Exchange Rate Economics: Where Do We Stand?

edited by Paul De Grauwe

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The Euro, Eastern Europe, and Black Markets: The Currency Hypothesis

by Hans-Werner Sinn and Frank Westermann

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7 The Euro, Eastern Europe, and Black Markets: The Currency Hypothesis

Hans-Werner Sinn and Frank Westermann

Speculating with the euro has been disappointing for many professional investors because the movements of the exchange rate did not seem to follow conventional wisdom. The euro declined when the US economy went into recession, and it began to rise when the European stock marked slumped in early 2002.

In this chapter we elaborate on an explanation that one of us had suggested in two newspaper articles.[1] According to this explanation the euro weakened before the physical currency conversion because holders of black money and eastern Europeans fled from the old European currencies, and it strengthened thereafter because these groups of money holders developed a new interest in the euro.[2]

Although we regard an episode in economic history, we also attempt to contribute to the theory of the exchange rate by explicitly introducing currency stocks in addition to interest-bearing assets in the international portfolio of wealth owners. The inclusion of currency stocks is a simple, though uncommon, extension of the portfolio balance approach. It leads to an explanation for the negative correlation of the stock of deutschmarks in circulation and the value of the deutschmark, which Frankel (1982, 1993) once called the "mystery of the multiplying marks." Also, by this means, we can modify traditional interpretations of the portfolio balance approach, leading to new kinds of predictions for the exchange rate.

By the portfolio balance approach, it is often argued that the exchange rate is the relative price of interest-bearing assets and thus reflects the profitability of the economies involved. Given the stocks of these assets, an increase in the profit expectations for US firms, for example, implies a change in the desired composition of the portfolio in the direction of US assets. Since the composition of the portfolio cannot

change in the short run, the dollar appreciates until any preference for portfolio restructuring in the aggregate disappears.

The problem with this interpretation is not only that it no longer fitted when the US slump began in 2000 or when European share prices fell, but also that it abstracts from the role of currency in the portfolios of international investors. After all, the exchange rate is the relative price of two currencies rather than shares, and shares have their own prices, which are quoted instantaneously at the stock exchange. When share prices are flexible, a profit or demand based portfolio interpretation cannot easily explain the exchange rate because there are two prices for shares, one of which seems to be redundant. If, for example, the profit expectations of the new economy are captured by the Nasdaq, there is no need for the price of the dollar to capture them too.

To determine the exchange rate in the presence of flexible share prices, other assets whose prices are not flexible are required. In the formal model derived below, interest-bearing assets whose rates of return are controlled by a central bank via passive interventions and money balances whose rates of return are fixed at a level of zero are considered in addition to stocks. We use this model to develop a new theory of the exchange rate that we call the "currency hypothesis." This is because we see the exchange rate basically as the ratio of marginal utilities of money holding. By the currency hypothesis we are able to explain the startling empirical development of the euro exchange rate with a changed demand for money balances. It is well known that the traditional portfolio balance model, which does not contain national money balances, has been relatively unsuccessful in explaining the exchange rate (Taylor 1995). Our version of the portfolio balances model reconciles the theory with the development of different exchange rates. In particular, we use it to explain the development of the deutschmark–dollar exchange rate in the period from the fall of the Iron Curtain to the physical introduction of the euro. It is this period that is identified by a unique historical experiment that creates huge shifts in the demand for deutschmarks.

7.1 Eurosclerosis, New Economy, and the Euro

To detect the flaw of traditional exchange rate explanations it is useful to start with the development of the euro. Figure 7.1 depicts the time path of the euro in terms of dollars from 1990 to July 2002. A synthetic

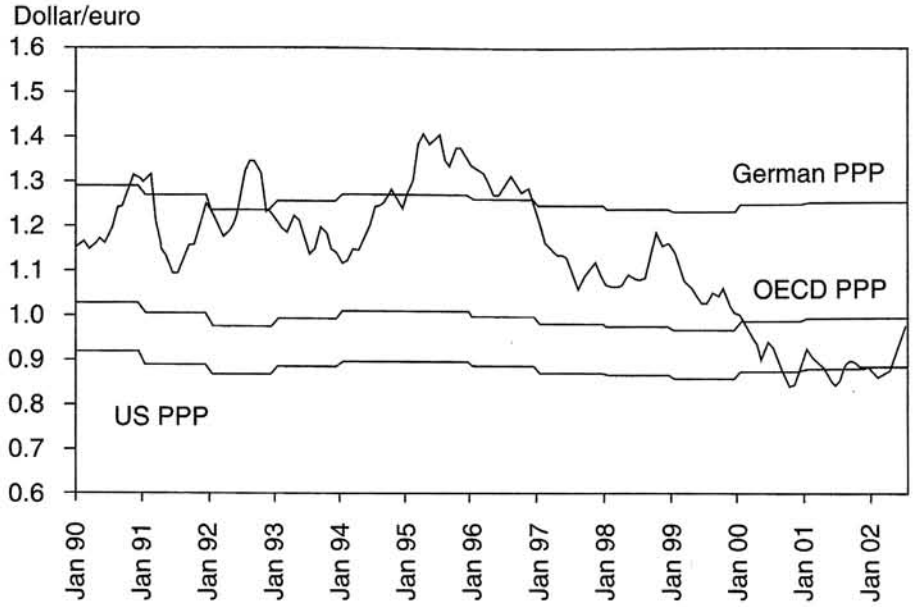

Figure 7.1
The development of the euro. Exchange rates are monthly data, while PPPs are given at an annual frequency. Different PPPs are computed with respect to the different consumption baskets in the United States, the OECD, and Germany. The latest data point is from July 1, 2002, with a value of 0.989 for the euro. (Sources: Federal Reserve Bank of St. Louis, Economic and Financial database, www.stls.frb.org/fred/; March 2002, and CESifo homepage, www.cesifo.de.)

euro was constructed for the years before 1999 by way of an official final exchange rate with the deutschmark. The diagram also shows the purchasing power parity (PPP) in accord with OECD, US, and German commodity baskets.

As the figure shows, the euro was strong, hovering around the upper PPP bound, until 1996. From 1997 onward it began a decline only to recover in February 2002, which was the month when the conversion of the old euro currencies into the physical euro was completed.

Many reasons for the long period of decline in the value of the euro are given in the literature, including labor market rigidities,[3] the European welfare net,[4] the Kosovo war,[5] Italy's ability to violate the Maastricht rules,[6] the excellent growth performance of the US economy,[7] and the initially high US interest rates.[8] However, the most frequent argument, which also underlies some of the media assessments, is the high volume of capital flows into the United States in recent years, in particular, the high volume of direct investment flowing into the new American economy.[9] We call this the economic prosperity view.

As figure 7.2 shows, capital flows into the United States were huge in the 1990s, and they have continued to increase until 2002, reaching

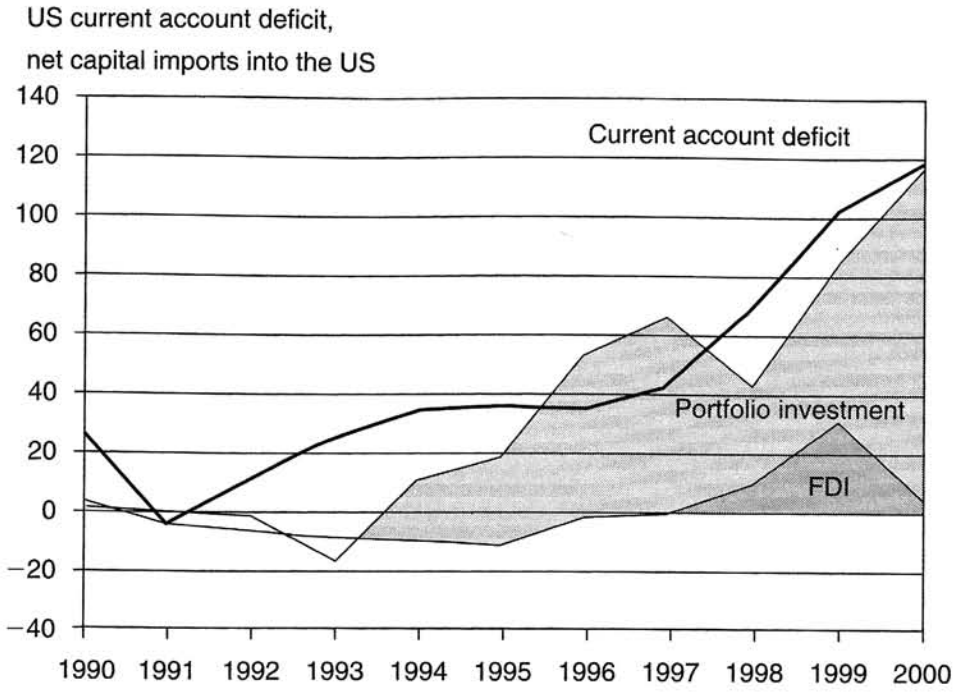

Figure 7.2
Capital imports into the United States and current account deficit. FDI = Foreign direct investment. The current account is defined as the sum of the capital account and the balance of payments (which is near 0 in the United States). The capital account is the sum of net direct investment, net portfolio investment and other investment. Other investment includes international credit and repayments of credits, participation of governments in international organizations and international real estate purchases. (Source: IMF, International Financial Statistics, CD-ROM, March 2001.)

a level of more than 4 percent of US GDP. In most years the capital flow was predominantly portfolio rather than direct investment, but in 1998 and 1999 the direct investment was also substantial, peaking at about a third of total US capital imports. In view of the size of the US capital imports it is understandable that many observers have attributed the strength of the dollar to the prosperous investment opportunities in the new American economy, and in contrast to the meagre outlook for an apparently desolate Europe suffering from a so-called Eurosclerosis.

