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7 Heterogeneous Behavior in Exchange Rate Crises

Fabio C. Bagliano, Andrea Beltratti, and Giuseppe Bertola

The large changes experienced by European exchange rates certainly had large ex post wealth and welfare effects. It is not difficult to define and measure official reserve losses during the buildup of a currency crisis: as a loss of reserves entails an exchange of foreign-currency-denominated assets for domestic-currency-denominated ones, it is equally straightforward, in principle, to evaluate the accounting loss that ensues from eventual devaluation in a central bank's balance sheet that, through intervention, has become heavily exposed to exchange rate depreciation. Of course, exchange rate policy is primarily aimed at longer-run macroeconomic issues, and public-sector losses from devaluation are trivial from that perspective. From a microeconomic point of view, however, gains and losses in the central bank's balance sheets correspond to very real losses and gains in private-sector balance sheets: if the devaluation does occur after the loss of reserves, "speculators" earn capital gains; symmetrically, as long as the devaluation does not occur, high domestic interest rates hurt the private sector if monetary policy is tightened while yielding (accounting) profits for the central bank.

At the empirical level, this perspective brings forth many difficult and relatively unexplored issues. In central banks' balance sheets, assets whose counterpart is in a resident agent's balance sheet ("domestic credit") are denominated in domestic currency, while "reserves," whose counterpart appears in foreign balance sheets, are denominated in foreign currency. Private-sector bal-

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ance sheets, however, need not feature the same coincidence. Beyond standard balance-of-payments statistics based on an increasingly ill-defined distinction between "resident" and "nonresident" agents in a world of high capital mobility, only scant evidence is available on the currency and counterpart structure of various private agents' balance sheets.

At the theoretical level, standard models of exchange rate crises are silent on many of the relevant issues: the counterpart of central bank reserve changes is taken to be portfolio reallocation by a single representative agent and is driven by current and/or expected monetary policy developments (for a recent survey, see Obstfeld [1994]). Introspection and data, however, suggest that different individuals' and institutions' financial positions are differently exposed to the risk of devaluations in reality. The widely cited "convergence play" in the period of relative stability leading up to the ERM (exchange rate mechanism) crises, namely, the fact that portfolio managers would try and take advantage of large interest rate differentials between "weak-" and "strong-" currency-denominated assets (see, e.g., IMF 1993, chap. 3), is itself evidence of heterogeneity in the financial market: whereas the attempt to take advantage of apparent arbitrage opportunities would lead to interest rate convergence in an equilibrium representative-agent model, interest rate differentials persisted in the precrisis ERM, to indicate that other agents ("speculators") were betting on "divergence."

In this paper, we study interactions among optimizing agents and a central bank in an environment where a *devaluation* may occur with exogenously given probability. This has two advantages. On the one hand, exchange rate crises may be viewed as "controlled experiments" for the difficult task of modeling heterogeneous portfolio formation. On the other hand, focusing on devaluations makes it possible to frame the analysis in terms of two periods ("before" and "after" the devaluation) and to disregard ongoing dynamics to the extent possible. Our approach is intermediate between that of standard macroeconomic models, where exchange rate policy is viewed as a game between willful monetary authorities and a single "public" body, and that of more recent "microstructure" contributions concemed with individual traders' minute-by-minute problems (see Lyons, chap. 5 in this volume, and the references therein). In our analysis, we do not focus on fundamentals as much as the former literature does: we shall not try to interpret the monetary authorities' behavior, and monetary and exchange rate policies are exogenous to our approach. In contrast to the "microstructure" approach, we explicitly model the behavior of the market's main actors, who provide inputs to the traders and intermediaries on which those complementary contributions focus.

To keep our analysis as simple as possible, we model optimization in terms of a mean-variance retum objective, abstracting from the portion of wealth allocation that is not directly relevant for our problem. We pay close attention to the structure of each agent's balance sheet, treat it as the outcome of individual maximization problems, and derive the structure of equilibrium retums on

available assets. These features are essential to any framework intended to investigate devaluation gains and losses: as these depend on the structure of balance sheets, the model should be able to explain why agents other than the central bank (whose behavior is taken to be exogenous) were caught by the devaluation with a specific asset and liability structure.

In our stylized model, devaluation expectations are uniform across agents. Of course, this is not uncontroversial (see Frankel and Rose 1994, sec. V, and the references therein). We prefer to allow for heterogeneity in more directly interpretable respects, namely, for differences in risk aversion, asset preference, and need for liquidity. Heterogeneous objectives lead different agents to take different positions in domestic and foreign assets and to react differently to changes in the perceived probability of devaluation. To the extent that our stylized agents may be taken to represent households, firms, financial institutions, and central banks, the model can be used to interpret certain characteristics of the data.

The paper is organized as follows. Section 7.1 motivates our work with a review of readily available evidence on the Italian lira crisis in 1992. A first look at standard balance-of-payments statistics indicates that domestic banks, domestic nonbank investors, and foreign investors did contribute differently to official reserve losses. The theoretical analysis is organized in two main sections and several subsections. Section 7.2 sets up an accounting framework for the study of financial interactions among a central bank and a number of heterogeneous investors. In section 7.3, several elements of heterogeneity are considered and their implications in terms of portfolio choices and resulting gains and losses from devaluation evaluated. Section 7.4 goes back to the data, specifically to a variety of disaggregated statistics available in the Italian case.[1] We discuss the extent to which the peculiarities noted in section 7.1 may be rationalized by our theoretical considerations and the more disaggregated evidence. A concluding section summarizes the main findings and indicates directions for further research.

7.1 The Crisis of September 1992 in Italy

Our modeling perspective may be suitably applied to any period in which agents assign a positive (and nonnegligible) probability to the event of a change in the EMS parity grid. In this paper, we consider the lira exchange rate crisis of September 1992 and the summer months leading up to it. After some years of remarkable stability in the foreign exchange market (the most recent

1. We attempted to obtain similar statistics for other countries. Some Swedish data were kindly made available to us and may be considered in future work along the lines of this paper. Contacts with French and British central bank officials led to pleasant conversations, but no hard information. The officials we met readily acknowledged that the issues we focus on are of some importance and that balance-of-payment statistics throw very little light on them. Yet no better data appear to be available for those countries.

exchange rate crisis, leading to a devaluation of the lira, was in 1987), widespread fear of a realignment within the EMS (European Monetary System) originated from the negative and unexpected result of the Danish referendum on 2 June 1992.[2] The following four months witnessed sizable portfolio reallocations by various agents, with corresponding large changes in the reserve position of the central bank. This section provides a brief description of the events, highlighting the main facts that may motivate our theoretical analysis.

The first thing to note is that June 1992 marks a change of some of the trends in capital movements characterizing the preceding months. In fact, the completion of the process of gradual capital movements liberalization in 1990 (together with the adoption of the "narrow band" within the ERM in January of the same year, supporting expectations of exchange rate stability) favored a protracted large outflow of domestic nonbanking capital (by more than L 48,000 billion in 1991), mainly due to portfolio reallocations of households and financial companies and a heavy inflow of foreign funds (by almost 37,000 billion). Notwithstanding the conspicuous deficit of the current account, amounting to 26,500 billion, the loss of foreign reserves of the Bank of Italy was limited to some 8,500 billion owing to the large inflow of foreign currencies through the banking sector.

Between January and May 1992, the cumulative outflow of nonbanking domestic capital amounted to 39,100 billion and was offset by a net *inflow* of banking-sector capital of more than 35,000 billion. With a cumulative current-account deficit of 17,200 billion, foreign capital inflows of 17,500 billion (and small errors and omissions) limited the loss of central bank reserves to 6,300 billion.

The Danish no vote in the referendum on the ratification of the Maastricht Treaty on 2 June marked the beginning of the EMS crisis: foreign exchange market participants, which had largely disregarded the fundamentals of ERM members, became more responsive to certain countries' macroeconomic disequilibria and their possibilities of converging according to schedule. The crisis led to the abandonment of the ERM by the lira and the British pound in mid-September.

In the three months between June and August, there is evidence of differences in the behavior of the banking and nonbanking sectors of the Italian economy. In the face of a generalized rise in the perceived probability of a parity realignment within the EMS, different positions were taken by different agents. Figure 7.1 plots the monthly reserve loss of the Bank of Italy between February and December 1992, along with its determinants from balance-of-payments statistics. The distance between the solid line and the thick dashed line measures domestic financial intermediaries' capital flows: between June and August, this component sustained the financing needs of the Bank of Italy,

2. The data in table 5 in Eichengreen and Wyplosz (1993) indicate that almost 50 percent of surveyed dealers "first thought a change in ERM exchange rate was imminent" after the Danish referendum.

