed in the MCM and EPA models. In the Taylor model, expected future short-term interest rates are derived from forward simulations of the model, while in the other models expected future rates are based on adaptive expectations. Some of them do include, however, variables that might affect the future course of interest rates, such as government borrowing requirements (EPA and, for the United States only, OECD) or net foreign lending (EPA). The National Institute model has no long-term interest rates, and hence no term structure.

The estimates of the long-run response of long-term rates to short-term rates are derived from the term-structure equations rather than simulation results. The distinction is especially important for the Taylor model, where the simulated impact may be much larger, since expected future short-term rates are influenced even in the first period. We shall return to this issue in sections 6 and 7, where we discuss full-model properties.

Table 3.2 Term Structure of Interest Rates
(Impact and long-run responses of long to short rates.)

	MODEL				
Country	MCM	EPA	OECD	NIESR	TAYLOR
US	.13/.83	.21/.71	.21/1	....	.27/1
JAPAN	0/.76	.32/.63	.30/1	....	.28/1
GER	.30/.60	.09/.18	.27/1	....	.36/1

4. International Integration of Capital Markets

4.1. Asset Substitutability and Portfolio Balance

All multicountry models reviewed in this paper involve some form of portfolio model of the demand for foreign assets. The different models are distinguished, in terms of their specification and properties, by three crucial features:

1. The assumed degree of asset substitutability. Where this is assumed to be infinite, then the usual demand equation based on rate-of-return differentials cannot be directly estimated, and interest rates differ by the expected rate of change of the exchange rate.

2. The assumed process for determining expected future exchange rates. This is especially important for models assuming a high degree of asset substitution, since anything that influences the level of the expected future exchange rate has equivalent effects on the spot exchange rate.

3. In models that assume imperfect asset substitution, the key feature is the form chosen for estimation of the demand equation for foreign assets. If the portfolio demand equations are estimated with portfolio stocks, or changes therein, as the dependent variables (as in EPA), they generally show much smaller asset substitutability than if the equations are renormalized and estimated with the spot exchange rate as the dependent variable (as in OECD).

We shall first consider these and other specification issues, and then describe the estimated properties of the capital market linkages and exchange rate determination in selected multicountry models.[9] We start first with reference to a standard portfolio model. In a representative two-country model the home-country portfolio consists of domestic money (M), domestic currency bonds (B), and foreign currency bonds (F); the home wealth constraint (W) is given by:

$$W = M + B + EF \; ; \qquad (4.1)$$

where E is the exchange rate defined as the home currency price of foreign currency. Demand functions for the home-country portfolio are typically of the form:

$$M = m(i,\ i^{*}+\epsilon,\ P,\ y,\ W) \qquad (4.2)$$

$$B = b(i,\ i^{*}+\epsilon,\ P,\ y,\ W) \qquad (4.3)$$

---

[9] For a survey of the major theoretical issues relating to international asset substitutability, and the implications for policy, especially foreign exchange market intervention, under flexible exchange rates, see Boothe et al. (1985).

$$EF = f(i,\ i^{\star}+\epsilon,\ P,\ y,\ W)\ ; \qquad (4.4)$$

where P is the domestic price level and y domestic real income, i and $i^{\star}$ are home and foreign nominal interest rates respectively, and ϵ is the expected rate of depreciation of the home currency. Similar foreign demand functions (denoted by *) exist for foreign money ($N^{\star}$), domestic currency bonds ($B^{\star}$), and foreign currency bonds ($F^{\star}$). The bonds are assumed to be differentiated only by currency denomination, although in principle domestic currency bonds, B, could be issued in the home country by both home and foreign issuers, as could the foreign currency bond in the foreign country, $F^{\star}$.

Under the assumption of less-than-perfect asset substitutability, the above equations describe a class of models known as "portfolio balance" models. If we view the capital accounts of these models as represented by a demand equation for foreign bonds, such as equation 4.4, then a renormalization, and assumptions about the formation of exchange rate expectations, allow us to write the exchange rate as a function of relative bond supplies and rates of return. Portfolio balance models are sometimes estimated directly for all components of capital flows (as in EPA). Alternatively, as in OECD, one of the foreign asset demand equations can be renormalized and estimated as an exchange rate equation, with capital movements then determined residually by the balance of payments identity. A third alternative is provided by the National Institute model (GEM, or NIESR), which estimates a quasi-reduced-form exchange rate equation obtained by combining a portfolio demand equation (but without explicit measures of actual or desired portfolio proportions) with a simplified balance-of-payments identity (omitting the possible effects of changes in official reserves), so that the estimated equation includes the current account balance as well as the determinants of interest rates and expected exchange rates.

A second class of models, under the general heading of 'uncovered interest parity' models, is a degenerate form of the portfolio model in which asset substitutability is perfect. They may be viewed as degenerate forms of the portfolio balance model in the sense that the asset demand functions cannot be directly estimated in the form of equation 4.4, since there will be perfect correlation between the domestic and foreign interest rates, after adjusting for the expected rate of change of the exchange rate. In these models, of which MCM and TAYLOR are examples, the expected rates of return on assets of different currency denomination are always equalized:

$$i = i^{\star} + \epsilon. \qquad (4.5)$$

Since, as described in the previous section, interest rates on representative short-term domestic assets are set so as to equilibrate the supply and demand for domestic money, equation 4.5 determines the expected rate of change of the exchange rate in any model that assumes uncovered interest parity. For any given value of the expected future exchange rate, equation 4.5 can then be solved for the spot rate, and net capital movements determined residually from the balance of payments identity. Thus the uncovered interest parity models are similar in form to portfolio balance models renormalized as exchange rate equations. The key difference is that a portfolio balance variable appears as a determinant of the exchange rate in the portfolio balance model, with a coefficient that falls as the estimated degree of asset substitution increases.

In all models, the specification of the expected exchange rate has important implications for capital movements and the exchange rate. These expectations may be derived from actual forward simulations of the model (as in TAYLOR), based on actual or expected purchasing power parity (as in OECD), or based on recent exchange rate levels and changes. Exchange rate expectations are of greatest importance in the models with uncovered interest parity, as in these models any change in the expected future rate is translated directly into a corresponding change in the spot exchange rate, since the interest parity condition uses the interest rate differential and the expected future spot rate to determine the spot exchange rate.

4.2. Other Specification Issues

While exchange rate determination is not immediately affected by portfolio proportions in models assuming uncovered interest parity, this does not necessarily eliminate longer-run feedbacks from the current account to the exchange rate. This can be seen by adding a goods market equilibrium condition and a balance of payments condition to (4.1), (4.2) and (4.5). Although the capital account is passively determined, as long as there are wealth effects on consumption or on money demand then changes in the current account will eventually influence domestic demand and prices, and hence the equilibrium nominal exchange rate. A current account surplus will also add to the stock of net foreign claims, which will lead to increased interest and dividend receipts and to eventual appreciation of the real exchange rate. In models solved with model-consistent expectations for expected future exchange rates (such as TAYLOR and MULTIMOD), these longer-run effects show up immediately, in modified form, through their impact on the expected future exchange rate. In these models, movements in the spot exchange rate are influenced largely by the longer-run equilibrium properties of the system.

Aside from the greater modelling flexibility associated with relaxing the uncovered interest parity assumption, the portfolio balance approach has specific analytic applications which cannot be addressed by the monetary models. One implication of imperfect international asset substitutability is that relative supplies of domestic and foreign assets can affect their relative expected returns through the exchange rate. Sterilized intervention, the exchange of B for F with M unchanged, can have no exchange rate impact under the assumption of uncovered interest parity.

While the portfolio can be disaggregated so as to allow for more detailed linkage among exchange rates, capital flows and wealth, simplifying assumptions are frequently made. Currency substitution, for example, is typically assumed away, even in models assuming perfect international substitutability of bonds, by not including foreign money in the domestic portfolio.[10]

Theoretical models have employed the small-country assumption whereby there is no demand by foreign residents for the domestic-currency bond ($B^*=0$). International borrowing by both countries occurs through the issuance of F, the foreign-currency bond. An alternative assumption (used, for example, by OECD) is that countries borrow only in their own currencies. In the above example this corresponds to the case where B^* and F represent gross liabilities to foreigners and are each homogeneous in currency denomination and issuer. These assumptions simplify the accounting of the models by assuming away the problem of capital flows denominated in different currencies, but may misrepresent the linkages from the exchange rate to wealth.

Other assumptions are made regarding the level of aggregation. The lack of bilateral capital flow data for most countries, for example, requires specification in terms of multilateral flows and effective exchange rates. Two of the three imperfect asset substitutability models, OECD and NIESR, deal with capital movements on an aggregate basis, while EPA explains gross multilateral flows disaggregated into direct and portfolio investment and short-term bank and non-bank flows. MCM, a model with perfect asset substitutability, contains a similar degree of disaggregation, but with net private short-term capital flows determined residually from the balance of payments identity. The purpose of the disaggregated equations in MCM is to accumulate the asset and liability stocks used in explaining interest and dividend payments. The Taylor model, which also assumes perfect asset substitutability, does not model net foreign assets and the associated net investment income.

Portfolio models in the form of equations (4.1) through (4.4) are unstable, under conditions of static expectations and local asset preference, when net foreign asset positions are negative (Masson 1981). When net foreign assets are negative, and the net debt to foreigners is denominated in the foreign currency, a depreciation raises the domestic currency value of that indebtedness and lowers net national wealth. The resulting transfer of wealth to foreigners lowers the demand for the domestic bond and raises the demand for the foreign bond, requiring a depreciation for asset market equilibrium. This, in turn, sets up the need for further depreciation and, under static expectations, long-run instability. Branson and Henderson (1984) have demonstrated that under rational expectations there exists a unique

---

10 Cuddington (1983) presents evidence indicating that the currency substitution effects are weak.

saddle path solution for the exchange rate which involves a jump appreciation followed by depreciation sufficient to clear the asset market.

The potential instability of the net debtor model is not an issue in existing multinational models, since none has adopted the assumption that the exchange rate moves so as to provide immediate portfolio balance with existing stocks of assets. In models involving imperfect substitution of assets, either immediate portfolio balance is not imposed (e.g. EPA) or the exchange rate is derived from a renormalized equation with the exchange rate being determined through its role in defining the expected return on foreign investment (e.g. OECD). The issue cannot arise in the models assuming perfect asset substitution, since there is in any event no direct link from portfolio proportions to the exchange rate.