However, there are two problems with this interpretation: a possible confusion between supply and demand and a theoretical mistake in the reasoning underlying the economic prosperity view. Let us consider these problems in more detail.

The economic prosperity view implicitly uses the traditional portfolio balance model that threatens the exchange rate in terms of the relative prices of European and American assets.[10] Capital flow into the

United States is assumed to result from an increase in demand for American assets by European investors. The increase in demand, it argues, drives up the value of the dollar because the price of the dollar is the price of American assets.

However, if an observable capital flow results in Europeans buying American assets, the reason could also be an increase in the supply of such assets. The supply of American assets is equivalent to an excess of planned investments over planned savings, and this is the same thing as a planned current account deficit or an excess of planned commodity imports over exports. A planned current account deficit is a net supply of American assets in the international capital markets. If the planned current account deficit goes up and if the price of the dollar is the price of American assets, the value of the dollar will fall rather than rise as capital flows into the US increase.

As usual, an increase in trading volume in a market says little about whether this increase is demand or supply driven. The signal for it being demand driven is the strength of the dollar. However, this is not a compelling argument for the economic prosperity view. As we will see, there are other reasons for the dollar's strength, and there are two empirical observations that support the supply-side rather than the demand-side explanation of the capital flows.

The startling decline in savings by US households is one of these observations. At the start of the 1990s the savings rate was about 5 percent; then it fell continually until in 1999 and 2000 it became negative.[11] By contrast, the euroland savings rate was nearly 11 percent in 2000. The negative savings rate meant that American households were no longer buying assets but were selling them to finance their excess absorption in resources. Given the high American investment volume, the increase in the current account deficit and the increase in the supply of assets in international capital markets were the only way to replace the American lack of savings. This development is illustrated in figure 7.3.

A further piece of information that contradicts the economic prosperity view is the poor performance of the US stock market in 1999 and early 2000. If the economic prosperity view is correct, not only the dollar but also American share prices should have increased relative to their European counterparts. But this was not the case as was already pointed out by De Grauwe (2000). Although the European stock market index performed better than the American one, the dollar was rising. A similar phenomenon occurred in the first half of 2002.

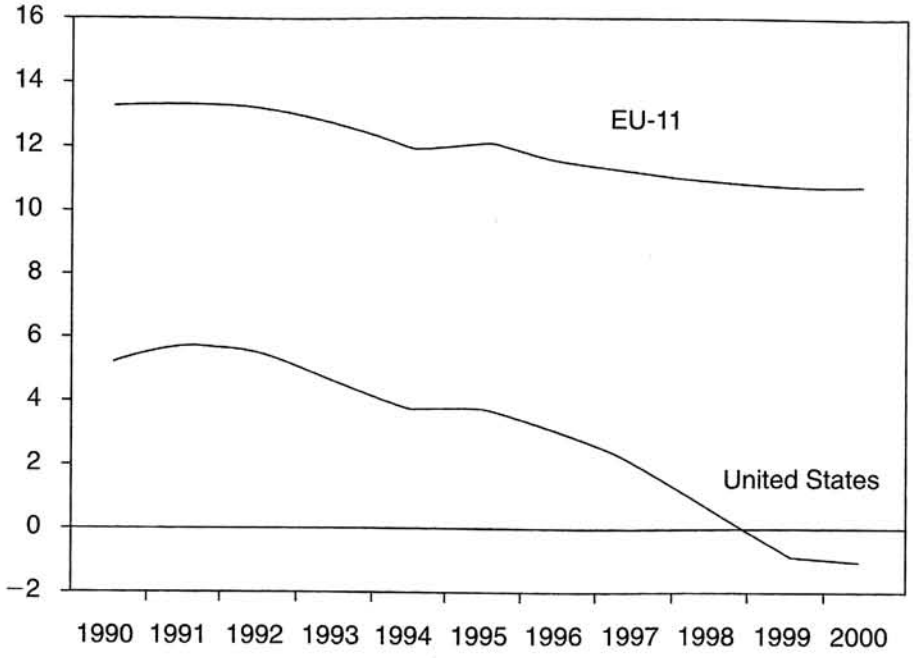

Figure 7.3
Savings rates compared. The savings rate is defined as private household savings divided by disposable household income. (Source: OECD Economic Outlook, OECD Statistical Compendium, CD-ROM.)

Newspapers attributed the new strength of the euro to a growing disinterest in American shares, but in fact the European share prices fell sharply relative to American share prices in the same period.

7.2 The Flaw in the Theoretical Argument

A larger problem with the economic prosperity view and the traditional portfolio balance model is that it does not seem to have a theoretical basis. The exchange rate is the price of a currency, and not the price of shares or other interest-bearing assets. It is true that the price of the dollar is a component of the price of American shares, if seen from the viewpoint of European investors, but the US share price itself is another component. This is a trivial but important point that may ultimately contribute to unraveling the puzzle.

Suppose that the return on US investment rises because of the new economy effect or for whatever other reason. This increase will raise demand for US shares among European investors and raise the price of American shares compared to the prices of European shares. But does this call for a revaluation of the dollar? Why is it not enough if the dollar price of American shares goes up relative to the euro price

of European shares? Obviously there are two relative prices for the same thing, and one is redundant.

The traditional portfolio balance approach downplays the redundancy problem by assuming that the rates of return for the trading countries' assets are fixed or determined by monetary policy.[12] The only way to reach a portfolio equilibrium, namely a situation where the aggregate of all investors is content with the assets they possess, is an exchange rate adjustment. However, if share prices are flexible, the exclusive focus on the exchange rate adjustment in the establishment of a portfolio equilibrium no longer makes sense.

The necessary amendments of the traditional portfolio balance model can best be understood by following the layman's argument for why a higher demand for US shares by European investors will drive up the share prices. It goes as follows: The investors sell their European shares in Europe against euros, and then they sell the euros obtained against dollars in the currency exchange market in order to use these dollars for the purchase of American shares. As this involves a demand for dollars and a supply of euros, so it is maintained, the value of the euro in terms of dollars must fall.

The fallacy of this view is that it overlooks the implications of the additional demand for US shares on share prices and the repercussions on foreign exchange markets. In the short run the volume of outstanding US shares is given. Thus the portfolio reshuffling planned by European investors will be possible only to the extent that American investors are crowded out and give their shares to the Europeans. The American investors, on the other hand, may not wish to keep the dollars they receive but to buy other things instead. If it is shares, they will go abroad because only there do they find the supply they need to satisfy their demand, and in particular, they will go to Europe where shares are cheap because they are sold by the European investors. Thus they will supply the dollars they received from the European investors in the currency exchange market and feed the demand for euros instead. If the original purchase of dollars drove up the dollar, this will instead drive up the euro and eliminate the effect on the exchange rate.

With the passage of time the crowding out of American share holders will become weaker because the share price increase induces an additional flow of new issues of shares to finance more investment. However, because an increase in planned net investment is equivalent to an increase in the planned current account deficit, this will not

generate a positive revaluation effect on the dollar. It will, however, imply a smaller share price increase.

The real possibility to generate a revaluation effect is if the crowded-out American shareholders do not go into foreign shares because they have a home bias in their preferences. There are two alternatives.

One is that the crowded-out American shareholders prefer to go into US money instead of European shares. This is the clearest case where a revaluation of the dollar occurs. However, it hardly supports the naive view that an increased demand for American assets drives up the dollar simply because there is a transitional demand for dollars in the process of portfolio conversion.