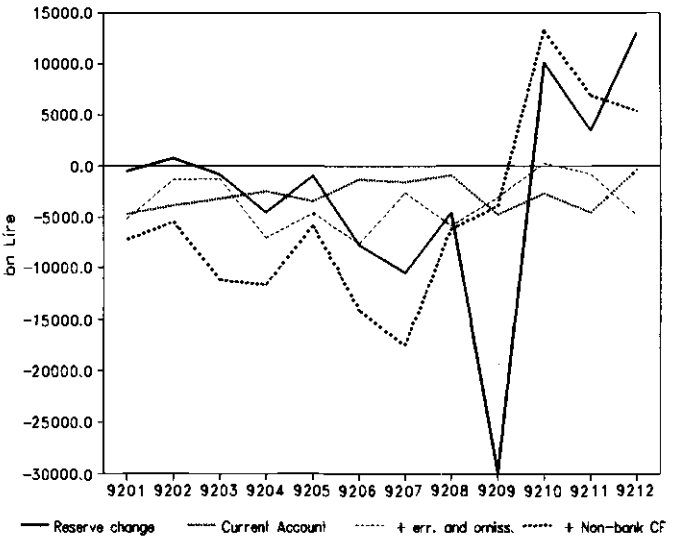

Fig. 7.1 Italy's balance of payments, 1992

with a cumulative inflow of about 15,000 billion. Apart from the current account deficit (about 3,500 billion in cumulative terms), the bank's reserve losses were reflected in a private-sector capital outflow totaling 21,400 billion (or 33,000 billion including errors and omissions, which may at least in part represent transactions by families).[3]

In early September, growing uncertainty in the run-up to the French referendum acted as a catalyst for the launching of speculative attacks, providing them with a fixed date. After heavy intervention by the Bundesbank and the Bank of Italy, and after an increase of 1.75 points in the discount rate, the lira was devalued by 6.76 percent on 13 September. After that, the Germans decreased the lombard by 0.25 and the discount by 0.5. A new attack was launched on 16 September; Britain left the ERM, Italy suspended the intervention limits, the peseta was devalued by 5 percent.

From the balance-of-payments data of figure 7.1, which are available only on a monthly basis, we see that the crisis brought about a dramatic reserve outflow (minus 30,000 billion in September). Even more strikingly, this outflow was matched by banking-sector capital outflows by 26,000 billion: nonbanking capital flows were negligible over the month, even accounting for errors and omissions, while the current account deficit was similar to those of previous months at 4,800 billion.

We feel that the remarkable apparent switch in domestic banks' portfolio

3. The balance-of-payments statistics do not register capital transactions unless they are carried out through authorized currency dealers, i.e., banks. Moreover, banks and individuals are not required to report operations valued at less than L 20 million.

choices deserves further attention at both the statistical and the theoretical levels. In interpreting the data displayed in the figure, however, one encounters various problems. First of all, the balance-of-payments data register end-of-period positions. The negligible change in private portfolio choices within the month of September might well hide offsetting movements before and after the devaluation. The lira/deutsche mark official parity was devalued by 7 percent on 13 September, and the exchange rate continued to depreciate after the abandonment of the ERM on 17 September. Speculation against the lira before each of those dates, and profit taking thereafter, would not be apparent in the available data. Second, the balance of payments registers only those transactions involving foreign counterparts. In a world of not only free capital mobility but also extensive financial deregulation, positions involving currency risk are routinely taken among agents based in the same country, while international transactions may well be denominated in either (or third) currencies.

Data at higher-than-monthly frequencies are not available to us (nor indeed to the Bank of Italy itself). However, the exchange rate policy arm of the Bank of Italy (Ufficio Italiano Cambi, or UIC, which is in charge of such statistics) does maintain and publish extensive records of banks' foreign-currency positions with both foreign and domestic counterparts. We analyze such data in section 7.4 below, after a brief analysis of several theoretical issues. The very existence of banks, in fact, requires that economic agents be heterogeneous, for otherwise no transactions would occur except those involving the central bank. Accordingly, in the next section we formulate a simple model where agents may be heterogeneous under a variety of respects.

7.2 Theoretical Considerations

We begin by studying the balance sheets of the various agents. This is useful to provide an accounting framework that may connect the portfolio positions of different agents. We do not consider the complete structure of assets and liabilities: instead, we focus on the financial positions that are relevant to the problem at hand. In the simple structure with which we begin, there is one central bank and one private agent. The private agent obtains credit from the central bank in two different currencies and repays the debt at the end of the period.

At time 0, the central bank's balance sheet reads (normalizing initial net worth to zero)

$$d_0 + f_0 x_0 = m_0. \tag{1}$$

On the left-hand side of (1), the central bank's assets include domestic credit d_0 and foreign-exchange reserves, which amount to f_0 in foreign-currency terms and are converted into domestic currency at the initial exchange rate x_0. On the right-hand side of (1), we have (domestic) high-powered money, m_0. All terms are expressed in units of domestic currency.

The distinction between "domestic credit" and "reserves" in (1) hinges on

currency denomination, not on whether the counterpart of those assets is a resident of the domestic country or a foreigu subject. In practice, however, domestic credit has resident counterpart *and* is in domestic currency; reserves have a nonresident counterpart *and* are in foreign currency. Throughout our discussion, we do not explicitly account for any agent's forward positions: there is no need to do so, in fact, as a forward position can be viewed as a combination of borrowing and lending in different currencies.

The relevant portion of the public's balance sheet, also expressed in domestic currency, is a mirror image of the central bank's:

$$m_0 = d_0 + f_0 x_0. \tag{2}$$

Other assets and liabilities are also present but (by definition) net out to zero and will be irrelevant to our analysis. The economy's representative agent holds (domestic) money for transaction purposes and finances the long money position by shorting both domestic- and foreign-currency assets on the right-hand side. Below we discuss the criteria that are used to make optimal decisions.

We consider only two periods or, better, an initial and a final position that might be thought of as embedded in an ongoing cash-in-advance sequence of models. Between time 0 and time 1, each (domestic-currency) unit of domestic credit yields a nominal interest i, while each (foreign-currency) unit of reserves yields nominal interest i^*. For simplicity, money pays no interest but is held for transaction purposes.

At time 1, the exchange rate is x_1, and assets mature with interest. The exchange rate change (if any) and interest payments are reflected in two net-worth items shown in the balance sheets at time 1:

$$d_0(1 + i) + f_0(1 + i^*)x_1 = m_0 + w_1^{CB}, \tag{3}$$

$$m_0 = d_0(1 + i) + f_0(1 + i^*)x_1 + w_1^{P}, \tag{4}$$

when expressed in domestic currency. There are now terms w_1^{CB} and w_1^{P} that account for a positive or negative net wealth at the end of period 1, as a consequence of movements of the exchange rate and of interest rate payments. Of course $w_1^{CB} = -w_1^{P}$: if there are only two agents, the gains of one are the losses of the other. We assume that the exchange rate at time 1 is determined on the basis of elements that are outside the control of the central bank, which does not have an objective function to maximize, and of the private agent.

7.2.1 Portfolio Choice

The central bank need not be concerned with its time 1 net worth, as monetary policy objectives probably dominate them.[4] Conversely, each individual member of the public gains utility from a low expected cost of debt and suffers disutility from a high variance of the same quantity. We specify the public's

4. The return on central bank assets affects the public sector's net worth and, eventually, the private sector's tax bill. Atomistic individual investors, however, have little reason to worry about that when deciding on their portfolio allocation.

objective function in terms of rates of return, and this can be interpreted as a second-order Taylor approximation of a constant relative risk-aversion utility function.[5] Let gross real returns be given by

$$r = 1 + i - (x_1 - 1)\omega \tag{5}$$

on domestic-currency denominated financial instruments and

$$r^* = 1 + i^* + (x_1 - 1)(1 - \omega) \tag{6}$$

on the asset denominated in foreign currency. To simplify notation, we normalize the initial exchange rate to unity: while x_0 would in general be endogenous in a floating-rate situation, it is exogenously given in the precrisis EMS situation that we consider (if we abstract from within-band fluctuations), and it is harmless to normalize $x_0 = 1$. This specification also implies that the same correction is done to the returns of the two assets after these have been translated to either currency; in fact, one can think of the correction done to the return on foreign assets as the sum of the two components $(x_1 - 1)$ and $-\omega(x_1 - 1)$, the former necessary for going from foreign to domestic currency, the latter common to both assets and representing the net deduction that has to be made to domestic-currency net worth to express the individual's wealth in real terms.

The parameter ω determines how important exchange rate risk is for the investor's marginal utility of wealth. The representative investor derives utility from wealth expressed in domestic currency if $\omega = 0$; at the other extreme, only the foreign-currency value of time 1 net worth matters if $\omega = 1$; and $0 < \omega < 1$ indexes intermediate cases.

