ECONOMIC PAPERS

COMMISSION OF THE EUROPEAN COMMUNITIES • DIRECTORATE-GENERAL FOR ECONOMIC AND FINANCIAL AFFAIRS

No. 43 January 1986

Toward: Understanding Major Fluctuations of the Dollar

Paul Armington*

Internal Paper

"Economic Papers" are written by the Staff of the Directorate-General for Economic and Financial Affairs, or by experts working in association with them. The "Papers" are intended to increase awareness of the technical work being done by the staff and to seek comments and suggestions for further analyses. They may not be quoted without authorisation. Views expressed represent exclusively the positions of the author and do not necessarily correspond with those of the Commission of the European Communities. Comments and enquiries should be addressed to

The Directorate-General for Economic and Financial Affairs,
Commission of the European Communities,
200, rue de la Loi
1049 Brussels, Belgium

ECONOMIC PAPERS

No. 43 January 1986

Toward Understanding Major Fluctuations of the Dollar

Paul Armington*

Internal Paper

---

* Mr. Armington is a consultant to the World Bank, whose support is gratefully acknowledged. This research is also supported through the Brookings Institution's Phase II grant from the National Science Foundation for research in international economic policy. An earlier version of this paper was presented at the meetings of Project LINK, September 1985, in Madrid, Spain. The views expressed here are solely those of the author, who also takes full responsibility for any shortcomings.

II/684/85-EN This paper only exists in English

ABSTRACT

The floating dollar appears to be cyclically unstable in the long run. The problem can be diagnosed with the aid of dynamic models. However, this understanding by itself is not sufficient to remedy the problem (through private speculation); and, therefore, monetary authorities should be prepared to take positions on the fundamental-equilibrium levels of exchange rates.

Toward Understanding Major Fluctuations of the Dollar

"The dollar problem" means different things to different people, depending in most cases on how they are affected by the present overvaluation of the U.S. currency. From the perspective of the analyst who attempts to understand the dollar's movements by formulating and estimating dynamic systems of equations, the dollar problem is essentially the finding that underlying cyclical tendencies in exchange rates for the major currencies are not as damped by anticipation of future changes in exchange rates as most observers have expected would be the case under "floating" or as they would wish to see in the future. Indeed, the cycles seem to be explosive in nature, implying that certain aspects of the international adjustment process would need to be reformed, or else that the system would tend to bounce from crisis to crisis, making abrupt and radical changes in behavior on each new tack. If society's clear preference is to avoid the latter outcome and to embrace the former, then the analyst's job becomes that of describing a process of reform that would damp (or stabilize) the cycles.

Based on this author's research since 1975 with dynamic models of exchange rate determination (focusing on rates against the dollar as the principal standard of the system), the increasingly-solid conclusion is that the present exchange rate system does tend to generate cycles, that these cycles are not damped (i.e., the system would generate swings of increasing amplitude and duration, if it continued parametrically unchanged for a long time), and that, therefore, the policy issue of how to define a remedial process is indeed a pressing one.[1/]

The positive and normative aspects of the dollar problem are distinct and should be dealt with separately. The positive aspect is a matter of understanding the relevant history, which we will attempt to do in this paper by asking what the data since the early 1970's suggest about this cyclical process. The normative aspect, treated more fully in a companion paper,[2/] is to formulate a countervailing process -- not observed in history but still feasible to implement as policy -- that would have a stabilizing effect on the operation of the system as a whole. The normative aspect requires that we make value judgements that are not required purely for the positive analysis; on the other hand, the former should follow from the latter much as a doctor's prescription follows from his diagnosis. We begin, therefore, with the diagnosis.

The contest between stabilizing and destabilizing forces

The exchange rate system, like the human body, has a defense mechanism against routine threats to the status quo. Hence, extended illness should be understood both in terms of the existence and strength of the attacking forces and in terms of the (relative) weakness of the defense mechanisms. The offensive and defensive forces are in constant conflict, and illness is a sign that the attack forces are winning. By the same token, the doctor's remedial strategy may be to strengthen the defense or to impede the offense, depending on the circumstances. In a companion paper (see note 2) we will suggest that, in the long run, "preventive medicine" for the dollar problem is the best strategy: apart from crisis management, policy in calm periods should focus on strengthening the system's natural defenses against instability, rather than trying to remove or directly offset the "causes" of dollar movements.

A "cyclical" force on the dollar may be conceived as an "*ex ante*" pressure for change in its value (in terms of foreign exchange, or, say, in terms of the SDR) that is part of a self-reversing dynamic process. It denotes an "underlying tendency" for change that may or may not be reflected in a commensurate, observed (or "*ex post*") change. If the self-reversing dynamic process is well enough understood to generate bets on its future continuation, then the cyclical force on the dollar will be more or less counterbalanced by "speculation," with the result that the *ex post* movement of the dollar will be "damped." That is, the wave pattern suggested by the *ex ante* force alone will be transformed, through the induced speculation force, such that its peaks and troughs will be "anticipated" -- hence, pared down and filled in.

Ex post cyclical instability of the dollar, thus, is *prima facie* evidence of inadequate speculation. Inadequate speculation becomes a clear problem for policy makers when the currently-observed value of the dollar is cyclically high (or low). In this situation, the self-reversing aspect of the underlying dynamic process virtually guarantees that the dollar will fall (or rise) -- in which case, the dollar may be said to be "overvalued" (or "undervalued"); but speculation does not prevent the current situation from arising. Nor, presumably, will it prevent the reverse situation from developing in the next phase of the cycle. All this is a problem because, inter alia, it leads to waste and inefficiency in the use of real resources as compared with a situation in which expectations about future price relationships were less uncertain. The problem for society resides in having such expectations about major currency movements in the future — expectations that are valid but not (apparently) an adequate basis for bets.

The possibility of smoothing out long cycles

As the term is usually used, "speculation" connotes very short-term position-taking. Is it logical to entertain the thought of speculative damping of cyclical forces whose periodicity is "medium-term," say, several years? Yes. The period of the underlying cycles is bound to be much less important than the precision of their measurement and the predictability of their future continuation. To illustrate, consider an extreme and fanciful case.

Suppose that a large percentage of the world's asset holders mysteriously but predictably undergo a continuous shift of "preference" from dollar claims to non-dollar claims, and back again, in a precisely-known function of the orbit of Halley's Comet around the Sun. Thus, there would be an underlying tendency for the dollar to (say) peak next March, and then to reach its next (underlying) trough in 38 years — which is exactly half the period of orbit of Halley's Comet.

It is hard to believe that this situation would present a policy problem, once the facts are understood and financial institutions have adapted to the consequent demands. Speculators would demand -- and national treasuries would provide — "Halley bonds," which would be used as vehicles for speculation on that underlying cycle. As the Comet starts toward the Sun from deep space, speculators would build up their long positions in dollar-denominated Halley bonds, the prices of which would tend to rise as the Comet moves toward the Sun. As the Sun is approached, speculators would sell off these bonds, taking their profit on the appreciation, thereby generating an extra supply of dollars counterbalancing the (presupposed) cyclically-high demand for dollars in that phase. Then, as the Comet heads back out of the center of the solar system, speculators would take up positions in foreign-currency-denominated Halley bonds, using non-dollar currencies that, at that stage, would be in excess cyclical supply. The result would tend to be smoothing of the ex ante exchange rate cycle. The period of cycle would not be crucial; Halley bonds would become favorite vehicles for inter-generational transfers.

In general, if forecasts of "the fundamentals" are sufficiently credible, speculation will be an effective stabilizer even if the underlying cyclical process is slow. If necessary, additional financial instruments and markets for trading them will evolve in response to the demand for such services. The primary issue is not the speed of the autonomous process but rather its predictability.

On the other hand, accuracy (or small errors) of forecast of the ex post exchange rates is not critical; speculators know that forecasts in this sense can never be accurate, if only because of competition among themselves. They don't require accuracy in this sense. It is not necessary for their profits, which depend on the much weaker condition of being able (usually) to guess the direction of change of exchange rates (or the direction of deviation from the forward rate, if speculation is in the forward market).

The dominance of stabilizing forces in the short run

Before describing the cyclical forces that speculation does not deal with effectively, we should note that the system's defenses against most types of potential instability are strong. It must be judged that, on the whole, the current exchange regime works remarkably well.

First, the system has the capacity to respond right away to perceived "structural" shifts -- step changes that call for an immediate realignment of currency values. Examples would include the strengthening of the dollar right after the end-'73 oil shock (which permanently raised the real price of oil) and after the shift in U.S. monetary regime late in 1979 (which signaled a long-term commitment to the fight against inflation). A recent example is the market response to the announcement of September 22, 1985, of a major shift in the Reagan Administration's attitude toward the issue of dollar overvaluation and toward the possible role of intervention in correcting it. This is not to say that "the market" gets it right immediately; but the rates do have the capacity to jump without much delay, thus avoiding the cumulative stress that would be entailed if administered parities or central rates were left unchanged unrealistically. The present system for determining the dollar's value is blessedly free of crises associated with the arthritic qualities of price-fixing institutions.

(2)

The efficiency of stablizing speculation is most obviously displayed in the offsetting of seasonal pressures. Net flows of merchandise trade, tourism, and other "real" transactions are often highly seasonal and constantly give rise to seasonal fluctuations in demands for foreign exchange. And yet _ex post_ exchange rates show no significant seasonal variation, at least where restrictions do not interfere. The seasonal pressures are accommodated by speculation, most notably in the form of "leads and lags" on cash settlements of commercial transactions. For example, traders with "net receivables" in a currency that is perceived to be seasonably weak in a given period will covert their obligations in that currency at some other time, either leading or lagging the time of accrual. In this way, seasonal and speculative pressures on rates are offsetting.

Speculation also is efficient at financing short-term trade imbalances -- even those whose reversibility (at least as to timing) is much less certain than seasonal imbalances. For example, exchange rates and trade balances are not unstable in the short run, even though so-called "J-curve effects" on trade balances are a quite normal phenomenon. We find that, often, depreciation worsens the terms of trade, which in turn worsens the trade balance before the (lagged) volume effects lead to an improvement of the balance. That worsening probably means that commercial traders in the world at large are temporarily holding more "exposure" in the currency of that deficit country. If they are willing to hold that increased exposure in anticipation of the improvement of the trade balance, or if there is equivalent speculative support in some other form (e.g., forward purchases in advance of the trade improvement, combined with interest-arbitrage inflows), then the corresponding currency need not depreciate further and can show short-run stability. And our econometric results do show that sort of stability.

In the above case, stabilizing speculation is assisted by expectations of improvement in the trade balance. What if there is no such help? Efficient financing of payments imbalances through speculation requires expectations about future exchange rates to adapt slowly to news about the current spot rate (apart from the effects on expectations of other relevant news). And this does, in fact, seem to be the case. Typically it seems to take two to three months for exchange rate "surprises" to become fully incorporated in expectations of future rates. Thus, there is some scope for spot rates to adjust (relative to expectations of future rates) in such a way as to enlarge or diminish the speculators' incentive to hold the pattern of currency exposure that is the immediate fallout of international commercial dealings. This is, of course, the core of the "portfolio balance" explanation of how spot rates get determined in the short run. This model does seem to fit, and the resulting estimated processes do show good short-run stability.

It should be added, though, that this stability depends on help from the responsiveness of interest rates (particularly, euro-currency short-term rates) to the rates of change in exchange rates. We find that the currency-translation element of expected yield (on assets denominated in a given currency) has only a tiny influence on investors' currency-switching behavior -- presumably because it is so uncertain as compared with the element of interest. Thus, it would take a large depreciation in a spot rate to generate a significant speculative interest in deposits in that currency, for a given set of interest rates. But as the currency depreciates in response to a balance-of-payments deficit, the corresponding euro-rate of interest tends to rise. And this rise not only tends to limit the depreciation of the currency but attracts deposits into that currency, hence financing the deficit. This process requires, of course, that the domestic monetary policy of the country concerned be consistent with the rise of its euro-rate, which implies some sort of leaning-against-the-wind policy of currency stabilization in that country. In our research, these processes have been verified for non-U.S. countries; the United States has not generally pursued such policies, according to our estimates, although there have apparently been exceptional episodes.

In sum, as we assess the defenses of the present system against potential instability, the speculative processes on which efficient floating theoretically depends seem alive and well. Reflecting the direct intervention of expectations in the determination of spot rates (i.e., the capacity of rates to jump to whatever level the market thinks is appropriate), exchange rates against the dollar can conform virtually immediately to fundamental change in the outlook. At the same time, in the absence of such news, expectations adapt slowly enough to permit speculative financing even of non-seasonal payments imbalances in the short run, given that euro-currency rates of interest on non-dollar claims also adjust to limit the movement in exchange rates while reconciling portfolio holders' preferences with the extant currency composition of net commercial receivables and other financial claims. The international currency markets, buttressed by exchange-stabilizing monetary policies pursued outside the United States, must be considered a robust defense against most forms of currency instability. Let us, then, look at the "attack" side of the dollar problem, to see where the challenge to the system's health is coming from.

