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The Role of Large Players in Currency Crises

Giancarlo Corsetti, Paolo Pesenti, and Nouriel Roubini

5.1 Introduction

What role, if any, do large traders and other highly leveraged institutions (HLIs) such as hedge funds (HFs) and proprietary desks of commercial and investment banks play in determining and propagating market volatility during crisis episodes? Some policy makers and analysts have expressed concern that the activity of large players in small markets ("big elephants in small ponds") may trigger crises that are not justified by fundamentals, destabilizing foreign exchange and other asset markets, creating systemic risk, and threatening the stability of the international financial system.

A typical argument is that the presence of large agents increases a country's vulnerability to a crisis because their short-term portfolio strategies provide a focal point for speculative behavior and induce small investors, other things being equal, to be more aggressive in their position-taking. True, phenomena such as herding (buying or selling an asset because other

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participants buy or sell at the same time), momentum trading (buying an asset when its price rises and selling when its price falls), noise trading, bandwagon effects, short-termism, and the like can occur in financial markets even if all agents are small and atomistic. However, market power stemming from size, reputation, and ability to leverage may give large players a significant role in affecting market dynamics with destabilizing consequences.

Specifically, concerns about the aggressive, possibly manipulative, practices of large traders were expressed in 1998 by the authorities of a number of small and medium-sized economies. To assess these allegations, the HLI working group of the Financial Stability Forum (FSF) established in 1999 a study group on market dynamics in small and medium-sized economies, which conducted a study of the 1998 market turmoil and the role played by HLIs in six countries (Hong Kong, Australia, New Zealand, South Africa, Singapore, and Malaysia).

Although the group could not reach consensus on the allegations of destabilization and distortion of market integrity, the report found circumstantial evidence of aggressive trading practices, pointing out the material role played by large players in some crises. Notably, the conclusions of the Market Dynamics Study Group, published in April 2000 (Financial Stability Forum 2000), were somewhat different from a previous study on HFs by the International Monetary Fund (IMF 1998). The IMF study, which was limited to the events in Asia up to late 1997, had concluded that HFs had not played a significant role in the early market turbulence.

In light of the results of these reports and, more generally, in light of the policy and academic debate on the 1997–98 events, our contribution aims to reconsider in detail, at both theoretical and empirical levels, the role that large players can play in currency crises and market dynamics.

This paper is organized as follows. In section 5.2 we present a stylized model of speculative attacks, analyzing the effect of large investors on the vulnerability of a country to currency crises. We first focus on a model in which speculative attacks are the outcome of self-fulfilling shifts in expectations from "good" to "bad" equilibria, in situations in which the economic fundamentals are neither too strong (ruling out crises altogether) nor too weak (so that a crisis is unavoidable).

Next, we consider a model with asymmetric and private information, building on the "global-games" literature (Morris and Shin 2000, Corsetti et al. 2000). In this model, the impact of a large trader on the market depends on the interaction of three elements: size, reputation for quality of information, and the ability to signal its portfolio position to the rest of the market. The key result is that, in general, the presence of large investors makes all other investors more aggressive, in the sense that the latter choose to liquidate their currency positions for stronger economic fundamentals relative to the case in which there are no large investors.

We conclude the theoretical section by discussing extensions of the model and several open issues: Do large traders destabilize markets? How large must a trader be to have a significant impact on market behavior? Do large players always benefit from signalling their trading? Or do they benefit from trading quietly to avoid adverse movement of prices while building their positions? Do they inhibit contrarian trade? Can large players manipulate markets (through cornering, "talking one's book," spreading rumors, etc.)?

On the basis of the results of section 5.2, section 5.3 provides an overview and an extension of the empirical literature on the behavior of large investors in currency markets. We first look at the evidence on the correlation between exchange rate movements and major market participants' net currency positions. We next consider a few recent case studies. A number of sources, ranging from press articles to academic case studies, have suggested that large HFs and HLIs played a role in numerous episodes of market distress in the 1990s, including the following: the exchange rate mechanism crisis in 1992–93; the 1994 U.S. bond market turbulence; the 1994–95 Mexican peso crisis; the speculative attack on the Thai baht in 1997; the fall of the Korean won in 1997; the crisis of the Malaysian ringgit in 1997–98; the "double play" on the Hong Kong stock and foreign exchange markets in 1998; the pressures on the Australian dollar in June and August 1998; the unraveling of the "carry trade" in the summer of 1998 and the rally of the Japanese yen; and the Russia to Brazil contagion episode in the summer and fall of 1998. We focus on a sample of these events and conclude by highlighting the links between our analysis and the findings of the FSF (2000) study.