In standard finance-theoretic models with independently distributed asset returns and non–purchasing power parity (PPP) goods-price inflation, the weight ω of the exchange rate in the investor's price index corresponds to his consumption-basket weight of goods priced in foreign currency (for a particularly clear exposition and references to earlier literature, see Dumas [1994]). This interpretation need not be appropriate in the extremely short-run perspective that we take in this paper: at the (say) weekly horizon when portfolio choices are made, the prices of both domestic and foreign goods are essentially fixed and independent of exchange rate developments. However, portfolio managers and investment returns are evaluated in terms of precise and presumably different currency denominations: German mutual funds aim to show good results in deutsche mark terms, and Italian banks aim to optimize net worth in lira terms. In general, this may be rationalized recoguizing that asset returns, depreciation rates, and inflation rates are driven by underlying macro-

5. For a similar approximation, which usefully simplifies the algebra in a discrete-time framework, see Dornbusch (1983). For an extensive treatment of the relevant issues, see Adler and Dumas (1983). For a more rigorous discrete-time treatment, see Dumas (1994). Frankel (1986) and others have proposed macroeconomic and empirical applications of similar models.

economic state variables. Thus, the relevance of short-term exchange rate developments to investment evaluation is mediated by their underlying relevance to the whole future path of utility-relevant prices and quantities. Formally, the adjustment represented by ω refers to the *wealth* (rather than *consumption*) deflator that is appropriate when the underlying state variables' evolution results in an exchange rate equal to x_1 at the end of the period. An Italian investor may be particularly concerned with lira returns and set $\omega = 0$ if the domestic currency is lira, not because he consumes only lira-price goods at time 1 (he may consume all sorts of goods, whose prices are anyway essentially constant at the weekly forecast horizon), but because the marginal value of time 1 wealth in his dynamic problem is high when lira assets do well (the lira appreciates relative to expectations), low when lira assets do poorly. However, the opposite might be true with a different assumption about the marginal utility of wealth in the two states, which would imply that a large ω is attached to domestic investors.

We specify a mean-variance objective function in rates-of-return terms and model the transaction services of high-powered money by an increasing and concave function $\tau(\cdot)$. Thus, the public's time 0 objective function reads

$$\max\left(\tau(m_0) + m_0\left\{E[1 - \lambda r - (1 - \lambda)r^*] - \frac{\gamma}{2}V[1 - \lambda r - (1 - \lambda)r^*]\right\}\right), \tag{7}$$

where E denotes the expectations operator, V the variance operator, and λ is the share of initial debt denominated in domestic currency (there is no coefficient on the expectation, which just reflects normalization of $\tau[\cdot]$ and γ).

Taking as given the rates of return and the distribution of the time 1 exchange rate, the public optimally chooses the amount of money held for transactions and portfolio composition. Our specification allows for a separation of the portfolio and of the initial debt problems: the investor chooses how much money to hold for transaction purposes, at which stage he needs to know how costly (in risk-adjusted terms) it is to finance money holdings; for each amount of money holdings, however, the portfolio shares are determined independently of the choice of initial debt. As we will see later, in general this does not imply that in equilibrium money demand is independent of the portfolio composition.

To model the EMS precollapse situation, we let

$$x_1 = \begin{cases} 1 + \Delta & \text{with probability } p, \\ 1 & \text{with probability } (1 - p), \end{cases}$$

where Δ is the (nonrandom) amount by which the domestic currency depreciates if the initial parity is abandoned. (We could let this be random, with messier algebra and little additional insight.)

The expected returns, variances, and covariances of domestic and foreign assets are easily computed:

$$Er = 1 + i - p\Delta\omega, \quad Vr = (\omega\Delta)^2 p(1-p),$$

$$Er^* = 1 + i^* + (1-\omega)p\Delta, \quad Vr^* = [(1-\omega)\Delta]^2 p(1-p),$$

$$\mathrm{Cov}(r, r^*) = -\omega(1-\omega)\Delta^2 p(1-p).$$

As for the role of portfolio composition, the expected overall opportunity cost of money holdings is, in gross terms,

$$1 + i^* + \lambda(i - i^* - p\Delta) + (1-\omega)p\Delta$$

if the investor puts a share λ in domestic liabilities; the corresponding variance of realized returns is given by

$$\Delta^2 p(1-p)[\lambda - (1-\omega)]^2$$

and equals zero if $\lambda = 1 - \omega$ (minimum variance portfolio).

The derivative of the expected return with respect to λ is $\Delta p - i + i^*$ and that of the return variance is $2\Delta^2 p(1-p)(\lambda + \omega - 1)$. Hence, to maximize the objective function (7), the portfolio share must satisfy the first-order condition

$$\Delta p - i + i^* - \gamma\left[\Delta^2 p(1-p)(\lambda + \omega - 1)\right] = 0,$$

from which we obtain

$$\lambda = (1-\omega) - \frac{i - (i^* + p\Delta)}{\gamma\Delta^2 p(1-p)}. \tag{8}$$

If $\gamma \to 0$, then λ diverges to plus or minus infinity according to the sign of the uncovered interest rate differential; if $\gamma \to \infty$, then $\lambda \to 1 - \omega$.

As for money demand, we have

$$\tau'(m_0) + [-i^* - \lambda(i - i^* - p\Delta) - (1-\omega)p\Delta] - \frac{\gamma}{2}\{\Delta^2 p(1-p)[\lambda - (1-\omega)]^2\} = 0, \tag{9}$$

or, considering (8),

$$\tau'(m_0) = \omega i^* + (1-\omega)i - \frac{(i - i^* - p\Delta)^2}{2\gamma\Delta^2 p(1-p)}. \tag{10}$$

In the presence of risk aversion, the choice about the amount of initial debt depends on expected return and variance. Thus, the simple theoretical framework that we consider integrates money-demand and portfolio-choice aspects. Specifically, money demand turns out to depend, first, on a weighted average of the rates of return on assets denominated in the two currencies, with weights given by the asset-preference parameter ω, and, second, on a downward adjust-

ment of opportunity costs by a "speculative" term, which is an increasing function of the absolute deviation from uncovered interest parity (normalized by the exchange rate variance) and a decreasing function of the agent's degree of risk aversion: intuitively, an agent who is not infinitely risk averse will be able, by taking a "speculative" position, to reduce the financing cost of money holdings.

7.3 Market Equilibrium and Heterogeneity

While individuals are price takers and quantity setters, in equilibrium quantity and/or interest rates must adjust to their optimal choices. In a representative-agent framework of analysis, equation (8) would immediately determine the equilibrium risk premium as a function of the relative quantities of the two liabilities in the central bank's balance sheet; financial market equilibrium requires that

$$i - i^* - p\Delta = \gamma\Delta^2 p(1-p)\,[(1-\omega) - \bar{\lambda}]. \tag{11}$$

The risk premium is equal to zero, of course, if asset supplies form a minimum variance portfolio for the representative investor; otherwise, the market must bear some risk and be compensated for it. If $\bar{\lambda} > (1-\omega)$, then i must be low, for any given $p\Delta$, since investors want to be compensated with a lower cost of debt in order to keep in their portfolio a share of domestic liability that is larger than the one corresponding to their asset-preference parameter. If $\bar{\lambda} < (1-\omega)$, conversely, investors compete for domestic-currency debt and bid up the interest rate it pays.

It is interesting to go beyond the standard representative-agent framework and try and rationalize the exchange rate crisis as the equilibrium outcome of interactions among heterogeneous agents. In reality, of course, there are very many potential sources of heterogeneity. The variables that we choose to emphasize in the model are the coefficient of risk aversion γ, the asset-preference parameter ω, which the agent uses to transform nominal returns into real returns, and the objective function.

In general, we may consider J investors with different coefficients $\omega^{(j)}$ and $\gamma^{(j)}$ and heterogeneous optimal portfolio shares given by

$$\lambda^{(j)} = (1-\omega^{(j)}) - \frac{i - (i^* + \Delta p)}{\gamma^{(j)} p(1-p)\Delta^2}. \tag{12}$$

In market equilibrium, we must have

$$d_0 = \sum_{j=1}^{J} \lambda^{(j)} m^{(j)} = \sum_{j=1}^{J} m^{(j)}(1-\omega^{(j)}) - \frac{i - (i^* + \Delta p)}{p(1-p)\Delta^2} \sum_{j=1}^{J} \frac{m^{(j)}}{\gamma^{(j)}},$$

from which an expression for the risk premium is readily obtained:

$$(13) \qquad i - i^* - \Delta p = p(1-p)\Delta^2 \left[\frac{\sum_{j=1}^{J} m^{(j)}(1-\omega^{(j)}) - d_0}{\sum_{j=1}^{J} \frac{m^{(j)}}{\gamma^{(j)}}} \right].$$

The structure that we have described can be further enriched by modifying the objective function of some agents. In what follows, we consider the case of an intermediary, characterized by lack of demand for money owing to absence of transaction purposes. This intermediary has reasons to exist in equilibrium, as it helps close the gap between the supply structure of the central bank and the demand structure of the private agents. The balance sheet of such an intermediary is

$$d_0 + x_0 f_0 = \delta_0 + x_0 \zeta_0,$$

where on the left we have the supply of the central bank and on the right we have the demand of the public. Net worth at time 1 is

$$w_1^{(I)} = (\delta_0 - d_0)(1+i) + (\zeta_0 - f_0)(1+i^*)x_1.$$

The portion of the (purely speculative) objective function regarding expected returns is

$$E\left[\left(\frac{\delta_0}{\delta_0 + x_0\zeta_0}\right)r + \left(\frac{x_0\zeta_0}{\delta_0 + x_0\zeta_0}\right)r^* - \left(\frac{d_0}{f_0x_0 + d_0}\right)r - \left(\frac{x_0 f_0}{f_0x_0 + d_0}\right)r^*\right] = E[\lambda^{(I)}(r - r^*)],$$

where we use the fact that $\delta_0 + x_0\zeta_0 = f_0x_0 + d_0$ and the notation

$$\lambda^{(A)} = \frac{\delta_0}{\delta_0 + x_0\zeta_0}, \quad \lambda^{(L)} = \frac{d_0}{f_0x_0 + d_0}, \quad \lambda^{(I)} = \lambda^{(A)} - \lambda^{(L)}.$$