The basic nature of the long cycle

The core of the underlying (ex ante) long cycle of the dollar is the dynamic interaction between the exchange rate and the balance of payments on current account. An appreciation of the dollar (here expressed as the exchange rate in real effective terms) leads dynamically to a worsening (algebraic lowering) in the current balance of payments, and this adjustment process is slow. It typically takes about two years for a rise in the dollar to register the bulk of its effects on the trade balance, according to our estimates. And, in turn, the process by which the worsening current account depresses the dollar is slow. The reason for this is that the deficit itself (i.e., the flow) has little systematic effect on the exchange rate, and instead it is the net external debt or net asset position (i.e., the stock, or the integral of the current-account balance) that finally does most of the job of bringing the dollar down. This is what we find empirically, and it is certainly consistent with the portfolio-balance theory of exchange rates. It takes time for the flow disequilibrium to build up the stock disequilibrium to the point where exchange rate adjustment begins to take place.

And by that time, the flow disequilibrium -- the trade deficit -- is very big and will stay big for a matter of years to come (reflecting the lags already mentioned). This in turn means that the stôck disequilibrium (net external assets or debt) will go on increasing for years -- indeed, for so long as the current balance remains in deficit. Therefore, the effect of net debt on the rate of change of the exchange rate continues for a long time. And, of course, it would be no surprise to find that, before this part of the process is over, the level of the dollar falls much below the level that would (after lags) be consistent with current-account equilibrium. This is precisely what we infer from the historical record and what our model predicts will happen within a few years from now.

In the final phase of this long orbit, the "undervaluation" of the dollar powers an improvement of the current balance, which then continues at a high enough level to normalize the external debt position and eventually to kick the dollar back into appreciation mode. At this point in time, the string of current account surpluses that are "in the pipeline" (reflecting the dollar's long undervaluation) will in due course generate such a global "dollar shortage" as to lead to another long period of dollar "overvaluation." And this is where we came in. Unfortunately, unless the system changes, the next period of dollar shortage will be much more violent than the present one.

Again, it should be stressed that this story is about ex ante cyclical forces or tendencies. The "underlying" existence of this mechanism can be inferred as likely from the estimation of dynamic models, but ex post developments will mask these tendencies via the system's defensive mechanisms and policy adaptations. It is not possible to use any model to predict ex post exchange rates with reasonable accuracy.

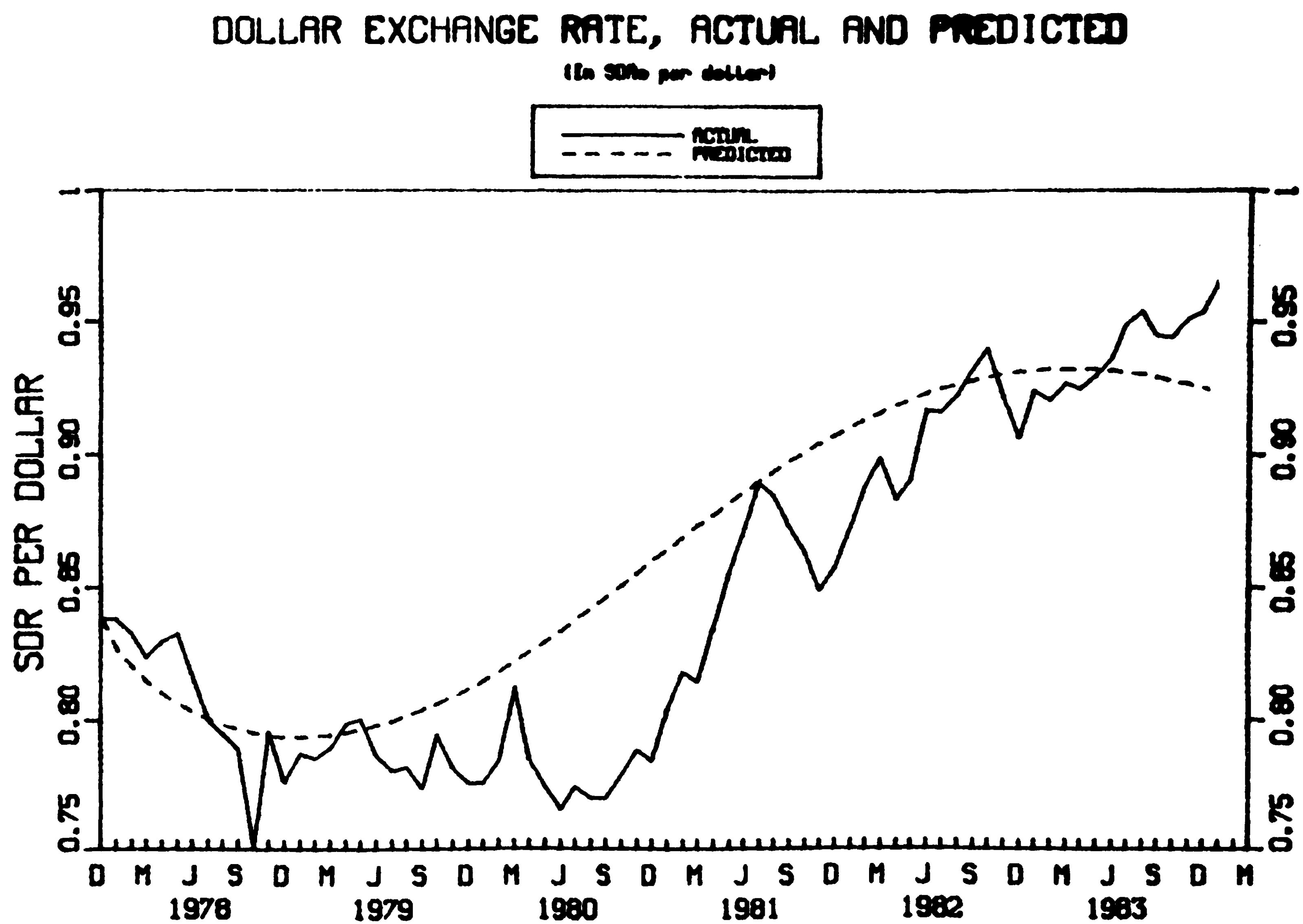
The following charts illustrate the long cycle by showing AWA Model predictions of the dollar exchange rate (against the SDR). These are medium-to-long run dynamic forecasts of a virtually-closed model (underlying overall inflation rates being the only exogenous variables), estimated on data for 1973-'83. The model is described in the Annex. The three charts differ only in the choice of period of solution, the initial conditions being the actual values of the endogenous variables at end 1977, and 1978, and end 1980, respectively. The "actual" series is also shown (the solid lines).

To appreciate fully the power of this long cycle, one has to probe below the surface of the estimated dynamics and ask why these troublesome lags are so long. Why, especially, may turning points in the dollar be so painfully delayed?

A complication: fiscal destabilization and shifts in the demand for money

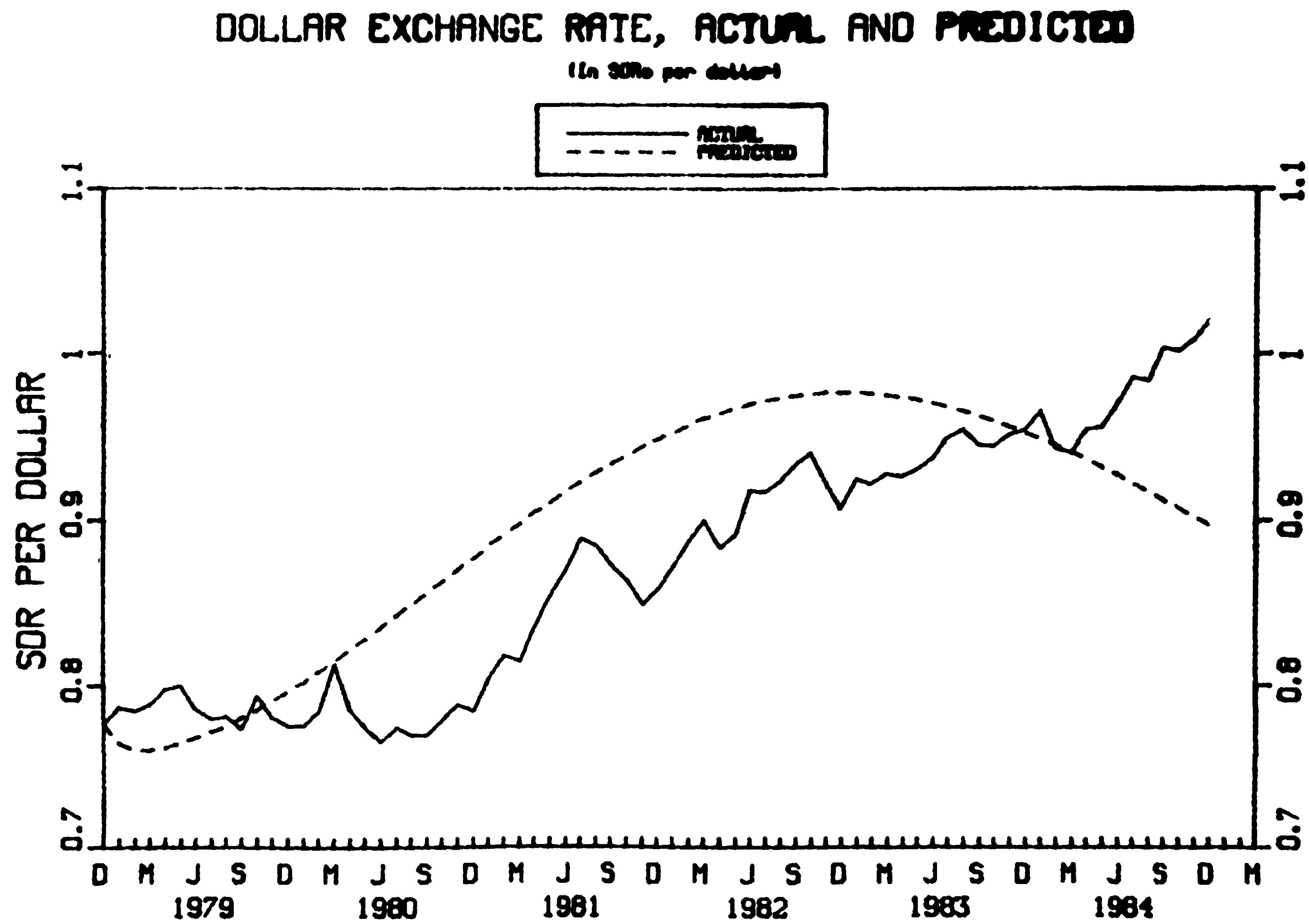
Events in 1983-84 illustrate one important answer: a strong dollar -- generated initially by a combination of tight money and a cyclically-strong trade account -- creates scope and incentive for an expansionary fiscal policy in the United States (and adds to incentives

January 1978 - December 1983



Note: Forecast initialized on December 1977.