There are two important premises to our assessment of the role of large players in crisis episodes. First, in the context of our study, a *large player* is defined as an agent with market power. The influence of a large player on the market outcome is not, however, mechanically related to its size, as measured by the value of asset holdings or market share. Clearly, players with equal size can differ in their ability to influence the portfolio strategies of other agents in the market, owing to, for instance, access to superior information or special forecasting ability. There are a number of reasons to expect a positive association between a trader's size and its reputation for quality of information. For instance, traders controlling a large portfolio of assets are able to devote more resources to data collection and analysis and thus are more likely to obtain superior information. However, large traders need not be better informed in all circumstances. If smaller market participants can better exploit information asymmetries and other market inefficiencies, the actions of large traders may have only limited influence. To shed light on this issue, our analysis is carried out under different assumptions about the precision of the large trader's information relative to the rest of the market.

Second, while herding may have exacerbated swings in capital flows and the ensuing changes in asset prices, it was a large set of investors—domestic and foreign, small and large, highly leveraged and not—who jointly contributed to market volatility in the turmoil episodes of the 1990s. Thus, although it is important to study the specific role that large HLIs might have played in these episodes, it is crucial to understand their role in the broader macroeconomic context in which these events occurred. In fact, most of the crisis episodes considered in this study unfolded against the backdrop of deteriorating macroeconomic fundamentals, policy uncertainties, and structural weaknesses.

5.2 Modeling the Role of Large Traders in Speculative Attacks

In this section we analyze leading theories of currency and financial crises, with the goal of understanding the role of large traders in generating and sustaining speculative attacks. We consider two classes of models of coordination games. The first allows for multiple instantaneous equilibria and sunspots, therefore interpreting the crisis as a switch from one rational-expectations equilibrium to another. The second focuses on games in which agents rely on private information in forming their beliefs about the fundamentals of the economy, as well as about other agents' beliefs and strategies. In these latter games, known as global games, the nature of crises is rooted not in the multiplicity of equilibria but in a stochastic flow of unobservable private information.

Our analysis focuses on static games, analyzing the decision process of agents who have to decide, independently and simultaneously, whether or not to attack a currency. A subsection deals with an example of a dynamic game with Bayesian learning (as discussed in Dasgupta 2001), in which agents may choose to take a position before the rest of the market or to wait so as to gain information by observing trading activity. We conclude with a discussion of open issues, pointing at a new generation of models that synthesize desirable features from different approaches.

5.2.1 A Unified Analytical Framework

To begin, consider a small open economy where the central bank pegs the exchange rate at some parity. The economy is populated by a continuum of risk-neutral traders, each of whom can take an infinitesimal position against the currency. In addition, there may be a single trader who can take a "large"—that is, discrete—position against the currency.

Let ℓ denote the mass of financial resources that are mobilized by (small and large) speculators when attacking the currency. The variable ℓ varies between zero (nobody attacks the currency) and 1 (the whole market attacks the currency).[1] As a stylized way to model heterogeneity in agents' size, we allow for a single large player that can mobilize resources up to $\lambda \leq 1$. The combined mass of resources available to small traders then amounts to $1 - \lambda$.

Because the focus of the analysis is on speculative attacks, we abstract

1. To motivate the boundaries on ℓ, one can think of factors such as credit constraints, short-sale restrictions, or prudential guidelines limiting the size of speculative open positions in a currency market.

from welfare-related considerations (a devaluation can be either good or bad for the economy), so the reasons that monetary authorities decide to relinquish the peg are not explicitly analyzed. It may be helpful to keep in mind the textbook example of an economy endowed with a stock of international reserves, where the central bank is willing to defend the exchange rate only as long as reserves are above some predetermined critical level. The central bank sets this level based on its assessment of the economic fundamentals of the country, indexed by θ in our model. The critical level is low when fundamentals are strong (θ is high): the central bank is willing to use a large amount of reserves to defend the exchange rate. Conversely, the critical level is high when fundamentals are weak (θ is low): even a mild speculative attack can force the central bank to abandon the peg.