By considering an objective function that also considers the variance of returns, we obtain a demand function:

$$(14) \qquad \lambda^{(I)} = \frac{i - i^* - \Delta p}{\gamma^{(I)} p(1-p)\Delta^2}$$

where $\gamma^{(I)}$ is the coefficient of risk aversion of the intermediary. Equation (14) shows that demand of the intermediary completely ignores the minimum variance portfolio and requires a risk premium for intermediating between the structures of the balance sheets of the central bank and the public. In the absence of such a risk premium, $\lambda^{(I)} = 0$, or $\lambda^{(A)} = \lambda^{(L)}$, and there is no economic role for the intermediary as the structure of his assets is identical with that of his liabilities.

The equilibrium condition for a market with both an intermediary and many heterogeneous private agents is

$$d_0 = \sum_{j=1}^{J} \lambda^{(j)} m^{(j)} + \lambda^L m - \lambda^A m = \sum_{j=1}^{J} \lambda^{(j)} m^{(j)} - \lambda^{(I)} m.$$

It follows that the equilibrium risk premium is now

$$i - i^* - \Delta p = \Delta^2 p(1-p)\left(\frac{\sum_{j=1}^{J}\lambda^{(j)}m^{(j)} - d_0}{\sum_{j=1}^{J}\frac{m^{(j)}}{\gamma} + \frac{m}{\gamma^{(f)}}}\right). \tag{15}$$

We see in (13) and in (15) that even the simple framework that we have been considering yields complicated equilibrium interactions between the various parameters. Moreover, money demand on the part of each agent is a function of the interest rates and of the various parameters, making it even more difficult to obtain sharp and general results. Suppose, for example, that one is interested in analyzing in the general case the reaction of the investors to a change in the probability of devaluation. The natural thing to do is to look at the demand function, equation (12), which, however, shows the importance of the risk premium. But equation (15) points out that the reaction of the equilibrium risk premium to a change in the probability of devaluation depends on the money demands of all the agents, in turn a function of the shares of the debts denominated in the two currencies. Lacking a closed-form solution, we set up two simple cases as candidates for understanding the patterns that we may see in the data.

As we are interested in heterogeneity in the behavior of the agents as a reaction to changes in the probability of devaluation, we note that there are two factors in the structure of our model that may give rise to heterogeneity: on the one hand, changes in money demand (a scale effect); on the other, changes in the composition of portfolios (a share effect). In general, the two are interrelated, but, to build intuition, it is useful to consider each of them in isolation.

7.3.1 No Intermediary, No Risk Premium, Different Asset Preference

The first simple case that we consider is that where there are only two investors, which we regard as "domestic" (superscript D) and "foreign" (superscript F), respectively, and no intermediary. Further, we suppose that the structure of the supply of the central bank is such as to eliminate the risk premium, that is, $\sum_{j=1}^{J}(1-\omega^{(j)})m^{(j)} = d_0$. In this case, uncovered interest rate parity holds, that is, $i = i^* + p\Delta$, and the optimal share for each investor, from equation (12), equals the minimum variance portfolio. Also from equation (10), we see that money demand has a simple structure, $\tau'(m^{(j)}) = \omega^{(j)}i^* + (1-\omega^{(j)})i$, for both the domestic and the foreign investors.

What is the effect of an exogenous increase in p if $\omega^{(F)} \neq \omega^{(D)}$? The scale effect can be seen clearly from equation (10), where the last fraction is equal to zero in light of uncovered interest parity: for given i^*, an increase in p brings about an increase in the domestic interest rate, and this in turn decreases money demand. It follows that an increase in p decreases the stock of money. If the structure of the supply of the central bank does not change, then there is a decrease in the amounts of both domestic and foreign liabilities of the central

bank. The latter can be interpreted as a loss of reserves on the part of the central bank. The share effect is absent, as the desired share is equal to the one corresponding to the minimum variance portfolio.

Note, however, that the scale effect by itself may yield a different reaction on the part of different investors in the holdings of debt denominated in the various currencies. From equation (12) is clear that, under the hypotheses of this particular case, the change in the holding of foreign debt is proportional to the change in money demand, $\dot{f}^{(j)} = (1 - \lambda^{(j)})\dot{m}^{(j)}$, where $j = D, F$, and where the dot over the variable indicates the (comparative statistics) change from one situation to another, in the current case from one with a given p to another with a larger p. The condition for having $\dot{f}^{(D)} < \dot{f}^{(F)}$ is therefore in this case that the parameters $\omega^{(D)}$ and $\omega^{(F)}$ are such as to maintain the following inequality:

$$\lambda^{(D)} < 1 - \frac{\dot{m}^{(F)}}{\dot{m}^{(D)}}(1 - \lambda^{(F)}).$$

Of course, the size of the balance sheets (i.e., money demand) depends on financing costs and is heterogeneous across agents in general. If it were to happen that the change in money demand is the same for the two types of agents, the condition simplifies to $\lambda^{(D)} < \lambda^{(F)}$ or, in terms of fundamental parameters, $\omega^{(F)} < \omega^{(D)}$.

The natural question is therefore, Is it reasonable to assume that the inequality in fact represents the relative behavior of domestic versus foreign investors? As noted in section 7.2, this may or may not be the case. What is important, however, is that the "scale" effect of money demand reduces the complicated general structure of the model to a simple mechanism that may be confronted with the character of available data.

7.3.2 One Intermediary and Different Degrees of Risk Aversion

In the second case, there is one agent (D) and one intermediary (F) with different attitudes toward risk: as we shall see, the intermediary's function is a meaningful one if this agent's risk aversion differs from that which would determine the equilibrium risk premium in his absence. As the intermediary does not hold any money, we have from equation (15) a relatively simple expression for the equilibrium risk premium:

$$i - i^* - \Delta p = \Delta^2 p(1 - p)\left(\frac{1 - \omega^{(D)} - \bar{\lambda}}{\dfrac{1}{\gamma^{(D)}} + \dfrac{1}{\gamma^{(I)}}}\right).$$

Uncovered interest parity holds if $1 - \omega^{(D)} = \bar{\lambda}$, of course. In general, it is now possible to calculate the difference between the portfolio shares of the two agents:

$$\lambda^{(D)} - \lambda^{(F)} = -\omega^{(D)} - (1 - \omega^{(D)} - \bar{\lambda}) \left(\frac{\gamma^{(I)} - \gamma^{(D)}}{\gamma^{(I)} + \gamma^{(D)}} \right).$$

We find that a sufficient condition for $\lambda^{(D)} < \lambda^{(F)}$ is $(1 - \omega^{(D)} - \bar{\lambda})(\lambda^{(I)} - \lambda^{(D)}) > 0$ and that $\lambda^{(D)}$ is always less than $\lambda^{(F)}$ when there is no risk premium.

Thus, the model may rationalize heterogeneous portfolio composition (domestic- vs. foreign-currency-denominated assets) without relying on asset-preference parameters and without necessarily identifying the domestic investor as the one with a low ω. Interestingly, differences in the change of the two agents' portfolio shares in response to sterilized intervention (an increase in $\bar{\lambda}$) depend on differences in the coefficients of risk aversion. If the "foreign" intermediary is less risk averse than the private agent, then the difference decreases, and the domestic investor absorbs a larger part of the central bank's reserve loss.

7.4 Disaggregated Data

We now return to the data. The nonbanking sector balance-of-payments data of figure 7.1 above, which still register only international transactions, may be usefully disaggregated into domestic and foreign agents' capital inflows and outflows. Figure 7.2 shows the behavior of *net total* domestic and foreign capital movements (including loans, commercial credits, and direct and portfolio investments) from January to December 1992. Between January and May, the cumulative inflow of foreign capital reached L 17,500 billion. The following three months preceding the peak of the crisis see a marked slowdown in the net inflow of foreign capital: the factors behind this are the uncertainty on the political side, the negative effect of the insolvency of EFIM (a heavily indebted state-owned financial holding), and the general skepticism on the progress toward European integration following the result of the Danish referendum.

7.4.1 Foreign versus Domestic Investors

From our perspective, it is interesting to find that foreign investors as a group were "convergence players" during the buildup of the crisis: a net foreign-capital flow into Italy (and presumably into lira instruments) of some 3,000 billion during the June–August period contributed to limit the reserve losses of the Bank of Italy and increased the lira exposure of foreign residents. Conversely, domestic capital consistently flows out throughout the period, with an acceleration of previous trends to a cumulative figure of 25,000 billion, of which more than 20,000 is due to households' and firms' portfolio investments.