The more direct link from international payments flows to the exchange rate in the directly-estimated portfolio balance models than in the models assuming uncovered interest parity may have other implications for long-run stability. J-curve effects, for example, were noted to lead to destabilizing exchange rate movements in the EPA and in early versions of MCM. In some cases stability has required the use of specific and constraining assumptions about exchange rate expectations.

4.3. Interest Rate Linkages

As noted, the portfolio approach provides for a rich menu of possibilities in modelling different exchange rate regimes and the alternative intervention rules of different countries. Differential treatment for specific subgroups within the model, such as the EMS countries for example, can also be a desirable feature. There is the potential, however, for more varied interest rate linkages to lead to unintended asymmetries in international transmission.

The interest rate linkages in models assuming perfect asset substitutability are straightforward: nominal rates differ bilaterally by the expected rate of depreciation of the home currency against the foreign currency. These parity conditions may be specified either in bilateral or multilateral form (i.e. in terms of some weighted average of foreign rates). If the latter form is used, consistency is assured for all cross-currency bilateral rates as long as the weighting procedure used for constructing the effective exchange rate is the same as that for constructing the world interest rate. This result is independent of the weighting matrix chosen.

In MCM, the combination of perfect asset substitutability with exchange rate expectations determined by relative price movements implies that in the long run real interest rates are equalized across countries, and nominal exchange rates reflect purchasing power parity. There are four exchange rates in MCM: the bilateral Canada/U.S. rate and weighted average rates for the U.K., Germany and Japan. For the most part the weighting is symmetric and based on the total world trade shares of the five countries.[11] In order to endogenize the stock of foreign assets for calculating investment income, some components of the capital account are modelled. The equations contain a variety of dissimilar direct interest rate links, but with no consequence for international transmission since the capital account is passive.

Symmetric treatment of interest rate linkages across countries is not exclusive to models assuming perfect asset substitutability. OECD derives effective exchange rates from world capital flows and world interest rates based on a geographical flows weighting matrix. The EPA model, which does not presuppose interest parity, has adopted a more flexible approach to foreign interest rates based on dominant country assumptions in the capital flow equations of the various country models. In the capital account equations for Japan, Germany, Italy and Canada, the U.S. rate is the dominant foreign rate while in the French model both U.S. and German rates appear, and in the U.K. model the foreign rate is a weighted average of the U.S., German, Canadian and Japanese rates.

4.4 The models compared

Table 4.1 records capital account elasticities for EPA, OECD, NIESR, MCM and TAYLOR. The elasticities for EPA are calculated from full-model simulation results. For OECD and NIESR they are based on direct structural evidence from estimated balance-of-payments sectors. The elasticities are computed as changes in the capital accounts as ratios to GNP arising from a sustained 100 basis point reduction in domestic short-term interest rates with fixed spot and expected future exchange rates. For MCM and TAYLOR, the elasticities are set equal to infinity, since this is a feature of the assumed specification.

Capital movements are at least ten times more interest-responsive in OECD, where the portfolio balance equation is renormalized and estimated as an exchange-rate equation, than in EPA and NIESR. The small size of the numbers reported in table 4.1, especially when compared with the infinitely large values reported for the models assuming perfect asset substitution (TAYLOR and MCM), is a consequence of reporting them as proportions of GNP, which is done for ease of international comparisons. A numerical comparison might also be useful. Each .001 of GNP, for the United States in 1987, represents almost $5 billion, so that in NIESR, which shows the least mobile capital for the United States, each percentage point increase in U.S. interest rates brings in about $18 billion of foreign capital in the first year.

---

[11] The only exception is the slightly different treatment of expected foreign inflation in the U.K. model compared to the other country models.

Table 4.1: Capital Account Response to 100 Basis Point Reduction in Short-Term Interest Rates (Proportion of GNP)

	U.S.	Japan	Germany
EPA[12]	-.0038	-.0030	-.0011
OECD[12]	-.0562	-.0273	-.1489
NIESR[13]	-.0036	-.0025	-.0067
MCM	$-\infty$	$-\infty$	$-\infty$
TAYLOR	$-\infty$	$-\infty$	$-\infty$

Table 4.2 records estimates of the marginal propensities to import for the various models, calculated as the income elasticities multiplied by the 1985 ratio of imports to GNP. These are derived as closely as possible from directly estimated equations, and represent, where available, the elasticities with respect to output rather than final spending, since we combine these data with those for the capital account to obtain approximate BP curves.

---

[12] These are the combined 1-year (1987) short- and long-term capital account impacts of 100 basis point reductions in short-term interest rates with fixed exchange rates (EPA, July 1987 for the United States and Japan, EPA 1987 for Germany).

[12] Derived from the coefficients of renormalized asset demand equations presented in Table 8 of Holtham (1984), and assuming world wealth equal to 3.0 times OECD GNP, and treating the GNPs of the United States, Japan and Germany as being .40, .14, and .08 of total OECD GNP, as in Bryant, Henderson, et al., eds., (1988, p. 14).

[13] The interest rate increase required to roughly stabilize the effective exchange rate after a move into current account deficit of $1 billion per quarter is roughly one quarter of a percentage point in the U.S., one point in Japan and two-thirds of a point in Germany. These figures were provided for us by Simon Wren-Lewis, and differ from those reported in Wren-Lewis (1987, p. 59), because the exchange rate equations have since been revised to embody smaller, and hence more plausible, cross-country effects in the exchange-rate equations. Capital account responses to interest rate changes are now somewhat larger for the United States, and twice as large for Germany, than they were in the earlier version.

Table 4.2: Short-Run Marginal Propensities to Import[14]

	U.S.	Japan	Germany
EPA	.03	.06	.10
OECD	.17	.12	.32
NIESR	.14	.13	.47
MCM	.19	.10	.37
TAYLOR	.11	.01	.33

Table 4.3 provides a cross-model comparison of relative slopes of BP curves, calculated as the import propensities of table 4.2 divided by the capital account response coefficients reported in table 4.1. These numbers show the required increase in short-term interest rates (measured in basis points) required to maintain balance-of-payments equilibrium in the face of a 1% increase in real GNP, with all prices unchanged.

---

[14] Computed as the short-run income elasticities multiplied by the 1985 ratio of imports to GNP. The EPA elasticities are from EPA (1984, Table 2); the German elasticity is a weighted average of the consumption and investment elasticities, with weights corresponding to final demand shares, and the Japanese elasticity is a weighted average of the short-term elasticities for mineral fuels, raw materials and foodstuffs, and manufactured goods. The OECD elasticities are weighted averages for imports of energy, food, materials and manufactures, from OECD (1988b). The MCM income elasticities for the United States are for imports excluding oil, as reported in Bryant, Holtham and Hooper, eds., (1988, p. 133). The MCM figures for Japan and Germany are approximations based on Edison, Marquez and Tryon (1986, Table 2). The TAYLOR elasticities are from Taylor (1987), and those for NIESR from NIESR (1988).

Table 4.3: Estimates of Slopes of BP

	U.S.	Japan	Germany
EPA	7.9	20.0	90.9
OECD	3.0	4.4	2.4
NIESR	38.9	52.0	70.1
MCM	0	0	0
TAYLOR	0	0	0

Finally, to draw together in summary form some of the key properties of the domestic and financial sectors of the multicountry models, we show in Table 4.4 the ratios of the estimated slopes of the BP and LM curves for each of the three countries in each of the five multicountry models under review. A ratio less than 1.0, indicating BP flatter than LM, means that the domestic currency would be expected to appreciate under an expansionary fiscal policy, assuming unchanged foreign variables and unchanged values for the expected future exchange rate. The ratio is equal to zero in those cases where international asset substitutability is assumed to be perfect, as in MCM and TAYLOR.

Table 4.4: Ratio of Slopes of BP to Slopes of LM, First Period[15]

	U.S.	Japan	Germany
EPA	0.14	0.45	- -
OECD	0.06	0.04	0.03
NIESR	0.72	1.08	1.53
MCM	0	0	0
TAYLOR	0	0	0

[15] The LM curve slopes are based on the short-run elasticities reported in table 3.1. Where more than one elasticity is reported, we use M2 in the United States and Japan, and for CBM in Germany, since these are the monetary aggregates held fixed in the fiscal expansion simulations to be discussed in section 5.

This completes our summary of the estimated structures of the domestic monetary sectors and the international financial linkages of the multicountry models. In the next two sections, we use this information to help explain some of the differences, both among models and among countries, in the international transmission of the effects of domestic fiscal and monetary policies. We shall start with fiscal policies, since there has been much discussion of the extent to which monetary policies and exchange rates influence the linkage between fiscal policies and current account imbalances.

5. International Transmission of Fiscal Policies

In this section, we use our survey of the structure and properties of the financial sectors of the multinational models to shed some light on some key questions in international macroeconomic policy. What do multinational models have to say about the role of exchange rate changes in determining the current account effects of fiscal policies? To what extent does this role depend on the procedures used for modelling domestic financial structures and the determination of exchange rates? Is the contrast between the United States and the rest of the OECD (referred to as the ROECD), which is evident in the results reported in Bryant, Henderson, et al., eds. (1988), also apparent when U.S. fiscal policy is compared with that in Germany and Japan, the two biggest national economies in the ROECD? If fiscal policy does have materially different effects in the three countries, to what extent is this due to differences in their financial structures, as depicted in the multicountry models?

We shall start first by looking at the exchange-rate effects of fiscal policy, since these provide a potentially important part of the process by which fiscal policy changes influence the current account. Other things equal, the domestic currency will appreciate in response to domestic fiscal expansion if the domestic LM curve is steeper than the BP curve. Intuitively, the lower the capital flow elasticities (i.e. the steeper the BP curve) the smaller will be the capital inflow associated with a positive interest differential, and the smaller will be the expected exchange rate appreciation from a positive fiscal shock. When the slope of the BP curve exceeds that of the LM curve, this suggests that the induced capital inflow will be too small at unchanged exchange rates to balance the deterioration in the current account, thus inducing a currency depreciation.

However, this analysis assumes unchanged exchange rate expectations and unchanged foreign interest rates. If an expansionary fiscal policy raises actual and expected domestic inflation, then this may induce an expected depreciation (as in OECD) which is greater than the increase in the domestic interest rate (relative to the foreign rate), so that the spot exchange rate may depreciate even in a model with a very flat BP curve.