The condition for a currency collapse is therefore

$$\ell \geq \theta. \tag{1}$$

Since $0 \leq \ell \leq 1$, a collapse always occurs if θ is negative (the economic outlook is so bad that the central bank has no incentive to maintain the peg even if no attack materializes) and never occurs if $\theta > 1$. A collapse may or may not occur for $0 \leq \theta \leq 1$, depending on whether the currency is attacked by a sufficient mass of speculators.

For simplicity, we assume that the ex post payoffs to individual agents are independent of the state of fundamentals.[2] From the viewpoint of each agent, taking a speculative position in the currency market entails a cost $t \leq 1$, including both transaction costs and the differential between the domestic and the foreign interest rate. Thus, if an agent attacks the currency but the currency does not collapse, its ex post payoff is $-t$, that is, the loss due to transaction costs incurred when speculating. If, instead, the currency collapses, the ex post payoff is assumed to be $1 - t$. If the agent does not attack, the payoff is identically equal to 0. All of these payoffs are measured per unit of domestic currency.

Agents take their speculative positions independently and simultaneously.[3] The timing is as follows: (1) Agents have a uniform ignorance prior about θ—that is, θ is uniformly distributed over the real line.[4] At the beginning of the period, they receive a signal about the state of fundamentals.

2. As will be apparent in what follows, the extension to the general case would confirm and strengthen our results.

3. In most of our study, we abstract from intertemporal considerations and focus on one-period models. Below we discuss a model that allows for a sequential-move game among speculators.

4. As pointed out by Morris and Shin (2000), improper priors make it possible to concentrate on the updated beliefs of the traders conditional on their signals without taking into account the information contained in the prior distribution. In any case, results with the improper prior can be seen as the limiting case as the information in the prior density goes to zero. See Hartigan (1983) for a discussion of improper priors and Morris and Shin (section 2) for a discussion of the latter point.

(2) Agents take their speculative positions in the foreign exchange market at given prices; ℓ is determined. (3) The state of the economy θ is revealed. (4) The central bank either defends or devalues the exchange rate according to equation (1).

5.2.2 Models with Symmetric Information

Common Knowledge and Multiple Equilibria

We now discuss models of currency and financial crises that stress the role of multiple equilibria, focusing first on the baseline case in which all agents are atomistic. Consider the following specification of the information structure: previous to trading, *all* agents receive the same public signal y about the fundamentals θ:

$$y = \theta + \tau\eta \qquad \tau > 0 \tag{2}$$

where $E(\eta) = 0$ and the probability distribution function of η is symmetric and smooth (we write H for the cumulative distribution function).[5] Note that agents do not know the exact state of the fundamentals. Given the uniform prior about θ, their posterior distribution of the fundamentals is H, with mean y and standard deviation τ.

To calculate the expected payoff for an individual agent i, one needs to specify its conjecture about the positions taken by the rest of the market. Consider the two extreme conjectures, which will be the relevant ones in equilibrium. The first is that all agents other than i attack the currency. Conditional on $\ell = 1$, the expected payoff from attacking for i can be written as

$$(1 - t)\Pr(\theta \leq 1 \mid y) - t\Pr(\theta > 1 \mid y) = H\left(\frac{1 - y}{\tau}\right) - t. \tag{3}$$

If the public signal is such that this expected payoff is nonnegative, it is optimal for i to speculate against the currency. Since all agents are identical, this must be true for everyone in the economy: when the above expression is nonnegative, $\ell = 1$ is an equilibrium.

The second conjecture is that no one attacks. Conditional on $\ell = 0$, the expected payoff from attacking is:

$$(1 - t)\Pr(\theta \leq 1 \mid y) - t\Pr(\theta > 1 \mid y) = H\left(\frac{0 - y}{\tau}\right) - t. \tag{4}$$

As before, if the public signal is such that the individual expected payoff is negative, it is optimal for i not to attack the currency. As all agents are identical, $\ell = 0$ is an equilibrium. Note that equation (3) is larger than equation (4): Individual payoffs are strategic complements. That is, given the signal y, they are increasing in the action taken by other agents in the economy.