Additional information on the likely heterogeneity of agents within the foreign and domestic nonbank sectors may be obtained by looking at the *gross* flows of foreign and domestic capital for portfolio investments. Figure 7.3 plots separately the amounts of portfolio investments and disinvestments by domes-

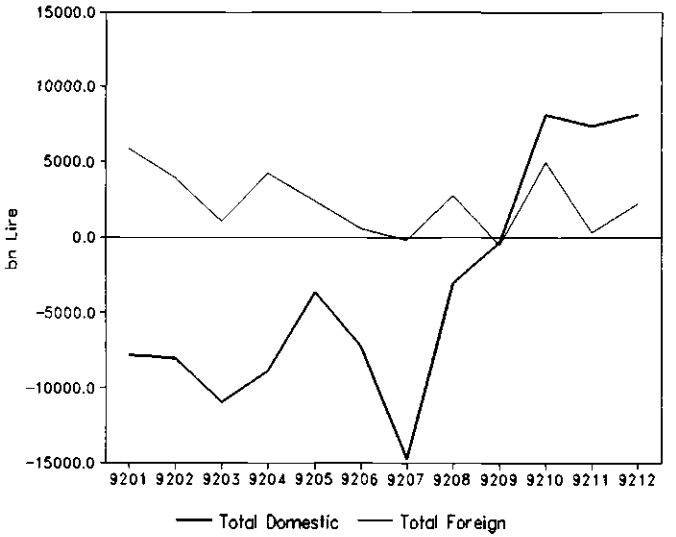

Fig. 7.2 Nonbank capital movements (net), 1992

Fig. 7.3 Portfolio investments: domestic and foreign

tic and foreign agents in 1992. For both sectors, investments and disinvestments tend to move in the *same* direction. The moderate net inflow of foreign capital over the period is the result of large investments *and* disinvestments, reaching a peak of more than 55,000 billion in June and decreasing thereafter to a minimum of around 35,000 billion in August. To the extent that transac-

tions of opposite sign are undertaken by the same agents within a month, such large gross figures may simply indicate high volume in the volatile April–July period, when many within-month round-trips were probably undertaken by active investors.[6] Such transactions were ex post inconsequential from the exchange rate point of view, given that no devaluation took place and exchange rate changes were extremely limited, but may have been profitable (or unprofitable) in light of the increasing and volatile interest rate differentials. Alternatively, high volume of both investments and disinvestments may reflect heterogeneity within the "foreign investor" aggregate—which unfortunately remains unobservable, as the data provide no disaggregation of foreign investors' positions with Italian counterparts. Domestic capital shows the same tendency, with investments and disinvestments rising until July to a peak of 45,000 and 35,000 billion, respectively. Once again, while part of this common movement in capital inflows and outflows may be the result of round-trip operations concluded within the month, the evidence may also suggest that the categories of foreign and domestic investors consist of classes of agents characterized by different behavior.

7.4.2 Domestic Banks and Investors

Within the banking-sector flows of figure 7.1 above, available statistics make it possible to analyze the net banking position in foreign currency, distinguishing between foreign and domestic counterparts, and to infer the extent to which banks maintained open positions in their own account, in addition to conducting foreign-currency operations motivated by the financing and investment needs of their domestic customers. In figure 7.4 we plot the changes (at constant exchange rates) in the foreign-currency position of resident banks from June to December 1992. We distinguish between changes due to spot operations with foreign counterparts, spot operations with domestic counterparts, and forward transactions. The total change in the spot position with foreign *and* domestic counterparts (the dashed line in fig. 7.4) shows that banks did not appreciably modify their net portfolio in the months preceding the crisis. Indeed, the inflow of foreign currency over June–August (by 14,700 billion, due to an increase in foreign-currency-denominated liabilities of 8,900 billion) was accompanied by a parallel change in the currency position with resident counterparts by some 10,600 billion. This is the result of an increase of banks' lending in foreign currency (mostly U.S. dollars, deutsche marks, and ECUs [European currency units]) to domestic agents (particularly nonfinancial firms) by 16,700 billion and an increase in liabilities (foreign-currency deposits by residents) by 6,100 billion. It is remarkable to find that, in June and July, domestic firms (and possibly households) borrowed a total of some 8,000 billion in foreign exchange from domestic banks.

6. Official sources do not indicate how frequently (daily, weekly, or even biweekly) "gross" portfolio transactions are collected and aggregated.

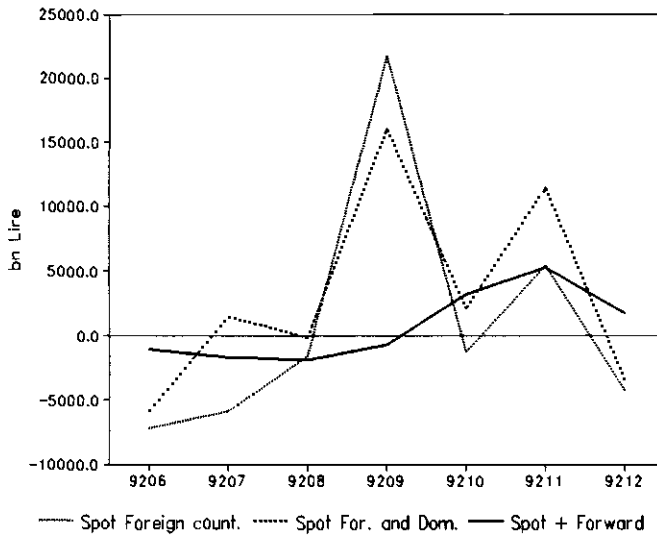

Fig. 7.4 Banks' changes in foreign-currency position

Once the change in the *forward* position is considered, it becomes evident that the banks' overall position changed only slightly over the whole June–December period (the solid line in fig. 7.4). This is most clearly visible in September, when the spot position displayed a substantial change, resulting in a net outflow of foreign currency by 21,700 billion, only partially matched by a negative change in the foreign currency position toward domestic counterparts (due more to an increase in liabilities than to a reduction in assets). In this month, banks changed their *net* forward position by 16,800 billion, determined by an increase by 25,200 billion in forward debts mostly with nonresident counterparts. Indeed, throughout the June–September period, forward operations by banks were conducted mostly with nonresident agents, suggesting that, although domestic firms increased their borrowing in foreign currency from the banking system, they did not cover their foreign-currency position, relying on the stability of the lira exchange rate.

As noted by Eichengreen, Rose, and Wyplosz (chap. 9 in this volume), Bank of Italy (1993), and IMF (1993), the mechanics of balance-of-payments crises fueled by foreign speculators entail lending by domestic institutions in domestic currency to foreigu residents. Available data indicate that Italian banks did not engage in such activities, but other financial intermediaries (Istituti di Credito Speciale) did increase their foreign position in lira by some 7,000 billion between June and September. Inasmuch as it does not entail foreign exchange rate risk, such lending is not directly relevant to our analysis. It may indicate, however, that some foreign agents did take short positions against the lira, even though, on net, the foreign investor's aggregate was mildly supportive of the lira (see fig. 7.2 above).

The distinction between households and firms within the domestic-investor aggregate is obviously very relevant to our perspective. The UIC kindly made some unpublished data available to us, which we plot in figures 7.5, 7.6, and 7.7 and on which we briefly comment below. In all these figures, and especially in figure 7.5 (financial companies), we again see high volatility, which is unlikely to be due to heterogeneity within such relatively narrow categories. We find in figure 7.6 that domestic nonfinancial firms increased assets with foreign counterparts by some 1,000 billion net over the period; these were presumably not the same firms that took positions of similar size and opposite sign with domestic banks, and it would be interesting to explore the source of such heterogeneous behavior. The behavior of households, in figure 7.7, is "speculative" but relatively smooth, with little acceleration of the steady capital flow resulting from the previous liberalization of cross-border financial transactions.

7.4.3 Gains and Losses from Devaluation

In September, the capital-flow trends were reversed: foreign capital flows show a negative, although small, figure of 500 billion, whereas domestic capital outflows came to a stop. However, the outflow of only 350 billion over the whole month is likely to be the aggregate result of two very different patterns before and after the devaluation and the suspension of the lira from the ERM. In fact, in the following quarter, until the end of 1992, large net *inflows* of domestic capital were registered, for a cumulative figure of 23,500 billion, as portfolios were reallocated to take in profits from devaluation. Meanwhile, foreign capital inflows resumed with a view to exploiting capital gains generated by the likely decreases of interest rates, contributing to rebuild the central bank's reserves by some 7,500 billion over the final quarter of 1992. The bulk of capital flows during the whole year, both domestic and foreign, are attributable to the *portfolio* investment component, to which households and financial companies are likely to contribute most.