The alternative is that the crowded-out American shareholders prefer to go into American bonds instead of European shares. If the central bank does not stabilize the interest rate by open market operations, this will drive down the interest rate and crowd out previous bondholders. If these then choose European bonds or shares instead of the American bonds they sold, there is again a countervailing supply of dollars in the exchange market. However, if the central bank stabilizes the interest rate by selling bonds and buying the dollars that the crowded-out shareholders do not want, the countervailing effect will be mitigated, and on balance, an appreciation of the dollar will remain.

The lesson from these considerations is that the dollar appreciates when more dollars are demanded or fewer dollars are supplied, not when more American interest-bearing assets are demanded. It is surprising how frequently this simple fact has been overlooked in the literature on the determinants of the exchange rate.

One of the reasons why the layman's argument overlooks the possible repercussions resulting from the actions of crowded-out shareholders is that it focuses on transitional demand and supply flows in the currency exchange markets rather than on ultimate preferences for stocks of assets such as shares, bonds, and currencies. To analyze what is happening to the exchange rate, we need a portfolio balance model enriched with stock demands for domestic and foreign currency. According to such a model, the interest rate, the price of shares, and the exchange rate are determined by the need to equate desired with actual wealth portfolios. At any point in time the actual portfolio of assets is given in the aggregate, and thus a desire to restructure this portfolio cannot be fulfilled. Instead, asset prices, rates of return, and exchange rates have to adjust until people's preferences fit the given actual stocks of assets available, notwithstanding the fact

that from a microeconomic point of view, it is always possible to adjust the portfolio to the preferences.

A Friedmanian thought experiment exemplifies the merit of a currency-augmented portfolio balance approach in the present case. Suppose that the European investors who wish to replace their European shares with American ones pack these shares into coffers, fly to the United States, and negotiate directly with the American shareholders. They then find an exchange rate between European and American shares, and hence relative rates of return, at which the American shareholders are willing to participate in the deal. In general equilibrium, this direct deal cannot result in any exchange rate other than the one brought about by a transitional conversion of European shares into euros, of euros into dollars, and of dollars into US shares. Thus the thought experiment confirms that the dollar–euro exchange rate cannot be effected if the American shareholders who sold their shares are happy to hold European shares instead.

If the dollar appreciates, it must be because American shareholders are not happy with all the European shares they purchased and convert them into other assets in a way that increases the demand for of US money balances or reduces the supply of such money balances. As explained above, the first of these cases is the straightforward move from European shares into American money. The second case results from the wish to convert European shares into American bonds (or bills). If this induces the Fed to supply more bonds and reduce the stock of currency in circulation so as to defend the short-term interest rate, US currency will become more scarce and the dollar will appreciate.

7.3 Why Money Matters

To clarify the role of currency in the determination of the exchange rate more formally, we now specify a simple two-country portfolio balance model with a representative international investor who chooses among three types of assets in each of the two countries: shares S, bonds (or bills) B, and money M.[13] The two countries are the United States and Europe. In a market equilibrium the share prices, the exchange rate, and the interest rates are determined so as to equate the desired portfolio structure resulting from the investor's optimization to the actual one, which is taken as given.[14]

The units of account for measuring the volumes of shares, bonds, and money are the respective national currencies. The volume of shares S is expressed in terms of the nominal share value. The market value of a share is a multiple P of the nominal value. We call this multiple the share price. When r denotes the rate of return on nominal share values, $r \cdot S$ is the dividends distributed and r/P is the effective rate of return on shares (without a potential return from share appreciation). Let i denote the rate of interest on bonds. Variables that refer to the United States are labeled with an asterisk; variables without an asterisk refer to Europe and are expressed in terms of euros. The exchange rate e is the price of euros in terms of dollars.

The representative international investor is meant to reflect the aggregate of all wealthly Americans and Europeans. He optimizes his portfolio for a given investment period, which may or may not be part of a multiple-period setting. At the beginning of the period he has a given endowment of assets that constitutes his total wealth W in terms of euros, but he chooses to re-optimizes his portfolio structure, taking the two share prices, the exchange rate, and the two interest rates as given.[15] The investor's budget constraint in terms of euro expenses for the six types of assets available is

$$W = S^* \frac{P^*}{e} + B^* \frac{1}{e} + M^* \frac{1}{e} + SP + B + M. \tag{1}$$

Note that the choice of numéraire is arbitrary but meaningless. Nothing would change by choosing the dollar as the numéraire.

Among other things, the investor's decisions depend on expectations of end-of-period share prices and of the end-of-period exchange rate, which we denote $\tilde{P}$ and $\tilde{e}$. The model predicts that changed expectations about these variables will immediately translate into their current counterparts, but we fix the expectations throughout this chapter in order to concentrate on the fundamentals affecting the exchange rate. Our discussion focuses on changed stocks of assets due to government policies, changed real returns, and changed preferences for certain types of assets, given the expectations. The investor's utility is assumed to be given by the sum of end-of-period wealth plus a liquidity service

$$U\left(\frac{\sigma^* S^* \tilde{P}^*}{\tilde{e}}, \frac{\beta^* B^*}{\tilde{e}}, \frac{\mu^* M^*}{\tilde{e}}, \sigma S\tilde{P}, \beta B, \mu M\right),$$

which depends on the respective expected stock values $S^*\tilde{P}^*/\tilde{e}$, $B^*/\tilde{e}, M^*/\tilde{e}, S\tilde{P}, B$, and M.[16] The liquidity service is meant to capture all considerations important for the choice of assets other than their contribution to the pecuniary return, including risk characteristics, Baumol-Tobin type transactions costs, the timing of planned commodity purchases, and the like. The Greek symbols $\sigma^*, \beta^*, \mu^*, \sigma, \beta$, and μ denote parameters of the utility function, which allow us in a simple fashion to represent arbitrary preference changes including those that generate cross-price effects among different assets. We assume that U is an increasing, separable, and strictly concave function and that the parameters are unity before a preference change takes place.

Formally, the investor's decision can be depicted by maximizing the Lagrangean

$$\begin{aligned} L = {} & S^*\frac{1}{\tilde{e}}(\tilde{P}^* + r^*) + B^*\frac{1}{\tilde{e}}(1 + i^*) + M^*\frac{1}{\tilde{e}} + S(\tilde{P} + r) + B(1 + i) + M \\ & + U\left(\frac{\sigma^* S^* \tilde{P}^*}{\tilde{e}}, \frac{\beta^* B^*}{\tilde{e}}, \frac{\mu^* M^*}{\tilde{e}}, \sigma S\tilde{P}, \beta B, \mu M\right) \\ & + \lambda\left(W - S^*\frac{P^*}{e} - B^*\frac{1}{e} - M^*\frac{1}{e} - SP - B - M\right) \end{aligned}$$

with respect to the six different asset volumes considered in the model. Here the first line is end-of-period wealth in terms of euros, the second gives the liquidity services, and the third contains the investor's budget constraint where λ is the Lagrangean multiplier. The marginal conditions resulting from this optimization approach are

$$\frac{e}{\tilde{e}} \cdot \frac{\tilde{P}^*(1 + \sigma^* U_{S^*}) + r^*}{P^*} = \lambda, \tag{2}$$

$$\frac{e}{\tilde{e}}(1 + i^* + \beta^* U_{B^*}) = \lambda, \tag{3}$$

$$\frac{e}{\tilde{e}}(1 + \mu^* U_{M^*}) = \lambda, \tag{4}$$

$$\frac{\tilde{P}(1 + \sigma U_S) + r}{P} = \lambda, \tag{5}$$

$$1 + i + \beta U_B = \lambda, \tag{6}$$

and

$$1 + \mu U_M = \lambda. \tag{7}$$

These equations are similar insofar as they all show that in the optimum the sum of each asset's own rate of return factor plus the marginal liquidity service, possibly corrected by a growth factor reflecting the expected exchange rate adjustment, equals a common yardstick, the Lagrangean multiplier λ. In the case of US shares (2), the rate of return factor is a combination of the growth factor of the dollar in terms of euros, $e/\tilde{e}$, of the growth factor of the US share price, $\tilde{P}^*/P^*$, and the effective rate of return on US shares, r^*/P^*. In the case of dollar currency (4), the rate of return factor is just the growth factor of the dollar in terms of euros, and in the case of euro currency, it is simply one. The other cases should be self-explanatory. In general, an asset's pecuniary rate of return factor is smaller, the larger this asset's marginal liquidity service. As the rate of return on shares tends to be higher than that on bonds and the latter higher than that on cash, the marginal liquidity services will presumably follow the adverse ordering.