For the sake of comparison with the global-game model discussed below,

5. This implies $\Pr(\eta \leq x) = \Pr(\eta \geq -x) = H(x)$.

we now rearrange equations (3) and (4) to describe the optimal behavior by individual speculators in terms of "trigger strategies." Note that, conditional on everyone else attacking, the maximum value of the public signal at which an agent optimally chooses to attack is

$$y^* \equiv 1 - \tau H^{-1}(t). \tag{5}$$

Conditional on $\ell = 1$, the optimal strategy pursued by any individual agent is to attack if and only if $y \leq y^*$. By the same token, if everyone else refrains from attacking ($\ell = 0$), the threshold value for an agent to choose not to attack is

$$\underline{y}^* \equiv 0 - \tau H^{-1}(t). \tag{6}$$

Thus, conditional on $\ell = 0$, an agent refrains from speculation if and only if $y > \underline{y}^*$.

Now, either threshold is a rational-expectations equilibrium. However, what determines the choice of one threshold over the other is not explained by the model. Simply, it is assumed that exogenous uncertainty—the same for all individuals—drives the threshold selection. Note that, because $y^* > \underline{y}^*$, the model predicts that an attack will occur for certain (irrespective of which equilibrium threshold is selected) if $y \leq \underline{y}^*$, but it will never occur if $y > y^*$. In the first case, the signal about fundamentals is so bad that each individual's expected payoff from attacking is nonnegative regardless of the action taken by the rest of the market: everyone attacks the currency. In the second case, the expected payoff is negative even if everyone else attacks the currency: no one speculates.

When the public signal is in the range $\underline{y}^* < y \leq y^*$, the economy may or may not be hit by a speculative run on the currency, depending on which threshold is chosen by the speculators.[6] Note that for it is rational for each individual to participate in the attack only if everyone else attacks the currency. As all agents choose the same threshold, this model assumes common knowledge not only of the public signal on the fundamentals but also of the actions undertaken by every individual in the market. This means that, in equilibrium, each individual must somehow know that all the other agents have simultaneously chosen to attack.

Large Traders in Models with Symmetric Information

We now recast the model to allow for a large trader. The presence of a large trader does not affect the upper threshold, y^*, corresponding to an equilibrium in which all agents attack the currency. What *does* change is the lower threshold, $\underline{y}^*$. When the signal on the fundamentals is positive but

6. We should note here that a speculative attack by the entire market does not necessarily coincide ex post with a collapse of the currency, as this only occurs if the ex post value of the fundamentals θ is smaller than 1.

weak, the speculative firepower of a large investor may be sufficient to force a devaluation, even if no small agent participates in the attack. The expression for the lower threshold equation (6) is therefore replaced by

$$\underline{y}^*(\lambda) \equiv \lambda - \tau H^{-1}(t). \tag{7}$$

Thus, the larger the trader's size λ, the larger the range of public signals that trigger an attack and the lower the range of signals over which an attack may or may not occur. The conclusion from this model is straightforward. The presence of a large trader increases the vulnerability of a peg, as this trader trivially solves the "coordination problem" in a speculative attack for signals in the interval between 0 and λ.

Although in this benchmark model we cannot analyze the effects of varying the relative precision of the large trader's information (the signal is the same for every agent), we can nonetheless derive an important result by varying the precision of the public signal. From equations (5) and (7), it is apparent that (if t is relatively small, i.e., $t < 1/2$) both thresholds $\underline{y}^*(\lambda)$ and y^* are increasing in τ. Higher uncertainty—say, a mean-preserving spread of the distribution of the public signal—leads all agents to raise the trigger for an attack, regardless of the equilibrium on which agents coordinate.

In equilibrium, small traders always take the same side of the market as the large one. To avoid misunderstandings of this model, we stress that this does not imply that the large trader has signalling ability or represents a focal point. For $y < \underline{y}^*(\lambda)$, the currency is expected to collapse even if no small trader attacks the currency. For $\underline{y}^*(\lambda) < y \leq y^*$, the presence of a large trader makes no difference; in this region, an attack by a large trader does not represent a focal point, at least no more so than any other event relevant to the coordination of agents' expectations on a particular equilibrium. This is not to deny that signalling and focal points may be relevant in equilibrium selection. However, these elements require a different approach, possibly loosening the assumption of common knowledge about the fundamentals.

5.2.3 Models with Asymmetric Information

We now turn to a class of coordination games according to which incomplete information is the key element of a theory of speculative behavior. The approach in this section is based on the mechanism of equilibrium selection first analyzed by Carlsson and van Damme (1993) for the case of two agents, then in a series of papers by Morris and Shin for a continuum of agents, including a contribution to the theory of currency crises (Morris and Shin 1998). Building on this approach, Corsetti et al. (2000) have provided a comprehensive theory of the role of large traders in a currency crisis. The analysis in this subsection discusses this contribution in detail.