As already said, data for September must be interpreted with care since they possibly aggregate different behavior before and after devaluation. Moreover, a general reason for caution is the use, by both banks and nonbanking agents, of *domestic currency swap* (DCS) contracts to cover (or to take) a foreign-currency position. Such operations have the same nature of forward transactions in foreign currency but only entail payments in lire, amounting to the difference between the spot exchange rate at the date of maturity of the operation and the rate agreed on at the contract date. Data on DCSs are available only for the banking sector from January 1993.[7]

Our model of market equilibrium under heterogeneity points out many reasons why different agents may be differently exposed to the risk of devaluation.

7. Inspection of 1993 data indicates that DCSs were used by banks mainly to offset their overall spot + forward position, which was much larger than that shown in the figure. If banks' behavior was similar in the months of interest, when the spot + forward position of the banking sector was close to zero, the amount of offsetting DCSs may have been small.

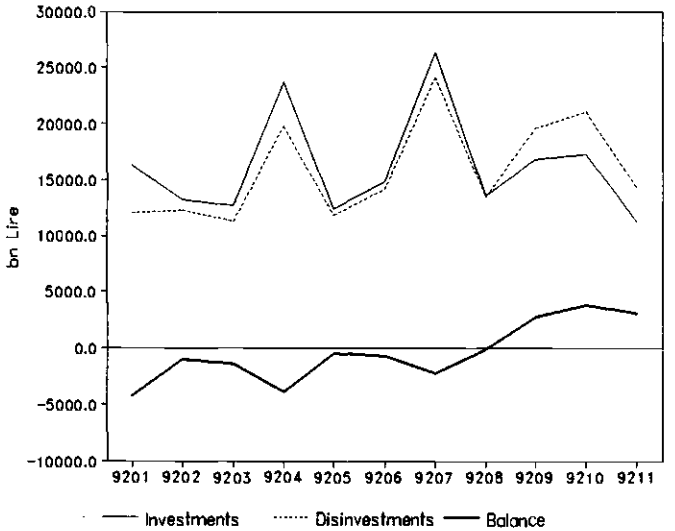

Fig. 7.5 Portfolio transactions of financial companies

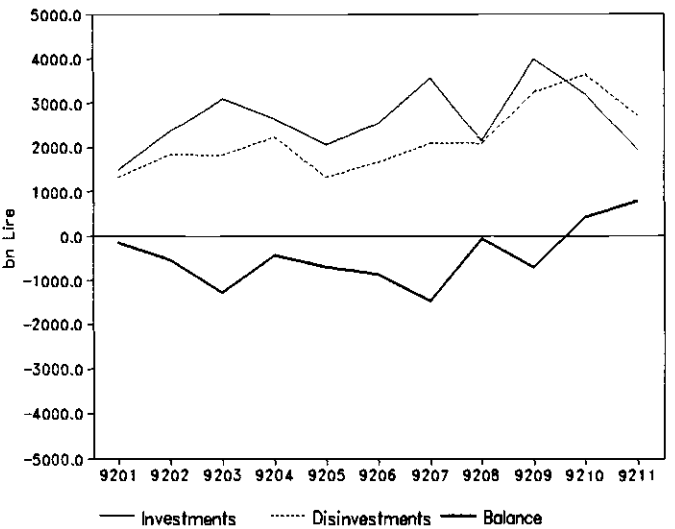

Fig. 7.6 Portfolio transactions of nonfinancial private companies

Considering a theoretical model allows several intuitive insights. The size of interest differentials is endogenously determined by our model, so that ex ante market equilibrium implies indifference for every agent, given expectations and risk aversions. But, of course, heterogeneous portfolio composition (for whatever reasons) implies differential ex post gains and losses from devalua-

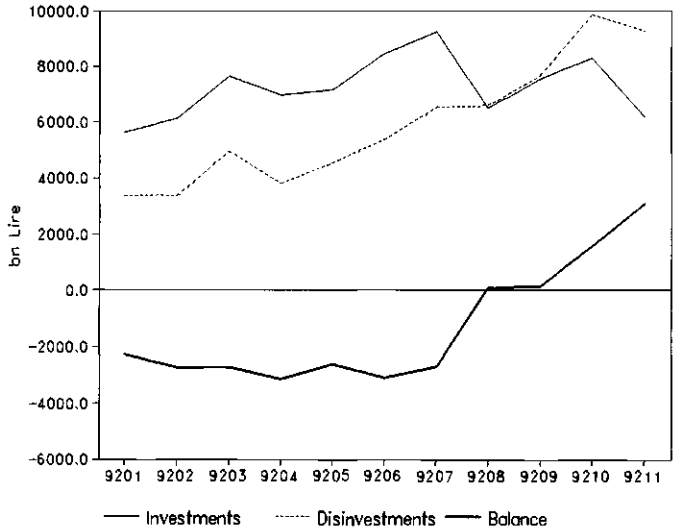

Fig. 7.7 Portfolio transactions of households

tion: if and when the devaluation is realized, "convergence players" lose, while "speculators" gain.

Starting from the evidence discussed in previous subsections, we now try and quantify the gains and losses from devaluation for various (classes of) agents. We first consider the buildup of the crisis (from June to August 1992), when a generalized increase in the perceived probability of devaluation occurred, leading investors to reallocate their portfolios of lira and foreign-currency assets and liabilities. Given the yield differential prevailing throughout the period between Italian and foreign short-term financial instruments, such reallocations entailed gains and losses on the portfolio returns. In the calculations, we used the spread between the Italian one-month interbank rate and an analogous rate for Germany as a "representative" yield differential. We also assumed that the exchange rate is fixed, given that within-band movements of the lira nominal exchange rate were very small on a monthly average basis.

Cumulating the central bank reserve losses displayed in figure 7.1 above, and applying the interest rate differential shown in figure 7.8 to the resulting change in foreign-currency position between June and August, we find that the private sector as a whole suffered an ex post interest-differential loss of L 325.9 billion. Applying the same procedure to the disaggregated capital flows of figures 7.2 and 7.4, we find that domestic investors suffered a L 276 billion loss on account of the interest-rate differential, while foreign investors gained (if only about L 20 billion) by playing on convergence during this period. Apart from the current account and the "errors and omissions" entry (which may reflect unrecorded capital flows of unknown origin), the last component of the

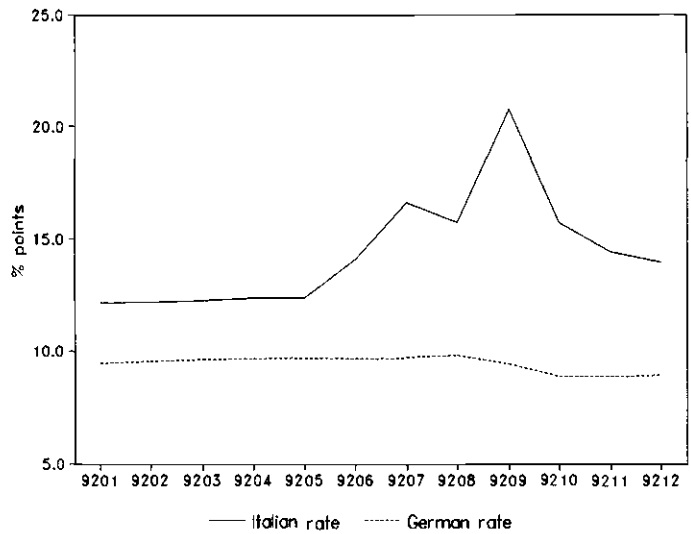

Fig. 7.8 Money market interest rates: Italy and Germany

balance of payments on a spot basis is that labeled "authorized foreign-currency dealers" (essentially Italian banks). As noted above, this component appears very large in the "convergence" direction on the basis of balance-of-payments conventions, resulting in a cumulative interest rate differential gain of some L 175 billion; however, offsetting transactions with domestic counterparts reduces the gain to only 67 billion on the banks' own account, while those domestic agents who were borrowing in foreign currency saved some L 106 billion in interest payments. Additional transactions on the forward market further reduced the interest rate gain of banks as well as their exposure to devaluation risk: the counterpart of such transactions is mostly nonresident in June, while the following months see the banks engaged in intermediation between resident and nonresident agents (nonresidents take long lira positions with banks on a forward basis, while residents' forward contracts "will deliver" foreign currency to banks).

In September, the lira devaluation was realized: the 7 percent devaluation of the official ERM parity on 13 September was followed by further depreciation after the subsequent abandonment of the ERM. For the purpose of our rough calculations, we apply a 15 percent devaluation to the change in foreign exchange positions of the various categories of investors we consider. To the change in foreign-currency exposure between June and August, we should of course add the further investments or disinvestments in September before the devaluation date. Unfortunately, as already mentioned, time-disaggregated data are not available for September. Therefore, any calculation of devaluation gains and losses necessarily relies on hypotheses about the evolution of the

agents' net position in September. In what follows, we make two simple (albeit extreme) assumptions as to the within-month behavior of domestic and foreign nonbank investors.