Let a bar above a variable indicate the given asset stocks in the economy. The investor's wealth in terms of euros with which he enters the period is then determined by

$$\bar{S}^* \frac{P^*}{e} + \bar{B}^* \frac{1}{e} + \bar{M}^* \frac{1}{e} + \bar{S}P + \bar{B} + \bar{M} \equiv W. \tag{8}$$

Equations (1) through (8) define the demand functions for all six assets. The asset prices, the exchange rate, and the interest rate follow if we assume that, for each asset, demand equals supply:

$$S^* = \bar{S}^*,\ B^* = \bar{B}^*,\ M^* = \bar{M}^*,\ S = \bar{S},\ B = \bar{B},\ M = \bar{M}. \tag{9}$$

In total, there are now 14 equations, one of which is redundant. They explain six asset stocks, two interest rates, two share prices, one exchange rate, the Lagrangean multiplier, and the wealth level, in a total of 13 variables.

There is no need to explicitly solve for all of these variables because a number of useful observations can easily be derived by inspecting the equations. One concerns the economic prosperity view. Suppose that σ^* in equation (2) increases and/or σ in equation (5) declines while the marginal utilities of money holding remain constant. Equations (4) and (7) then fix the exchange rate e and the Lagrangean multiplier λ. As U_{S^*} and U_S are fixed by the given levels of S^* and S, it follows from (2) and (5) that the changed preferences for share holdings will be accommo-

dated only by an increase in the price of US shares P^* and/or a decline in the price of European shares P. No exchange rate movements are necessary to maintain a portfolio equilibrium.

Changes in the nominal rates of return r and r^* in favor of American assets would, as the reader can easily verify for himself, have very similar effects. If the money demands do not change, they would not, as the economic prosperity view predicts, result in an appreciation of the dollar but, once again, only in an increase in the US share price relative to the European one.

A similar remark applies to the rates of interest on bonds. Again, the exchange rate e and the Lagrangean multiplier λ are fixed by (4) and (7) independently of these interest rates. An increase in the preference for US bonds as reflected by an increase in β^* will, according to (3), only result in a fall in the US interest rate, and similarly an increase in the preference for European bonds will reduce the European interest rate according to (6) without affecting the exchange rate.

The crucial equations for the determination of the exchange rate are (4) and (7). Together they imply that the value of the euro is explained by the marginal liquidity services of euros and dollars in the international wealth portfolio:

$$e = \tilde{e} \cdot \frac{1 + \mu U_M}{1 + \mu^* U_{M^*}}. \tag{10}$$

No pecuniary rates of return of the assets on which the portfolio balance approach focuses enter this formula, since these rates are endogenous to the market equilibrium. This reiterates the point made above, which is less trivial than it sounds: the currency exchange rate is the exchange rate between two types of money, and not the exchange rate between interest-bearing assets.

The remarkable aspect of these neutrality results is that preference changes concerning interest-bearing assets will result in price and rate of return changes that are large enough to compensate for these changes but do not affect the exchange rate. For exchange rate movements to come along with such preference changes, it would be necessary that preference changes for money balances be involved too. Consider, for example, the home bias discussed in the previous section implying that crowded-out American shareholders like to go into American money. In the aggregate model considered here, this can be captured by the assumption that the increased preference for American

shares comes along with an increased preference for US money, meaning an increase of μ^*. According to equation (10) this would indeed imply a weakening of the euro.

Thus far we assumed that the stocks of assets are given in the portfolios and that the pecuniary rates of return are flexible. Rate of return adjustments will then be able to accommodate the preference changes with regard to bonds and shares but not with regard to money holdings, because the pecuniary return of money is fixed at zero. Only a changed preference for money holding needs an exchange rate adjustment to keep the desired portfolio structure in line with the given actual one.

Things are different, though, when other rates of return are fixed too. The relevant case here is that the two central banks fix the national interest rates and accommodate any changes in preferences for money and bonds with appropriate open market policies that change the composition of the outstanding stocks of bonds and money balances. This will affect the marginal liquidity services of money balances and will have repercussions on the exchange rate according to equation (10).

From equations (3), (4), (6), and (7) it follows that the national interest rates are given by

$$i^* = \mu^* U_{M^*} - \beta^* U_{B^*} \quad \text{and} \quad i = \mu U_M - \beta U_B. \tag{11}$$

Given the stocks of money and bonds and hence given U_{M^*}, U_{B^*}, U_M, and U_B, a national interest rate obviously decreases with a decrease in the preference for the respective national money (decrease of μ^* or μ) and/or an increase in the preference for national bonds (increase of β^* and β), as was explained. To prevent this from happening and to fix the interest rates, the central banks have to accept any exchange between the national stocks of money and bonds that the public wants to carry out at the given interest rates; that is, they have to intervene passively by supplying more of the respective stock in demand and withdrawing the other one from the market.

Passive intervention of this type will make the exchange rate reactive to changed preferences for bond holdings and protect it partly from changes in the preference for money holdings. Consider, for example, the case of an increased preference for US bonds, as is reflected by an increase in β^*. To avoid a decrease in the US interest rate, the Federal Reserve Bank will react by selling bonds against US currency, which increases U_{M^*} and lowers e according to (10). The dollar appreciates after an increase in the demand for US bonds. Similarly a depreciation

of the euro, e, could be brought about by a reduced preference for European bonds if the European Central Bank fixed the interest rate by buying bonds and selling euros—or, as discussed in the previous section, by an increased preference for American bonds which the Fed accommodates with a contractionary open market policy.

Things would be similar if the central banks intervened also to keep the effective rate of return on shares constant, but of course they don't. This is the crucial point overlooked in the existing portfolio balance literature. If the central bank intervenes only to keep the interest rate constant and if no more than the preference for shares changes as is reflected by σ^* and σ, equations (2) through (7) continue to ensure an isolation of the exchange rate. This confirms the above criticism of the economic prosperity explanation of the euro's weakness and of the traditional portfolio-balance approach as such. Even when the central bank intervenes passively to keep the interest rate constant, changes in profit expectations, in preferences for share holdings, or in preferences for direct investment cannot influence the exchange rate unless they also imply changes in preferences for bonds or money balances.

Let us now discuss the reason why a passive intervention might partially protect the exchange rate against changes in liquidity preferences. Suppose that the preference for euro currency declines, as is represented by a reduction of μ. According to (10), this will depreciate the euro, and according to (11), it will reduce the European interest rate. To prevent the interest reduction, the European Central Bank will buy back money balances against private bonds. In itself, this will increase U_M and increase e, meaning it will stabilize the exchange rate. The stabilization will not be perfect, though, because the increase in the stock of bonds results in a reduction in the marginal utility from bond holding, U_B. According to (11), a constancy of the interest rate therefore implies that the marginal utility from money holding, μU_M, will not be pushed back to where it was before the preference change and that there is a negative net effect on the euro.

This can also be seen by deriving a modified interest parity condition from equations (3) and (6), which relates the exchange rate to the national interest rates and the marginal liquidity premia for bonds:[17]

$$e = \tilde{e} \cdot \frac{1 + i + \beta U_B}{1 + i^* + \beta^* U_{B^*}}. \tag{12}$$

As the passive intervention triggered off by the decline in μ increases the stock of bonds held by the public, B, and thus reduces the bonds'

marginal liquidity service U_B, equation (12) ensures that the net effect on the exchange rate is negative. A similar result holds for an increase in μ^*. As the reader may verify for himself, a negative net effect on e and a decrease of M^* can also result from an increase in the preference for dollar currency if the dollar interest rate is given.

The effect has a certain similarity with an active intervention in the exchange market. If such an intervention is sterilized in the sense that it leaves the interest rates fixed in the two countries, it will involve a sale of dollar currency and dollar bonds against euro currency and euro bonds so as to keep the respective national differences in the marginal liquidity services of money and bonds constant, as is indicated by (11). The decline in the marginal utility of US bonds, and the respective increase in the marginal utility of European bonds that results from this change in the structure of the market portfolio, raises the fraction on the right-hand side of (12) and hence the value of the euro.[18]

It is a common feature of the active and passive interventions that a decline in the stock of euro currency exhibits a positive effect on the value of the euro. However, the distinguishing feature is that this effect comes independently when the central bank intervenes actively in the foreign exchange market while it is only an induced compensating effect, which cannot offset the primary effect when the central bank intervenes passively by fixing the interest rate. Thus the correlation between the stock of euro currency and the value of the euro should be negative in the case of active intervention with a given interest rate, and positive in the case of passive intervention after a change in the currency preference. As we showed above that a negative correlation would also characterize the case of passive intervention after a change in bond preferences, it seems that the sign of the correlation between the currency stocks and the exchange rate might be a clue for finding the causes of the weak euro.[19]

It is essential for our theory that American and European bonds be imperfect substitutes in the international portfolio. If they were perfect substitutes, a preference shift would be made from European to American currency. The shift would be accommodated by a contractionary open market policy in Europe and an expansionary one in the United States, so as to keep the interest rates constant and not affect the exchange rate. The simplest way to depict this possibility in our model would be to assume that bonds do not deliver marginal liquidity services in addition to their pecuniary return, such that $\beta^* U_{B^*} = \beta U_B = 0$.