Table 5.1 gives the nominal exchange rate changes in the first period and on average over the first year (first period/first year) of a positive fiscal shock equal to 1% of GNP. As expected, based on the estimates reported in Table 4.4, the models generally show immediate own-country appreciations in response to fiscal expansion. The exceptions are the NIESR results for Japan and Germany, where BP curves are estimated to be steeper than the corresponding LM curves. On average over the first year, the models show appreciations for all three countries, except for the OECD model, which shows a first-year depreciation for the United States, and LINK, which shows a small DM depreciation in response to German fiscal expansion. For all three countries, the exchange rate impact is much larger in TAYLOR than in the other models.

Table 5.1: Nominal Impact and First-Year Exchange Rate Changes (%) from Increases in Government Purchases Equal to 1% of GNP
(+ve = appreciation of local currency)

	U.S.(FX/$) (Shock F3)	Japan($/Y) (Shock F1)	Germany($/DM) (Shock F2)
EPA	0.6/1.6	0.5/0.8	1.0/0.1
LINK	/0.1	/0.0	/-0.1
OECD	0.0/-0.1	0.1/0.4	0.2/0.4
MCM	1.5/1.7	1.0/1.1	0.3/1.1
TAYLOR	6.7/6.6	5.2/5.1	4.4/4.3
NIESR	1.6/1.8	-0.4/0.5	-0.4/1.0

We have not been able to examine the partial properties of the LM and BP curves for the LINK model, but it would appear that the slopes are generally rather similar for all three countries, as the exchange rate changes are small in all cases.

One case requiring more explanation is that for U.S. fiscal expansion in the case of the OECD model. Although the BP curve is flatter than the LM curve in OECD, the model shows a first-year depreciation of the U.S. dollar in response to fiscal expansion.[16] This occurs for two reasons: first because foreign interest rates rise, and second because the expected future exchange rate, which is primarily determined by current and expected future purchasing power parity (PPP), indicates an expected future depreciation of the U.S. dollar, since U.S. prices are increased by more than foreign prices in response to the U.S. fiscal expansion.[17]

In earlier papers analyzing asymmetries in the transmission of fiscal policies (e.g. Bryant, Henderson et al, 1988), it was seen that multiplier effects were more truncated (i.e. more short-lived) in the United States than in the ROECD, and that the current account and foreign GNP effects of U.S. fiscal policies were greater than for ROECD policies, despite the fact that the ROECD is 50% larger than the United States. Because interest rates were increased much more in the United States (in response to U.S. fiscal expansion) than in the ROECD (in response to ROECD fiscal expansion), it was conjectured that this asymmetry might be due to a steeper LM curve in the United States than in the ROECD, and that this result might in turn be due to one-way effects flowing from U.S. to foreign interest rates. The evidence prepared for this conference permits a more precise evaluation of this notion. What do the current results indicate?

First, as shown in Table 3.1, there is no general evidence from the models that LM curves are steeper in the United States than in Japan and Germany. The MCM and NIESR models do show steeper LM curves in the United States than in the other two countries, as does EPA in the case where the Japanese interest rate RSEC is endogenous. However, the TAYLOR and OECD models both have LM curves that are flatter in the United States than in the other two countries. None of the current evidence relates to the rest of the ROECD countries (which together account for more than 60% of ROECD output), and the model set is somewhat smaller in these experiments, so complete reconciliation with the earlier evidence is not possible. However, it would seem that the higher interest rates in the United States (in response to U.S. fiscal expansion) than in other countries (in response to their fiscal

---

[16] Although the dollar appreciates very slightly on impact (up by 0.02% in the first semester), it is lower by 0.12% in the second semester.

[17] The latter factor is substantially the more important of the two. In simulation F3 for the OECD model, for example, foreign interest rates change by about .6 as much as do U.S. rates. Assuming a foreign rate response of this proportion, then the capital account sensitivity of Table 4.1., which was computed under the assumption of foreign rates unchanged, would decline, causing an upward revision of the estimated BP slope from 3.0 to 7.6. This is only a fraction of the increase necessary to achieve slope equality with the 36.0 slope of the LM curve, implying that the major explanation is in the relatively rapid price response of the U.S. model and its impact on the expected exchange rate.

expansion) is perhaps more likely to result from the higher prices induced in the United States, which have the effect of reducing the real money supply more there than elsewhere.

Second, the current results are less uniform than the earlier ones in showing fiscal multipliers to be more truncated in the United States than elsewhere. The panels of figure 5.1 compare the fiscal multipliers of the United States with those for Japan and Germany for each of the models reviewed in this paper. There is no systematic appearance of more multiplier truncation for the United States than for the other countries, except for the EPA model. Since the models surveyed in this paper are similar to the versions assessed in the earlier experiments (as shown in Helliwell 1988), this slight difference probably reflects primarily the properties of the models for ROECD countries other than Japan and Germany, or the amplifying effects that might exist when all ROECD economies undertake fiscal expansion simultaneously.[18]

Third, the evidence from the models assessed at the earlier EPA conference (EPA, MCM and OECD) indicated that induced nominal exchange rate changes did not play a very important role in determining the current account effects of fiscal policies (Helliwell 1988, section 4). This was seen by comparing results of fiscal policies run with exogenous and endogenous exchange rates, and seeing that the effects of the fiscal policies on the current account balance were altered by less than 10% when nominal exchange rates were made endogenous. This suggests that the major part of the current account effects flowed through the changes in income and expenditure, supplemented by the real exchange rate changes caused by the price-level effects of the fiscal policy changes. In the discussion in that conference, it was noted that this result might be altered materially if the model set was expanded to include models with rational or model-consistent expectations, since these typically show larger appreciations in response to fiscal expansions.

The current results confirm that the model with rational expectations (TAYLOR) does have the largest induced appreciation of the U.S. dollar in response to U.S. fiscal expansion, but the role of this

---

[18] This hypothesis was assessed and supported by comparing the effects of sustained ROECD and own-country fiscal expansions for Japan and Germany, using the adaptive expectations version of the G-7 model described in the next footnote. As suggested in the text, the multicountry nature of the ROECD fiscal expansion produces a less truncated multiplier. This happens because the cross-country GNP effects are delayed and less truncated than the own-country effects. For example the first-year Japanese GNP effects of an ROECD fiscal expansion are 1.25 times as large as those of a Japanese fiscal expansion. This ratio grows steadily as time passes, reaching 1.9 in the fourth year. For Germany, the more open of the two economies, the corresponding ratio is always larger than for Japan, but shows the same pattern, rising from 2.0 in the first year to 3.6 in the fourth year.

exchange rate flexibility is not directly assessed, nor is it possible to tell how much of the additional appreciation on the Taylor model is due to the use of model consistent expectations.

To help cast more light on the role of alternative expectations processes, we compare in figure 5.2 the consequences, for exchange rates, inflation rates, interest rates, real GDP and price levels, of U.S. fiscal policies under different assumptions about the formation of expectations for future interest rates, inflation rates, and exchange rates. These results are drawn from simulations of a G7 version of the recently developed IMF MULTIMOD.[19] The results show that the U.S. dollar appreciates much more sharply in the consistent expectations version, and then depreciates thereafter, in order to maintain expected interest arbitrage. The real GNP effects are similar in the two versions, but inflation is almost twice as great in the consistent expectations version. With more U.S. inflation and more nominal appreciation of the U.S. dollar, the consistent expectations version shows more real appreciation of the dollar under U.S. fiscal expansion,[20] with the result that the current account effects of the fiscal policy are larger. However, the differences over the first three years are not very great, with the consistent expectations version showing current account effects about 15% larger than the adaptive expectations version.

6. International Transmission of Monetary Policies

In this section we discuss briefly the effects of monetary expansions in the United States, Japan and Germany, with emphasis on

---

19 MULTIMOD is described in Masson, Symansky, Haas and Dooley (1988). It contains separate country blocks for the United States, Japan, and Germany, with aggregate treatment of the remaining four members of the G7, of the next largest 11 industrial countries, of high-income oil exporters, and of developing countries. The G7 version, known as INTERMOD, has been developed by the Working Group in International Macroeconomics in Ottawa. It contains separate country blocks for each of the G7 countries, with the rest of the world handled exactly as in Masson et al (1988). Version 1.0 of INTERMOD, as described in Helliwell, Meredith, Durand and Bagnoli (1988) is used for the results reported in this paper. The fiscal shock reported in figure 5.2 follows Masson et al. in being 1% of GNP in the first year, and then declining thereafter. We are currently experimenting with fiscal shocks that are of constant size over six years, and starting in 1987, to match more closely the experiments done with other models for this conference.

20 Over the first three years, the real value of the U.S. dollar is 2.1% higher under model-consistent than under adaptive expectations.

the roles of interest rates and exchange rates.[21] Figures 6.1 to 6.3 show, in summary form, the domestic and international effects of monetary expansions in the United States, Japan and Germany, respectively. The upper four panels of each figure show the domestic effects of a 1% increase in the money supply[22], while the bottom four panels show the effects on interest rates and real incomes in the other two countries. As much as possible, the scales have been kept the same in all of the income and interest rate charts, to make comparisons easier among countries and among models. The figures show annual averages rather than quarterly values, to better reveal the main trends of the results.

Looking first at the own-country effects of monetary expansion, the real GNP effects are roughly similar in the three countries, at about 0.5% increase in the second year, trailing quite rapidly away after that for all models except MCM, which generally shows the longest-lasting real effects in all three countries. All models show domestic currency depreciation as a results of monetary expansion, with the nominal exchange rate falling by about the same amount as the increase in the domestic price level, although doing so much more rapidly. Thus the exchange rate flexibility serves to roughly insulate the other countries from the direct inflationary effects of monetary expansion.

The real cross-country effects of monetary expansion are generally negative. This is the expected result in models, such as these mostly are, where asset substitutability is high, and the exchange rate depreciates initially by more than domestic prices are increased. The size of the negative income effects is quite small, however, with the exception of the NIESR model, where the initial depreciation is much

---

[21] Our discussion is kept brief, since the international transmission of monetary policy in these models is the focus of Brayton and Marquez (1988). Our concentration is on the links between model structure and simulation results.

[22] For most models the chosen aggregate is M2 in the United States and Japan, and CBM in Germany. The Taylor model uses M1 for all countries. The OECD model uses M3 for Germany, and the EPA uses M1 for Germany.

higher than in any of the other models.[23] The negative cross-country income effects are largest for U.S. monetary expansion.