First, we may take the net change for the month of September to have occurred before the devaluation: then, the cumulative central bank reserve loss would amount to L 52,743 billion between 1 June and the devaluation date, to imply an interest rate loss of L 744 billion and a capital gain of L 7,163 billion for private-sector counterparts.[8] On a disaggregated basis, the total change in domestic investors' foreign exchange positions between June and the end of September would have afforded a capital gain of about L 3,810 billion on devaluation, which of course dwarfs the L 516 billion June–September loss on interest rate differentials. Conversely, foreign investors would have suffered an overall loss of some L 350 billion, mainly due to the L 390 billion capital loss on devaluation. As to Italian banks, their spot position with foreign counterpart becomes much more positive in September, both because liabilities decrease and because assets increase (about half the net change is due to each). Their spot position in foreign currency with domestic counterpart decreases (−5,600 billion); about half of this reflects a decline in foreign-currency loans to domestic customers, the rest an increase in foreign-currency liabilities (foreign-currency bank accounts). Overall, calculations based on cumulative spot position changes from June to 30 September (evaluated at constant exchange rates) say that Italian banks should have gained about L 1,700 billion as a result of a 15 percent devaluation. As we know, however, their foreign-currency position was almost fully offset by counteracting transactions with domestic resident participants (whose total losses would be put by these calculations at L 563 billion on account of interest differential gains, +152, and capital gain losses, −736) and on the forward market: the Bank of Italy did not take large forward positions (or, at least, none are apparent in available statistics), indicating that the sizable forward positions of the Italian banking sector must have had private counterparts.[9]

Alternatively, we may try and estimate devaluation gains and losses allowing for a reversal of capital flows within the month of September. For example, we can impute all the gross outflows registered in September to the period before the devaluation. This admittedly extreme assumption would see domestic investors reducing their exposure to devaluation by some L 56,000 billion in the first half of the month: then, the cumulative change in their foreign-currency

8. Our model could be readily extended to allow for interactions between different central banks: in fact, the Bank of Italy's "reserve loss" largely consisted of an increase in official short-term liabilities (L 20,000 billion were obtained from the ERM short-term loan facility, and L 2,300 billion were drawn [in deutsche marks] from a Bank for International Settlements credit line). Such positions, which on devaluation result in transfers between different countries' official institutions, are not directly relevant for the calculations that we perform here.

9. This is in interesting contrast with the Swedish data that we plan to analyze in future work. In Sweden, the private sector took positions against the krona mainly in the forward market, and the Swedish central bank absorbed such positions in the crisis period.

holdings since June would imply a capital gain of over L 12,000 billion from a 15 percent devaluation, and a large part of these would have been realized in the second half of the month, as the gross inflows of about L 57,000 billion would be the result of profit-taking portfolio reallocations under the assumption under consideration. The even larger gross flows in foreign investors' portfolios would similarly imply capital gains or losses on the order of L 10,000 billion.

7.5 Concluding Comments

This paper has tried to bring theoretical analysis and Italian data to bear on the redistributive effects of an exchange rate crisis. These take place certainly between central banks and the private sector as a whole and, to the extent that different agents' behavior is heterogeneous, also across different classes of private investors.

While the theoretical model that we have set out is admittedly very simple, it suggests that economic theory may be able to rationalize differences in the behavior of "foreign" versus "domestic" agents, or of end users of liquidity versus financial intermediaries, without resorting to differences of opinion or information across such classes of investors. As we feel that it is conceptually unappealing to allow for heterogeneous expectations, we would prefer to try and rationalize what evidence is available, extending standard models to account for investor heterogeneity under different and more readily interpretable respects.

Understanding the welfare effects of currency crises may be relevant to a better understanding of alternative exchange rate regimes. No exchange rate is truly and permanently fixed, and the welfare effects of exchange rate crises may be so large as to outweigh the gains from periods of relative exchange rate stability. Even disregarding such normative issues, however, further theoretical and empirical work on the microfoundations of transactions that result in reserve loss is certainly relevant to the mechanics of exchange rate crises and of their resolution.

Allowing for heterogeneous behavior across different classes of investor is likely to afford further insights in future research. Of course, not all dimensions of heterogeneity are necessarily relevant to the problem at hand: to the extent that different portfolio positions reflect unexplained "noise" and cancel each other out, they may be safely disregarded at the aggregate level. Useful theoretical models need to address heterogeneity not only across a central bank and a vaguely defined "market" but also across agents whose different objective functions and constraints are readily interpretable from an economic point of view and, one hopes, observable in the data. To an investment banker, an exchange rate crisis may be an opportunity to "ride the tide" and come out of the crisis with as large a portfolio value as might be obtained by moving from one currency to the other: such speculative objectives are sought by investors

of this type, who face few institutional constraints on their portfolio policies. To a household that is simply concerned with the consumption of a basket of domestic good, the crisis need not be as exciting until its final effects on prices and/or wages unfold: even though a rational wealth maximizer should never give up the opportunity to increase wealth with a timely round-trip in foreign currency, suitable investment vehicles need not be readily available to households and other unsophisticated investors.

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Comment Lorenzo Bini-Smaghi

The paper by Bagliano, Beltratti, and Bertola (henceforth BBB) can be broadly divided into two parts. In the first, the authors develop a theoretical model in which heterogeneous investor behavior is explained on the basis of differences in terms of agents' degree of risk aversion, asset preference, and objective

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function, while assuming, instead, for the purpose of the analysis, homogeneous expectations. In the second part, BBB examine Italian balance-of-payments data to assess possible heterogeneity in agents' behavior and estimate the effect of the September 1992 devaluation of the lira in terms of gains and losses for the central bank, residents, and nonresidents.

My comments concentrate on the second part. They mainly address the question of using balance-of-payments data for the analysis of heterogeneous behavior. It is suggested that great caution is required in the use of such data because of their limited quality and significance and that their usefulness for the analysis may be seriously impaired.

Balance-of-payments data may seem an obvious choice for the analysis of heterogeneous behavior since they report transactions between buyers and sellers of financial assets. However, not much further information on these agents is provided, except that they are located in different countries, which makes it very difficult to assess heterogeneity on the basis of possible differences in risk aversion, asset preference, or objective function, the main features of BBB's theoretical model. Furthermore, balance-of-payments data have several shortcomings. First, their statistical accuracy is rather limited, even in industrial countries. Looking in particular at Italian data, it is noticeable that in the period June–August 1992 the "errors and omissions" were recorded at L 11 trillion, about half the size of the change in official reserves and nearly three times the current account balance. More important, international banking statistics, which are generally considered to be more reliable, show for Italian banks an enormous discrepancy between assets and liabilities: L 65 trillion in September 1992 (20 more than in January 1992), which is more than half their net external asset position.

Second, balance-of-payments statistics do not provide full information on the currency denomination of assets and liabilities sold or acquired by residents and nonresidents in a given period. It is therefore very difficult to draw inferences concerning the effect of balance-of-payments transactions on currency diversification or to calculate who lost and who gained from a devaluation. This shortcoming might have become particularly relevant for Italy in view of the rapid development of the Eurolira market, which led to a substantial increase in lira-denominated flows of funds between the domestic market and the Euromarket.

Third, balance-of-payments statistics do not record a wide set of transactions undertaken by residents and nonresidents aimed at hedging the risk incurred in foreign exchange operations, for instance, domestic currency swaps. The data for the latter were not recorded by Italian banking statistics before the end of 1992. However, the data available thereafter show that the amount of such transactions has been comparable to the currency exposure of banks, suggesting that not taking this type of information into account may lead to biased conclusions.

Let me turn now to some of the findings of the paper and indicate how they may be affected by the above comments.

In section 7.4.1, BBB note that, during the buildup of the crisis (June–August 1992), Italy recorded an inflow of foreign capital while residents were increasing their outflows, which would suggest that, while the former were "convergence players," the latter were instead diversifying their portfolio away from lira-denominated assets. This conclusion may not be fully justified. First, the acquisition of foreign assets by residents and nonresidents should be viewed as part of their respective portfolio diversification strategies; account should also be taken of investment in domestic assets. In the case of Italy, residents' acquisition of foreign assets must also be viewed in terms of the portfolio adjustment that took place after the liberalization of capital movements in 1990. The developments mentioned by BBB could therefore be consistent with homogeneous behavior if residents and nonresidents increased their respective holdings of foreign assets as part of a similar portfolio diversification process.

Second, balance-of-payments data do not indicate whether the foreign inflows of capital recorded in the summer of 1992 implied an increase in nonresidents' long lira positions or whether they were instead covered for the exchange rate risk. Similarly, the outflow of funds by Italian residents may to a large extent have been accompanied by borrowing in foreign currency, as banking statistics indicate, or other forms of hedging against exchange rate risk. The larger the hedging component, which is not reported in balance-of-payments data, the more residents and nonresidents' behavior may in fact have been rather homogeneous while appearing different. A definite answer requires more information than is provided in figure 7.2.