Equations (10) through (12) would then imply that fixing the interest rates eliminates any effect of a changed preference for money holding on the exchange rate. Similarly equation (12) would imply that the ECB tried the impossible when it intervened in the foreign exchange market to stabilize the euro without changing the European interest rate. However, we find it hard to believe that bonds denominated in different currencies and separated by a flexible and risky currency exchange rate will even come close to being perfect substitutes. This is the old dichotomy between the portfolio balance and the monetary approaches, which can only be solved empirically.

Feldstein and Horioka (1980) and Dooley, Frankel, and Mathieson (1987) have argued that a high correlation between savings and investment points to a rather limited international substitutability of assets, and within our model we will also be able to provide supporting evidence for a limited substitutability.[20] If American and European bonds are perfect substitutes, the value of the euro and the stock of euro currency should be uncorrelated both in the presence of demand and supply shocks if one controls for the interest rates. On the other hand, if they are imperfect substitutes, then controlling for the interest rates, there should be a negative correlation when supply shocks dominate and a positive correlation if demand shocks dominate. These are clear-cut predictions, and we will show that during the historical period considered there was indeed a very significant positive correlation.

7.4 Black Money and Deutschmarks Circulating Abroad

The deutschmark provides a particularly striking example of the positive correlation between the stock of currency in circulation and the foreign exchange value of this currency: in the late 1980s and early 1990s the Bundesbank and the public had regularly been surprised, if not alarmed, by the fact that the German monetary base grew much more rapidly than was anticipated, typically exceeding the projection corridor the Bundesbank had published. During this period there was a persistent revaluation pressure for the deutschmark. The pressure even led to the collapse of EMS in 1992, which implied a sudden revaluation of the deutschmark relative to most of the European currencies and the dollar.[21] Since 1997, however, this trend has been reversed (see figure 7.1), and so has the trend in the growth rate of money balances. When the external value of the deutschmark began to decline,

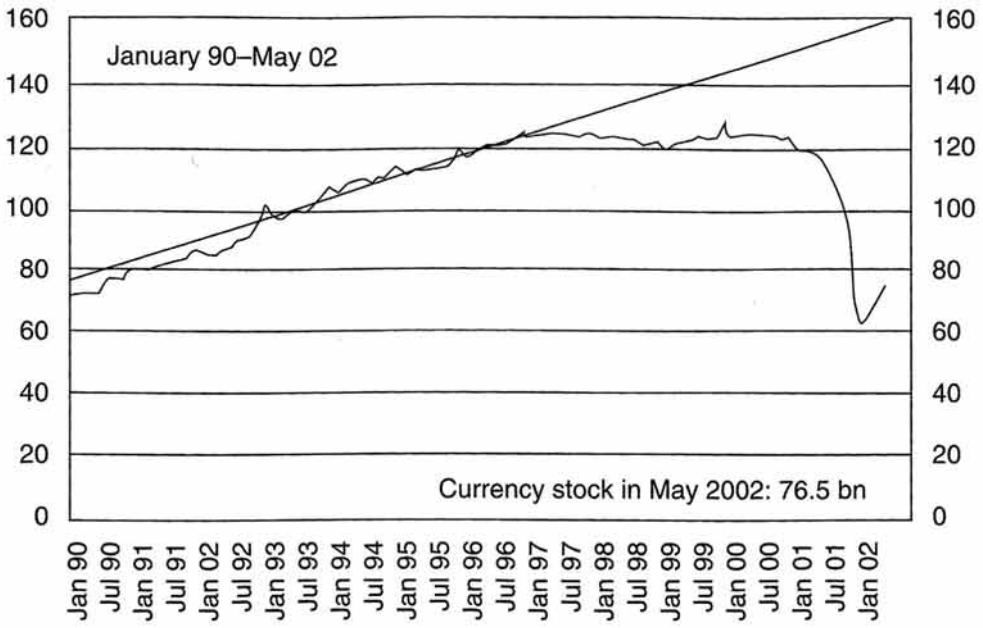

Figure 7.4
German currency in circulation (monthly data, billion). (Source: Deutsche Bundesbank homepage, 2002.)

the growth rate of the German monetary base began to decline relative to its trend, and during the year 2000 even the base itself began to fall with a gradually accelerating speed. Figure 7.4 illustrates this development.

The development of the stock of all euro currencies, as depicted in figure 7.5, paralleled that of the stock of deutschmark currency. No econometric approach is need to uncover the movements. Obviously the stock of euro currencies in circulation was falling against the trend from about 370 billion € to about 250 billion €, which is a decline of 120 billion € or one-third. This is ten times more than the numbers monetary theorists usually try to interpret.

The numbers are also huge if compared with previous intervention and speculation volumes. George Soros is said to have succeeded to tilt the EMS with only a few billion pounds, and the ECB's frequent interventions to stabilize the euro had probably not exceeded 4 billion euros in total.

It can only be guessed what the reasons for the euro currencies returning to the ECB were. We believe that it has do to with the announcement and anticipation of the physical currency conversion, which induced a flight from euro currencies into other assets including other currencies. There are two categories of flight money: deutsch-

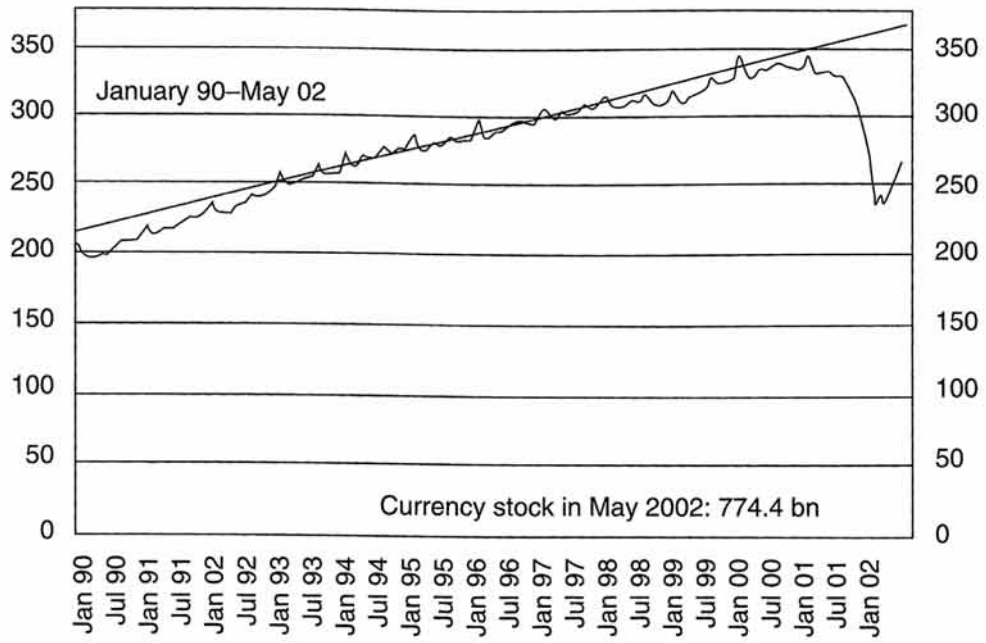

Figure 7.5
Euro zone currency in circulation (monthly data, billion). (Sources: September 1997–May 2002 Deutsche Bundesbank (2002), January 1990–August 1997 Ifo estimate based on monthly changes.)

marks that were legally and illegally held for transactions purposes outside Germany, and stocks of black money denominated in all euro currencies that were held by west Europeans. Other reasons that relate to the more technical aspects of the currency conversion could have been important in the very last moment before the conversion, but the deviation from the trend began too early for these reasons to have a considerable explanatory weight.