By the time three or four years have passed, most of the models show fairly small residual real income effects of the monetary expansion, both at home and abroad.[24] Prices are generally higher, for the country undertaking the monetary expansion, generally by slightly less than the 1% increase in money supplies. The EPA model tends to show the smallest increase in prices in each country, ranging from about .3% in the United States and Japan to next to nothing in Germany.

7. Conclusions and Suggestions

We shall first list some of the key similarities and differences in model structures, then assess the implications of these differences, and finally suggest what seem to us to be some promising lines for further experimentation or model improvement.

7.1 Similarities and differences:

The multicountry models tend to have fairly simple and domestically oriented monetary sectors. Even those with substantial disaggregation of monetary assets in some national blocks, as with EPA, can be reasonably represented by conventional LM specifications.

Of the five models whose structural detail was analyzed in this paper, four are quarterly and one semestrial. Three of the quarterly models (TAYLOR is the exception) use distributed lags in their money

---

[23] The extreme exchange rate volatility of NIESR, under monetary shock, tends to make its results the outliers for most domestic and foreign effects of monetary policy. This required the scales of the figures to be set so large as to make the results from some of the other models indistinguishable from zero, and from each other. The NIESR results appear to flow principally from the quasi-reduced-form exchange rate equations. The dynamic form of these equations is such that a temporary shock to interest rates has a permanent effect on the exchange rate, for a given value of the current account. The exchange-rate effects of monetary expansion are thus not only much larger on impact but also more sustained than in the other models.

[24] The principal own-country exception relates to U.S. and Japanese monetary expansion in MCM, and the initially positive and then negative effects of Japanese policy in TAYLOR. The principal cross-country exceptions are the continuing negative effects, on Japanese GNP, of U.S. monetary expansion in EPA (stemming from falling Japanese income from foreign investments),and the generally large, and possibly unstable, cross-country effects in NIESR.

demand equations. These lags affect the dynamics of the adjustment to monetary shocks, but generally do not affect the slopes of the LM curves, since most equations assume similar lags for both income and interest rates.[25]

The derived slopes of LM curves (Table 3.1) do not reveal any systematic evidence of differences among the United States, Germany, and Japan. There tends to be more difference among the models in their estimates of the LM slope for a particular country than there is among countries for any given model.

The LM slopes are measured with respect to short-term interest rates, while the effects of monetary conditions on spending operate through long-term interest rates. In all of the models, a term-structure relation is used to link the two rates, with the impact effect being about .3 in most cases. Long-run responses of long-term interest rates with respect to changes in short-term rates are constrained to be homogeneous in Taylor and OECD, and estimated to be (generally) less than homogeneous in MCM and EPA. Under model-consistent expectations, one would expect long-term interest rates to move to match changes in expected future short-term interest rates. This condition is imposed in the Taylor model, of the five models whose results are reported here, and also in MULTIMOD (Masson et al., 1988).

Three quite different procedures are used to model international portfolio linkages. The MCM and Taylor models assume that uncovered interest parity always holds, so that the exchange rate is determined solely by interest rates, at home and abroad, and by the expected exchange rate. The EPA model employs estimated portfolio demand equations, and OECD uses a portfolio demand equation renormalized and estimated as an exchange-rate equation. This renormalization apparently has the effect of greatly increasing the implied interest-elasticity of international capital movements, so that the derived slope of the BP

---

25 W. Poole (1987) has suggested that one reason why the data prefer lagged forms of money demand equations based on short-term interest rates may be because the more appropriate specification would have money demand respond to current and expected future short-term interest rates, with long-term interest rates being the best measure of these otherwise unmeasured series. Using a long time series for U.S. velocity, he finds that interest elasticities are much higher, and the equations better-fitting if long-term interest rates are used instead of short-term rates. We have assessed the hypothesis with annual data for 1961-85 for the income velocity of base-money in each of the G7 economies. After correcting for autocorrelation, we find significant supporting evidence for the United States and Canada. For Japan and Germany, the elasticities were higher for long-term than for short-term interest rates, although not significant in either case. For Italy the elasticity is correctly signed only for the short-term rate. For France and the United Kingdom the elasticities were incorrectly signed for both long-term and short-term interest rates.

curve is much flatter for OECD than for EPA. For the EPA model, the derived slopes of the LM and BP curves are very similar, while for OECD the BP curve is much flatter. However, the quasi-reduced-form exchange-rate equations of NIESR produce BP curves more similar to those of EPA than of OECD.

The models also differ in how they determine and use expected future exchange rates. The Taylor model applies open parity using expected future exchange rates obtained from the forward solution of the model. In OECD and MCM the expected exchange rate also plays a crucial role, since MCM imposes open parity and the OECD exchange rate equation implies a unit elasticity of the spot exchange rate with respect to the expected future rate. In both models the expected exchange rate is based on adaptive expectations of expected relative GNP or GDP deflators at home and abroad. Exchange rate expectations are less important in EPA, since expectations have a less direct role in determining the spot exchange rate.

7.2 Implications of the model differences

The differences among the models in the estimated properties of their financial sectors, as represented by the slopes, and the relevant dynamic properties, of their LM curves, is partly responsible for the differences in their estimation of the size and international transmission of the effects of fiscal policies. More detailed experimentation, involving full-model simulations with alternative parameters and equation structures, would be required to be much more precise. In some models, e.g. Taylor and OECD, the estimated international differences in LM slopes are probably large enough to influence the nature of the transmission process. Given the finding that intermodel differences in LM slopes for the same country are large relative to the estimated international differences, it would seem desirable to establish more securely the statistical basis for the international differences before relying too much on the derived results.

As was shown in figure 5.1, there is no strong evidence that fiscal multipliers are more truncated in the United States than in the other two countries. Thus the systematically more sustained fiscal multipliers reported for the ROECD as a whole, when compared to the United States, is likely to be due to factors other than differences in domestic LM curves, or in own-country fiscal multipliers, among the largest three economies. Assessment of the possibilities will require more investigation of the extent to which fiscal expansion in the ROECD countries is mutually reinforcing, and thus possibly sustaining the ROECD group multiplier at levels above those that would be achieved by the two largest ROECD countries acting on their own.

The Taylor model's application of model-consistent expectations for the term structure of interest rates, expected exchange rates, and expected inflation produces a markedly different pattern of results to both fiscal and monetary shocks.

Under expansionary fiscal shock, the exchange rate appreciates more and faster in the Taylor model. This is not a necessary result of consistent expectations, which require only that the open parity condition be maintained throughout the future path of the simulation. As the OECD results illustrate, if fiscal expansion gives rise to expected future inflation, or if future depreciation is expected to be necessary to service the accumulating debt[26], then the exchange rate could appreciate less, or even depreciate, under consistent expectations.

In circumstances where the short-term interest rate remains above control for several periods, the Taylor model, or any other model with model-consistent expectations, produces a larger initial change in the long-term interest rate, thus tending to increase the effect on real spending, which generally responds to changes in long-term interest rates. This truncates slightly the real GNP effects of fiscal policy, as shown in the figure 5.2 comparisons for consistent and adaptive expectations versions of a G7 version of MULTIMOD.

7.3 Suggestions for further research

Given the volatility of asset prices, and the dependence of those prices on expectations, an explicit treatment of expectations seems almost inescapable for any fully satisfactory model of financial markets and their international linkages. The current crop of multinational models employ two alternative possibilities in their treatment of expectations, either making them adapt to recent experience or be determined by the future simulation paths of the model being used for analysis. Both procedures are informative, although neither is fully satisfactory.

To go further, it will be necessary to retain the explicit forward-looking features of the model-consistent expectations, while recognizing that market participants are varied in their views, are either unknowing or unbelieving of the processes depicted by any particular model of the economy, and are faced by uncertainty about many factors that are treated as fixed in model simulations. Key among these are future developments in the structure of financial markets, and assessments of credit risks, the likely future paths of policy, and

---

[26] This possibility, which is central to assessing the sustainability of current account positions, and hence of exchange rates (as emphasized by, e.g. Krugman 1987), is not embodied in the Taylor model, because debt accumulation and foreign debt service payments, are not modelled. Some of these channels are included in MULTIMOD, which shows a smaller appreciation under fiscal expansion (Masson et al. 1988).

the likelihood of turmoil in financial markets. All of these possibilities tend in current models to be subsumed in exogenous variables and structural parameters, or assumed not to exist.

Models with single-valued paths for future variables, and with well-articulated and well-understood equilibrium properties, are useful for many purposes, but they are probably not a very realistic way of modelling market expectations. To do better will require more explicit study of learning processes, and of the methods people actually use in simplifying complex situations to obtain rules for current action. Since this involves a major and not clearly mapped-out research effort, it would seem appropriate in the meantime to treat expectations explicitly, and to use both adaptive and model-consistent processes for determining these expectations, since they may for some purposes provide brackets about the behaviour of market participants.

Although consistent expectations models can now be run efficiently even on quite small computers (see, e.g. Taylor 1988) they require 50 or 100 times as much computing to obtain a solution[27]. To minimize the cost of maintaining and running models with model-consistent expectations, it may be helpful to develop benchmark studies of the key differences between adaptive and consistent expectations results, and then use adaptive expectations versions for day-to-day assessments. The benchmark rules of thumb can then be used to give a preliminary estimate of how the consistent expectation results would differ.

As international financial integration proceeds, it is becoming more difficult to assume that demands for national money, at any level of aggregation, depend only on national short-term interest rates. In particular, returns on financial investments in other currencies, which are heavily influenced by expected changes in exchange rates, are likely to play increasing roles in international portfolio allocation, including currency and bank deposits of the types that enter monetary aggregates.

Even transactions balances are likely to become more international as globalization proceeds. Thus national income, output, or sales may all provide insufficient measures of transactions demands for any particular national money. These demands are likely to depend also on the size and structure of each country's trade and investment relations, as well as on the nature of the exchange rate systems in operation.

Since many of the macroeconomic issues addressed by multicountry models relate to questions of portfolio balance and the future building-up and servicing of national and international debts, future modelling efforts should focus on finding suitable links back from debts to asset prices and exchange rates. The convenient assumption of

---

[27] See Taylor (1988) for evidence on the times taken for adaptive and consistent expectations solutions.

uncovered interest rate parity will probably have to be adjusted to reflect portfolio balance and risk considerations, even if in a rough-and-ready manner.

Because the future sustainability of current account positions depends largely on the interaction between portfolio positions and the expected evolution of prices, incomes, productivity, and exchange rates, the extended treatment of portfolio balance issues could most fruitfully be addressed if expected future values for exchange rates and interest rates are treated explicitly.

