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Rolf Schneider*

Is the Performance of the Dollar a Random Process?

It is still frequently argued that a random process would be the best way of predicting the DM/dollar exchange rate. In the following empirical analysis, however, Dr. Rolf Schneider comes to the conclusion that the behaviour of the dollar can be explained largely in terms of basic economic variables.

The behaviour of the US dollar has been a source of continual surprise for many years. There is almost no other economic variable for which the predictions have been so consistently and fundamentally wrong. It is therefore hardly surprising that academic forecasters such as the German Board of Economic Experts and the economic research institutes are reluctant to predict movements in the dollar and only use the exchange rate as an exogenous variable with a set value in their forecasts. This is obviously unsatisfactory, since the macro-economic impact of exchange rate changes is too important to be ignored. In many instances macro-economic prognoses are proved wrong not because of an error in estimating the underlying economic relationships but because the wrong values have been assigned to important variables such as the exchange rate.

Disenchantment with Exchange Rate Theory

There has been no lack of attempts to devise theories to explain the behaviour of the dollar. The number of theoretical models increased particularly rapidly in the late seventies and early eighties, when dramatic changes in parities occurred in the wake of the switch to floating exchange rates. These new approaches are associated with names such as Dornbusch, Mussa, Frenkel, Kouri, Dooley and Isard, to name but a few. Although often differing in detail, they are all based essentially on two elements: purchasing power parities and the theory of interest rate parities. Bofinger¹ has shown that most of the recent exchange rate theories consist of a combination of variants of these two theoretical approaches.

Whereas the exchange rate used to be considered as the relative price of goods, in modern theories it is now interpreted mainly as the relative price of interest-bearing financial assets in the domestic economy and abroad. Its behaviour is therefore explained in terms of the "fundamentals" in the monetary markets. These financial market models of the exchange rate fall into two groups. In the monetary approach, domestic securities are regarded as perfect substitutes. This assumption is abandoned in the portfolio balance approach and the behaviour of the exchange rate is considered to be determined by changes in the perception of risks on different types of investment as well as changes in the yields on domestic and foreign financial assets.

The re-orientation of exchange rate theory was swiftly followed by an attempt to test the new approaches empirically. The results of the econometric studies were sobering, however. In particular, the simple monetary approach, in which the theory of purchasing power parities is complemented by postulating that prices are determined directly by the money supply, proved to be completely inadequate. Even the more sophisticated Dornbusch model, in which prices are rigid over the short term – in other words, changes in the money supply can also induce short-term effects in the real economy – contributed little to explaining the behaviour of the dollar. By the beginning of the eighties a comparative study by Gaab² had already concluded that only a relatively small part of exchange rate variance –

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¹ See the survey of theories in P. Bofinger: Wechselkurstheorien und Wirtschaftspolitik, in: Kredit und Kapital, 1986, pp. 184-212.

² W. Gaab: Der Beitrag alternativer Finanzmarktmodelle zur Erklärung des DM/\$-Wechselkurses von 1974 (10) – 1981 (5), in: Zeitschrift für Wirtschafts- und Sozialwissenschaften, 1982, pp. 601-643.

20% at most – could be explained using financial market models and had proclaimed that today's exchange rate was the best predictor of rates in the future. From this it is but a short step to the thesis that the dollar exchange rate can best be described as a purely random process.³ According to this view, market participants' expectations are continuously modified by new information entering the market at random, so that the behaviour of the exchange rate can be interpreted as "white noise".⁴ This judgement has struck a chord in academic circles and calls into question the attempt to explain the dollar exchange rate in terms of fundamentals.

Single-cause Explanations

Even without using pretentious statistical methods it is obvious that attempts to explain the dollar exchange rate in terms of a single determinant will almost invariably produce false results. For example, the sharp appreciation of the dollar in 1980 and 1981 could be explained in terms of an exceptional rise in interest rates; long-term rates in the United States had risen from 8 to 13% between the beginning of 1979 and the end of 1981. But why did the dollar continue to strengthen during 1982, even though interest rates had fallen to 10% and the interest rate differential in relation to other countries had gradually narrowed?