The first category must have been substantial because the German currency was the only one among the euro currencies that served as a means of transactions in other countries, in particular, in eastern Europe and Turkey but also in other parts of the world. In a Bundesbank discussion paper published by Seitz (1995), the accumulated stock of deutschmark currency outside Germany was estimated to be between 60 and 90 billion in 1995, which is equivalent to 30 to 45 billion €. At the time this number was between 25 and 35 percent of the German monetary base and between 10 and 15 percent of the monetary base of what later would be the euro countries.[22]

The deutschmarks circulating abroad began to return after the firm announcement of the currency union at the Dublin meeting in 1996. Foreign money holders had heard about the abolishment of the

deutschmark and were afraid of sustaining a conversion loss. Even in Germany, many people were afraid of losing part of their wealth, despite the frequent advertising campaigns for the euro. The uncertainty of ordinary people elsewhere in the world must have been much bigger, since they were not informed about the conditions of the conversion and probably wondered what all this euro business was about. No doubt they heard that the deutschmark was to be abolished in 2002 and had wind of the talk about a new currency replacing it. But they did not know who would carry out the conversion, what the exchange rate would be, and what commission fees would be charged. Those people afraid of sustaining a loss continued to hoard deutschmarks and hurried into the dollar or other currencies, including their own, which were free of this kind of uncertainty. The recipients of the deutschmarks, typically banks and other financial institutions, then returned the deutschmarks to the Bundesbank in exchange for interest-bearing assets, typically short-term securities that were counted as part of M3.

It is interesting in this regard that that the ECB announced in its *Bulletin* of November 2001 a redefinition of its stock of M3 because a growing proportion of such securities had been accumulated by foreigners and was nevertheless counted as part of M3. Short-term securities with a maturity of up to two years that were being held by foreigners were decided no longer to be included in the definition of M3. According to the ECB's own information this amounted to an adjustment of the published increments of M3 on the order of 40 billion € in one year. An analogous comparison between the old and new M3 figures for the period back to January 1999 shows that the effect could even have been on the order of 100 billion €. It is unclear how much of this can be attributed to the returning deutschmarks, but the figures must be seen as a clue to the forces at work.

Further evidence comes from two surveys. One was conducted by us, using the Ifo Institute's Economic Survey International, a quarterly transnational poll among country experts. We asked 150 experts in eastern Europe, typically economists working for international companies, about a potential shift in the interest of ordinary people from the deutschmark to the dollar. Of the 71 people from 15 countries who responded to the poll, a majority of 54 percent reported that the public showed a growing interest in the dollar, 78 percent thought that the public had not been sufficiently informed about the introduction of the euro, and another 54 percent said that the public was at least partially

worried about losses if they did not soon exchange their German marks into a permanent currency such as the dollar.

Another, much more extensive survey with thousands of east Europeans was conducted by the Austrian Central Bank (Stix 2001). The survey was taken at various times over two years in Croatia, Hungary, Slovenia, the Czech Republic, and Slovakia. It affirmed that the decline of the share of D-mark in circulation in the total euro money supply was due to the deutschmarks returning from abroad and that as late as May 2001 no less than 41 percent of the holders of deutschmarks who had made up their minds planned to exchange their stocks not into euros but into other currencies.

Let us now turn to the second reason for the flight of cash, namely the flight of black money in the run-up to the physical conversion of euro currencies. According to the European laws against money laundering the official conversion of larger sums of old cash into euros was not possible without registration. People who held stocks of black European monies therefore had to find ways to gradually convert them outside the banking system before the official conversion date, but they could not convert them into the euro because this currency existed only in a virtual form. Thus they had to go into the dollar, the pound, or other currencies that were not part of the euro group, and the sellers of these international currencies then exchanged the surplus stocks of euro currencies against interest-bearing assets that, after a substitution chain, ultimately came from ECB, which tried to stabilize the interest rate as explained above.

Unfortunately, no official statistics are available that allow a precise distinction between the two sources of the decline in currencies as depicted by figures 7.4 and 7.5. Neither black stocks of money balances nor currency stocks held in eastern Europe are easily observable. Nevertheless, there is indirect evidence that provides rough estimates of the relative magnitudes involved.

Consider first the results of Schneider and Ernste (2000) on the size of the black economy in Europe. According to these authors, the share of the black economy in the euro countries is about 14 percent of the actual GDP including the black activities. Based on this figure and the trend value of 370 billion euro, as shown in figure 7.5, the potential stock of black currency at the time of currency conversion can be expected to have been 52 billion € or more.

Figures 7.4 and 7.5 make it clear that roughly this sum could have contributed to the net decline of the currency in circulation until the

time of physical currency conversion. As the results of Schneider and Ernste reveal that Germany's black market share in GDP is close to the European average and as German GDP is about 31 percent of the total of all euro countries, the reduction in the stock of deutschmarks in circulation would have had to be 31 percent of 120 billion €, in other words, 36 billion € if it was exclusively explained by the black market effect. However, figure 7.5 reveals that the decline against the trend of the stock of deutschmarks in circulation was much higher, about 90 billion €. This clearly points to the importance of the eastern European effect. Assuming that the 30 billion € decline of non-German currency in circulation, revealed by figures 7.5 and 7.6, can be explained fully by the black market effect[23] in the non-German euro countries, which produce 69 percent of the GDP and should therefore hold 69 percent of the stock of black money, the total black market effect for all euro countries can be taken to be about 45 billion €. Thus the remainder of the total decline of 120 billion €, which is 75 billion €, can be seen to reflect the stock of deutschmark currency that returned from eastern Europe and other parts of the world, or did not flow there in the first place because of the expected euro introduction.

These are only rough estimates. Whatever the true relative importance of the two effects may be, the fact that ordinary people outside Germany and west European holders of black money had lost their interest in euro currencies in the run-up to the currency conversion is beyond doubt. There was exactly the kind of reduced preference for euros that was modeled by a decline of the utility parameter μ in the previous section.

Our theory indicates that this reduced preference would have lowered the value of the euro and the European interest rate if the ECB had not intervened. The euro and the interest rate would have adjusted such that the existing stocks of money balances continued to be held in the international wealth portfolio. However, the ECB intervened passively so as to stabilize the interest rate. As explained in the theory section, this mitigated the decline of the euro without eliminating it, while the stock of circulating currency fell.

The mechanism through which this actually happened is that the euro currency held by foreigners and black market agents went to international financial agencies (banks and investors) that held both euro and dollar currencies. Some of the dollars delivered by these agencies may have come from the Fed in exchange for US securities and some of the euros received by them went to ECB in exchange for

European securities. In the end, the euro declined, and there was less US currency and more European currency in the international portfolio of these financial agencies, and more US currency and less European currency in the aggregate international portfolio of all private agents taken together, including eastern Europeans and black market agents. This interpretation fits the observed decline of the stock of outstanding deutschmarks as shown in figures 7.4 and 7.5 and the simultaneous decline of the euro as shown in figure 7.1.

It even fits the rise of the euro after February 2002 when the currency conversion was completed (see figure 7.1). As was predicted by us in the journal articles and other contributions,[24] currency demand by eastern Europeans and holders of black money went up immediately after the physical conversion, forcing the ECB to pump more money into the economy so as to maintain its interest target, and the euro began to appreciate rapidly, taking by surprise the analysts who believed in a correlation between the strong US recovery and the value of the dollar. The development after the physical currency conversion mirrors that of the virtual conversion before it: the euro has been gradually taking the places emptied by the old euro currencies, in particular, the place of the deutschmark in eastern Europe. In a recent paper the ECB (Padua-Schioppa 2002) estimated that until May 2002 no less than 18 billion € were transferred to countries in eastern Europe. The fall of the Iron Curtain bolstered the deutschmark in the early 1990s. Fear of its conversion into the euro weakened it after 1997 and with it the euro itself. By the same logic, the euro has started to gain strength in the period since the conversion.

7.5 A Quantitative Assessment of the Effect

An important question is whether a decline of the monetary base by about 120 billion € against the trend can cause effects large enough to explain the actual exchange rate movements. The search for its answer requires an empirical determination of the corresponding reaction coefficients. Here we take two different approaches. First, we review the evidence from recent studies of micro data on the effect of money demand on the exchange rate. Second, we estimate a modified portfolio balance model, using macro data.

Recent contributions by Evans and Lyons (1999, 2001) on the "micro structure of the exchange rate" conclude that each billion of additional sterilized dollar currency demand raises the dollar exchange rate by up

to half a cent in the short run and about 30 cents in the long run. If these figures apply equally to the euro, then our theory explains the depreciation of the euro by about 36 cents in the period 1997 to 2000. This is extremely close to the actual depreciation, which was 34 cents during this period.

In order to assess the co-movement of the exchange rate and relative money supplies from macro data, we now analyze empirically the determinants of the exchange rate. The question in the context of our model is whether the currency in circulation has a significant positive partial effect on the exchange rate of the euro in the presence of the other variables. The co-integration technique is used to study the empirical long-run relationship among the five variables relevant to our model: the exchange rate, relative money supplies, relative interest rates, relative bonds, and relative share prices. We analyze the co-movements for the period from 1984 to the end of 2001 for German, Japanese, UK, and Swiss exchange rates with respect to the United States.