In the meantime, the data and structure of existing multicountry models could be used more systematically to expose and test the significance of apparent international differences and possible convergence in the structure of financial markets. Results of such tests may help to reduce the incidence of implausible model properties and international differences that we have found in some of the models embodying less constrained structure and dynamic responses.

Given the ambitious nature of this shopping list, we should perhaps add one final suggestion designed to simplify the research agenda. Our comparison of models involving different degrees of disaggregation suggests to us that disaggregation of financial sectors does not seem to make much difference to the broad pattern of results, and may therefore be avoided by those who are more interested in questions of international financial linkages and comparisons.

References

Artis, M.J. and M.K. Lewis. (1976), The Demand for Money in the U.K.,1963-73, **Manchester School** (44), 147-81.

Ball, R.J., ed., (1973), **The International Linkage of National Economic Models**. (Amsterdam: North-Holland).

Blundell-Wignall, A., M. Rondini and H. Zeiglelschmidt (1984), The Demand for Money and Velocity in Major OECD Countries, **Working Paper No. 16**, Economics and Statistics Department, (Paris: OECD).

Boothe, P., K. Clinton and D. Longworth (1985), **International Asset Substitutability: Theory and Evidence for Canada**, (Ottawa: Bank of Canada).

Boughton, J. (1981), Recent Instability in the Demand for Money: An International Perspective, **Southern Economic Journal** (47), 579-97.

Branson, W.H., and D.W. Henderson (1984), The Specification and Influence of Asset Markets, **NBER Working Paper No. 1283**.

Brainard, W.C. and J. Tobin (1968), Pitfalls in Financial Model-Building, **American Economic Review, Papers and Proceedings** (58),99-122.

Brayton, F., and J. Marquez (1988), The Behaviour of Monetary Sectors and Monetary Policy: Evidence from Multicountry Models, (Washington: Federal Reserve Board).

Bryant, R., D. Henderson, G. Holtham, P. Hooper and S. Symansky, eds. (1988), **Empirical Macroeconomics for Interdependent Economies**. (Washington: Brookings Institution).

Bryant, R.C., G. Holtham and P. Hooper, eds. (1988), **External Deficits and the Dollar: The Pit and the Pendulum** (Washington: Brookings Institution).

Christ, C.C. (1971), Econometric Models of the Financial Sector, **Journal of Money, Credit and Banking** (3), 419-449.

Cooley, T.F. and S.F. Leroy (1981), Identification and Estimation of Money Demand, **American Economic Review** (71) 825-44.

Cuddington, J.T. (1983), Currency Substitution, Capital Mobility and Money Demand, **Journal of International Money and Finance (2)**, 111-133.

Cuthbertson, K. and M.P. Taylor (1987), Buffer-Stock Money: an Appraisal, in **The Operations and Regulation of Financial Markets**, C.A. Goodhart, D. Currie, D. Llewellen, eds. (London, Macmillan) 103-124.

Davidson, J. and J. Ireland (1987), Buffer Stock Models of the Money Sector, **National Institute Economic Review**, August, 67-72.

Edison, H.J., J.R. Marquez, and R.W. Tryon (1986), The Structure and Properties of the FRB Multicountry Model, Part I: Model Description and Simulation Results, **International Finance Discussion Paper** No. 293 (Washington: Federal Reserve Board).

Engle, R.F. and T.C. Liu (1972), Effects of Aggregation Over Time on Dynamic Characteristics of an Econometric Model, in **Economic Models of Cyclical Behaviour**, B.H. Hickman (ed), **National Bureau of Economic Research, Studies in Income and Wealth Vol. 36,** (Columbia University Press: New York).

EPA (1984), **EPA World Economic Model**, Vol I Model Properties and Multiplier Analyses, Discussion Paper No. 16.

EPA (1987), **EPA World Economic Model** - July 1987 Version, Economic Research Institute, Economic Planning Agency, Tokyo.

Fair, R. and J. Taylor (1983), Solution and Maximum-Liklihood Estimation of Dynamic Nonlinear Rational Expectations Models, Econometrica 51: 1169-1185.

Friedman, M. and A. Schwartz (1963), **A Monetary History of the United States 1867-1960**, (New York: National Bureau of Economic Research.

Friedman, B.M. (1978), Crowding Out or Crowding In? Economic Consequences of Financing Government Deficits, **Brookings Papers on Economic Activity (3)** 593-641.

Friedman, B.M. (1980), How Important is Disaggregation in Structural Models of Interest Rate Determination?, **Review of Economics and Statistics (62)**; 271-276.

Helliwell, J.F. (1988) The Effects of Fiscal Policy on International Imbalances: Japan and the United States, **EPA Symposium, Tokyo, March** 15-17.

Helliwell, J.F., G. Meredith, Y. Durand and P. Bagnoli (1988), INTERMOD: A G-7 Version of the IMF's MULTIMOD, mimeo., (Ottawa: Department of Finance).

Holtham, G. (1984), Multinational Modelling of Financial Linkages and Exchange Rates, **OECD Economic Studies No. 2.**

Horton, G. (1984), Modelling the World Economy, **U.K. Treasury Working Paper No. 33.**

Jonson, P. (1976), Money and Economic Activity in the Open Economy: the U.K. 1880-1970, **Journal of Political Economy (84)**; 979-1012.

Judd, J.P., and J.L. Scadding (1982), The Search for a Stable Money Demand Function: A survey of the Post-1973 Literature, **Journal of Economic Literature (20)**, 983-1023.

Kane, E.J. (1977), Good Intentions and Unintended Evil, **Journal of Money, Credit and Banking (9)**, 55-69.

Krugman, P. (1987), Adjustment in the World Economy, **NBER Working Paper No. 2424.**

Laidler, D. (1983), The "Buffer Stock" Notion in Monetary Economics Supplement to **Economic Journal** (94), 17-34.

Laidler, D. (1985), **The Demand for Money: Theories, Evidence and Problems**, 3rd ed., (New York: Harper and Row).

Marquez, J. (1988), The Behavior of Monetary Sectors and Monetary Policy: MCM Simulation Results, mimeo, January.

Marty, A.L. (1961), Gurley and Shaw on Money in the Theory of Finance, **Journal of Political Economy** (69), 56-62.

Masson, P.R. (1981), Dynamic Stability of Portfolio Balance Models of the Exchange Rate, **Journal of International Economics** (11), 467 477.

Masson, P.R., and S. Symansky, R. Haas, and M. Dooley (1988), MULTIMOD: A Multi-Region Econometric Model, **IMF Working Paper 88-23**, (Washington: International Monetary Fund).

McKibbin, W., and J. Sachs (1986) Comparing the Global Performance of Alternative Exchange Arrangements, **NBER Working Paper No. 2024.**

Milbourne, R. (1987) Disequilibrium Buffer Stock Models: A Survey, mimeo, Department of Economics, Queen's University, Kingston.

Muth, R. (1961) Rational Expectations and the Theory of Price Movements, **Econometrica 29**: 315-335.

National Institute of Economic and Social Research (1987), The Structure of the Institute's Global Econometric Model, **National Institute Economic Review (119)**, 37-39.

National Institute of Economic and Social Research (1988), **GEM Model Manual**, (London, NIESR).

Niehans, J. (1982), Innovation in Monetary Policy, **Journal of Banking and Finance (6)**, 9-28.

OECD (1988a), **The OECD Interlink System** (Paris: OECD).

OECD (1988b), EPA International Symposium Supplementary Information, mimeo, **Economics and Statistics Department, OECD**.

Owen, D.P. (1981), Dynamic Models of Portfolio Behaviour: A General Integrated Model Incorporating Sequencing Effects, **American Economic Review (71)**, 231-239.

Podolski, T.M. (1986), **Financial Innovation and the Money Supply** (Oxford: Basil Blackwell).

Poole, William (1987), Monetary Policy Lessons of Recent Inflation and Disinflation, **NBER Working Paper** No. 2300.

Purvis, D.D. (1978), Dynamic Models of Portfolio Behaviour: More on Pitfalls in Financial Model Building, **American Economic Review (68)**, 403-409.

Richardson, P. (1988), The Structure and Simulation Properties of OECDs Interlink Model, **OECD Economic Studies No.10**.

Rose, D.E. and J.G. Selody (1985), **The Structure of the Small Annual Model**, Technical Report No. 40 (Ottawa: Bank of Canada).

Silber, W.L. (1975), Towards a Theory of Financial Innovations, in **Financial Innovation**, Lexington Books.

Silber, W.L.(1983), The Process of Financial Innovation, **American Economic Review, Papers and Proceedings (73)** 89-95.

Taylor, J.B. (1987), The U.S. Trade Deficit, Savings-Investment Imbalance and Macroeconomic Policy: 1982-1987, paper prepared for the conference "The U.S. Trade Deficit -- Causes, Consequences and Cures", **Federal Reserve Bank of St. Louis**, October 23 and 24.

Taylor, J.B. (1988), The Treatment of Expectations in Large Multicountry Econometric Models, in Bryant, Henderson, et al., eds., **Empirical Macroeconomics for Interdependent Economies**.

Tobin, J. (1969) A General Equilibrium Approach to Monetary Theory, **Journal of Money, Credit and Banking** (1), 15-29.

Walters, A. (1971) Consistent Expectations, Distributed Lags and th Quantity Theory, **Economic Journal** 81: 273-281.

Wei, W.S. (1978) The Effect of Temporal Aggregation on Parameter Estimation in a Distributed Lag Model, **Journal of Econometrics (8)**, 237-246

Wojnilower, A.M. (1980), The Central Role of Credit Crunches in Rec Financial History, **Brookings Papers on Economic Activity** (2), 277-326.

Wren-Lewis, S. (1987), Introducing Exchange-Rate Equations into a World Econometric Model, **National Institute Economic Review (119)**, 57-69.

Zellner, A. and C. Montmarquette (1971), A Study of Some Aspects of Temporal Aggregation Problems in Econometric Analyses, **Review Economics and Statistics** (53), 335-342.