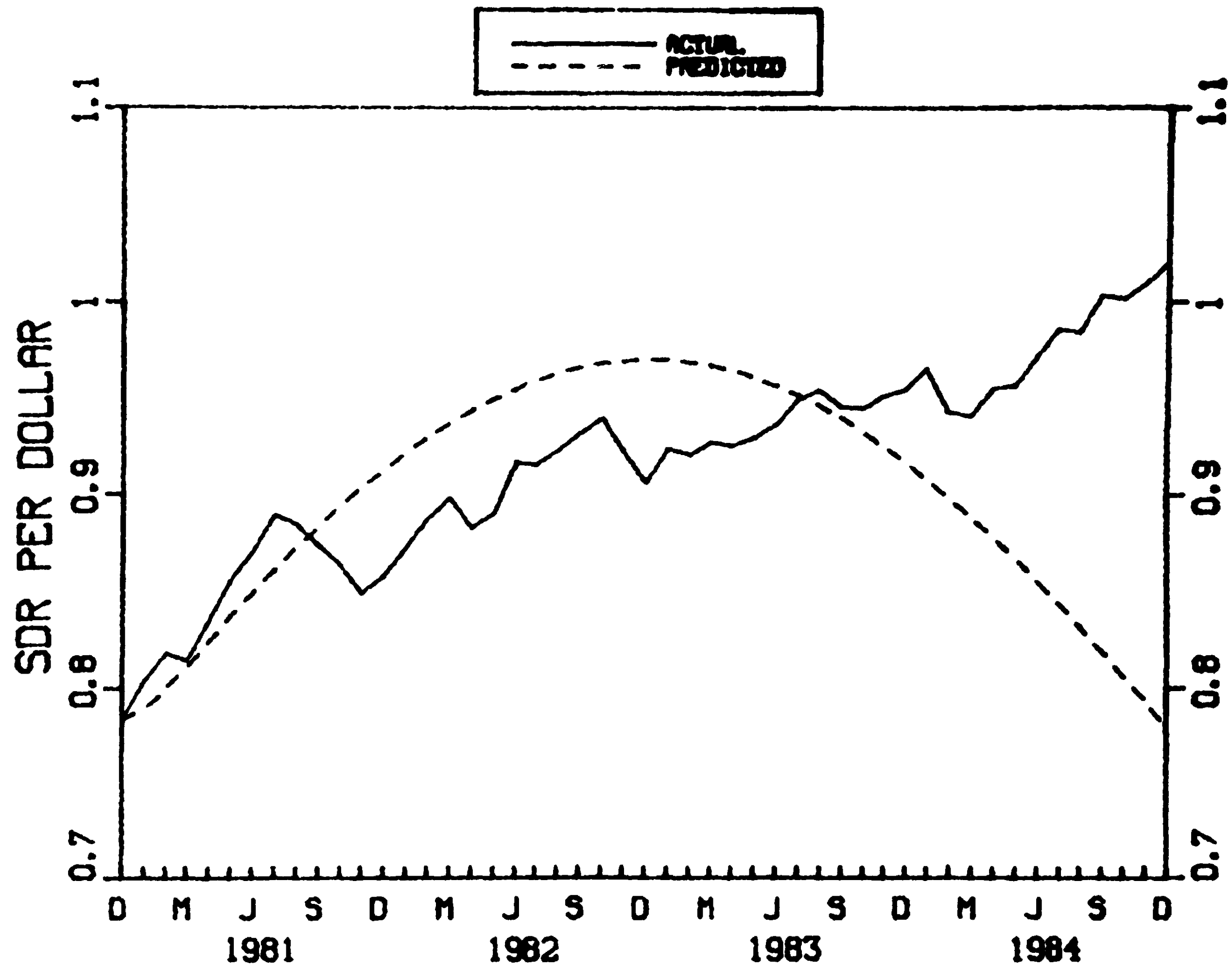
JANUARY 1979 - December 1984



Note: Forecast initialized on December 1978.

December 1980 - December 1984

DOLLAR EXCHANGE RATE, ACTUAL AND PREDICTED



Note: Forecast initialized on December 1980.

for fiscal contraction elsewhere). An exceptionally elastic supply of foreign savings can temporarily remove the curbs that the rising "conditionality" of foreign borrowing usually places on pro-growth fiscal measures. The result is, in due course, higher growth of final demand in the United States than elsewhere, which in turn increases the global demand for working balances in dollars relative to the global demand for working balances denominated in other monies. Barring full accommodation by the respective banking authorities, the "price" of U.S. money is pushed up (further) relative to prices of other monies. That is, the dollar strengthens further.

Here, the exchange rate is viewed as the flow-price of liquidity (a service flow) denominated in a particular currency. It is analogous to the wage rate as an influence on the demand for labor. The level of the rate, not the expected change in it, is doing the explanatory work. That is, the exchange rate is not functioning (in this particular process) as an ingredient of yield on assets, and hence this process is logically distinct from the process whereby wealth redistribution (via current account imbalances) eventually forces adjustments in currency values so as to satisfy wealth-holders' preferences across currencies of denomination of assets.

But the two processes do become dynamically interwined. What happens is that the U.S. fiscal stimulus (and non-U.S. fiscal contraction), by eventually increasing the relative global demand for U.S. money -- as reflected in net inflows of monetary capital to the U.S. banking system -- drives up the dollar and shifts global demand for goods and services from U.S. to non-U.S. output. The realized effect is to depress the U.S. current balance (further), counterbalancing ex post the net inflow of monetary capital. This result in turn raises the external debt, relative to what it would have been without the divergent fiscal policies. In short, these policies act to delay the downturn of the dollar while increasing the magnitude of its future decline by increasing the amplitude of the build-up of external debt.

The temporary prosperity consequent on a strong dollar (which keeps down inflation of goods prices in dollar terms and which generates real U.S. income by improving the U.S terms of trade) could perhaps be extended so long as U.S. final demand grows faster than final demand for other countries' goods and services. This differential would tend to sustain the net inflow of monetary capital to the United States; and the upward effect of this process on the dollar might counterbalance for a long time the downward effect stemming from the wealth redistribution implied by the U.S. current account deficit. To achieve this result, the U.S. Government would probably need to keep cutting taxes or let disbursements rise rapidly.

The trouble with this strategy, of course, is that such measures would have to be taken in larger and larger amounts over time, in order to offset the ever-growing ex ante effects on the dollar of the external debt (which would keep growing since the current account would stay in deficit). Eventually, global portfolio preferences would be binding. That is, eventually, erosion of the U.S. ability to borrow abroad must reduce the relative growth of U.S. final demand (by driving up interest rates in dollar terms). At this point, the real underpinnings of the net inflow of monetary capital would be shot away, while, simultaneously, the extant debt and deficit positions would be much worse than they would have been without the tax cuts, or spending increases. At this point the dollar would tend to be realigned quickly; but of course the changes in exchange rates that one might actually observe under those circumstances would be even less predictable than usual, while the shock to global economic activity would similarly be incalculable. This is the situation that we are entering now, in October 1985.

The moral of this story is that, if the U.S. Government's planning horizon is not long, it has powerful incentives to pursue policies that are indeed destabilizing. For instance, if Congress somehow had inside information that Doomsday was unalterably scheduled for 1990, they probably would be well advised to go for sustained high growth through fiscal stimulus. This is not to say, of course, that under the floating-dollar regime fiscal policies have been systematically destabilizing. There is probably nothing systematic about U.S. fiscal policy. Indeed, in the 1978 dollar-undervaluation period, relatively expansionary fiscal policies in the United States probably tended to support the demand for dollars, hence limiting its decline. The policy response to that crisis was not to raise taxes (which arguably would have depressed the dollar further by easing conditions in the global dollar market) but rather by tightening monetary conditions from the supply side. And, naturally, that response did the trick.

Other difficulties around turning points

The recitation of the factors influencing the long cycle of the dollar would be incomplete without mention of "speculative bubbles," the "safe haven" argument, and shifts in asset preferences more generally. Although the modeling work drawn on in this paper gives no quantitative clues as to the importance of these factors, more specialized studies have pointed to their significance.[3/] Certainly, from close observation of exchange market behavior and of news commentary during the months leading up to November 1978 and February 1985, one would reasonably surmise that swings in "sentiment" about the dollar can be huge, and that most investors do not see their own views at such times as being passing intellectual or emotional fads. By October 1978 the popular view had developed that the dollar-centered system was being permanently replaced by a multi-polar reserve system that would be reflected in a major and lasting decline in the dollar's role in private portfolios. On the other hand, by February 1985, the view was that investing in "U.S. Inc." was the only game worth playing -- apparently reflecting the popular opinion that the United States had discovered the Fountain of Eternal Growth. At that point the U.S. economy was about seven months into a year of only 2 percent growth, but that fact was not yet known. The bubble apparently burst when people got a fuller picture of what was really going on.

From the standpoint of analyzing "the dollar problem" as it is conceived in this paper, the important points about these psycho-dynamic phenomena are these: they tend to be piggy-backed on the fundamental cyclical forces, and they make exchange rates even less predictable from a speculator's standpoint than they would otherwise be.

It's hard to believe that shifts in "sentiment" would be quantitatively important if it weren't for more fundamental sources of cyclical instability. One casually observes that really outlandish views about the dollar outlook normally become pervasive only in periods when currencies are (or are becoming) way out of line from any reasonable measure of fundamental equilibrium rates. (There was, for example, the "permanent levitation" theory of early 1985). But when the dollar does get way out of line, the power of market psychodynamics to push it even further out of line, or at least to delay basic turning points, should not be underestimated.

This observation ties in with a second one -- that it becomes much riskier to bet on turning points being reached, within a given horizon, if "bubbles" and things are about. In normal or average times (by which we mean over our sample period taken as a whole), expectations appear to be revised by less, over given short intervals, than spot rates themselves move. This provides a basis for speculation to be stabilizing in normal times (as already pointed out). Whether this is true around long-term cyclical peaks or troughs of the dollar is doubtful, at best. The volatility of spot rates during 1985 (which may well have encompassed such a basic turning point) suggests that speculation becomes less stablizing around such extremes.

To sum up this section: we find from model estimation and analysis that the "attack forces" against long-run stability of the dollar are formidable. These forces reflect how commercial and financial business evolves dynamically in private sectors; they are not policy-produced. The kicker on the up side, though, is the short-run fiscal incentive for the United States to go for growth when the dollar is strong, which adds to the dollar problem because under this circumstance net capital inflows dominate the U.S. balance of payments in the short run. For political reasons, there presumeably is not a fully-symmetric danger of U.S. fiscal contraction when the dollar is weak. Finally, the cyclical forces for instability are probably aggravated somewhat by speculative bubbles and other whimsical shifts in investor sentiment that may become important when the dollar is far from equilibrium.

Weakness of Defenses against long-term instability

We should now return to the "defense" side of the system and investigate further the issue of why it seems relatively weak, when set against the dangers just outlined. As already argued (in the Halley's Comet example), the first line of defense is private speculation. The second line is monetary policy, which will be considered later.

Ten years ago there was still a strong following for the view that private forecasting could show people with money how to bet, so that they would sell overvalued currencies and buy undervalued ones. Economic reasoning, with or without benefit of econometrics, was supposed to be the method. Now, by 1985, that view has been virtually laid to rest. Forecasts of exchange rates based on even the best models of "the fundamentals" simply are not very credible as a basis for market operations. This is the proximate "cause" of the dollar problem, and probably the key to its cure.

What is the evidence that exchange rate forecasts do not matter? As part of the AWA Model, we estimate the relative influence on portfolio switching (among currencies) of the interest rate payable on an asset and the expected capital gain (or loss) due to the expected change in the exchange rate (over the comparable period) for the currency in which that asset is denominated. For a given number of points of expected yield over a given interval, the interest element gets about 13 times as much weight (in motivating portfolio-switching behavior) as the exchange rate factor, presumably because the latter is so uncertain. In other words, the contribution of the exchange rate forecast to the evaluation of overall yield gets discounted by a factor of 13. This estimate is up considerably from what it used to be several years ago, when we were using a sample period limited to the 1970's. A few years ago our estimate of this factor was much lower.

The virtual irrelevance of models to market operations

It is no wonder that forecasts are thus discounted when one reads the famous Meese-Rogoff research and finds that the spot rate, taken as a forecaster, usually does less badly at predicting future exchange rates than a fair sample of econometric models -- even when the true values of any exogenous variables in those models (which of course would not be known ex ante) are used.[4/] In other words, when several simple, standard economic models of exchange rates are estimated for various sample periods, using only the data base that would have been available to the forecaster at the time he makes his forecast, and even assuming that he correctly predicts his exogenous variables, he still does not do better in terms of accuracy than he would do if he just took the current spot rate as his forecast. If this is so, why would any investor pay for a model forecast or even bother his head with difficult economic reasoning? And, in fact, few of them do.

Econometricians should not feel badly about the Meese-Rogoff results because, after all, theory tells us that the spot rate should be an extremely good forecaster. It immediately reflects the balances between huge amounts of demands and supplies for various monies. Furthermore, both the spot rate and model forecasts tend to outperform the forward rate (as a forecaster of the future spot rate). This suggests that neither the spot rate nor the models are biased forecasters, whereas the forward rate is biased. One should expect the forward rate to be a biased forecaster (biased by interest rate differentials and the power of covered arbitrage) unless forward-market speculation is extremely responsive to deviations of the forward rate from the expected future spot rate. And since the latter expectation is not generally held with enough confidence to bet on, this responsiveness is low. Expectations about the underlying cycle do not forcefully guide the forward rate, so it is no surprise that they do not guide the spot rate either.

The fact that the spot rate outperforms the forward rate (because the latter is biased) is a sufficient basis for speculative profits (since there exists a better-than-even chance of making a profit gross of transactions costs, from buying forward when the spot rate exceeds the forward rate, or from selling forward when the spot rate is lower than the forward rate). It keeps the speculative activity alive in the forward markets and helps to generate the necessary balance for what commercial traders, hedgers, and arbitragers want to do. Speculative activity performs its economic function reasonably well without benefit of economic models.