The Johansen (1991) procedure is used to test for the presence of co-integration.[25] The Johansen test results are reported in panel A of table 7.1, along with the robustness of this model and some econometric issues. The long-run coefficients in the table were the exchange rates normalized to one. All variables are defined as in the theoretical model above.

The empirical results are consistent with our impression from the data analysis and the discussion in the previous sections. We first focus on the long-run coefficients. In all countries, except Switzerland, which used to control money supply rather than interest rates, the currency in circulation has a positive effect on the exchange value of the domestic currency. Because American and European bonds are perfect substitutes, this contradicts the view that a policy of fixing the interest rates eliminates the effect of currency demand changes on the exchange rate.

The positive correlation between the monetary base and the foreign exchange value of the currency had also been observed in earlier work by Frankel (1982, 1993), who called it the "mystery of the multiplying marks" and attributed it to model misspecifications or wealth effects in the monetary model of the exchange rate. Indeed, the positive correlation seems puzzling if the monetary base is seen as resulting from a supply policy of the central bank and active interventions. However, according to our model, the positive correlation has a straightforward explanation in the historical episode considered here if variations in the

Table 7.1
Currency augmented portfolio balance model Johansen co-integration results, 1984:1 to 2001:4

Variable	GER	UK	JAP	SWI
A. Long-run coefficients				
tr	80.57	62.18	82.55	115.25
cv	68.52	47.21	68.52	68.52
$\ln M - \ln M^*$	0.804	1.622	0.145	−7.825
	(0.414)	(0.219)	(0.993)	(9.145)
	(1.943)	(7.386)	(0.146)	(−0.856)
$\ln i - \ln i^*$	0.009	0.013	0.014	0.109
	(0.014)	(0.006)	(0.085)	(0.166)
	(0.680)	(2.090)	(0.166)	(0.659)
$\ln B - \ln B^*$	−0.129		0.024	2.443
	(0.197)		(0.164)	(2.636)
	(−0.654)		(0.151)	(0.926)
$\ln P - \ln P^*$	−1.179	−0.079	−0.025	3.970
	(0.257)	(0.091)	(0.153)	(5.247)
	(−4.580)	(−0.874)	(−0.164)	(0.756)
B. Reversion coefficients				
$\Delta(\ln e)$	0.134	−0.239	−0.003	−0.009
	(0.044)	(0.106)	(0.001)	(0.020)
	(3.009)	(−2.247)	(−1.838)	(−0.448)
$\Delta(\ln M - \ln M^*)$	0.155	0.140	0.988	−0.003
	(0.039)	(0.081)	(0.191)	(0.026)
	(3.922)	(1.725)	(5.168)	(−0.119)
$\Delta(\ln i - \ln i^*)$	0.240	−1.166	3.855	0.150
	(0.457)	(1.569)	(2.718)	(0.378)
	(0.524)	(−0.743)	(1.418)	(0.396)
$\Delta(\ln B - \ln B^*)$	0.019		0.022	0.036
	(0.035)		(0.189)	(0.012)
	(0.550)		(0.120)	(3.000)
$\Delta(\ln P - \ln P^*)$	−0.060	−0.176	−0.158	0.092
	(0.062)	(0.059)	(0.397)	(0.026)
	(−0.972)	(−2.961)	(−0.399)	(3.496)

Note: Bond data were not available for the United Kingdom. The Swiss data start in 1989, as stock market data were not available before. *tr* denotes the likelihood ratio test statistic for the null hypothesis of zero cointegrating vectors against the alternative of one cointegrating vector. The asymptotic critical values are denoted by "cv." In all cases, except for Switzerland, there exists only one cointegrating vector. Standard errors and *t*-statistics are in parentheses.

foreign and black market demand for a country's currency are taken into account.

The other estimates are also broadly in line with our theoretical model. The positive effect of the interest rate (for Germany, Japan, and Switzerland) on the value of the domestic currency can have two explanations. One is that it results from an increased preference for the domestic currency which, as indicated by (10) and (11), will imply a revaluation and an increase of the interest rate if the central bank does not intervene. The other is that the central bank actively intervenes by tightening the money supply. According to (11), this increases the difference of the marginal liquidity premia of money and bonds and hence the interest rate, and according to (10), it implies a revaluation.

Bonds have a smaller negative effect in Germany, although it is not statistically significant and may be the counterpart of the positive effect of money holdings, since interventions imply that bonds and money balances vary inversely.

The significant negative coefficient of share prices supports the puzzle established by De Grauwe (2000), that the value of an economy's currency varies inversely with its prosperity, which is the opposite of what the economic prosperity view predicts. By our model, the explanation for the negative correlation is that domestic shareholders whose preferences imply a home bias switch between domestic shares and domestic money, depending on the information they receive. This changes the marginal liquidity premium on domestic money balances conversely to share prices. According to equation (10) the domestic currency appreciates when share prices are low, and vice versa.

Given the co-integration result, we use a vector error correction model to explore the reaction to a deviation from the long-run equilibrium.[26] The responses of each of the variables to deviations from the long-run equilibrium are captured by the revision coefficients reported in table 7.1. In the cases of Germany, the United Kingdom, and Japan, the exchange rate and the relative money bases react to the deviations from the equilibrium, while most others do not.

It is known from the work of Meese and Rogoff (1983) and Taylor (1995) that the empirical research on exchange rate determination suffers from instability of the parameters over time, and poor out-of-sample performance. This problem also applies to our empirical exercise. In order to check the robustness of our estimation procedures, a set of appropriate tests was performed, using several estimation proce-

dures that addressed econometric problems associated with this type of regression exercise. For example, we estimated an ARCH model, correcting for conditional heteroscedasticity, examined alternative lag structures in the co-integration exercise, and implemented an instrumental variables approach, aiming to reduce the endogeneity problem by way of lagged values as instruments. While most of our variables were affected by these alternative specifications, our main variable of interest, the relative money stocks, remained remarkably robust, exhibiting in most cases the significant positive correlation with the exchange rate predicted by our theory.

7.6 Conclusions

In this chapter we provide a criticism of the portfolio balance approach, and we attempt to develop a new theory of the exchange rate that we call the currency hypothesis. We take an explicit two-country portfolio model with money, bonds, and shares and show that there is little reason to expect the demand for shares to translate into the exchange rate because this demand is already reflected in the share price. We argue that what counts most is the stock demand for money in the narrow sense of the word. The exchange rate is the price of one type of money in terms of another and not the price of interest-bearing assets, as both portfolio managers and economists who developed the portfolio balances approach have claimed.

This theoretical result is confirmed by a number of empirical tests of exchange rates among various currencies. The tests demonstrated a strong and robust positive correlation between a country's stock of currency in circulation and the respective exchange value of this currency.

Our currency hypothesis is motivated historically by our observing the movements of the exchange value of the deutschmark and the euro from the time of the fall of the Iron Curtain to the physical conversion of the euro. We explain these co-movements in quantitative terms, using the "microstructure of the exchange rate" approach. With the fall of the Iron Curtain, the deutschmark became popular in eastern Europe in the early 1990s, leading to an unprecedented monetary expansion and the appreciation crisis of 1992. Fear of loss in its conversion into the euro reduced the demand for deutschmarks and weakened both the deutschmark and the euro after 1997. By the same logic, and predicted accurately by us in earlier contributions on this topic, the

euro has gained in strength since the time of the physical conversion. A good reason for the appreciation of the euro is that it is ideally suited for black market operations and is finding friends in eastern Europe and elsewhere.

Notes

Earlier work along these lines was presented at a workshop on Exchange Rate and Monetary Policy Issues in Vienna, April 2001, and at the CESifo Macro and International Finance Area Conference in Munich, May 2001. We gratefully acknowledge useful comments by Paul De Grauwe, Walter Fisher, Huntley Schaller, and Haakon Solheim.

1. Hans-Werner Sinn, *Handelsblatt*, November 6, 2000, *Financial Times*, April 4, 2001, and *Süddeutsche Zeitung*, April 6, 2000. See also Paul Krugman's comment on Sinn in *New York Times*, April 1, 2001, and *Bundesbank Geschäftsbericht* of April 4, 2001.

2. Alternative explanations can be found in Alquist and Chinn (2002) and Corsetti (2000).

3. *Economist*, June 5, 1999, p. 13; April 20, 2000, pp. 25–26. *Der Spiegel*, October 2000, "Interner Bericht des Finanzministeriums fordert tiefgreifende Reformen zur Stabilisierung des Euro."

4. *Economist*, June 5, 1999, p. 14.

