Comment on Sven W. Arndt's
"On Exchange Rate Dynamics"

By Bruce Brittain*

In his paper "On Exchange Rate Dynamics", *Sven Arndt* raises issues that have bothered economists since exchange rates were floated: Why do exchange rates move so much? Are destibilizing speculators responsible? Or do economic actors that influence underlying conditions take the blame? The current literature, including contributions by *Frenkel* (1976), *Dornbusch* (1976), *Kouri* (1976) and *Mussa* (1976) emphasizes the role of monetary authorities who, for a set of ill-specified reasons, alter the quantity of money in circulation, setting in motion a rational market response that adjusts some or all prices — including the exchange rate — to a new level incorporating the information about the new stock of money. Money stocks are highly variable, holders of money rationally recognize that money influences prices and exchange rates so exchange rates are highly variable too.

Sven Arndt concurs in this judgment although his reasons — incorporated in his model of exchange rate dynamics — are slightly different. *Sven's* model is supposed to be a simple period model of asset price determination in which goods prices are immutably fixed at the beginning of the period and cannot change during the period. Other prices, such as forward exchange rates, spot exchange rates and interest rates are free to move. Consumption, production and accumulation plans are laid at the beginning of the period presumably for end of period realization.

When something disturbs equilibrium, the home country money stock rises, for example, exchange market participants predict that prices in the home country will rise and they bid this information into the forward value of the currency — increasing the number of domestic currency units it takes to buy a unit of foreign currency for delivery in the next period so that expected purchasing power parity will hold. Producers also realize that prices will rise in consequence of the money stock increase but are incapable of changing prices which were frozen at period's beginning and they withhold goods from the market. They pre-

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fer to stockpile goods as an inflation hedge. Interest rates get bid up too — not because people expect more inflation — but because people demand comparable rates of return on competing assets which, in this case, are goods in inventory and bonds. Consumers are fooled and don't stockpile. Instead, they consume whatever producers choose not to allocate to increased inventories.

In this formulation of the model, the current spot exchange rate will not change during the period. Home country interest rates have risen, the forward value of the currency has risen, current prices are still the same — so that interest parity, actual purchasing power parity and expected purchasing power parity all hold with no movement in the spot exchange rate required. If, however, the monetary authorities choose to stabilize interest rates by, according to *Arndt,* increasing the stock of money whenever interest rates rise, part of the adjustment to an initial disturbance which was borne originally by a movement in the domestic interest rate would now be borne by the spot exchange rate. This is because the forward rate has changed by the same amount as was the case before the interest rate stabilizing action, but the interest rate movement has been attenuated. As long as interest parity holds, the spot rate must now rise. Pursuing interest rate targets, therefore, increases spot exchange rate variability.

I have two criticisms of *Arndt's* paper — one is quite narrow in focus, the other quite general. The narrow point is that *Arndt's* model incorporates economic rationality in only a selective and limited way. While the model represents an improvement over the *Dornbusch* (1976) formulation of exchange rate dynamics by allowing discrete, serially uncorrelated commodity price adjustments that incorporate the same information about inflation as do the movements of the forward exchange rate, this advance has been made at the cost of introducing other unattractive irrationalities. Specifically, producers and consumers differ in their ability to forecast and therefore act differently in the face of the same information about the future course of goods prices. Producers know how to forecast prices from the money stock but consumers don't. If consumers were to forecast future prices in the same way as producers in the *Arndt* model, product prices would probably rise at the same time as the money stock increased. But if this form of rationally were allowed, the price rigidity that is essential to Arndt's analysis would disappear.

A second irrationality is that rational expectations are built into goods price and exchange rate forecasts but not into interest rate forecasts. This means that an investor allocating his portfolio among money, private bonds und public bonds applies knowledge about the future course of prices and exchange rates — components of the own rate of return

on money which substitutes for bonds in the portfolio — while excluding that same information insofar as it affects the own rate of return on bonds themselves. A more attractive model would have consumers forecasting as successfully as producers and all individuals explicitly bidding inflation premia into the interest rate.

My general criticism is that *Sven* has not written down the specific form of his exchange rate model, has thereby left too much about how economic agents are behaving to intuition and has raised inconsistencies of the kind that *Foley* (1975) warned us to avoid when constructing discrete-time models. In *Foley's* terminology, *Sven* appears to mix discrete-time flow-equilibrium models of exchange rate determination with discrete-time stock-equilibrium models of exchange rate determination and the two with continuous-time models. The two discrete-time models are inconsistent.

At first, the model appears to be a flow-equilibrium discrete-time model — commodity prices, exchange rates, rates of interest are all set at the beginning of the period based on production, consumption and accumulation intentions and reflect a fairly sophisticated planning process that takes into account the effect of government actions on future prices — particularly in the exchange market where the forward exchange rate is determined so that expected purchasing power parity holds.