The main feature of the global-games approach to speculative crises is that agents do not share information about the fundamentals of the economy, but observe informative *private* signals about it. Even if the noise of the private signals becomes very small, individual information about the fundamentals never becomes common knowledge among traders. In other words, upon receiving its own signal, the representative trader can only *guess* the signals reaching the other traders, as well as their conjectures about each other's information and guesses. It cannot, however, count on the other traders to *know* its information and conjectures—each agent forms its beliefs based exclusively on its own information. This departure from the assumption of common knowledge of the signal is crucial for the results that follow.

The Global-Games Approach to Currency Speculation

Once again, we start by abstracting from the presence of a large trader (i.e., $\lambda = 0$). As in the previous section, agents have a uniform ignorance prior over θ; however, here there is no public signal to all agents. Rather, each small trader in the continuum receives a private signal,

(8) $$x_i = \theta + \sigma\varepsilon_i \qquad \sigma > 0,$$

where the distribution of ε_i is smooth and symmetric (we let F denote the cumulative distribution function). Although there is no public information about θ, the distribution of the fundamentals θ as well as of signals x_i is common knowledge.[7]

Conjecture that, as before, all agents (optimally) follow a trigger strategy: they attack if and only if their signal is below some optimally selected threshold x^*; otherwise, they refrain from attacking. As noise is independent of the fundamentals, the expected mass of agents attacking the currency is equal to the probability that any particular agent receives a signal below x^*. Thus, for a given x^*, the population of agents attacking the currency at θ will be

(9) $$\ell(x^*, \theta) = \Pr(x_i \leq x^* \mid \theta) = F\left(\frac{x^* - \theta}{\sigma}\right).$$

7. To understand the logic of the model in the absence of common knowledge of the signal, it is useful to look at an example in which the noise in the private signal is distributed uniformly with a bounded support of size $\pm\beta$ around the realization of θ. Agent i knows that the fundamentals are distributed in an interval of size β on each side of x_i, that is, $\theta \in [x_i - \beta, x_i + \beta]$. As the realization of θ may fall on an extreme of this interval, agent i cannot exclude that the signal of agent j is equal to $x_j = x_i + 2\beta$. However, if agent j receives a signal as far as 2β from x_i, j concludes that θ is in an interval of size 2β around $x_i + 2\beta$ and, most importantly, cannot exclude that agent i's signal x_i is 4β distant from its actual position. Iterating once more the argument above, we see that agent i cannot exclude that agent j believes that agent i's own beliefs about agent j's signal are as far as 6β from x_i, and so on. Note the paradox in this result. Agent i is 100 percent sure that θ is β-close to i's own signal. Agent i also knows that all other agents get a signal within an interval of 2β. However, the fact that agents do not have common information useful to locate the position of the fundamentals makes them worry about the possibility that their opponents' beliefs about fundamentals and signals wander quite far away from where the fundamentals and the signals actually are.

Now, we know that a crisis occurs when ℓ is at least as large as θ, that is, when

$$\ell(x^*, \theta) = F\left(\frac{x^* - \theta}{\sigma}\right) \geq \theta. \tag{10}$$

Thus, the maximum value of the fundamentals at which a crisis materializes must satisfy

$$\ell(x^*, \theta^*) = F\left(\frac{x^* - \theta^*}{\sigma}\right) = \theta^*. \tag{11}$$

This means that, given x^*, the peg collapses for any realization of the fundamentals below θ^* and survives otherwise.

Next, if agents expect the currency to collapse for any $\theta \leq \theta^*$, the expected profit from an attack—conditional on receiving the signal x_i—is

$$(1 - t)\Pr(\theta \leq \theta^* \mid x_i) - t\Pr(\theta > \theta^* \mid x_i) = F\left(\frac{\theta^* - x_i}{\sigma}\right) - t. \tag{12}$$

Because agents attack if and only if their expected profit is nonnegative, the minimum value of the signal x_i at which they attack, x^*, satisfies

$$F\left(\frac{\theta^* - x^*}{\sigma}\right) - t = 0. \tag{13}$$

Thus, given θ^*, agents optimally choose to attack upon receiving a private signal smaller or equal to x^* as defined above.