In 1983 the US trade deficit began to increase dramatically. In this situation the current account approach postulated a falling dollar; in fact, the US dollar continued to appreciate with undiminished vigour during 1983. The view rapidly gained ground that it was not the trade deficit as such that was decisive for the valuation of a currency but whether an economy in which a large proportion of total demand was financed from abroad offered good growth prospects and hence opportunities for high returns on real capital.⁵ This more strongly portfolio-oriented line of argument undoubtedly still offers the most plausible explanation for the tremendous appreciation of the dollar until the beginning of 1985, but it is less convincing for the period thereafter. After slowing down between mid-1984 and mid-1985, economic growth in the United States again accelerated noticeably in the second half of 1985, but the dollar plummeted. The same happened at the end of 1987; after growing more slowly in 1986, GDP resumed its rapid expansion during 1987. Since no discernible progress had been made towards reducing the trade deficit, the dollar again depreciated sharply in the turbulent weeks at the end of that year. The trend in the monthly trade statistics seemed increasingly to be the only significant factor determining the dollar exchange rate. In 1988 the emphasis again shifted slightly. When

economic indicators suggested that economic growth would slow down significantly from the autumn onwards the dollar again showed a passing tendency to weaken after having strengthened in the first half of the year.

It is striking that the debate about explaining the dollar exchange rate is dominated by a succession of single explanatory variables, each enjoying a moment of glory before being eclipsed by the next. The reason for this may lie in the volatility in the formation of expectations in the foreign exchange markets, but it may also signify that exchange rate behaviour cannot be explained satisfactorily in terms of a single determinant. If there is a series of equally important determinants, at any given moment in time the exchange rate will be determined by the one that varies the most during that particular period. If interest rates in the United States and Germany fluctuate relatively little, as has been the case in the recent years of low inflation, substantial changes in trade balances and in the relative cyclical positions of their economies can have a decisive bearing on the dollar/DM exchange rate without the fundamental importance of interest rates for exchange rate determination having diminished.

Multi-dimensional Analysis

The remainder of this article will attempt to reconstruct the course of the dollar exchange rate in the eighties using a combination of various explanatory approaches.⁶ The objective will be to explain the extreme exchange rate movements of 1984-85 and 1987-88. Bofinger suspects that for movements of this magnitude the estimates based on fundamental determinants will be even more unsatisfactory than those for earlier periods.⁷

Experience with the system of floating exchange rates has shown that the purchasing power parity can, at the most, serve as a rough yardstick of exchange rate developments over the long term. Any measurement of the differential in purchasing power between two countries throws up statistical and methodological problems, but it is probably generally accepted that in purchasing power terms the dollar was significantly undervalued against the Deutsche Mark in 1979 but

³ Cf. S. Schulmeister: *An Essay on Exchange Rate Dynamics*, Discussion Paper, Wissenschaftszentrum Berlin, 1987, pp. 5 ff.

⁴ Cf. W. Gaab, *op. cit.*, p. 632.

⁵ Cf. R. Pohl: *Ein empirischer Versuch zur Erklärung der Dollar-kurstendenz*, Beitrag zur 17. Sitzung des Ausschusses Geldtheorie und Geldpolitik des Vereins für Socialpolitik am 6. und 7. Februar 1987, Berlin, 1987, p. 3.

⁶ Cf. P. Bofinger, *op. cit.*, p. 203.

⁷ Pohl has also spoken in favour of a combination of various explanatory models; cf. R. Pohl, *op. cit.*, p. 4.

drastically overvalued in 1984 and 1985. Even today, these years-long deviations of the dollar from its purchasing power parity are still frequently described as "misalignment".