5. ECB, *Monthly Bulletin*, June 1999, p. 39.

6. Ibid.

7. Ibid.

8. *Der Spiegel*, online, Interview with Karl Otto Pöhl, June 19, 2000.

9. "Interner Bericht des Finanzministeriums ...," ibid. See also "Prospects for sustained growth in the Euro area," ch. 2, *European Economy*, vol. 71, 2000. Office for Official Publications of the EC, Luxembourg, pp. 62–67.

10. The literature ranges from Branson (1977), Branson, Halttunen, and Masson (1977), Branson and Henderson (1985), Girton and Henderson (1976), and Henderson (1980) to Dooley and Isaard (1982), Sinn (1983a), MacDonald and Taylor (1992), and Mann and Meade (2002), to mention only a few of the relevant papers. For a description of current research and further references, see Isaard (1995).

11. The officially measured savings rate does not include capital gains. This is not a problem in the present context where the savers' willingness to absorb assets offered in the capital market is concerned.

12. See note 8.

13. We also formulated a more elaborate model distinguishing, among other things, between American and European investors, but the more parsimonious model presented here is sufficient for the points we wish to make.

14. An increase in the portfolio volume will not affect share prices, interest rates, and the exchange rate if preferences are homothetic and growth does not change the actual portfolio structure. For simplicity we assume that this is the case.

15. This is the general structure of a multi-period stochastic portfolio decision problem. See Sinn (1983b) for a more extensive elaboration on this problem. Here we cut things short by considering one period only and simplifying the utility function.

16. See Fried and Howitt (1983) for a discussion of the potential liquidity services and a formulation along these lines.

17. Equation (12) specifies the interest rates rather than the exchange rates when the respective asset stocks are given and the ECB does not intervene. According to (3) and (6), in equilibrium the interest rates on American and European bonds have to adjust such that they complement the marginal liquidity services of bonds to generate the required overall return factor λ. This then automatically satisfies the interest parity condition without giving equation (12) much explanatory power for the determination of the exchange rate. When central banks intervene passively to fix the interest rates, the explanatory power increases.

Although (12) refers to the spot rate e, it can also be used to determine the forward rate $\tilde{e}_f$ by way of the covered interest parity condition $\tilde{e}_f = e \cdot (1 + i^*)/(1 + i)$. The forward rate is not the same as the expected future spot rate. The relationship between these rates is found by substituting (12) into the preceding equation:

$$\tilde{e}_f = \tilde{e}\frac{1 + \beta U_B/(1 + i)}{1 + \beta^* U_{B^*}/(1 + i^*)}.$$

This expression shows that a reduced preference for euro currency combined with the adjustment to the interest rate reduces the euro's forward rate relative to its expected future spot rate without affecting the forward premium or the swap rate.

18. In practice, the interventions by the ECB involved the sale of US treasury bonds, which required the Fed to react with an expansionary open market policy increasing the money supply so as to avoid an increase in the US interest rate.

19. It should be noted that the positive correlation between the stock of money balances and the foreign exchange value of this money that the currency hypothesis predicts refers to high-powered base money (M0) rather than broader money aggregates. There are two reasons why an extension of the argument to M1, M2, or M3 is not possible. First, demand, savings, and time deposits may be implicitly or explicitly interest bearing and may therefore classify as part of B rather than M in our model. Second, even if demand deposits and cash are considered as close substitutes by the public, M1 may not be positively correlated with M0. Suppose that the demand for euro cash declines. In that case, the cash will return to the banks in exchange for demand deposits. The money multiplier will increase and induce the banks to expand M1 by giving out more loans to their clients. This will contribute to the decline in the marginal utility of money and the downward effects on the exchange rate and the interest rate. Thus, before and without passive intervention by the ECB, there is a negative correlation between M1 and the exchange rate and none between M0 and the exchange rate. If the ECB intervenes to reestablish the targeted interest level, it can only partly offset the exchange rate effect, and it reduces M0 as was shown above. However, the net effect on M1 will be unclear. Indeed, M1 remained remarkably stable during the collapse of euro base money in the years before currency conversion.

20. See also chapter 1 by Evans and Lyons in this volume.

21. For analyses of this episode see Eichengreen and Wyplosz (1993), De Grauwe (1994), and Sinn (1999).

22. No less than 60 percent of the US monetary base is said to circulate outside the United States (see Porter and Judson 1996). The outstanding deutschmarks were a source of a significant seignorage profit made by the Bundesbank, as was calculated by Sinn and Feist (1997, 2000). When the euro was introduced, the deutschmark constituted a much larger fraction of the euro-11 monetary base than the share in the ECB profit remittances, which was only 31 percent, according to the average of Germany's GDP and population shares. Sinn and Feist calculated that this implied a seignorage loss which was equivalent to a one-off capital levy of nearly 60 billion DM or 30 billion € on the German Bundesbank.

23. It is also possible that some of the decline was due to other, more technical, reasons such as the ordinary citizen's attempt to minimize the stock of money balances at the time of currency conversion. However, all countries would have been affected in proportion to their GDP size. In this case the idiosynchratic component of the reduction in money demand applied to Germany was on the order of 75 billion €. Note that our estimates of the composition of the decline in money balances have only an informative character. None of our arguments for why a decline in money balances reduces the exchange value depends on the causes of this decline.

24. See, in particular, the articles in *Handelsblatt* and *Financial Times* published in 2000, as cited in note 1, as well as Sinn and Westermann (2001).

25. All series are nonstationary in levels and stationary in first differences. We let $\boldsymbol{x}_t$ be a 5×1 vector containing the variables $\{e, \ln M - \ln M^*, \ln i - \ln i^*, \ln B - \ln B^*, \ln P - \ln P^*\}$. The Johansen test statistics are devised from the sample canonical correlations (Anderson 1958; Marinell 1995) between $\Delta \boldsymbol{x}_t$ and $\boldsymbol{x}_{t-p}$, where t is time and p denotes the lag length, adjusting for all intervening lags. To implement the procedure, we first obtain the least squares residuals from

$$\Delta \boldsymbol{x}_t = \boldsymbol{\mu}_1 + \sum_{j=1}^{p-1} \boldsymbol{\Gamma}_j \Delta \boldsymbol{x}_{t-j} + \boldsymbol{\varepsilon}_{1t},$$

$$\boldsymbol{x}_{t-p} = \boldsymbol{\mu}_2 + \sum_{j=1}^{p-1} \boldsymbol{\Gamma}_j \Delta \boldsymbol{x}_{t-j} + \boldsymbol{\varepsilon}_{2t},$$

where $\boldsymbol{\mu}_1$ and $\boldsymbol{\mu}_2$ are constant vectors, $\boldsymbol{\Gamma}$ is a matrix of parameters, and $\boldsymbol{\varepsilon}_1$ amd $\boldsymbol{\varepsilon}_2$ are vectors of the error terms. The lag parameter p is identified by the Akaike information criterion. Next, we compute the eigenvalues, $\lambda_1 \geq \cdots \geq \lambda_n$, of $\boldsymbol{\Omega}_{21}\boldsymbol{\Omega}_{11}^{-1}\boldsymbol{\Omega}_{12}$ with respect to $\boldsymbol{\Omega}_{22}$ and the associated eigenvectors, $\boldsymbol{v}_1, \ldots, \boldsymbol{v}_n$, where the moment matrices

$$\boldsymbol{\Omega}_{lm} = T^{-1} \sum_t \hat{\boldsymbol{\varepsilon}}_t \hat{\boldsymbol{\varepsilon}}_t'$$

for $l, m = 1, 2$, and n is the dimension of $\boldsymbol{x}_t$ (i.e., $n = 5$ in this exercise). $\lambda_1 \ldots \lambda_n$ are the squared canonical correlations between $\Delta \boldsymbol{x}_t$ and $\boldsymbol{x}_{t-p}$, adjusting for all intervening lags. The trace statistic,

$$tr = -T \sum_{j=r+1}^{n} \ln(1 - \lambda_j),$$

where $0 \leq r \leq n$, tests the hypothesis that there are at most r cointegration vectors. The eigenvectors, $\boldsymbol{v}_1, \ldots, \boldsymbol{v}_r$ are sample estimates of the co-integration vectors.

26. Specifically, the changes in each of the five variables are modeled using $\Delta \boldsymbol{x}_t = \boldsymbol{\mu} + \sum_{j=1}^{p} \boldsymbol{\Gamma}_j \Delta \boldsymbol{x}_{tj} + \boldsymbol{\alpha} \boldsymbol{ec}_{t-1} + \boldsymbol{\varepsilon}_t$, where $\boldsymbol{ec}_t$ is the error correction term.

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