Once the conceptual experiment of increasing the money stock is performed, however, the model begins to look like a continuous time model. The money stock is increased after the period's beginning, commodity prices are frozen but all other prices are free to move — which they do. The forward exchange rate and interest rate rise. Producers alter their sales plans, choosing to stockpile goods rather than sell them on the open market, consumers' consumption plans are frustrated. Since producers are continually fine tuning marketing decisions and some subset of prices is continuously responding to a flow of shocks that could well be continuously occurring in *Sven's* formulation, the model cannot be the flow equilibrium, discrete-time model we first thought.

Finally, to derive the result that policy may be responsible for a considerable amount of spot exchange rate fluctuation, *Sven* proposes a policy reaction function that has policymakers attempting to smooth interest rates. The monetary authority does this by increasing the money stock whenever interest rates rise to take advantage of the liquidity effect on interest rates. But the presence of the liquidity effect raises the possibility that the model is neither a flow-equilibrium discrete-time model nor a continuous time model but a stock-equilibrium discrete-

time model where today's prices adjust so that economic agents are satisfied with the stocks of assets they are currently holding.

The ambiguity would be unimportant if steps had been taken to make the model consistent. Unfortunately, contradictions exist. For example viewed as a discrete time flow equilibrium model, *Sven*'s framework implies that an increase in the money stock increases interest rates. People are happy with today's new higher stock of nominal cash balances despite the higher interest rate because tomorrow's nominal transactions demand for money will be greater in line with the forecasted higher value of prices. Viewed as a discrete-time stock-equilibrium model, *Sven*'s framework implies that an increase in the money stock decreases interest rates because the community must be convinced to hold the stock of money at today's prices and the only way this can happen is for the opportunity cost of holding cash balances to fall. The flow model applies when *Sven* first experimentally raises the money stock. The stock model applies when the monetary authorities stabilize interest rates.

I think the basic problem is that *Sven* has written down only nine equations to describe a model that contains markets for domestic and foreign public bonds, domestic and foreign private bonds, domestic and foreign money and domestic and foreign goods and in which producers and consumers behave differently. There are clearly an unknown number of unspecified equations that are needed to completely describe the behavior of all economic variables including, of course, exchange rates. Had the equations been written down, the models' inconsistencies could have been brought to the fore and eliminated.

Despite the model's shortcomings, I think *Sven*'s paper is a good start to analyzing important issues — even outside the limited area of international monetary theory. In particular, the introduction of rational expectations to monetary models of exchange rate determination is useful because it may help us distinguish between two competing rational expectations models that explain why, during the last two years, increases in the U. S. money supply growth rate have been associated with increases in short-term interest rates. Both rational expectations models explain this positive association but the two competing models imply widely differing views of economic behavior. In one of the models, private market participants are monetarist while the monetary authority is not. In the other, the monetary authority is monetarist and the private market knows this but has no independent view on whether inflation is a monetary phenomenon.

This distinction between the market being monetarist and the market believing the monetary authority to be monetarist is important in *Wil-*

liam Poole's (1976) discussion of monetary targetting — the central bank practice of holding money growth to within pre-specified target ranges. *Poole* recognizes short run variations in the money stock may be demand determined rather than exogenously determined by random variations in the supply of central bank credit to the private sector. In *Poole*'s model, an increase in money demand generates expectations that the monetary authority will subsequently reduce the rate of growth of the money stock in order to achieve its monetary growth target. Anticipating a future liquidity shortage, the market bids a liquidity premium into today's interest rates. If this model applies, the monetary authority is monetarist, but the market is not. The market still forms its expectations rationally by anticipating future monetary policy.

A competing rational expectations model of the positive association between money and interest rates is suggested implicitly by *Fama* (1976). In similar models interest rates rise when the money stock grows more quickly because the market anticipates a permanently higher rate of price increase and bids an inflation premium into the short term interest rate. Under both models the interest rate rises when the money stock rises, so it's hard to imagine empirical tests that distinquish between the two.

We can see, intuitively, how the problem can be resolved by extending these two models to incorporate markets for foreign exchange with the following example. If the market is monetarist and the money supply growth rate rises, rational economic agents will bid an inflation premium into interest rates and will forecast a higher value of the price level in all future time periods. Assuming market participants also recognize that purchasing power parity will hold in future periods, the forward value of the currency should be bid to a discount. On the other hand, if the monetary authorities are monetarist while the market is not, and the money growth rate increases, rational economic agents will bid a liquidity premium (not an inflation premium) into financial market instruments. Assuming that interest parity holds, all values of the currency, including the forward rates will be bid up. In the first instance, the increased money supply growth rate increases interest rates and decreases the forward value of the currency. In the second instance the increased money supply growth rate increases interest rates but forces a decline in the forward value of the currency. Clearly, the inclusion of the exchange market in monetary models allows us to distinguish between competing rational expectations theories of interest rate determination where monetary models that exclude the foreign exchange market do not.

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