The true purpose of any examination of the factors determining the dollar exchange rate is to get to the bottom of this so-called "misalignment". Investigation therefore focuses not on the nominal dollar/DM exchange rate but the exchange rate adjusted for differences in the performance of prices in the two countries. Measured in terms of relative movements in consumer prices, the dollar exchange rate of DM 1.82 in 1980 would correspond to a rate of around DM 1.55 in 1988. Over a period of less than ten years the purchasing power parity between the two currencies has therefore shifted considerably. To analyse the exchange rate without taking account of this shift would probably be problematic. Hence it is not the nominal value of the dollar against the DM that is to be explained in the behavioural equation, which we have still to define, but its real value. This naturally entails an implied assumption that purchasing power parities help determine the long-term exchange rate trend.

With the spread of monetary exchange rate theories in the seventies, less and less regard had been paid to current account balances as determinants of exchange rate developments. It is only in recent years that current account imbalances have made a come-back in exchange rate analysis. Now, however, trade deficits are no longer viewed mainly as an expression of an oversupply of foreign exchange but as an adjustment in the composition of international portfolios. Every current account deficit is associated with a corresponding capital inflow. If foreign borrowing is used to earn high returns at home and to offer favourable growth prospects, there is an incentive for international investors to transfer their capital to the country concerned.⁸ Hence if a country is running a current account deficit and at the same time has a lead in the economic cycle, an appreciation of its currency is highly likely.

This assessment of the impact of a current account deficit on the exchange rate is controversial, however, since other portfolio composition theories show the opposite effect, with investors dividing their assets between domestic and foreign securities according to their preferences. If residents and non-residents wish, in accordance with their various risk premiums, to hold the

larger part of their portfolios in domestic currency, a current account deficit in the country in question leads to a reduction in demand for domestic securities and hence to a depreciation of the currency, since residents' net monetary assets decline while those of non-residents increase.⁹ According to this line of thinking, a trade deficit has a distinctly adverse effect on the external value of the currency.

The various portfolio approaches do have at least one merit in that they have again introduced trade imbalances into exchange rate models. The influence of both trade imbalances and economic growth on the exchange rate will be examined in the equation expressing the behaviour of the DM/dollar exchange rate. Introducing these two possible determinants separately should help clarify whether strong economic growth coupled with a rise in the trade deficit is able to stabilise the exchange rate of the currency, or whether cyclical developments have too weak an effect on the exchange rate, so that variations in the foreign trade position, irrespective of cause, trigger a clear exchange rate trend. Of course, it is also conceivable that neither economic growth nor foreign trade imbalances are systematically linked to exchange rate developments over the long term.

Role of Interest Rates

What role do interest rates play in explaining the behaviour of the dollar exchange rate? Pohl has drawn attention to an important point in this connection.¹⁰ He criticises the fact that in most models the differential between nominal interest rates at home and abroad is regarded as significant for investors' decisions; it would be more correct to consider the real differential. In his model he assumes

- ☐ that the expected dollar exchange rate will coincide with the expected purchasing power parity in the longer run;
- ☐ that the planned investment period influences investment decisions;
- ☐ that the rate on bonds with a life corresponding to the investment period is the representative nominal yield, rather than the money market rate.

On the basis of these assumptions he deduces that at any given time the exchange rate is determined by the current purchasing power parity, the investment period and the expected real interest rate differential. Hence in this model a pronounced discrepancy between the exchange rate and the purchasing power parity does not in principle conflict with the assumptions of purchasing power parity theory.

⁸ Cf. W. Filc: Bestandsorientierte Wechselkurstheorien und Wirtschaftspolitik, in: Kredit und Kapital, 1987, pp. 48-72.

⁹ A detailed description is to be found in W. G a b, op. cit., pp. 614 ff.

¹⁰ R. P o h l, op. cit., pp. 3 ff.