FIG. 5.1 OWN-COUNTRY FISCAL MULTIPLIERS

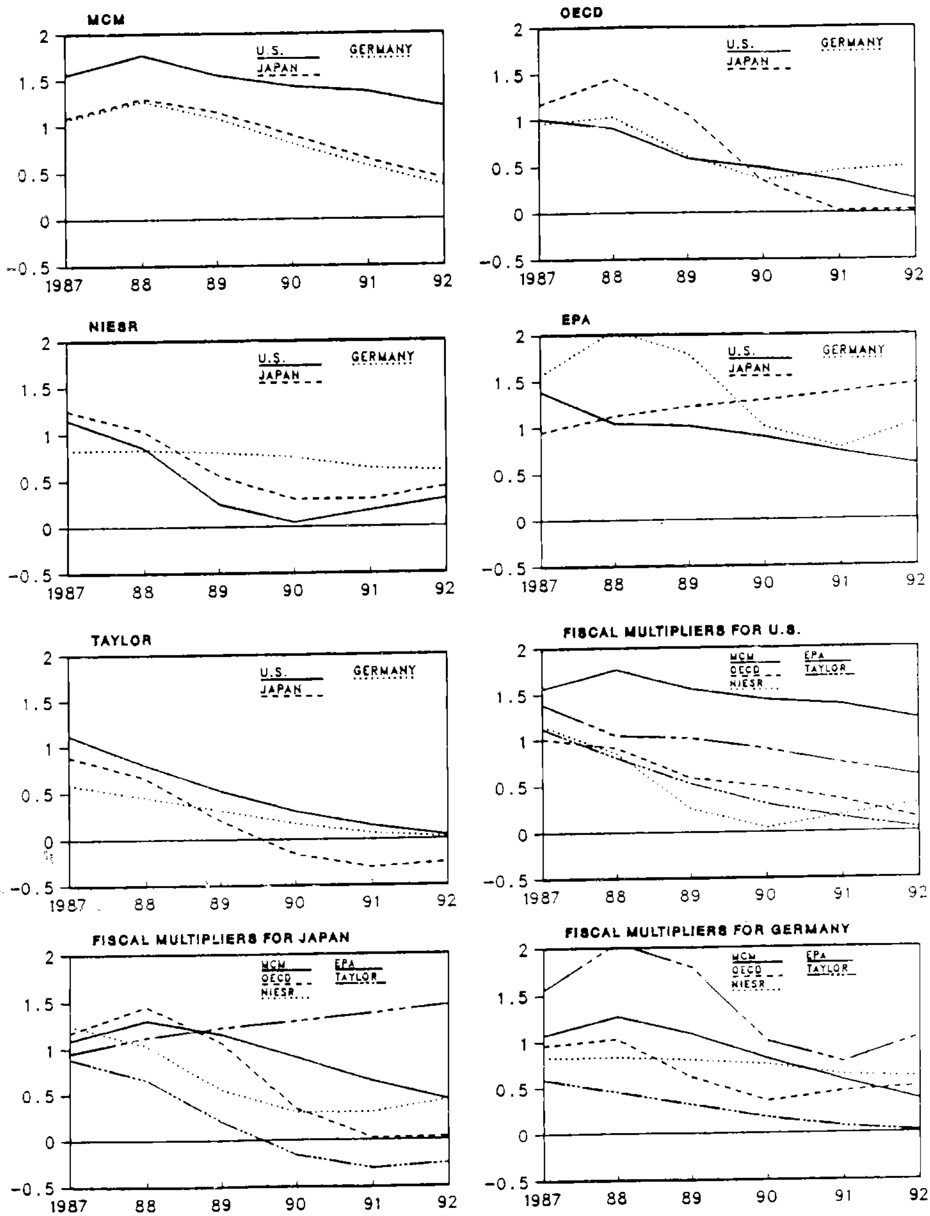


FIG. 5.2 U.S. FISCAL: EFFECTS OF EXPECTATIONS

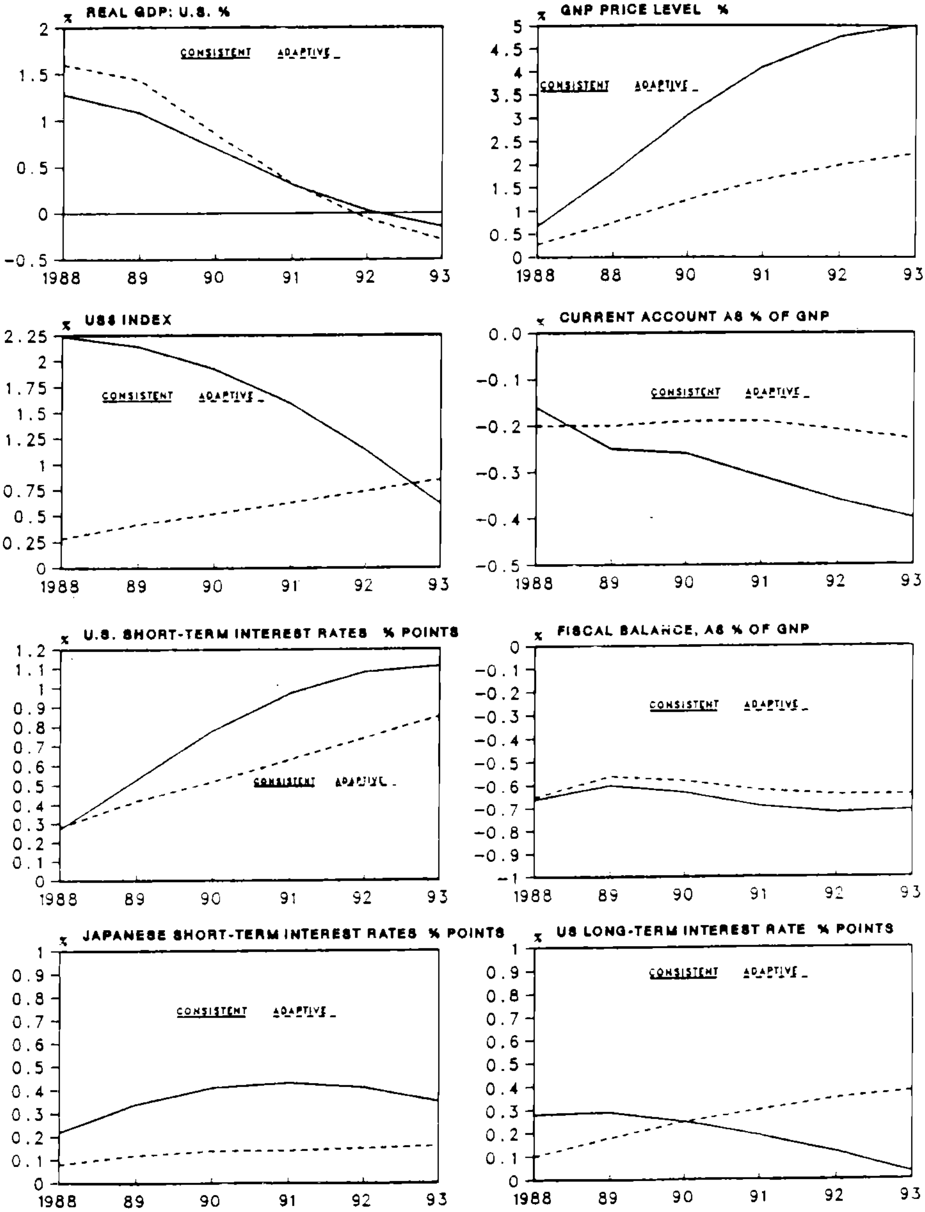


FIG. 6.1 U.S. MONETARY EXPANSION OF 1%

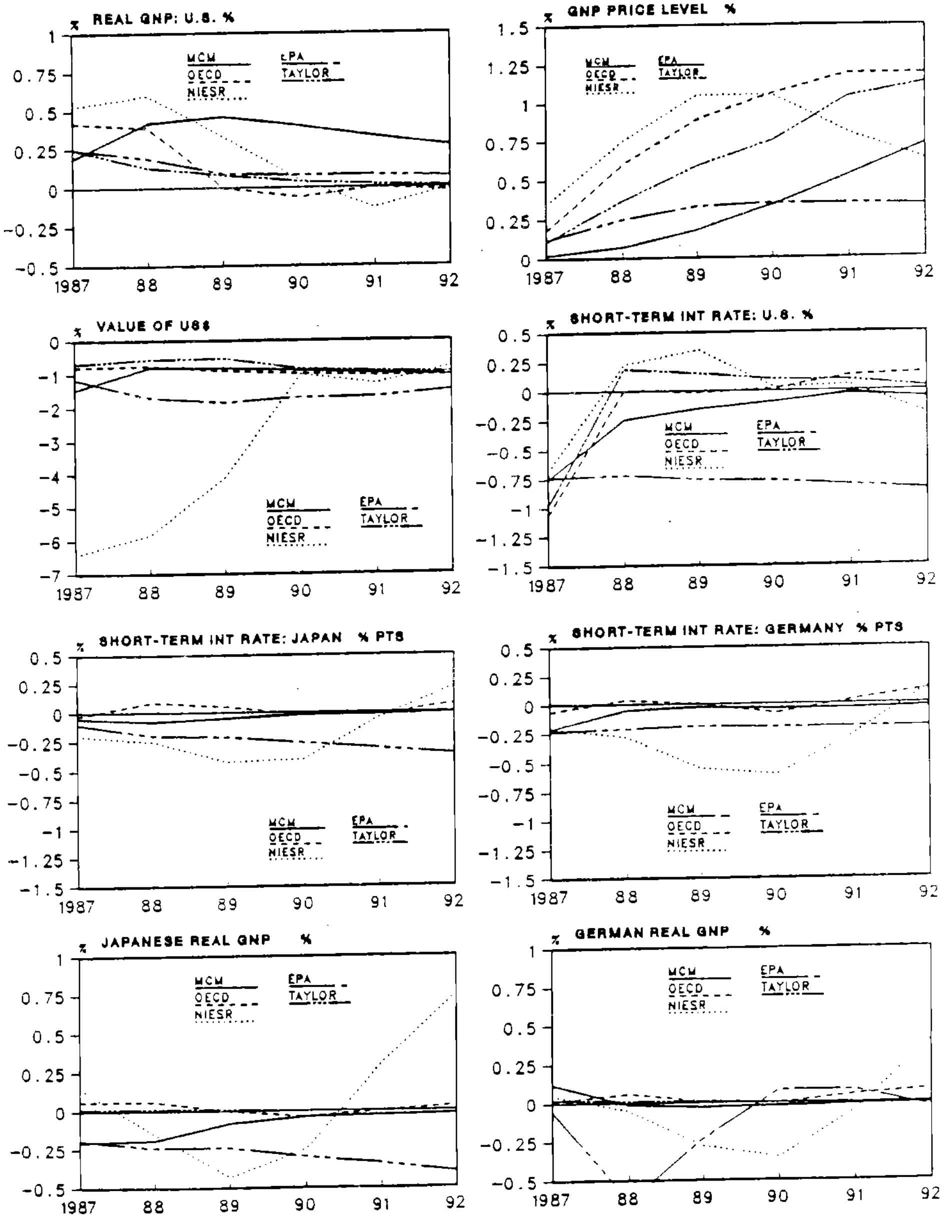


FIG. 6.2 JAPANESE MONETARY EXPANSION OF 1%

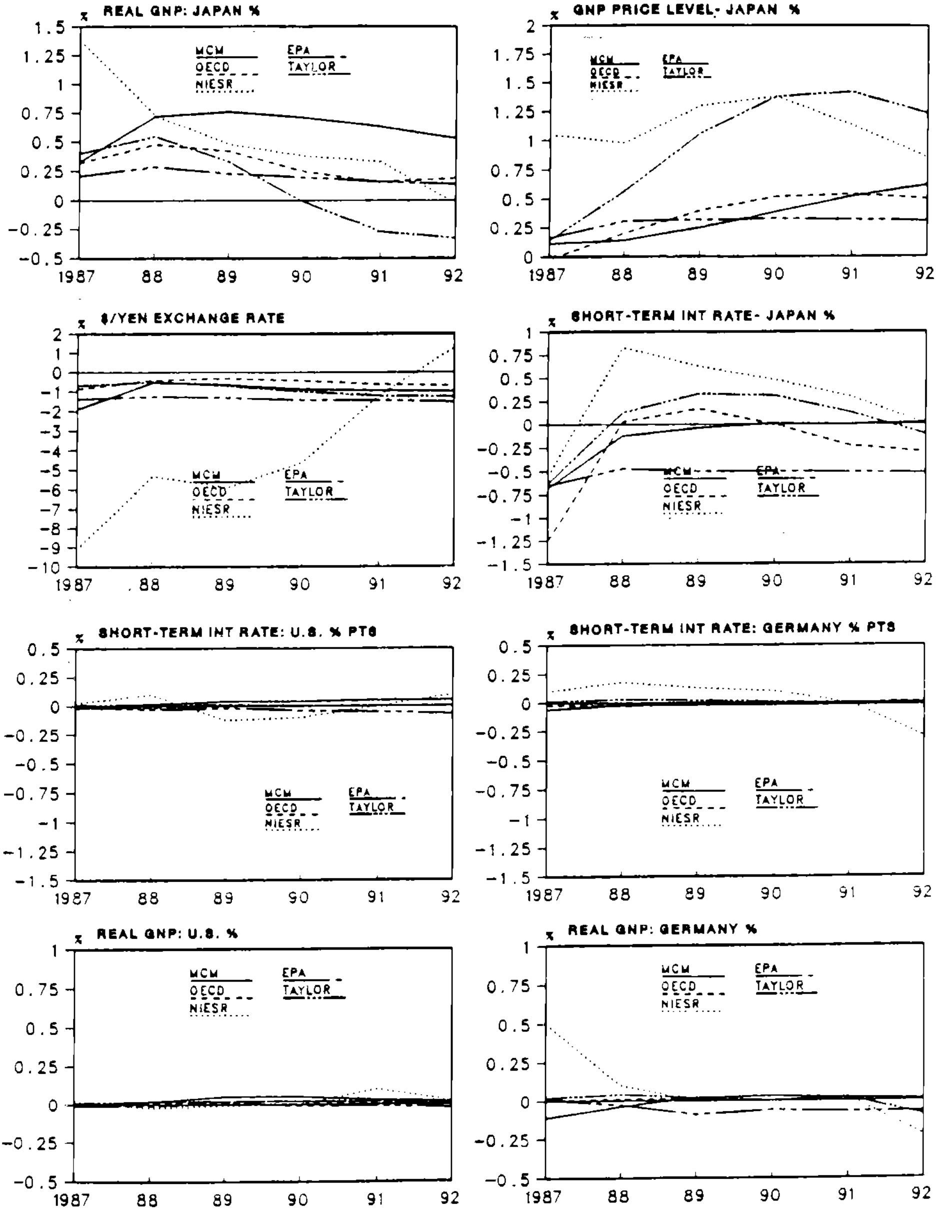
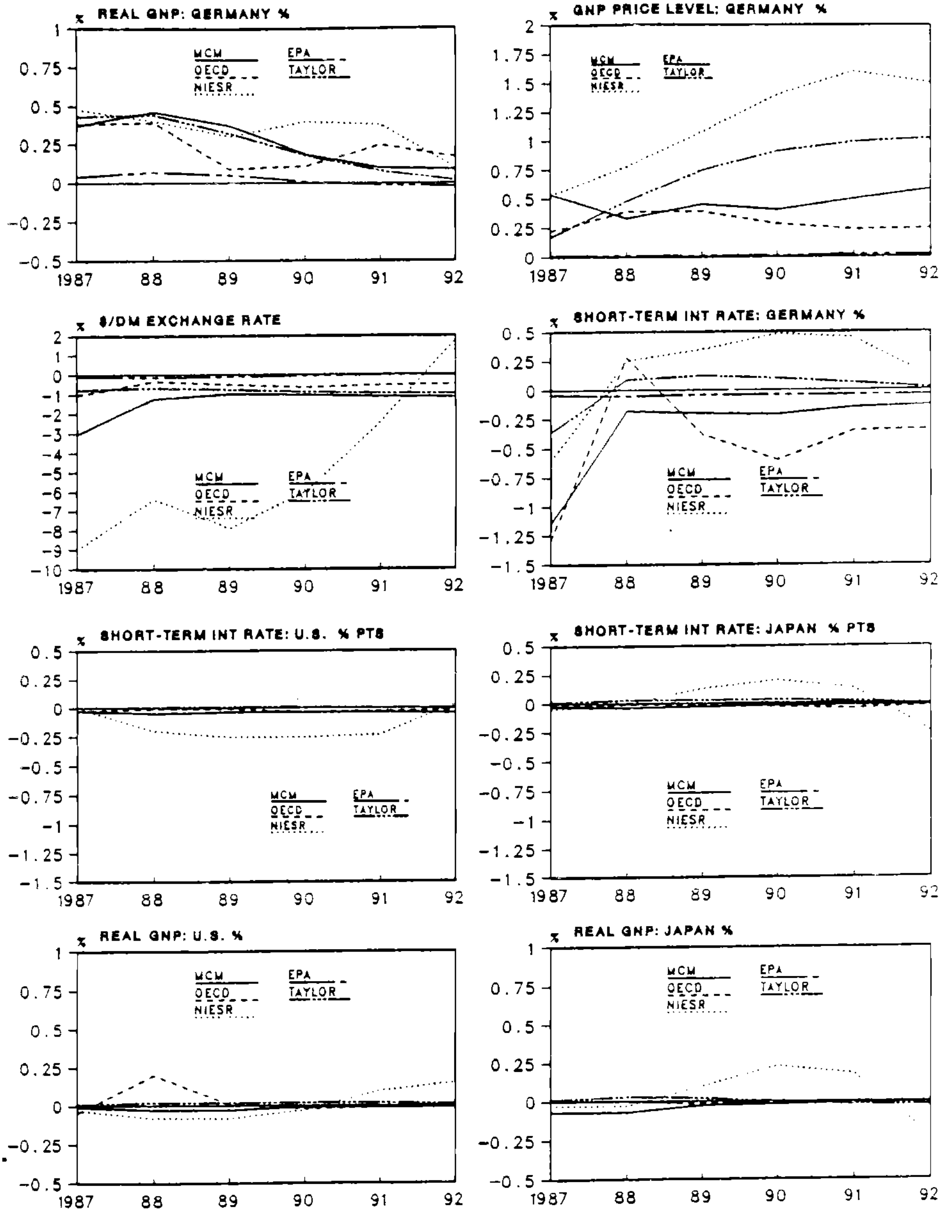


FIG. 6.3 GERMAN MONETARY EXPANSION OF 1%



Appendix
Domestic Financial Sectors in Five Multicountry Models

In this Appendix we provide a brief description of the domestic financial sectors of each of the models, with special reference to their treatment of the United States, Japan and Germany. We also report the basic interest and income elasticities for the money demand functions, either in terms of the aggregates or their components. These parameter estimates underlie the estimates of the slopes of the LM curves, as reported in Table 3.1. Since long-term real interest rates constitute the key link between the financial sector and the real side of the economy, the interest rate term structure relationships are described. A comparative evaluation of the LM curves and of term-structure relationships appears in the main text of the paper.

A.1 The Federal Reserve Model: MCM.

MCM links five country models together: the U.S., Japan, Germany, the United Kingdom and Canada. The prototype model is based on the following assumptions: asset markets are perfectly competitive, agents are risk neutral, short and long securities are perfect substitutes, as are foreign and domestic currency bonds, expectations are adaptive. There is no equities market in this model, and with only two domestic assets, money and bonds, the bond market is redundant (or implicit). The long-term interest rate is determined by a term structure equation. Since long- and short-term bonds are assumed to be perfect substitutes, the long-term rate is a distributed lag function of short-term rates, based on the assumption of adaptive expectations.