The equations (11) and (13) represent a system of two equations in two unknowns (x^* and θ^*) that completely characterize the equilibrium of the model.[8] Solving this system, it is easy to see that the equilibrium in trigger strategies is unique. From equation (13) above, accounting for the symmetry of the signal, it follows that

$$1 - F\left(\frac{x^* - \theta^*}{\sigma}\right) = t. \tag{14}$$

Comparing equations (13) and (14), the threshold value for the fundamental is

$$\theta^* = 1 - t. \tag{15}$$

Note that $1 - t$ is also the proportion of agents attacking the currency at $\theta = \theta^*$. Using this result in equation (11) yields a closed-form solution for the individual threshold:

8. The system above is a Bayes-Nash equilibrium. According to the standard definitions, a strategy for an agent is a rule that prescribes an action for each realization of the agent's private signal. A profile of strategies (one for each agent) is an equilibrium if, conditional on the information available to each agent i, and given the strategies followed by other agents, the action prescribed by the strategy followed by agent i maximizes the conditional expected payoff (utility).

(16) $$x^* = \theta^* - \sigma F^{-1}(t) = 1 - t - \sigma F^{-1}(t).$$

Note that, if we let the noise in the private signal go to zero, the trigger point tends to the threshold value for the fundamental: $x^* \rightarrow \theta^*$. As agents become more confident about the information content of their signal, the level of the optimal trigger tends to coincide with the threshold value θ^*. A well-known feature of this model is that not only is its trigger-strategies equilibrium unique, but agents also optimally select the trigger strategy characterized above over any other possible strategy. The proof of uniqueness can be found in Morris and Shin (2000).[9]

Large Traders in Models with Asymmetric Information

A large trader of size λ is now introduced in the economy. The small traders keep receiving private signals x_i with the properties stated above, and the large trader receives a private signal denoted by x_l:

(17) $$x_l = \theta + \sigma_l \varepsilon_l \qquad \sigma_l > 0$$

where the distribution of ε_l is smooth and symmetric (we write L for the cumulative distribution). Notably, σ_l can and will differ from σ. In other words, the precision of the signal of the large trader (which is the inverse of the variance of the signal σ_l^2) can differ from the precision of the signal of a typical small trader.

This is a realistic feature of the model. On the one hand, as argued in the introduction, it is widely believed that large traders tend to have access to superior information. On the other hand, even if large traders are better informed on average, under some circumstances the ranking of information may favor small traders. It is therefore useful to analyze both cases. In the model, it is assumed that all agents in the market are aware of their relative information precision; that is, the distribution of the signals, including the relative size of σ and σ_l, is common knowledge.

To derive the equilibrium, conjecture again that all players play trigger strategies.[10] From the previous subsection, we know that the mass of small traders attacking the currency is equal to the probability that any particular agent receives a signal below some optimal trigger x^*, as in equation (9).

9. Two points are worth noticing. First, the equilibrium is unique in the sense that agents choose a unique threshold for their signal. With a continuum of agents there is no aggregate uncertainty, so there is also a unique level of the fundamentals that triggers a crisis. In equilibrium, however, agents may and will choose different actions depending on the specific realizations of their signals. In other words, there will be heterogeneity in the behavior of investors—to be contrasted with the strong result in common-knowledge, multiple-equilibrium models in which everybody takes the same action in equilibrium. Second, the structure of information is crucial to uniqueness. As shown by Morris and Shin (2000), were agents to receive both a private and a public signal, there would be some threshold for the relative precision of these two signals beyond which the equilibrium in trigger strategies is no longer unique—despite the presence of private information, we are back to the case discussed in the previous section.

10. We refer to Corsetti et al. (2000) for proof that trigger strategies would be optimally selected even if agents were allowed to choose other types of strategies.

Now, the small traders amount to a percentage $1 - \lambda$ of the market. Thus, the condition for a crisis to occur as a result of an attack exclusively by the small traders is equivalent to equation (10) rescaled by $1 - \lambda$:

$$(18) \qquad (1-\lambda)F\left(\frac{x^* - \theta}{\sigma}\right) \geq \theta,$$

and the value of the fundamentals below which the currency collapses satisfies

$$(19) \qquad (1-\lambda)F\left(\frac{x^* - \underline{\theta}}{\sigma}\right) = \underline{\theta}.$$