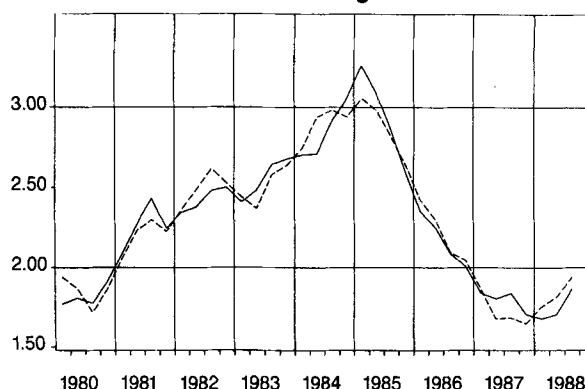
Experience in the late seventies and in the eighties has shown that the nominal interest rate differential alone contributes little to explaining the exchange rate, but that there are repeatedly distinct parallels between the behaviour of the real differential and that of the exchange rate. Pohl's approach provides a plausible theoretical explanation of the importance of real interest rates for investment decisions on the international bond market. An attempt will therefore be made not to confine the investigation to nominal interest rates as exchange rate determinants in the specification made here. It goes without saying that the real interest rate relevant to a particular investment decision is not necessarily identical with the nominal interest rate adjusted for the current rate of inflation. It is probable that a better indicator of inflationary expectations can be found by smoothing the rates of price increase.

Furthermore, the a priori adjustment of the DM/dollar exchange rate for changes in purchasing power parity in the behavioural equation accords with another element in Pohl's approach, namely that over the longer term the normal perception of an "appropriate" dollar exchange rate shifts in parallel with the purchasing power parity. In 1970 many people would undoubtedly have considered the dollar seriously undervalued at an exchange rate of DM 2, but at today's purchasing power parity there are probably few who would still hold that opinion.

The justification for combining various models to explain the dollar exchange rate is also based on the consideration that investors in the international financial markets do not form a homogeneous group. Pohl's remarks certainly offer a plausible behavioural model for investors in the bond markets, but it is doubtful whether a change in bond yields also reflects a change in yields on real capital. The relatively low real interest rates in Japan and the high real interest rates in Western Europe suggest that at least on the international level there is no direct link between yields on real capital and those on bonds.

Variations in yields on real capital are particularly significant for investment decisions on share markets. If, as is to be supposed, bond yields are determined largely by monetary factors rather than yields on real capital, a potential investor on the international share markets must choose another indicator on which to base his decision. The extraordinary attention the capital markets pay to the rate of growth in GNP indicates its widespread use as an indicator of an economy's current potential and the associated opportunities for profits on the share markets. A high rate of economic growth makes investment in real capital in that country more attractive, at least as long as the credibility of financing that growth is not called into question.

DM/Dollar Exchange Rate



For reasons of presentation, the estimates of the real exchange rate have been converted back into nominal rates.

— actual rate
----- estimated rate

Behavioural Equation

$$ER = a_0 + a_1 LIUS + a_2 CPIUS + a_3 RGNPUS + a_4 TBUS + a_5 TBG + a_6 RLIG$$

	Lag	Coefficients	t values	Lag distribution
a_0		1.40	(4.74)	
a_1		0.073	(5.51)	Almon polynomial lag distribution of the 2nd degree
	t	0.032	(3.62)	
	t-1	0.021	(5.41)	
	t-2	0.012	(4.25)	
	t-3	0.006	(1.48)	
	t-4	0.002	(0.46)	
a_2		-0.121	(7.10)	Almon polynomial lag distribution of the 1st degree
	t	-0.048	(7.10)	
	t-1	-0.036	(7.10)	
	t-2	-0.024	(7.10)	
	t-3	-0.012	(7.10)	
a_3	t-1	0.019	(6.10)	
a_4	t			
	$\sum_{t=1}^2$	0.0036	(3.13)	uniform distribution
a_5	t			
	$\sum_{t=1}^3$	-0.057	(5.66)	uniform distribution
a_6		0.024	(1.31)	

Coefficient of determination: $R^2 = 0.948$

Standard error: $SE = 0.063$

Durbin-Watson statistic: $DW = 0.90$

ER: real DM/dollar exchange rate

LIUS: USA - long-term interest rates

CPIUS: USA - consumer price index (percentage change over previous year)

RGNPUS: USA - real GNP (percentage change over two years)