The structure of the financial sector, outlined in Table A.1, is described by means of a balance sheet representation of the domestic financial claims and relevant sectors in the model. Endogenous asset (or liability) demands (or supplies) applicable to all three countries are indicated by the symbol D (or S) under the appropriate sector heading. In other cases, a specific country designation is employed, using a slash followed by the letters U for the United States, J for Japan, or G for Germany. The fundamental agents in the economy are identified by the column headings while the rows represent the various asset markets. The relevant sectors include persons (H), firms, both financial (FF) and non-financial (NFF), the public sector including the government (G) and the monetary authorities (CB), and foreign nationals or non-residents (NR). The interest rate corresponding to each asset market is indicated under the "rate" column, using the model's mnemonics. The last column designates the method of determining the interest rates either by market equilibrium (ME) equating demand and supply, or via a reduced-form specification (RF), a particular version of which is a term-structure relationship (TS). The rate on CDs is determined by inverting the demand function (DEM). These conventions apply to our descriptions of all five models.

Although MCM does account for international capital flows in terms of direct investment and portfolio investments, non-residents' holdings of domestic securities cannot be distinguished by the type of financial claims and are therefore not represented in table A.1. The main focus of the model is on the demand for money, the decomposition of which reflects consideration of different reserve ratios by deposit type.