If the large trader attacks the currency as well, the financial resources mobilized by speculators on the left-hand side of equation (18) are increased by λ. Following the same steps as above, consider the level of fundamentals $\overline{\theta}$ that solves

$$(20) \qquad \lambda + (1-\lambda)F\left(\frac{x^* - \overline{\theta}}{\sigma}\right) = \overline{\theta}.$$

Obviously it is $\underline{\theta} < \overline{\theta}$. When the fundamentals are below $\underline{\theta}$, the currency collapses whether or not the large trader attacks. When the fundamentals are between $\underline{\theta}$ and $\overline{\theta}$, the peg collapses if and only if all traders, small and large, speculate against the currency. To sum up, with a large trader we have two thresholds for the fundamentals ($\underline{\theta}$ and $\overline{\theta}$) instead of a single one (θ^*). Note that the distance between the two is not equal to λ.

Next, consider the expected payoff of the large trader. This agent knows that, if it attacks, the currency will collapse for any $\theta \leq \overline{\theta}$. Clearly, it chooses to attack as long as the expected profit conditional on its signal is nonnegative, that is, as long as

$$(21) \qquad (1-t)\Pr(\theta \leq \overline{\theta} \mid x_l) - t\Pr(\theta > \overline{\theta} \mid x_l) = L\left(\frac{\overline{\theta} - x_l}{\sigma_l}\right) - t \geq 0.$$

The highest value of the signal at which it attacks—that is, its trigger, x_l^*—thus solves

$$(22) \qquad L\left(\frac{\overline{\theta} - x_l^*}{\sigma_l}\right) = t.$$

To evaluate the expected payoff of the typical small trader is not as easy. Small traders know that the currency will certainly collapse for any realization of the fundamentals worse than $\underline{\theta}$. When θ is between $\underline{\theta}$ and $\overline{\theta}$, a collapse will only occur if the large player participates in the attack—that is, if and only if the large trader receives a signal worse than x_l^*. The expected profit from an attack conditional on the signal x_i must therefore be written in such a way as to keep these different regions of the fundamentals separated from each other.

Conditional on the signal x_i, we write the posterior density over θ for a small trader as

$$\frac{1}{\sigma} f\left(\frac{\theta - x_i}{\sigma}\right). \tag{23}$$

The expected payoff to attack conditional on signal x_i is therefore[11]

$$\Pr(\theta \le \underline{\theta} \mid x_i) + \Pr(\underline{\theta} \le \theta \le \overline{\theta}, x_l \le x_l^* \mid x_i) - t \tag{24}$$
$$= F\left(\frac{\underline{\theta} - x_i}{\sigma}\right) + \frac{1}{\sigma}\int_{\underline{\theta}}^{\overline{\theta}} f\left(\frac{\theta - x_i}{\sigma}\right) L\left(\frac{x_l^* - \theta}{\sigma_l}\right) d\theta - t.$$

The analysis of the model can be considerably simplified with a change of variables, using the following definitions:

$$z \equiv \frac{\theta - x^*}{\sigma},\ \underline{\delta} \equiv \left(\frac{\underline{\theta} - x^*}{\sigma}\right),\ \text{and}\ \overline{\delta} \equiv \frac{\overline{\theta} - x^*}{\sigma}. \tag{25}$$

It can be shown that both $\underline{\delta}$ and $\overline{\delta}$ are monotonically decreasing in x^*. The threshold for the large player (x_l^* in equation [22]) can now be written as

$$x_l^* = x^* + \sigma\overline{\delta} - \sigma_l L^{-1}(t) \tag{26}$$

while the optimal threshold for the small players, x^*, is the unique solution to the following equation:

$$F(\underline{\delta}) + \int_{\underline{\delta}}^{\overline{\delta}} f(z) L\left(\frac{\sigma}{\sigma_l}(\overline{\delta} - z) - L^{-1}(t)\right) dz - t = 0. \tag{27}$$

Once x^* is determined,[12] the large trader's switching point, x_l^*, and the two thresholds for the fundamentals are also uniquely determined.

Does a Large Trader Increase Financial Fragility?
The Role of Size and Information Precision

In contrast to the model with small traders only, the model with a large player has no closed-form solution. However, the key results can be analyzed by focusing on its limiting properties—that is, by letting agents become arbitrarily well informed about the fundamentals.