Recently, some portfolio optimization routines, designed to assist futures-market speculators on the Chicago IMM, have expressed the forecast of the future spot rate as a weighted function of the present spot rate (and other current financial price data) and of a forecast based on economic fundamentals; the weight attaching to the latter is itself calculated so as to optimize the assumed objective function, given the model's track record. Various economic models have been tried. The weight they get in this optimization routine averages around 5 percent. This is a pretty good indicator of the strength of the linkage between economically-based expectations of exchange rates and current market operations.[5/]

In short, speculative activity is performing its function but does not get much help from economic models. That this is true can be corroborated by checking with major commercial and banking establishments that would, in principle, have the greatest interest. There are some model-based exchange rate services, many of which sprang up in the 1970's, but they are struggling for survival, and the high-growth area of their business tends to be in developing "technical" trading strategies that are at least as likely to be destabilizing as stabilizing in their economic effect. If people thought there was money to be made in developing state-of-the-art exchange rate models, immense R & D resources would be pouring into the effort. But, if anything, this effort is now declining.

One can agonize at length over why models do not do well. The reasons are well known. There is no particular reason to believe that the key functions of the models are at all constant over time, as is formally assumed in the estimation of them. Certainly, policy responses do not lend themselves readily to this assumption of constancy, and private reactions are complex functions of private expectations about official behavior. In short-run forecasting, economic models always get it wrong because, by definition, they cannot anticipate "news", and a key feature of the floating dollar is that it does respond immediately to news (though often in ways that seem capricious). Even if economic forecasts of rates at some horizon date had a good degree of accuracy, any position taken on the basis of that forecast would have a high probability of being wrong in the shorter run -- generating a large unrealized loss before that horizon date was reached.

As for forecasting to long horizon dates -- as might be particularly relevant to the sort of anticipatory action needed to deal with cyclical instabilities -- the problem that one may naturally encounter is that the instability of the model itself (which may have a valid basis in fact) may lead to highly-improbable forecasts. The analyst judgmentally expects parametric changes to occur over that long period, even though they are not allowed for in the estimation of the model itself. Whatever merit there may be in the model for diagnostic purposes, its long-term forecasts truly lack credibility and (probably) accuracy.

The silver lining for private forecasters

A point of satisfaction for the economic forecaster, though, is that the model may still do well in calling the long-term direction of changes correctly. It is significant that models generally do much better on predicting direction of change than on accuracy (say, as measured by root mean squared errors).[6/] One can say, often, that the dollar is likely to go in a certain direction, based on the fundamentals, sometime during a broadly-specified future period. But the exact process that will start and stop its movement, and the level it will stop at, cannot be inferred from the historical record or from one's theoretical framework. The evidence of some success in predicting direction of change over lengthy periods does suggest the possibility of encouraging countercyclical speculation — if the risks of short-term losses could be adequately reduced. Under present arrangements, these risks seem to be too high to expect cyclical instability to be damped in this way, but obviously the situation would be very different if the authorities themselves took an open position on the levels of fundamental equilibrium exchange rates.[2/]

In brief, then, a model may well be good enough to diagnose the qualitative nature of the dollar problem but still not accurate enough to provide a credible basis for action that would be stabilizing, given the policy environment. Despite the ever-growing sample period that is relevant for estimation of the dynamics of the dollar float, learning that would be constructive to the solution of the problem is not taking place at any perceptible speed. During the last few years, instead, we have learned mostly about why constructive learning cannot occur. We have accumulated both theoretical and empirical evidence for the inconstancy, instability, and indeed the indeterminancy of exchange rate relationships.

In the popular press, and then in the U.S. Government, a near-consensus was forged that the dollar became grossly overvalued by early 1985, while at the same time the financial markets grew to accept the idea that a view of the economic fundamentals is practically irrelevant to actual currency operations. That really is the point that deserves to be focussed on, in the discussion of whether and how to improve currency arrangements.

Monetary policy as a limited stabilizer

The second line of defense against dollar instability is monetary policy. What we can verify with dynamic models is that monetary policy -- especially as conducted outside the United States -- restricts or stabilizes the rate of change of the dollar but not its level. This follows from our finding that it is the expected yield on assets (and its change) that is the external target of monetary stabilization policies outside the United States. (Some evidence for these assertions will be found in the Annex, especially Section B and the estimates given in Section E.) But even complete stabilization of yields (including rates of capital gain or loss from currency translation) would not prevent the level of the exchange rate from drifting way off base in the long run.

The level of the exchange rate is of course restricted in the long run by the fact that it controls the international competitive position in markets for goods and services. This is true given that domestic monetary aggregates are fundamentally controlled in all the major countries by the respective central banks, and the trend rates of change in these aggregates determine the trend rates of change of the respective domestic price levels in terms of local currency. But the long-run restriction on the level of the exchange rate that is thus implied by the long-run need to retain international competitiveness does not preclude, either logically or empirically, explosive cycles.

But how do we know that relative purchasing power parity does not tend to be maintained continuously, thus placing a short-to-medium-run restriction on the level of the exchange rate (given the tracks of the monetary aggregates)? To the extent that such a PPP-force might prevail, it would provide a channel for automatic stabilization of the exchange rate level that was independent of the slow adjustment speed on trade and the stock-flow factors that pose the threat of instability. More specifically, if given inflation differentials were continously and fully incorporated into expected changes in exchange rates, and hence into spot rate trends (via the tendency toward portfolio balance), the occasional need for exchange rates to adjust by large amounts to correct already-large disequilibrium in competitive positions might be reduced. And, presumably, this would militate against big deviations of observed spot rates from their underlying trends continously satisfying PPP.

We have measured this continuous force toward PPP; unfortunately it is very small and not significant statistically. (This is the parameter ψ in the AWA Model, discussed in the Annex.) Moreover, this force has apparently been declining over time -- perhaps as investors have learned to ignore it. But our model estimation does corroborate the view that there is a trade-off between the strength of the continuous PPP force and the strength of the cyclical process whereby price competitiveness eventually gets adjusted through swings in trade balances, external debt, and exchange rates. (The evidence of such a trade-off is that the estimates of the parameters governing the two processes, particularly the parameter ψ versus the parameters α_1 , in the AWA Model, tend to move in opposite directions, given changes in data or specification.) This suggests that, if the PPP force could be strengthened as a matter of policy, the forces for instability would be weakened.

The main point here is that, even if the monetary authorities of the major countries controlled domestic inflation and stabilized expected rates of change in exchange rates against the dollar, they would not be doing enough to give speculators the pegs they need (and that the system needs) to keep things reasonably stable. Information about what the <u>levels</u> of the rates ought to be, of significance to market operators, must somehow be supplied in order to make a real difference to the system's behavior.

How to empower monetary policy as a stabilizer

The question of how to get such information on exchange rate levels can be answered -- not precisely and unambiguously, but well enough to contribute to better performance of the system in the future. Roughly speaking, one needs to calculate the underlying trend levels of exchange rates that are consistent with PPP or with some more general concept of fundamental equilibrium.[7/] Any dynamic model used for diagnostic purposes may (but does not necessarily) have a steady-state solution for all the endogenous variables and for the exchange rate levels in particular. If it does, the steady-state level of each exchange rate will be a particular function of the estimated constants and parameters of the model and of the levels of the exogenous variables (e.g., the trend levels of domestic prices or money stocks). The rates of change in these "fundamental equilibrium exchange rates" (FEERs) will normally be particular functions of the rates of change in the exogenous variables. Appearing in these functions will be estimated parameters of the model.

It would be legitimate and interesting to calculate FEERs in a variety of models. For purposes of such research we should define the class of models that are relevant. To serve the purpose at hand the model should ideally:

(1) have a well-defined steady state;

(2) go as far as the state of the art allows to specify realistic dynamics;

(3) handle stabilization policies as endogenous functions, if that is an empirically valid characterization of these policies; more generally, avoid including exogenous variables that in reality are interdependent with exchange rates;

(4) be estimated consistently.

The desirability of (1) is based on the idea that the steady state is the simplest and perhaps the most "objective" way to define fundamental equilibrium. Criterion (2) is needed to maximize the credibility of the policy strategy in the eyes of market operators. Criterion (3) is necessary to avoid begging the question. Any calculated FEERs will depend on the levels of variables treated as exogenous in the model, and if these variables are in reality interdependent with exchange rates, then the question of their steady-state levels would need to be addressed. And the only satisfactory way to do this is to endogenize these variables in the model. This may well mean that fully satisfactory models will have <u>no</u> exogenous variables, apart from "time". Criterion (4) is needed for accuracy and credibility; in practice it probably means estimation of the entire system in one shot by Full Information Maximum Likelihood.

To the extent that these criteria conflict (e.g., completeness of specification versus consistency of estimation), a balanced package must be the aim. Judgments will differ, of course, on the trade-offs encountered in balancing these criteria, and no one model may emerge as uniquely more useful than some others. On the other hand, any model that does well in satisfying all four criteria will be an adequate tool for the purpose, in this author's opinion. FEERs generated by all such models will probably be closely clustered, relative to the deviations of spot rates from the FEERs that we have been seeing and that we are likely to see in coming years, if the system's behavior is not qualitatively improved. At the present state of research, this assertion is no better than an informed guess, and it would seem important to gather evidence supporting or contradicting it.

If this view is correct, there is no need to use just one model and to ignore others. Moreover, any such model should be re-estimated periodically in order to keep the parameter estimates consistent with the full information set available. Such updating is very unlikely to shift the FEERs substantially over short periods, but over long periods the updating of estimates will help to keep abreast of changing trends.

A major purpose of the FEERs is to encourage counter-cyclical (hence, stabilizing) speculation by reducing the risk of betting on the depreciation of overvalued rates and on the appreciation of undervalued rates. The idea is thus to strengthen a process that is already operating (as we have noted) but that happens to be too weak to be effective, given the virulence of the "attack forces" in the system.

Implicit in this proposal is that monetary authorities calculate FEERs, and publish them (or else publish the method of their calculation with sufficient precision so that others can do the calculation), and hence endorse the estimates. In this sense, the monetary authorities need to "take a position" on exchange rates, which naturally means that they need to take some risk (at least in a political sense).

Moreover, to reduce the private risk of countercyclical speculation, it is necessary that the monetary authorities give some weight to deviations of spot rates from FEERs -- that is, other things being equal, to ease monetary conditions when the currency is overvalued and to tighten them when the currency is undervalued.

The most efficient and direct way to do this would be through forward-market operations: the authority would be prepared to buy its currency forward when undervalued, for instance; this would be seen by private traders as an expression of official intent to tighten during the period of the forward contract. If these intentions were made good, the effect would tend to be profits for the authority, and the private incentive would thus be to compete for these profits by anticipating official action in the forward markets.

This strategy would be an efficient way to accomplish the objective because it should minimize actual changes in official balance sheets. In principle, it could tend toward a pure signaling system, with private traders calculating the FEERs in advance, anticipating the likely official action, and hence themselves driving the spot rate sufficiently close to the FEER. Ultimately, the gravitational force of the FEER on the spot rate would naturally depend on the weight that deviations (of the spot rate from the FEER) would get, *ex ante*, in the conduct of monetary policy, as this policy is perceived by private operators.

Focusing official use of FEERs on forward operations would be the most direct way to buttress private speculation, because then the authority could take a position on the speed of intended adjustment.

Forecasting with the estimated models should give some notion of the time it is likely to take for the spot rate to return to the steady-state level. Now, as we have stated, these forecasts are not very accurate, but the direction is usually right, and the models supply the best evidence that exists about the relevant speeds of adjustment. So the authority should take these estimated dynamics into account when selecting the markets in which to operate. To the extent feasible (which at present, admittedly, is not great), the authority should avoid making forward bets that would appear to assume an unrealistically fast adjustment of the spot rate, taking into account the speeds of adjustment of supporting policies. In this way the authority could exercise the most direct sort of leadership of the private process of stabilizing speculation.

In sum, if it is possible to use a dynamic model to understand the disequilibrium of the exchange rate and related variables, and on this basis to diagnose the dollar problem, then it should be possible to use that same model to compute an equilibrium path for that rate through time. A relatively simple measure of such paths would be the mathematical steady state of the model, if it exists. There will never be a uniquely satisfactory model, nor, therefore, a uniquely acceptable equilibrium path. But that fact does not rule out the possibility that the general approach may be useful.

The steady-state vector of the various exchange rates at any time (like the present) can be viewed as a complex transformation of the relevant body of historical data -- a transformation that, though perhaps complicated, can enter the domain of public opinion and become part of the state of data to which portfolio managers respond through time. Once that happens, and once monetary policies themselves begin to respond to deviations of spot rates from "FEERs," exchange rate fluctuations will become damped, as diagnosed by the models. That is, as it becomes possible to estimate the models on the basis of data for the period over which FEERs were calculated and used, the model's estimated parameters will incorporate the effects of that damping, and the formal stability analysis of the model will reflect those effects.