Table A.1 MCM: Structure of the financial sector.

Assets/Sectors	H+NFF	FF	CB	G	NR	rate	method
Money							
Reserves		D	S			RS1*	ME
Currency	D	D/JG				0	
Demand D.	D					0	
Time D.	D					RTD	RF
Savings D.	D/G				D/G	RSAV	RF
For'n-held D.					D/G		
CDs	D/U	S/U				RCD	DEM
Domestic securities							
Commercial paper						RS/U	RF
Bank Debentures						RLA/J	TS
Corporate Bonds						RL/U	TS
Gov.-short						RS1/UG	
Gov.-long						RLGB/UG	TS
Mortgages						RHL/UJ	RF

* 3 month TB rate for U.S. and Germany; call money rate for Japan.

Short-term interest rates are determined by the equilibrium of the demand and supply of free reserves. Demand for free reserves depends on the composition of deposits, reserve ratios, costs and the volatility of reserves. Demand for the various components of monetary aggregates, which include currency, demand, time and savings deposits, is based on a portfolio model which is homogeneous in wealth (defined as cumulated savings). The German model also includes deposits held by foreigners (subject to a different deposit ratio), and allows for partial adjustment of free reserves as a function of rediscount rates.

The estimated income and interest rate elasticities are reported in table A.2.

Table A.2 MCM: Money demand elasticities*

	Interest rate			Income		
	USA	JAP	GER	USA	JAP	GER
Currency	-.13	-.01	-.05	.87	.63	.63
demand dep.	-.04	-.06	-.11	1.03	.43	1.35
Time dep.	-.19	-.25	-.19	1.27	1.19	-1.73
M2	-.10	....	....	1.16	....	....

* Long run estimates, from Marquez (1988). The interest rate semi-elasticity, for comparison with the other models, is equal to the elasticity divided by the average proportionate interest rate. For M2, using an average interest rate of .06, the semi-elasticity is 1.67.

Term-structure equations differ between the major countries in the model. For Germany, the long-term rate is a distributed lag function of the short-term rate combined with seasonal factors; in the U.S. model the lagged short rate is supplemented by adaptive expectations of inflation; in Japan, the conventional term structure equation is combined with an inverted supply function of bank debentures. In the long run, long-term interest rates do not respond proportionately to movements in short-term rates.

A.2 The EPA World Economic Model.

The EPA model covers nine countries (including the G-7 plus Korea and Australia) and six other regions. In the U.S., Japanese and German models, short-term interest rates are determined by equating the demand and supply of free reserves, with the discount rate also having a substantial effect in the Japanese case. The Eurodollar rate (which in turn depends on the US short rate) also appears in the current version of the Japanese block, although it is to be dropped in the next version.[28] The structure

---

[28] In the U.K. and Italian models, short-term rates are determined by the demand for and supply of M1 (U.K.) or M2 (Italy). Policy reaction functions of the monetary authorities are used to determine short-term interest rates in the

of these domestic financial sectors is summarized in Table A.3. Overall, the approach is quite similar to MCM. Demand and supply for bank reserves solve out for the key short-term interest rate while a reduced-form approach is used to determine the other interest rates. Transactions in foreign securities, not reported in Table A.3, are based on a portfolio model with a partial adjustment specification; both asset and liability positions are identified with some disaggregation between short and long-term capital.

Table A.3 EPA: Structure of the financial sector.

Assets/sectors	H+NFF	FF	CB	G	NR	rate	method
Money							
Reserves		D	S			RSTB/U RSMM/JG	ME
Currency	D					0	
Demand D.	D					0	
Time D.	D					RT*	RF/UG EXO/J
Savings D.	D/UG					RSAV	RF
CDs/U	D	S				RCD/U	DEM
Securities							
Commercial loans	S					RLC/U	DEM
Bank Debentures						RSEC/J	TS
Corporate bonds						RLCB/U	TS
Mortgages						RMOR/G	RF
Gov. -short						RSTB/U	
-long						RSEC/G	

* Includes rates on small time deposits, money market funds, passbook savings and time deposit rates at Savings and Loan companies for U.S.; EXO: exogenous.
Source: EPA (1984, 1987).

Demand for money is based on a components approach in the framework of a portfolio model. Major explanatory variables include private net worth (cumulated personal savings) or financial net worth (claims on the government and foreigners), transactions variables (GNP or domestic absorption), rates of return on the assets and those of close substitutes. The key parameter estimates are shown in table A.4.

Canadian and French models.

Table A.4 EPA: Money demand elasticities.*

	Interest Rate			Income		
	USA	JAP	GER	USA	JAP	GER
Currency	-.70	-.62	-1.22	.75	1.02	.27
	-.88	-.54	-3.82	.75	1.02	.86
Demand D.	-1.42	-2.67	-1.54	.68	1.00	.80
	-1.22	-2.30	-1.84	.68	1.06	.80
Time D.	-1.89	0/-1.22	7.59	1.21	.55	.28
	-1.24	0/-1.05	13.08	1.12	.46	.40
M1	-1.24	-2.16	-1.46	.70	1.01	.62
	-1.14	-1.86	-2.60	.70	1.05	.89
M2	-1.67	-.61/-1.49	2.31	1.07	.71	.49
	-1.18	-.53/-1.28	3.79	1.00	.63	.68

* Semi-elasticities for interest rates; based on simulations of the financial blocks. The first-year results are shown in the first line, and the sixth-year results in the second line. For Japanese time deposits and M2, the first number assumes that the bank debenture rate is exogenous. Source: EPA model group.

Long-term interest rates are determined by a term structure equation which also takes into consideration market pressure variables such as government borrowing requirements and net foreign lending as a proportion of GNP. Expectations of future inflation are additional factors in the Japanese and German models. Long-term homogeneity of long-term rates to short-term rates is not a feature of these models.

A.3 INTERLINK (OECD).

INTERLINK has large blocks for each of the G-7 countries, smaller blocks for each of the other OECD countries, and for six non-OECD regions. A standardized representation of the financial block for the G-7 countries was adopted to enhance the transparency of the model and to avoid differences in model properties resulting from different research strategies. Equity markets are ignored, and the bond market is implicit, so that the domestic financial block has only three basic components: a money demand equation, a term structure equation and adaptive expectations for long-term interest rates. The structure is shown in table A.5.

Table A.5 OECD: Structure of the financial sector.

Assets/Sectors	H+NFF	FF+CB	G	NR	Rates	Method
Money	D	S			RS	ME
Domestic securities*				D		
Bonds						
short					(RS)	
long					RL	TS
Foreign securities*	D	D				

* Net foreign asset position is modelled as per portfolio model; distinction is made between dollar and non-dollar assets in foreign portfolios.

In previous versions of the OECD model, short-term interest rates were determined by a monetary policy reaction function. In the current version, short rates are either set exogenously or solved from the money market equilibrium by specifying a path for the money supply. The money demand equations share a common specification in that short-term rates and GNP are the sole arguments. The only substantial difference among the countries is that nominal partial adjustment was used for the United States, while real partial adjustment was preferred for Japan and Germany. The elasticities are reported in table A.6.

Table A.6 OECD: Money demand elasticities.*

	Interest rate			Income		
	USA	JAP	GER	USA	JAP	GER
M1	-.28			.1		
	-2.8			1.0		
M2	-.51	-.47		.26	.50	
	-2.1	-1.4		1.07	1.50	
M3			-.33			.29
			-1.8			1.6

*Semi-elasticities for interest rates. Short and long-run elasticities are shown in the first and second lines, respectively. Source: INTERLINK model equations.

In the term structure equations, rational lag formulations are used to link long and short rates. Government borrowing requirements relative to GNP are also included in the US model.

A.4 NIESR (National Institute).

The quarterly Global Economic Model (GEM) of the U.K. National Institute for Economic and Social Research[29] includes 9 countries and 7 other regions. The financial blocks for the G-7 countries share a similar structure. The structure of NIESR is broadly that of the U.K. Treasury's World Economic Prospects model presented in Horton (1984). In the financial blocks, narrow and broad money demand equations exist for each country, where real balances depend on activity (either total final expenditure or GNP), nominal interest rates and inflation (CPI or GNP deflator), and a time trend. Dynamics are usually captured by an error correction process.

Nominal interest rates can be determined in a number of different ways. Reaction functions are estimated for the major countries to capture the recent behaviour of the authorities. Alternatively, nominal or real interest rates can be fixed. Finally, interest rates can be varied to keep the money stock on a predetermined path. Term structure relations do not exist, as there is only a single interest rate for each country.

Table A.7 NIESR: Money demand elasticities.*

	Interest			Income		
	USA	JAP	GER	USA	JAP	GER
CBM			-0.18			0.0
			-2.51			1.05
M2	-0.39	-0.17		0.21	0.0	
	-1.8	-1.65		1.21	1.0	

* Semi-elasticities for interest rates; short-run and long-run values on first and second lines, respectively; CBM: central bank money; M1 is M1B for the United States.
Source: NIESR Model Version GEM33.F.

---

[29] The model is described in National Institute (1987 and 1988), and Wren-Lewis (1987).

A.5 The Taylor Model.

The Taylor model adopts a standardized framework for each of the G-7 economies. The financial side of the model is a disaggregated version of the Mundell-Fleming approach to international capital markets with perfect asset substitutability. Interest rates are determined in the model by assuming money supply is exogenous in each country. The partial adjustment money demand equations in each country are inverted to determine the short-term interest rates. The financial structure and money demand elasticities are shown in tables A.8 and A.9, respectively.

Table A.8 Taylor: Structure of the financial sector.

Assets/Sectors	H+NFF	CB+FF	G	NR	Rates	Method
Money (M1)	D	S			RS	ME
Bonds						
-short					(RS)	
-long					RL	TS

Table A.9 Taylor: Money demand elasticities.*

	Interest			Income		
	USA	JAP	GER	USA	JAP	GER
M1	-.22	-.48	-.65	.04	.14	.40
	-4.73	-1.91	-2.13	.85	.55	1.30

* Semi-elasticities for interest rates; short-run and long-run values on first and second lines, respectively.

The term-structure equation is forward-looking and incorporates model-consistent expectations. Rational expectations of future variables appear throughout the model: expectations of future prices and incomes appear in the consumption equation, expectations of future output and prices appear in the investment equations, expectations of future exchange rates appear in the exchange rate equations and expectations of future wages, prices and output appear in the wage equations. The solution method is the Fair-Taylor (1983) algorithm.