TBUS: USA - trade balance (change over previous year in billions of dollars)

TBG: Germany - trade balance in billions of DM

RLIG: Germany - real interest rates (long-term interest rates less increase in prices for private consumption)

The behavioural function for the dollar was estimated using quarterly data for the period from the first quarter of 1980 to the third quarter of 1988. The use of monthly data was considered inadvisable, partly on account of gaps in the data but also because monthly statistics are likely to be influenced more strongly by speculative movements and less by fundamental determinants. In order to gauge the importance of lags, a number of slightly modified specifications were tested; only the best of the tested functions will be discussed here; where appropriate, however, reference will be made to estimations that produced poorer results.

Strong Influence of Real US Interest Rates

The results show that real interest rates in the United States have a pronounced influence on the exchange rate between the dollar and the Deutsche Mark. However, it proved an advantage to introduce nominal interest rates and the inflation rate into the behavioural equation separately and to smooth both determinants with an appropriate lag distribution. The difference between nominal interest rates and the current rate of price increase is also significant, but introducing the inflation rate and interest rates separately improves the fit appreciably.

This finding allows conclusions to be drawn about the formation of expectations. Presumably market participants do not look at the difference between interest rates and the inflation rate direct but from separate views of the likely trend in prices and interest rates. The good results produced by smoothing the inflation rate and nominal interest rates are also an indication that market participants are not guided simply by current fluctuations but form an impression of price and interest rate developments over the medium term. Hence an unforeseen slowdown in inflation as a result of a fall in raw materials prices, for example, should not lead to expectations of a permanent corresponding fall in the inflation rate.

It is surprising that real interest rates in Germany have no significant impact on the DM/dollar exchange rate. The sign of the coefficient is even the opposite to what would theoretically be expected. Introducing nominal interest rates and the rate of price increase into the behavioural equation separately does not produce noticeably better results.

Undoubtedly the attempt to find empirical evidence that real interest rates in Germany influence the exchange rates is made more difficult by the fact that US and German real interest rates sometimes move in the same direction. The correlation coefficient between real interest rates in the two countries is 0.53.

The German real interest rates' lack of significance together with the high statistical certainty of the American ones suggests, however, that the DM/dollar exchange rate responds relatively little to fluctuations in real interest rates in Germany. The deductions to be made from this finding are far-reaching: if real interest rates in the United States and Germany rise in parallel and provided other exchange rate determinants do not alter substantially, there is a high probability that the dollar will appreciate even though the interest rate differential between the two countries remains unchanged.

This accords with a phenomenon observed repeatedly in the past, the last instance having occurred recently. After falling for a short period, interest rates turned upwards again worldwide in November 1988. The markets came increasingly to expect higher interest rates in view of the continued expansion in economic activity and concern about more restrictive monetary policy. In the United States and Germany short and long-term rates began to rise. In December the dollar received strong upward impetus from the rise in US rates. A few European central banks, most notably the Deutsche Bundesbank, attempted to resist the movement by means of exchange market intervention and increases in rates on central bank facilities. Although the rise in interest rates was steeper in Germany than in the United States, it made no impression on the very firm tendency of the dollar. The increases in official interest rates announced by European central banks had clearly reinforced the worldwide opinion that the monetary authorities in the United States would soon raise US rates further; the international interest rate spiral was expected to take another twist.

How can one explain this observation that rising interest rates worldwide often go hand in hand with a tendency for the dollar to appreciate, in other words that rising interest rates create a preference for dollar assets? It is possible that a single world capital market still does not exist, despite the internationalisation of capital flows. Even today, the dollar area is still the capital market international investors prefer. This "bias" in favour of the US capital market means that capital will flow into the United States if the market offers an "adequate" return.

In these circumstances a German policy geared towards exchange rate stability entails extremely high costs. In order to hold the DM exchange rate steady, the Bundesbank must make large interest rate changes to counter the effect of even minor corrections in US monetary policy.