The amount of damping of course depends on the weight that the authorities are prepared to give to deviations from FEERs in running their overall stabilization policy. The analyst cannot presume to say what this weight should be. All he can say is that this is the lever to use. And when it comes to preferences, it looks like there would be wide agreement now that this weight should be greater than its recent historical value of near-zero.

Conclusion

The monetary authorities constitute the second line of defense against cyclical instability of the dollar, but they have been ineffective in this defense because they have not been able or willing to convey to the marketplace any sense of what the levels of exchange rates ought to be. So private risk assessments have not been strongly related to deviations of spot rates from any measure of fundamental equilibrium (such as the steady state of an appropriate model). Thus, the forces tending toward cyclical instability of the dollar float have not been substantially curbed by any official commitment to stability as a goal of policy.

How can one explain the failure of monetary policies to deal with the dollar problem? An explanation is not hard to find. The tools of disequilibrium dynamics are not yet familiar to most people in positions of influence. Although most people naturally think in disequilibrium terms when they read the newspaper, the intellectual tools for most of the academic discussion of exchange rate management are the tools of static equilibrium analysis. A discrete "shock" somehow materializes exogenously, and the authorities are meant to see it and offset its effects, in the process optimizing their social welfare functions. This sort of analysis has proved to be sterile, for reasons that should be obvious by now.[8/]

On the other hand, the theoretical attack on this approach that draws its inspiration from efficient-market theory has been paralyzing. The practical thrust of its message is that there can't be a dollar problem, and even if there were one, nothing could be done about it. Although correctly pointing to the difficulties of drawing valid and useful conclusions for monetary policy from older styles of analysis, the efficient-market intelligensia has not produced a coherent policy strategy for dealing with problems of near-efficiency in the foreign exchange markets.

The U.S. Administration now recognizes the need for active official involvement in correcting the dollar overvaluation that emerged during 1981-85, but it has apparently not yet understood the structural nature of the problem nor what to do about it. As yet (December 1985) there has been no hint of a commitment to a workable policy of dollar stabilization that would be consistent with a return to a tenable balance in the world economy. Under these circumstances, the official move to drive the dollar down (commencing with the Group-of-Five meeting of September 22, 1985) may well inaugurate the next great phase of dollar undervaluation.

A vital first step has been taken: the U.S. Government has recognized that the monetary authorities need to take some sort of policy position regarding the level of the exchange rate. An official clarification and articulation of that policy position is now needed, in order to successfully manage the risks that the world economy faces in 1986 and in the following years.

Notes

1/ Econometric evidence is provided in the Annex to this paper which documents the AWA Exchange Rate Model. The estimation and analysis reported in that Annex was based on data through September 1983. More recently, re-estimation including data through 1984 has, as expected, strengthened the case made in the main text of this paper. That is, in several key respects, estimates of parameters contributing to the long-run cyclical instability of the system were revised upward or became more significant statistically. Throughout this paper, assertions about the functioning of the system are generally based on the AWA Model research -- often the reference being to some particular aspect of the model specification or parametric estimate.

2/ See Paul Armington, "Equilibrium Exchange Rates and the Return to Balance in the World Economy" (forthcoming).

3/ See, for instance, Wing T. Woo, "Speculative Bubbles in the Foreign Exchange Markets," Brookings Discussion Papers in International Economics, No. 13, March 1984.

4/ The latest in this line of research is Richard Meese and Kenneth Rogoff, "Was It Real? The Exchange Rate-Interest Differential Relation; 1983-1984" (mimeo). Or earlier, by these authors, "Empirical Exchange Rate Models of the Seventies: Do They Fit Out-of-Sample?" Journal of International Economics 14, February 1983.

5/ Relevant references here are John F.O. Bilson, "Macroeconomic Stability and Flexible Exchange Rates," AEA Papers and Proceedings, May 1985, pp. 62-67. See also his paper with David Hsieh, "The Profitability of Currency Speculation," manuscript, University of Chicago, 1984. Also, Paul Armington and Catherine Wolford, "Identifying Opportunities for Speculative Profit Using the AWA Exchange Rate Model," manuscript, Armington, Wolford and Associates, May 1984.

6/ Evidence on the performance of the AWA Model in forecasting direction versus accuracy is summarized in Armington & Wolford paper cited in note 5.

7/ A number of rather different concepts and measures of equilibrium exchange rates exist. A companion paper (note 2) surveys this subject briefly.

8/ For a recent example of this sort of analysis, see OECD, Exchange Rate Management and the Conduct of Monetary Policy, Monetary Studies Series, Paris, 1985.

ANNEX:

The AWA Exchange Rate Model

Contents

A. Introduction: data and notation
B. Non-U.S. equations of the behavioral model
C. Derivation of the structural model (non-U.S. equations) from the behavioral model
D. The U.S. equations
E. Tables

Annex I. The AWA Exchange Rate Model

A. Introduction: data and notation

The AWA model deals with the stocks of global liabilities (or assets) outstanding in given currencies--those for Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Switzerland, the United Kingdom and the United States. These stocks are here constructed simply by integrating the adjusted current account balances of the corresponding countries over the sample period, using arbitrary, but large, initial stocks as the starting points. (The relative size of these initial stocks is given by the weights of the respective currencies in the 16-currency SDR basket introduced by the IMF in 1974.) The current account data have been obtained quarterly in dollar terms (from the IMF Data Fund), deflated by the U.S. GNP deflator, seasonally adjusted, and further adjusted (by a simple pro-rata process) so that they sum to zero across the ten countries in the model. Thus, if the resulting stocks (integrals) are summed across this "world" of 10 major countries, "world" liabilities (or assets) are constant. That is, world "wealth" in this sense is fixed, by construction, but its currency composition varies in function of the histories of current account imbalances — a deficit being assumed to increase the relative stock of global wealth required to be held in the corresponding currency, and a surplus being assumed to reduce that relative stock. Fluctuations in such stocks put pressure on currency values as well as on interest rates. The model is a set of log-linear equations that describe these pressures.

The other data used are as follows: exchange rates are end-of-month spot rates against the dollar; interest rates are end-of-month 90-day eurocurrency rates (except U.S., which is a domestic CD rate); domestic "underlying" price levels are annual GDP deflators. Quadratic interpolation is used to change all non-monthly variables to frequency of one month, which is the basic time unit of the model.

The U.S. dollar is chosen as the numeraire currency. There is no equation for the U.S. exchange rate or for the U.S. balance of payments (both being implied by the non-U.S. equations). There are, however, equations for the U.S. interest rate (90-day CD) and domestic price level (GNP deflator), which are solved within a small sub-model of the United States that also includes total final demand (for U.S. output), private domestic demand, and the current receipts and payments of the consolidated U.S. household and business sectors. 1/ This U.S. model has been estimated using quarterly data; then the results have been re-stated at monthly frequency and merged with the the non-U.S. equations.

The only exogenous variables in the AWA Model are the underlying trends of domestic prices, plus dummies (like TIME) and stochastic disturbances.

1/ Documentation for this U.S. model is available separately in Armington and Wolford (September 1983).

In the notation used below, non-subscripted variables refer to any particular country, unless otherwise noted--i.e., any one of the countries included in the model. Likewise, parameters vary across countries, except as noted. Variable names designate the natural logarithm of the variable. For interest rates, the variable is the natural log of the expression 1 plus the proportionate rate of interest.

The notation is as follows:

Variables in the Non-US Equations (logarithms)	Description
X	stock of liabilities or assets (in a particular currency)
$\hat{X}$	desired (equilibrium) level of X, given all yields
ρ	effective rate of discount on X (equal, with opposite sign, to the effective rate of return on X)
ρ_w	average of ρ across all assets or countries in the model
r	interest rate in terms of local currency (the log of 1 plus the proportionate rate, expressed at a monthly rate) 1/
e	actual exchange rate, in U.S. dollars per local unit
$\tilde{e}$	future exchange rate as expected by money managers (adaptive)
$\overset{*}{e}$	present underlying exchange rate as interpreted by commercial traders (adaptive)
$\bar{e}$	fundamental trend of exchange rate, related only to underlying trend of price level

1/ When the U.S. interest rate appears in the non-U.S. equations, the true monthly data for the U.S. 90-day CD rate is used. (The same series expressed at quarterly frequency is used in estimating the U.S. sub-model).

$\bar{P}$	underlying trend of the domestic price level (exogenous), approximated by a quadratic interpolation from annual data 1/
$\hat{r}$	desired interest rate (i.e., the appropriate rate from the standpoint of monetary policy)
$\bar{r}$	fundamental level of r, related only to the underlying trend of the price level
R	the real (or price-level-adjusted) exchange rate
$\bar{R}$	the underlying real exchange rate, as viewed by commercial traders

Variables in the U.S. Equations 2/ (logarithms)	Description
r	90-day CD rate (the log of 1 plus the proportionate rate)
P	GNP deflator
Y	real final demand (GNP less change in inventories)
Z	exports of goods and services plus public-sector expenditures (constant dollars)
M	imports of goods and services plus public-sector receipts (constant dollars)
E	Y - Z (= real private absorption of home output)
D	dummy for interest rate equation (1.0 from 1967 through 1973, and zero at other times)
T	dummy for "time"
U	long-term cycle dummy, represented by a sine curve with a period of forty years, with troughs in 1960 and 2000 (thus a peak in 1980).

1/ Also supplied for the United States. $\bar{P}$ for the United States, while treated as exogenous in the estimation of the non-U.S. equations, is (in forecasting) derived from the solution for P in the U.S. bloc.
2/ These data are obtained quarterly for estimation purposes and (except r) interpolated to monthly frequency when the U.S. sector is merged with the non-U.S. equations. For r, the true monthly series is used in the merged model.

B. Non-U.S. equations of the behavioral model 1/
Demand for Assets (9 independent equations):

$$(1)\quad \hat{X} = -\sigma(\rho - \rho_w)$$

Parameter σ, assumed equal across countries, may be interpreted as a measure of "level-3 smoothing activity." The (omitted) constant term may be viewed as some portion of (constant) world wealth, such that in the steady state, when $\rho = \rho_w$, the demand for claims denominated in the given currency is equal to that constant portion of global claims. In disequilibrium, ρ will normally be adjusting so as to drive $\hat{X}$ toward X, which is in turn determined by the current account of the balance of payments (equation 11). Parameter σ, the elasticity of substitution between assets denominated in different currencies, is a rather small number (a little over 1--see Table 1), owing mainly to uncertainties about exchange rate expectations.

Stock/flow adjustment of effective discount rates (9 equations):

$$(2)\quad d\rho = \alpha_1(\hat{X} - X) - \delta dX$$

This is a standard adjustment function used in models of commodity prices. See, e.g., Richard (1978). The effective rate of discount is the "price" that moves to clear the market for X. Both stock disequilibrium and flow

1/ Parameters, indicated by Greek letters, are expected to be positive, except as noted. Constants and disturbances are not noted but are implicit, except in the definitions. All relations are stochastic except (3), (6), and (12). The material in this section represents an updating of, and improvement upon, the earlier specification described in Armington (January 1982). A somewhat similar system was described by Richard (1980).

disequilibrium (the current balance, dX) may affect ρ. The α_1 parameters are strongly determined in the estimation and account for most of the adjustment of the ρs. The δs, while having the right sign, are statistically weak (see Table 1). In the hypothetical steady state, $\hat{X}$=X, dX=0, and dρ=0. In the true disequilibrium condition, movements in X and the limited nature of the feedback to $\hat{X}$ (since σ is small) keep the ρs in perpetual motion.

Definition of the effective rate of discount (for all 10 countries):

(3) $\rho = -\gamma r + \beta_1[e - (\tilde{e} - d\bar{e})] - d\bar{e}$

Parameters γ and β_1 are constrained to be the same across countries. The negative of ρ can be thought of as the expected rate of return on holding X, expressed at a monthly rate. Correspondingly, $\underline{r}$ and $d\bar{e}$ are expressed at monthly rates, and $\tilde{e}$ is the asset market's forecast positioned one month ahead in time. Parameter γ (now estimated at 13) scales up the number of interest-rate "basis points" so that they become comparable (in terms of motivating capital flows) with basis points of expected gain or loss owing to the predicted exchange rate movement. Parameter γ exceeds one because future exchange rates are not predictable with good accuracy. The predicted movement is in turn decomposed into a "trend" term, $d\bar{e}$, and a deviation-from-trend term (the bracketed expression in (3)) that compares the present actual exchange rate with the expected rate "discounted" to the present using that trend. Such a deviation measures an expected capital gain or loss, not over one month necessarily, but over a period of time comparable to the time it would take for $\underline{e}$ and $\tilde{e}$ to be equalized (assuming no further changes in $\underline{e}$). This represents an approximation of the rational holding period of speculative positions. Thus, to express this gain or loss at a monthly rate, the bracketed expression in (3) needs to be divided by the mean time lag in the adjustment of $\bar{e}$ to $\underline{e}$, that is, multiplied by the corresponding speed of adjustment, in months. This speed of adjustment is the parameter β_1, presently estimated very solidly at 0.4 months (i.e., a mean time lag of 2.5 months), as shown in Table 1. Note: for the United States, $e=\underline{e}=\bar{e}=0$.