Another statement in section 7.4.3 suggests that after the devaluation Italian residents sold back foreign assets "to take in profits from devaluation" while nonresidents were resuming inflows "with a view to exploiting capital gains generated by the likely decreases of interest rates, contributing to rebuild the central bank's reserves by some 7,500 billion over the final quarter of 1992." This apparent difference in behavior may not correspond to reality as the increase in official reserves was obtained mainly through swaps with commercial banks of funds mostly borrowed abroad by the latter. More generally, the reflow of capital by residents seems to have been accompanied by hedging of the foreign exchange risk through operations that, as BBB suggest, may have taken the form of domestic currency swaps. Indeed, the developments in the exchange rate of the lira after the devaluation of September 1992 confirm that the reflow of portfolio capital was largely hedged by both residents and nonresidents. This would suggest that, even after the devaluation of the lira, residents and nonresidents displayed rather similar investment behavior.

In section 7.4.3, BBB seem to determine who lost and who gained from the lira devaluation of September 1992. This exercise is undoubtedly very difficult,

Table 7C.1 Italian Foreign Assets and Liabilities (end-1991)

	Total (trillion lire)	Proportion: Of Total	Proportion: In Lire
Assets:	488.3	100.0	16.0
Loans	24.3	5.0	55.5
Commercial credits[a]	52.3	10.7	39.0
Bank assets	124.7	25.5	10.9
Official reserves	95.9	19.6	...
Other	191.1	39.2	12.6
Liabilities:	608.7	100.0	24.2
Loans	124.2	20.4	46.5
Commercial credits[a]	31.1	5.1	34.0
Bank liabilities	275.9	45.3	13.1
Other liabilities	177.4	29.2	82.3
Of which foreign official debt[b]	72.75	12.0	35.5

Source: Banca d'Italia, *Bollettino economico,* no. 20 (p. 39), and estimates based on UIC (Ufficio Italiano Cambi) data.

[a]Estimates.

[b]Treasury bills and proportion of official loans held by nonresidents.

especially in view of the comments made above, that is, that balance-of-payments data do not indicate the extent to which foreign exchange risk is hedged. Furthermore, BBB conduct this exercise on the basis of flow data, that is. the changes in the portfolios of residents and nonresidents. rather than on the stocks of assets and liabilities underlying the net external position of Italy. The data on stocks at the end of 1991 show that Italian residents held L 488.3 trillion of foreign assets, of which 95.9 trillion was official reserves, while foreign liabilities amounted to 608.7 trillion. The data can be updated to September 1992, using balance-of-payments data, in particular to take account of the decrease in official reserves (by 59 trillion) and the increase in private residents' foreign assets. However, no estimate is yet available of the currency composition of the flows during these nine months.

Conducting the exercise on the basis of end-1991 data (table 7C.1) shows that, excluding official reserves, the private sector held L 329.6 trillion of assets denominated in foreign currency, as against 310.8 trillion of liabilities. Thus, the net foreign currency position of the Italian private sector was slightly positive. by L 18.8 trillion. Its net position in lire was negative, by 235.2 trillion. A devaluation of the lira, with unchanged end-1991 stocks. improved the already positive net foreign asset position of Italian residents, measured in lire; conversely, it worsened the net position of nonresidents vis-à-vis Italy, measured in foreign currency.

The above considerations suggest that the gains and losses calculated on existing stocks are much larger than those measured by BBB on the basis of 1992 flows. An appropriate calculation of the effects of the devaluation would

therefore need to be conducted on the basis of an integrated stock-flow analysis.

Given the shortcomings of balance-of-payments data, one possibility for further analysis of heterogeneity would be to use survey data. The Group of Ten conducted an assessment of the causes of the 1992 crisis on the basis of a survey of the behavior of financial intermediaries in the major countries. In Italy's case, some interesting features emerge from the survey:

- Although market participants developed a common assessment of the causes of the September 1992 crisis and behaved in a similar way, nonresident financial institutions appear to have been more active than the resident ones.
- When the crisis became more acute, the behavior of the various operators became more similar, as "all participants were on the same side of the market."
- The lira exchange market appears to be structured in a somewhat peculiar way, with two tiers: the first made up of a handful of large institutional investors that sometimes take very large positions and appear to have an information advantage and to play a role in forming the views of other participants; the second tier is made up of minor Italian marketmakers and final customers, who are largely price takers and generally more cautious.

The survey analysis points to heterogeneous behavior in the foreign exchange market, although in terms not of residents and nonresidents but of marketmakers and others, leaders and followers. To a certain extent, the distinction may overlap with that of balance-of-payments since most marketmakers are foreign financial institutions, but the analytic and policy implications may be different.

These, however, are only suggestions for further analysis of a subject that appears to be of particular interest for the understanding of the functioning of foreign exchange markets. It is a merit of BBB's paper to have contributed and stimulated the discussion on this issue.

Comment

Richard K. Lyons

The paper's main objectives are (i) to demonstrate empirically that position taking in 1992 differed across groups and (ii) to rationalize those differences without resorting to differential information. My comments pertain more to the latter. I will begin with some broader observations and then move to the model's specifics.

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First, I want to link this paper to the topic of the conference, namely, microstructure. *Microstructure*, broadly defined, encompasses at least three dimensions of the market: (1) physical structure (e.g., number of dealers), (2) informational structure (e.g., transparency of order flow), and (3) agent structure (e.g., discretionary vs. nondiscretionary liquidity traders). The contact point between microstructure and the Bagliano, Beltratti, and Bertola (henceforth BBB) paper is squarely in the third dimension—agent structure—the first two dimensions playing no role in their model. In BBB, what distinguishes a class of agents is the direct linkage to the domestic money supply: nominal domestic balances enter utility directly, together with the cost of providing domestic balances.

Next, I want to comment on the association between crises and microstructure, an association that runs through much of part II of this volume. This focus might lead one to believe that the impetus for foreign exchange microstructure comes largely from EMS (European Monetary System) crises. My view is different. In my view, the impetus for microstructure comes primarily from the floating experience: (i) extraordinary volume, both levels and growth; (ii) increased volatility under floating without increased volatility of fundamentals; (iii) the 1980s dollar cycle; and (iv) forward discount bias. (Microstructural tools are well suited to address the first two; the last two are tougher.) To help judge the impetus from EMS crises, I pose the following question: If the floating dollar had never occurred and all we had were the experiences of the EMS, would we be pursuing microstructure at this juncture? I suspect not.

I turn now to the BBB model. Some models are easier to take to the data than others. This model is one of the others. The result is a virtual decoupling of their two central objectives: empirical demonstration of differential position taking and theoretical rationalization without differential information. Although the authors are careful not to oversell the paper's connection of those objectives, the marriage is uneasy nonetheless.

That said, the model is insightful in its integration of money demand with portfolio choice. This is achieved by specifying the (domestic) public's balance sheet as equal to the flip side of the central bank's balance sheet. A cost of this approach is that the portfolio decision is therefore rather limited; but this cost is small in relation to the elegance of the approach.

In the model, the central bank is passive. Its balance sheet is determined by the portfolio choice of the public. In choosing its portfolio, the public trades off the utility derived from (nominal) monetary assets against the disutility from the liabilities that finance the monetary assets. The disutility from the liabilities has two sources: (i) debt servicing costs and (ii) variability in debt servicing costs. Crisis (devaluation) influences the public's trade-off through both these sources since the cost of debt is a function of the stochastic exchange rate. From this structure, the authors are able to derive equilibrium portfolio implications. By introducing heterogeneity in risk aversion, liquidity

preference, or asset preference, the authors can rationalize differential position taking without resorting to differential information.

There are a number of nagging issues within the original version that the authors should clarify. I will touch on three in particular. First, where do the nominal interest rates come from in this model? These are central to determining the cost of the public's liabilities. Although they appear exogenous through the derivation of market equilibrium, the authors' example has the domestic rate moving with a change in the probability of devaluation.

The second nagging issue is the evolution of the central bank's balance sheet. What does it look like at $t = 1$? Where does the return on its assets enter? Why doesn't the (domestic) public internalize this? Clarification along these lines will help support the sharp dichotomy between central bank and public.

The third nagging issue is their first simple case. In particular, the experiment considers an exogenous increase in the probability of devaluation p under heterogeneous asset preferences, domestic versus foreign. It is not clear why the derivative of equation (11) has the sign it does. The authors should clarify the assumptions required (note that $p[1 - p]$ is maximized when $p = 1/2$). Further, if the interest rate moves, what determines how much it moves? In its current state, their first case has too much in the background to provide the clarity it might have.

I close with two perspective comments. First, the concept of a completely passive central bank in the face of a crisis makes it especially difficult to harmonize the two parts of the paper—empirical and theoretical. This contributes substantially to the uneasy marriage noted above. Finally, the authors' distaste for heterogeneous expectations motivates them to look toward heterogeneity in risk aversion, liquidity preference, and asset preference. I do not share their distaste: an increasing body of empirical work supports the presence of heterogeneity in expectations. They describe their mechanism as "more readily interpretable." But how much can be said empirically about heterogeneity in risk aversion or liquidity preference? Is heterogeneous asset preference truly in the set of deep parameters, or is it something to be derived? How much do we learn about differential position taking from a model that starts with differential asset preference?