Economic Growth and Foreign Trade

As expected, rapid economic expansion in the United States has a positive impact on the dollar exchange rate, but there is no evidence that economic growth in Germany has any effect. Nevertheless, a comparison of various estimation methods showed that short-term variations in the rate of growth in the United States have a far smaller impact than the attention the financial markets give to quarterly GNP figures. The most significant influence comes from cumulative economic growth over two years; it would seem that a fairly long period of strong growth is needed before international investors consider that a country's performance has been permanently improved.

The trade balances of Germany and the United States both bear the expected sign. It proved beneficial to use the change in the US trade balance in the equation rather than the absolute level. This is undoubtedly an interesting aspect. A tendency towards an improvement in the US trade deficit is already enough to bolster the dollar in the financial markets, even if the deficit is still high by comparison with earlier years.

This circumstance, which probably explains a large part of the recovery of the dollar in the first half of 1988, can be interpreted perfectly well in terms of portfolio theory. A rising deficit increases the risk premium demanded for investments in the dollar area; a falling deficit leads to greater confidence in the competitiveness of US businesses. The level of the risk premium depends on a number of factors, but at a time when expectations rapidly adjust to take account of new information even a change in the direction of a variable is probably often regarded as a change in the fundamentals.

The behavioural equation explains around 95 % of the variance in the dollar exchange rate between the first quarter of 1980 and the third quarter of 1988. The high explanatory value of the specification, expressed in terms of the correlation coefficient, is achieved without including the lagged value of the exchange rate. The results therefore contrast sharply with those of many earlier empirical studies, which estimated a low explanatory value of the fundamental determinants and could only achieve satisfactory results by using random walks. For example, Gaab notes that at best 20 % of the variance of exchange rate changes can be explained by the fundamental exchange rate models he tested; by contrast, the behavioural equation used here explains around 60 % of exchange rate changes.

The good results achieved for the period under examination do not necessarily mean that the equation

will be equally good for forecasting developments in other periods. There remains the fundamental question as to the stability of the coefficient values and attention must also be drawn to another general problem affecting *ex ante* prediction of the dollar exchange rate. From his experience of forecasting the author knows of no other important economic variable that reacts so sensitively to changes in the main determinants. This can be illustrated by two economic scenarios for 1989 based on the behavioural equation used here:

Scenario 1:

- ☐ economic growth in the USA will amount to around $3\frac{1}{2}\%$ during 1989;
- ☐ despite very rapid economic growth, there will be a further gradual reduction in the trade deficit; for 1989 as a whole it will be \$25 billion lower than in 1988;
- ☐ long-term interest rates in the USA will rise rapidly in 1989 to around 10 %; consumer prices will increase by around $4\frac{1}{2}\%$.

Scenario 2:

- ☐ real GNP in the USA will grow by only $2\frac{1}{2}\%$ in 1989;
- ☐ despite slower economic growth, the trade deficit will stagnate at the level recorded in the second half of 1988;
- ☐ long-term interest rates in the USA will remain at around 9 %; as in scenario 1, consumer prices will rise by around $4\frac{1}{2}\%$.

The same data for Germany are used for both simulations: long-term interest rates of 7 %, a rate of increase of $2\frac{1}{2}\%$ in consumer prices in 1989 and no change in the trade surplus from 1988.

DM/dollar Exchange Rate

	2nd qtr. 1989	3rd qtr. 1989	4th qtr. 1989
Scenario 1	1.90	1.88	1.89
Scenario 2	1.82	1.71	1.64

Scenario 1 opens up the prospect of a strong dollar, worth about DM 1.90 at the end of 1989. Scenario 2, on the other hand, implies a marked weakening of the dollar in the course of the year. In scenario 2 the dollar is around 13 % lower at the end of 1989 than in scenario 1. The simulations show that even moderate changes in the behaviour of fundamental economic variables can lead to pronounced differences in the trend of the dollar. Unexpected fluctuations in the dollar exchange rate should therefore not be interpreted as market reaction to random occurrences; in many cases they can undoubtedly be explained in terms of fundamentals.