<u>Adaptive expectations of the future (one period ahead) exchange rate, as interpreted by asset managers:</u>

$$(4) \quad d\tilde{e} = d\bar{e} + \beta_1[e - (\tilde{e} - d\bar{e})]$$

This is the standard formulation for adaptive expectations in continuous time, with the modification that asset-market participants are here assumed to have a view of the underlying trend in $\underline{e}$, derived extraneously from a long-term view of relative inflation in the respective country (see equation 5). β_1 here is, of course, the same speed of adjustment that appears in (3).

<u>Link of underlying trend of exchange rate and underlying inflation:</u>

$$(5) \quad d\bar{e} = -\psi(d\bar{P} - d\bar{P}_{US})$$

Parameter ψ is constrained to be the same across countries. In a long-run equilibrium model with a "PPP" assumption, ψ would be expected to be about 1.0. We find, though, that ψ in disequilibrium is no more than about 0.1. Apparently, uncertainties surrounding the significance of inflation differentials for asset-market pricing, over horizons normally relevant for participants in these markets, are so great as to deprive those differentials of much direct impact. This doesn't mean that inflation is irrelevant to exchange rate determination, but only that its systematic influence in disequilibrium (i.e., apart from "news" impacts that would constitute disturbances in (4)) is transmitted through the determination of current account balances in (11) and hence to the asset markets via (2). Indeed, before payments balances were endogenized in the model, ψ was estimated to be much bigger and stronger statistically. And the more success we have had in endogenizing the feedbacks to the flows and stocks in the system, the lower the estimate of ψ has become and the less its significance.

Definition of ρ_w:

(6) $\rho_w = \sum_k (c_k \rho_k)$, $k = 1,\ldots,10.$

The c_k are weights, taken as SDR basket shares (using the 16-currency basket introduced by the IMF in 1974 and that endured until 1981). Country 10 here is the United States, and the U.S. interest rate enters the model at this point and hence influences desired capital flows via (1).

Equation blocks (1) to (6) are used to form the "exchange rate equations" of the structural model; see Part II.C.

Adjustment of interest rates to appropriate levels:

$$(7) \quad dr = \lambda(\hat{r} - r)$$

This formulation allows for lags in the implementation of monetary reactions to the external environment, these reactions being here represented by changes in interest rates on euro-currency deposits. The estimates for λ are strong and tightly clustered, and they imply a mean time lag, on average, of three weeks (Table 1).

The effective rate of discount [1/] as the target variable of international financial stabilization policy:

$$(8) \quad \hat{r} = \bar{r} + \alpha_2(\rho - \bar{\rho}) + \alpha_3(d\rho - d\bar{\rho})$$

Parameters α_2 and α_3 may be interpreted as measures of "level-4 smoothing activity." Their signs are expected to be negative, since if ρ is high, e is "overvalued," and r should fall to achieve a smoothing action. In this formulation, $\hat{r}$ may be viewed as a proximate target of policies aimed at maintaining, in international markets, the relative attractiveness of assets denominated in local currency. For example, through policy action that reduces the average liquidity of the outstanding stock, r can presumably be raised, thus making that stock more attractive to hold and inducing desired capital inflows through (3) and (1). Following Phillips (1954), α_2 can be called the "proportional stabilization policy," and α_3 can be called the

1/ Note: Only the disequilibrium variance of ρ is included in (8); that is, the e terms appearing in (3) are dropped from (8) and (10).

"derivative stabilization policy." These policy parameters, calculated only for the non-U.S. countries, are very strongly identified in the estimation (Table 1). (An attempt to estimate such an equation for the United States got nowhere--the U.S. estimates for both α_2 and α_3 being essentially zero). The statistical strength of the estimates is attributable in part to the choice of interest rate series: "domestic" interest rate series generally yield less strong results than the euro-deposit rates used here.

Link of underlying level of the interest rate and underlying inflation:

(9) $\gamma\bar{r} = \psi d\bar{P}$

This formulation is suggested by the steady-state conditions on "real" interest rates that are implied by equation sets (1) to (6). Since the bracketed expression in (3) is zero in the steady state, and since ρ is constant and equal across countries in this state, there would be a tendency for the expression ($\gamma r-\psi d\bar{P}$) to be equalized across countries if the steady state were approached. At the same time, by definition, $\underline{r}$ would be tending toward $\bar{r}$ everywhere. Thus, interest rate policies would be consistent across countries and with the pursuit of international asset market equilibrium if (9) is true. That is, given (7) to (9), the interest rate levels toward which monetary policies are tending, as the authorities' ρ-targets are realized, are the same interest rate levels that would satisfy the system (1) to (6) if all portfolios and payments flows were in balance and if all exchange rates were exactly as anticipated. It might be argued, moreover, that if the steady state had always been true, there would be no basis for expecting γ and ψ to differ from 1; further, it is later shown that ψ must be 1 in the steady state, in order to be consistent with the steady state of the trade equations. With these additional stipulations, therefore, the steady state form of (9) is just the Fisher condition.

The target level of ρ for currency stabilization:

$$(10)\quad \bar{\rho} = \beta_1 \sum_k [w_k(e_k - \tilde{e}_k)]$$

This formulation is similar to ρ_w except: a) the foreign interest rates do not appear here (as a consequence of tests that seemed to show only a concern with the exchange rate component of foreign yields); b) only the non-trend variance of ρ_w is relevant here; c) weights w_k need not be (and generally are not) the same as weights c_k. In computing $\bar{\rho}$ for the smaller EMS currencies, for example, we assume that Germany gets the preponderant weight. The w_k are not estimated but, like the c_k, are entered as constants; they are chosen to be consistent with actual currency arrangements and on the basis of the actual results of estimation.

Equation blocks (7) to (10), along with (3) and (4), are used to form the "interest rate equations" of the structural model; see Part II.C.

Linkage of the balance of payments on current account to the underlying, real effective exchange rate and to the current, real effective exchange rate:

$$(11)\quad dX = \eta(\bar{R} - \bar{R}_w) + \phi[R - R_w]$$

As already noted, a positive (or negative) value of dX is associated with an adjusted deficit (or surplus) on current account (Part II.A.). Parameters η (expected to be positive) may be interpreted as measures of long-run "level-5 smoothing activity," critical in generating turning points in the long-run cycles. The ϕ may be either positive (stabilizing) or negative (destabilizing). Negative estimates of ϕ could serve to generate so-called "J-curve" effects. As it turns out (Table 1), virtually all of our estimates of ϕ are negative and, therefore, destabilizing to the system (i.e., contributing to the undamped character of the cycles and delaying turning points--see Tables 3 and 4). The J-curve effects are particularly strong for Italy and the United Kingdom. On the other hand, the long-run "price" elasticities η (which are meant to capture all relevant aspects of the real-transfer process following eventually upon a "fundamental" overvaluation or undervaluation of a currency) are virtually all positive, according to our estimates (Table 1); and, with some exceptions, they are at least as large as would seem broadly consistent with adequate medium-term adjustment (Table 6). The major exceptions are the Netherlands and the United Kingdom, for whom the normal price-volume relationships were seriously distorted in the sample period by changes in the price of oil and gas.

Definition of the underlying real exchange rate, as viewed by commercial traders:

(12) $\bar{R} = \overset{*}{e} + \bar{P}$, and $\bar{R}_w = \sum_k [s_k(\overset{*}{e}_k + \bar{P}_k)]$

where s_k are trade weights calculated using the IMF Multilateral Exchange Rate Model, as described in Artus and McGuirk (1981). The current real exchange rate, R, along with R_w, is also defined as in (12), except that the current exchange rate, e, replaces $\overset{*}{e}$ in both definitions. R is meant to pick up mainly short-run, terms-of-trade effects, while $\bar{R}$ is meant to measure the competitive position, in a medium-term sense, with respect to trade in goods and services. A positive (or negative) value of $(\bar{R}-\bar{R}_w)$ suggests that home goods are viewed as overpriced (or underpriced) relative to those of trading partners taken as a whole. The weights s_k, attaching to the various partners' indices, are proportional to the computed medium-term effects, on the trade balance of the home country, of one-per-cent changes (ceteris paribus) in the respective, partner-country exchange rates, using the IMF "MERM" to perform these calculations. Thus, in this sense, a reduced form of the "MERM" is built into the AWA Model as a block of constants.

Adaptive formation of the (present) underlying exchange rate, as interpreted by commercial traders:

(13) $d\overset{*}{e} = \beta_2(e - \overset{*}{e}) - (d\bar{P} - d\bar{P}_{US})$

Parameter β_2 can reflect the speed with which "level-5 smoothing activity" is effected; thus a higher β_2 can indicate more such activity per unit of time.

β_2 is solidly estimated at .05 (Table 1), implying a mean time lag of slightly less than two years. In other words, it would take about two years for an actual change in R (due to a change in e) to be fully recognized as an underlying change in the competitive position and hence to entail the real adjustments signified by η. (Of course, it is immaterial whether this is literally a "recognition lag" or a lag of some other nature.) This long lag turns out to be a major factor, like the negative ϕs, contributing to the undamped and attenuted quality of the cycles in the system (Table 4).

Equation (13) also specifies that $\overset{*}{e}$ will have an underlying trend that offsets the underlying inflation differential vis-a-vis the United States. In the steady state, $e=\overset{*}{e}$, and $R=\bar{R}=\bar{R}_w=R_w$. Since, in addition, $e=\bar{e}$, consistency between (5) and (13) requires that $\psi=1$ in the steady state.

Equation blocks (11) to (13) are used to form the "current account" equations of the structural model; see Part II.C.

C. Derivation of the structural model (non-U.S. equations) from the behavioral model

This derivation is long and laborious but is straight-forward algebra, with differentiation required to set up the replacement of "expected" or "underlying" values by their equivalents in terms of observable variables. For detailed notes on this derivation, contact Armington, Wolford & Associates.

To derive the exchange rate equations, substitute (1) into (2), and use (3), (4), and (5) or their derivatives to eliminate ρ, $\tilde{e}$, and $\bar{e}$ as far as possible. This leads to a first-order system of exchange rate equations as follows:

$$de = \frac{\gamma}{\beta} dr + \frac{\alpha_1 \sigma \gamma}{\beta} (r - r_W) + (\beta_1 - \alpha_1 \sigma)\, e - (\beta_1 - \alpha_1 \sigma)\tilde{e} + \alpha_1 \sigma\, e_W - \alpha_1 \sigma\, \tilde{e}_W$$

$$- \frac{\alpha_1}{\beta} X - \frac{\delta}{\beta} dX - (1+\beta_1)\psi d\bar{P} - \frac{(1-\beta_1)}{\beta_1} \alpha_1 \sigma \psi (d\bar{P} - d\bar{P}_W) - \frac{(1-\beta_1)}{\beta_1} \psi d^2\bar{P},$$

where $r_W = \sum_k (c_k r_k)$, $e_W = \sum_k (c_k e_k)$, $\tilde{e}_W = \sum_k (c_k \tilde{e}_k)$,

and $d\bar{P}_W = \sum_k (c_k d\bar{P}_k)$.

Then differentiate this equation, substitute from (4) to eliminate de, solve for the $\tilde{e}$ terms, and substitute the result into the above equation, so as to get rid of all $\bar{e}$ terms. The result is a system that is second-order in e and r, which can be written as follows:

$$\text{I.}\quad d^2e - \frac{\gamma}{\beta_1}d^2r - \gamma(1 + \frac{\alpha_1\sigma}{\beta_1})\,dr + \gamma\frac{\alpha_1\sigma}{\beta_1}dr_W + \alpha_1\sigma de - \alpha_1\sigma de_W - \gamma\alpha_1\sigma r$$

$$+ \gamma\alpha_1\sigma r_W + \alpha_1 X + \frac{\alpha_1}{\beta_1}\,dX + \delta dX + \frac{\delta}{\beta_1}\,d^2X + 2\alpha_1\sigma\psi d\bar{P} - 2\alpha_1\sigma\psi d\bar{P}_W$$

$$+ (\frac{1-\beta_1}{\beta_1}\,\alpha_1\sigma\psi + 2\psi)\,d^2\bar{P} - (\frac{1-\beta_1}{\beta_1})\alpha_1\sigma\psi\,d^2\bar{P}_W + (\frac{1-\beta_1}{\beta_1})\psi d^3\bar{P} = 0.$$

The third-order term, or acceleration in inflation, has not been included in the estimation; this exclusion reduces the number of exogenous variables by nine and hence gains valuable degrees of freedom.

To derive the interest rate equations of the structural model, substitute (10), and its derivative, into (8). Also substitute (9) into (8). The result is substituted into (7). Use (3), (4), and (5) to eliminate ρ, e, and $\bar{e}$ as far as possible, as above (note, however, footnote 1/, p. 31). This leads to a first-order set of interest rate equations, as follows:

$$\gamma dr = -\gamma\alpha_2\lambda r + \alpha_2\lambda\beta_1 e - \alpha_2\lambda\beta_1 e'_W - \gamma\alpha_3\lambda dr + \alpha_3\lambda\beta_1 de$$

$$- \alpha_3\lambda\beta_1 de'_W - \alpha_3\lambda\beta^2 e + \lambda\alpha_3\beta^2 e_W - \gamma\lambda r + \lambda\psi d\bar{P} - \alpha_2\lambda\beta_1\bar{e}$$

$$+ \alpha_2\lambda\beta_1\bar{e}'_W + \alpha_3\lambda\beta_1^2\,\bar{e} - \alpha_3\lambda\beta_1^2\,\bar{e}'_W,$$

where $e'_W = \sum_k (w_k e_k)$ and $\bar{e}'_W = \sum_k (w_k\bar{e}_k)$.

Then differentiate this equation, substitute from (4) to eliminate $d\bar{e}$, solve for the $\bar{e}$ terms, and substitute the result into the above equation, so as to get rid of all $\bar{e}$ terms. The result is a system that is second-order in r and e, which can be written as follows:

$$\text{II.}\quad d^2r - \frac{\alpha_3\beta_1}{K} d^2e + \frac{\alpha_3\beta_1}{K} d^2e_W' + [\beta_1 + \frac{\gamma(1+\alpha_2)}{K}]dr - \frac{\alpha_2\beta_1}{K} de$$

$$+ \frac{\alpha_2\beta_1}{K} de_W' + \frac{\gamma\beta_1(1+\alpha_2)}{K} r - \frac{\beta\psi}{K} d\bar{P} - \frac{\psi}{K} d^2\bar{P} = 0,$$

where $K = \gamma(\frac{1}{\lambda} + \alpha_3)$.

To derive the balance of payments equations of the structural model, substitute (12) and the corresponding definitions of R and R_W into (11), yielding a first-order system in X and $\overset{*}{e}$:

$$dX = \eta\overset{*}{e} + \eta\bar{P} - \eta\overset{*}{e}_W'' - \eta\bar{P}_W'' + \phi e + \phi\bar{P} - \phi e_W'' - \phi\bar{P}_W'',$$

where $\overset{*}{e}_W'' = \sum_k (s_k\overset{*}{e}_k)$, $\bar{P}_W'' = \sum_k (s_k\bar{P}_k)$, and $e_W'' = \sum_k (s_k e_k)$.

Then differentiate this equation, substitute from (13) to eliminate $d\overset{*}{e}$, solve for the $\overset{*}{e}$ terms, and substitute the result into the above equation, so as to get rid of all $\overset{*}{e}$ terms. The result is a system that is second order in X, as follows (d^2X being a measure of change in the deflated current account, expressed as a proportion of a given stock figure):

$$\text{III.}\quad d^2X + \beta_2 dX - \phi de + \phi de_W'' - \beta_2(\eta+\phi)e + \beta_2(\eta+\phi)e_W'' - \phi d\bar{P}$$

$$+ \phi d\bar{P}_W'' - \beta_2(\eta+\phi)\bar{P} + \beta_2(\eta+\phi)\bar{P}_W'' = 0.$$

(Note: in order to reduce the number of exogenous variables by ten, and hence gain valuable degrees of freedom in estimation, we are presently using $\bar{P}_W$ in place of $\bar{P}_W''$ in set III.)

The structural model (excluding the U.S. equations and identities) thus consists of sets I, II, and III, for each of 9 countries, or 27 equations. The $\bar{P}$ terms ("underlying" domestic price levels, calculated by a quadratic interpolation of annual GDP deflators) are all treated as exogenous, and everything else is endogenous. For estimation and analytical purposes this second-order system is expressed as a system of 27 first-order stochastic equations in (say) Π, μ, and τ plus 27 first-order identities: Π=de, μ=dr, and τ=dX. And this 54-equation, first-order system is then merged with the U.S. model (which is first-order) to obtain the system used for analysis and forecasting. Some of the W-subscripted variables are included as separate variables in the model, with the corresponding identities being added to the equation set; however, in most instances the individual partner-country variables are simply included in the stochastic equations, and the restrictions on their coefficients derived from the theory are carried through in the estimation.

D. The U.S. equations 1/

Stochastic:

(1) $dP = u_pU + c_p(Y - \bar{Y})$

where $\bar{Y} = t_yT$ and u_pU = the cyclically-neutral rate of inflation

(2) $dE = -c_E(r - u_pU)$

(3) $dr = f_r(\hat{r} - r) - c_r(Z - M) - b_r dY - t_r D + u_p dU$

where $\hat{r} = dP$

(4) $dM = f_M(\hat{M} - M)$, where $\hat{M} = b_M Y$

(5) $dZ = f_Z(\hat{Z} - Z)$, where $\hat{Z} = M$

Identity:

(6) $dY = w_E dE + w_Z dZ$,

where w_E and w_Z are weights.

1/ All variables are logarithms except for r, T, and D. For further information, see Armington and Wolford (September 1983).

The U.S. model has a steady state wherein all real flows are growing at the rate t_Y and where inflation dP (= u_pU = r) may be changing at the rate u_pdU. Merging this model with the non-U.S. equations (above) produces a system in which, in the steady state, "global" inflation and the general level of interest rates can move through the long cycle while inflation differentials for each pair of countries equal the respective interest differentials, which are in turn offset by trends in exchange rates (with $\psi = \gamma = 1$ in the steady state). All balance of payments flows (and therefore the U.S. public-sector budget) must be in equilibrium in the steady state, and all the associated net foreign debt (or asset) stocks are constant.

The structural form of the U.S. model is:

$$dP - c_pY + (c_pt_Y)T - u_pU = 0$$

$$dE + c_Er - (c_Eu_p)U = 0$$

$$dr - f_rdP + f_rr + c_rZ - c_rM + b_rdY + t_rD - u_pdU = 0$$

$$dM - (f_Mb_M)Y + f_MM = 0$$

$$dZ - f_ZM + f_ZZ = 0$$

$$dY - w_EdE - w_ZdZ = 0$$

E. Tables

Table 1. FIML Estimates of Non-U.S. Model Parameters*

Parameter	Country	Estimate	T-value
α_1	Belgium	4.3	4.0
	Canada	0.9	4.7
	France	1.3	4.3
	Germany	1.2	4.7
	Italy	4.6	4.2
	Japan	1.2	4.6
	Netherlands	1.0	4.7
	Switzerland	1.0	4.8
	United Kingdom	0.9	4.3
δ	Belgium	104.2	1.6
	Canada	5.1	0.9
	France	18.5	1.0
	Germany	3.5	0.4
	Italy	57.8	1.8
	Japan	12.7	2.0
	Netherlands	15.2	1.3
	Switzerland	-19.5	1.4
	United Kingdom	8.0	0.7
σ	Constrained across all countries	1.3	5.3
β_1	Constrained across all countries	0.4	11.4
γ	Constrained across all countries	12.9	6.2
ϕ	Constrained across all countries	0.1	1.2
λ	Belgium	2.2	6.4
	Canada	1.3	6.5
	France	1.2	7.7
	Germany	1.1	7.1
	Italy	1.4	8.3
	Japan	1.1	6.6
	Netherlands	1.4	7.7
	Switzerland	0.8	6.3
	United Kingdom	1.3	6.7

α_2	Belgium	-0.93	21.1
	Canada	-0.95	36.7
	France	-0.75	10.0
	Germany	-0.84	14.6
	Italy	-0.97	14.8
	Japan	-0.80	11.2
	Netherlands	-0.99	31.9
	Switzerland	-0.98	10.8
	United Kingdom	-0.92	12.7
α_3	Belgium	-0.41	6.2
	Canada	-0.60	6.8
	France	-0.65	6.3
	Germany	-0.59	5.7
	Italy	-0.71	8.0
	Japan	-0.72	5.8
	Netherlands	-0.54	6.8
	Switzerland	-0.74	5.6
	United Kingdom	-0.58	5.5
η 1/	Belgium	.0088	3.0
	Canada	.0031	1.0
	France	.0040	1.3
	Germany	.0087	2.1
	Italy	.0521	4.4
	Japan	.0139	3.4
	Netherlands	-.0007	0.2
	Switzerland	.0030	1.4
	United Kingdom	.0006	0.3
ϕ 1/	Belgium	-.0013	1.6
	Canada	-.0024	2.1
	France	-.0005	0.7
	Germany	-.0019	2.2
	Italy	-.0038	2.1
	Japan	-.0015	2.1
	Netherlands	.0011	0.9
	Switzerland	-.0009	1.5
	United Kingdom	-.0035	4.1
β_2	Constrained across all countries	.0502	6.0

* Estimation of January 1984; sample period from April 1973 through September 1983. FIML estimates of the parameters of the structural, continuous model, given in Part II.C, were computed using Clifford Wymer's program RESIMUL. For this purpose, the approximate discrete form of the continuous model was derived, using the standard transformations. See Wymer, Continuous System Manual. The basic time unit of the estimates above is monthly. In this estimation the model included the U.S. variables as endogenous, but the parameters (and constant terms) of the U.S. equations were fixed at the levels estimated separately (for a longer sample period -- see Table 2). This procedure creates a slight upward bias in the t-ratios computed for the non-U.S. parameters.

1/ The small scale of these "elasticities" reflects the use of large initial constants for the integration of the current account balances to form the corresponding stocks.

Table 2. FIML Estimates of U.S. Model Parameters*

Parameter	Estimate	T-value
c_P	.052	3.3
t_Y	.025	6.2
u_P	.016	2.7
c_E	1.153	5.8
f_r	.235	1.5
c_r	.031	2.8
b_r	.174	0.8
t_r	.0004	0.5
f_M	.330	3.6
b_M	1.572	42.7
f_Z	.061	1.7

* Estimates of September 1983; sample period from the third quarter of 1963 through the fourth quarter of 1982. FIML estimates of the parameters of the structural form of the U.S. model, given in Part II.D, were computed using Clifford Wymer's program RESIMUL. For this purpose the approximate discrete form of the continuous model was derived and estimated using quarterly data, and the basic time unit of the estimates listed above is quarterly. The basic time unit of the estimated model was then changed to one month, and the U.S. model was merged with the non-U.S. equations, for purposes of joint solution using Wymer's program APREDIC. Thus, the U.S. model may be solved as a closed, stand-alone model or as a component of the AWA Exchange Rate Model. For further explanation and analysis of these results, see Armington and Wolford (September 1983).

Table 3. Eigenvalues of the AWA Model
(Excluding zero roots)

	Non-U.S.-Sector roots		Damping Period	Period of Cycle	
	Real Part	Imaginary Part	In Months	In Months	
1 1/	.0158	0			
2 1/	-.0126	0	79.4		
3 2/	-.0486	0	20.3		
4	-.0494	0	20.3		
5	-.0502	0	19.9		
6	-.0506	0	19.8		
7	-.0515	0	19.4		
8	-.0542	0	18.4		
9	-.0556	0	18.0		
10	-.0617	.0013	16.2	4737	
11	-.0617	-.0013	16.2	4737	
12-20 3/	-.3768	0	2.7		
21 4/	-.5286	0	1.9		
22	-.7518	0	1.3		
23	-.9724	0	1.0		
24	-1.0905	0	0.9		
25	-1.1062	0	0.9		
26	-1.1773	0	0.8		
27	-1.1912	0	0.8		
28	-1.2635	0	0.8		
29	-1.3770	0	0.7		
30	-1.3850	0	0.7		
31	-1.4779	0	0.7		
32	-1.5380	0	0.7		
33	-1.6472	0	0.6		
34	-2.2325	0	0.4		
35	-5.1102	0	0.2		
36	-5.6486	0	0.2		
37	-1.2983	.0320	0.8	196	
38	-1.2983	-.0320	0.8	196	
39 5/	.0063	.0445		141	GF
40	.0063	-.0445		141	
41	.0041	.0376		167	JA
42	.0041	-.0376		167	
43	.0033	.0304		207	FR
44	.0033	-.0304		207	
45	.0031	.0227		277	IT
46	.0031	-.0227		277	
47	.0011	.0055		1148	CA
48	.0011	-.0055		1148	
49	.0002	.0053		1174	NE
50	.0002	-.0053		1174	
51	.000002	.0220		286	BE
52	.000002	-.0220		286	
53	-.00008	.0014		4587	SZ
54	-.00008	-.0014		4587	

U.S.-sector roots

55	-.0045	0	221	
56	-.1452	0	7	
57	-.0109	.0539	92	117
58	-.0109	-.0539	92	117

1/ The first two eigenvalues are due to the low U.K. estimate for η, undoubtedly distorted by the North Sea oil factor. If the U.K. η is raised into a "normal" range (see Table 6), these roots become roots of a U.K. exchange rate/BOP cycle, which is not damped.

2/ Roots 3-11 are associated with the speed of adjustment β_2.

3/ Roots 12-20 are associated with the speed of adjustment β_1.

4/ Roots 21-38 are associated with the speeds of adjustment toward portfolio balance and of r toward its target levels.

5/ Roots 39-54 are associated with 8 exchange rate/BOP cycles, one for each of the non-U.S. countries except the U.K. (see footnote 1). The countries are noted at right.

Table 4. Sensitivity of Estimated Long Cycles to Model Parameters

Effects on Undamped Cycles	Directional Effect of an Algebraic Increase in						
	σ	α_2 1/	η 1/	ϕ 1/	β_2	α_1 1/	δ 1/
Germany							
Real Part	-	-	-	-	-	+	-
Imaginary Part	-	+	+	+	+	-	+
Japan							
Real Part	-	+	+	-	-	+	-
Imaginary Part	-	+	+	+	+	-	+
France							
Real Part	-	-	-	-	-	+	-
Imaginary Part	-	+	+	+	+	-	+
Canada							
Real Part	-	+	+	-	-	+	0
Imaginary Part	-	+	+	+	+	0	0
Effects on Damped Cycles							
Netherlands							
Real Part	+	-	-	-	0	+	0
Imaginary Part	-	+	+	+	0	0	0
Belgium							
Real Part	+	-	-	-	-	+	0
Imaginary Part	-	+	+	+	+	-	0

1/ Refers to the parameter estimated for the country in the stub.

Note: A negative effect on a real part indicates that the cycle would be less explosive or more damped (and vice versa). A positive effect on an imaginary part indicates that the period of cycle would be reduced (and vice versa); hence, turning points would tend to be reached sooner. Zero indicates approximately no effect.

Table 5. Cross Effects of French and German Interest Rate Responses on Each Other's Cycles

	Directional Effect of an Algebraic Increase In: German α_2	French α_2
Effects on:		
Germany		
Real Part	-	+
Imaginary Part	+	-
France		
Real Part	+	-
Imaginary Part	-	+

Note: See note to Table 4.

Table 6. AWA Estimates for Price "Elasticities" Compared with Estimates Implicit in the IMF "MERM"

	η Estimates Implicit the IMF MERM 1/	FIML Estimates of η (AWA)
Belgium	.0023 - .0044	.0088
Canada	.0065 - .0090	.0031
France	.0042 - .0072	.0040
Germany	.0035 - .0062	.0087
Italy	.0078 - .0116	.0521
Japan	.0055 - .0080	.0139
Netherlands	.0021 - .0041	-.0007
Switzerland	.0015 - .0025	.0030
United Kingdom	.0020 - .0037	.0006

1/ The IMF Multilateral Exchange Rate Model can be used to simulate the medium-term effects on a country's trade balance of a one-percent change in its exchange rate, ceteris paribus; these effects are comparable (after normalization by initial stock figures used in the AWA model) to the elasticity η. The range shown here corresponds with the "Low Feedback Parameters" and the "High Feedback Parameters," Tables 5 and 6, pp. 301-4, of Artus and McGuirk (1981). The MERM effects are scaled to trade flows in 1977, which is about the middle of the sample period used to estimate the AWA model. The MERM effects do not include effects on trade in invisibles; thus it should not be surprising if they are smaller than the comparable figures for η.

REFERENCES

Argy, Victor (1982), "Exchange Rate Management in Theory and Practice," Princeton Studies in International Finance, No. 50, October.

Armington, Paul (January 1982), "A Closed, Multilateral Model of the International Adjustment Process, with No Sectoral Disaggregation" (mimeo).

__________ (June 1982), "What We are Learning About the Present Exchange Rate System," Papers of Armington, Wolford and Associates (mimeo).

__________ (May 1983), "How the Analysis of Economic Policies May Be Facilitated By Clifford Wymer's Computer Programs," Proceedings of a World Bank conference on sensitivity analysis, December 11, 1982 (mimeo).

Armington, Paul, and Wolford, Catherine (September 1983), "PAC-MOD: An Econometric Model of Selected U.S. and Global Indicators," World Bank (Global Modeling & Projections Division), Division Working Paper No. 1983-3.

__________ (January 1984), "A Model-Based Analysis of Dollar Fluctuations," Brookings Discussion Paper in International Economics, No. 11.

Artus, Jacques, and McGuirk, Anne (1981), "Floating Exchange Rates and the Multilateral Exchange Rate Model, IMF Staff Papers, Vol. 28, No. 2, June.

Bergsten, C. Fred, and Williamson, John (September 1982), "Exchange Rates and Trade Policy" (mimeo).

Dornbusch, R. (1982), "Equilibrium and Disequilibrium Exchange Rates," NBER Working Paper Series, No. 983, September.

Gandolfo, Giancarlo (1981), Qualitative Analysis and Econometric Estimation of Continuous Time Dynamic Models, North Holland, Amsterdam.

Jonson, P.D. et al (1982), "Exchange Rates and Capital Flows: A Sensitivity Analysis, The Canadian Journal of Economics, Vol XV, No. 4, November.

Knight, M.D. and Wymer, C.R. (1978), "A Macro-economic Model of the United Kingdom," IMF Staff Papers, Vol.25.

Phillips, A.W. (1954), "Stabilization Policy in a Closed Economy," Economic Journal, Vol. 64.

Richard, Denis M. (1978), "A Dynamic Model of the World Copper Industry." IMF Staff Papers, Vol. 25, No. 4 (December), pp. 779-833.

____________________ (1980), "A Global Adjustment Model of Exchange Rates and Interest Rates: Empirical Analysis," in D. Bigman and T. Taya (eds.), The Functioning of Floating Exchange Rates: Theory, Evidence, and Policy Implications, Ballinger, Cambridge, Massachusetts.

Wymer, C.R. (1968), "Computer Programs; Continest Manual," and Supplements (mimeo).

____________________ (1976), "Continuous Models in Macro-Economics: Specification and Estimation," presented at the SSRC-Ford Foundation Conference on Macro-Economic Policy and Adjustment in Open Economies, Ware, England.

____________________ (December 1982), "Sensitivity Analysis of Economic Policy" (mimeo).

Economic Papers

The following papers have been issued. Copies may be obtained by applying to the address mentioned on the inside front cover.

No. 1 EEC-DG II inflationary expectations. Survey based inflationary expectations for the EEC countries, by F. Papadia and V. Basano (May 1981).

No. 3 A review of the informal economy in the European Community, by Adrian Smith (July 1981).

No. 4 Problems of interdependence in a multipolar world, by Tommaso Padoa-Schioppa (August 1983).

No. 5 European Dimensions in the Adjustment Problems, by Michael Emerson (August 1981).

No. 6 The bilateral trade linkages of the Eurolink Model : An analysis of foreign trade and competitiveness, by P. Ranuzzi (January 1982).

No. 7 United Kingdom, Medium term economic trends and problems, by D. Adams, S. Gillespie, M. Green and H. Wortmann (February 1982).

No. 8 Où en est la théorie macroéconomique, par E. Malinvaud (juin 1982).

No. 9 Marginal Employment Subsidies : An Effective Policy to Generate Employment, by Carl Chiarella and Alfred Steinherr (November 1982).

No. 10 The Great Depression : A Repeat in the 1980s ?, by Alfred Steinherr (November 1982).

No. 11 Evolution et problèmes structurels de l'économie néerlandaise, par D.C. Breedveld, C. Depoortere, A. Finetti, Dr. J.M.G. Pieters et C. Vanbelle (mars 1983).

No. 12 Macroeconomic prospects and policies for the European Community, by Giorgio Basevi, Olivier Blanchard, Willem Buiter, Rudiger Dornbusch and Richard Layard (April 1983).

No. 13 The supply of output equations in the EC-countries and the use of the survey-based inflationary expectations, by Paul De Grauwe and Mustapha Nabli (May 1983).

No. 14 Structural trends of financial systems and capital accumulation : France, Germany, Italy, by G. Nardozzi (May 1983).

No. 15 Monetary assets and inflation induced distortions of the national accounts - conceptual issues and correction of sectoral income flows in 5 EEC countries, by Alex Cukierman and Jorgen Mortensen (May 1983).

No. 16 Federal Republic of Germany. Medium-term economic trends and problems, by F. Allgayer, S. Gillespie, M. Green and H. Wortmann (June 1983).

No. 17 The employment miracle in the US and stagnation employment in the EC, by M. Wegner (July 1983).

No. 18 Productive Performance in West German Manufacturing Industry 1970-1980; A Farrell Frontier Characterisation, by D. Todd (August 1983).

No. 19 Central-Bank Policy and the Financing of Government Budget Deficits : A Cross-Country Comparison, by G. Demopoulos, G. Katsimbris and S. Miller (September 1983).

No. 20 Monetary assets and inflation induced distortions of the national accounts. The case of Belgium, by Ken Lennan (October 1983).

No. 21 Actifs financiers et distorsions des flux sectoriels dues à l'inflation : le cas de la France, par J.-P. Baché (octobre 1983).

No. 22 Approche pragmatique pour une politique de plein emploi : les subventions à la création d'emplois, par A. Steinherr et B. Van Haeperen (octobre 1983).

No. 23 Income Distribution and Employment in the European Communities 1960 - 1982, by A. Steinherr (December 1983).

No. 24 U.S. Deficits, the dollar and Europe, by O. Blanchard and R. Dornbusch (December 1983).

No. 25 Monetary assets and inflation induced distortions of the national accounts. The case of the Federal Republic of Germany, by H. Wittelsberger (January 1984).

No. 26 Actifs financiers et distorsions des flux sectoriels dues à l'inflation : le cas de l'Italie, par A. Reati (janvier 1984).

No. 27 Evolution et problèmes strucurels de l'économie italienne, par Q. Ciardelli, F. Colasanti et X. Lannes (janvier 1984).

No. 28 International Co-operation in Macro-economic Policies, by J.E. Meade (February 1984).

No. 29 The Growth of Public Expenditure in the EEC Countries 1960-1981 : Some Reflections, by Douglas Todd (December 1983).

No. 30 The integration of EEC qualitative consumer survey results in econometric modelling : an application to the consumption function, by Peter Praet (February 1984).

No. 31 Report of the CEPS Macroeconomic Policy Group. EUROPE : The case for unsustainable growth, by R. Layard, G. Basevi, O. Blanchard, W. Buiter and R. Dornbusch (April 1984).

No. 32 Total Factor Productivity Growth and the Productivity Slowdown in the West German Industrial Sector, 1970-1981, by Douglas Todd (April 1984).

No. 33 An Analytical Formulation and Evaluation of the Existing Structure of Legal Reserve Requirements of the Greek Economy : An Uncommon Case, by G. Demopoulos (June 1984).

No. 34 Factor Productivity Growth in Four EEC Countries, 1960-1981 by Douglas Todd (October 1984).

No. 35 Rate of profit, business cycles and capital accumulation in U.K. industry, 1959-1981, by Angelo Reati (November 1984).

No. 36 Report of the CEPS Macroeconomic Policy Group. Employment and Growth in Europe : A Two-Handed Approach by P. Blanchard, R. Dornbusch, J. Drèze, H. Giersch, R. Layard and M. Monti (June 1985).

No. 37 Schemas for the construction of an "auxiliary econometric model" for the social security system by A. Coppini and G. Laina (June 1985).

No. 38 Seasonal and Cyclical Variations in Relationship among Expectations, Plans and Realizations in Business Test Surveys by H. König and M. Nerlove (July 1985).

No. 39 Analysis of the stabilisation mechanisms of macroeconomic models : a comparison of the Eurolink models by A. Bucher and V. Rossi (July 1985).

No. 40 Rate of profit, business cycles and capital accumulation in West German industry, 1960-1981 by A. Reati (July 1985).

No. 41 Inflation induced redistributions via monetary assets in five European countries : 1974-1982 by A. Cukierman, K. Lennan and F. Papadia (September 1985).

No. 42 Work sharing : Why? How? How not ... by J.H. Drèze (December 1985).

No. 43 Toward Understanding Major Fluctuations of the Dollar by P. Armington (January 1986).