Consider the case in which the information of the large trader is arbitrarily more precise than the information of the rest of the market, that is, $\lim \sigma/\sigma_l = \infty$. Evaluating equation (27) under this maintained assumption, we observe that for any $\theta \le \overline{\theta}$ (that is, for any $z \le \overline{\delta}$) the probability that a

11. Note that this expression requires the signal of the large trader to be independent from the signal of a typical small trader.

12. Observe that the function on the left-hand side of equation (27) is continuous and strictly increasing in both $\underline{\delta}$ and $\overline{\delta}$, variables that are in turn continuous and strictly decreasing functions of x^*. Also note that the left-hand side of equation (27) is positive for sufficiently small x^*, while it becomes negative for sufficiently large x^*. Thus, there is a unique x^* solving equation (27).

precisely informed large trader chooses to attack is equal to 1. We can thus write:

$$F(\underline{\delta}) + \int_{\underline{\delta}}^{\overline{\delta}} f(z)dz = F(\overline{\delta}) = t. \tag{28}$$

This expression has a simple interpretation. If in the limit the noise in the large trader's signal is zero, small traders need simply guess the position of the fundamentals, thereby forming their best estimate of the signal to the large trader. Intuitively, a large trader with extremely precise information does not add any noise to the estimation problem of small traders: they need not worry about the large trader's errors.

To solution of the model is then

$$\begin{aligned} \overline{\theta} &= \lambda + (1-\lambda)F(-\overline{\delta}) \rightarrow \lambda + (1-\lambda)(1-t) \\ x^* &\rightarrow \overline{\theta} - \sigma F^{-1}(t) \\ x_l^* &= \overline{\theta} - \sigma_l L^{-1}(t). \end{aligned} \tag{29}$$

These expressions establish a first important result. In equilibrium, $\overline{\theta}$, x_l^* and x^* are increasing in the size of the large player, λ. A larger λ makes the large and the small traders more aggressive, in the sense that they optimally choose to attack for higher values of their signals. In particular, since $\overline{\theta} > 1 - t = \theta^*$, relative to the benchmark with small traders only, the presence of a large, well-informed trader increases the fragility of the market by making small traders willing to attack the currency for stronger fundamentals.[13]

What if the information of the large trader is *less* precise than that of the small players? Will the size of the large trader still affect the fragility of the market (despite inferior information)? Interestingly, the answer is a qualified yes. Referring to Corsetti et al. (2000) for details, when $\lim \sigma/\sigma_l = 0$ the influence of an uninformed large trader on the small traders' strategies is either null or moderate, depending on the size of λ. If λ is small enough, varying λ does not affect the equilibrium strategy of small traders: Intuitively, the noisy behavior of the large trader is offset, in equilibrium, by the net positions taken by the bulk of the market. If λ is large enough, the "erratic" be-

13. A heuristic argument can help to clarify the latter point. As we observed in the first part of section 5.2.3, without a large trader ($\lambda = 0$) the threshold for an attack by small traders only is equal to $1 - t$. This means that, at $\theta = 1 - t$, a proportion of $1 - t$ of traders attacks the currency. Now, suppose that each small trader has a share λ of resources taken away, and that this share is given to a single large trader with arbitrarily precise information. At $\theta = 1 - t$, the amount of resources thrown into the market by small traders falls from $1 - t$ to $(1 - t)(1 - \lambda)$. However, at $\theta = 1 - t$, because of her arbitrarily precise information, the large trader will always attack the currency, using the full amount of the resources given to it. Thus, the overall amount of resources in the market increases from $1 - t$ to $\lambda + (1 - t)(1 - \lambda)$, so that $1 - t$ can no longer be the threshold of the fundamentals at which the currency collapses. However, this means that, in the presence of a large trader, the region of the fundamentals where the currency is expected to collapse becomes wider, and small agents are willing to follow a more aggressive trading strategy.

havior of the large trader cannot be offset by the rest of the market. Its presence still makes all traders more aggressive, but to a lesser extent than in the case discussed above.

We can now draw our main conclusions from this model by stressing two key elements for a theory of speculative attacks with large traders. The first element is size. In the model, λ is positively related to the small traders' expected payoff, through its influence on the region of fundamentals in which a collapse of the currency is possible. As the upper bound of this region, $\overline{\theta}$, is increasing in λ, speculative attacks can be successful for stronger fundamentals. Consistently, the threshold x^*—that is, the maximum estimated value of the fundamentals at which small traders are willing to attack the currency—is also increasing (in some limit cases nondecreasing) in λ.

The second element is the relative precision of information, as indexed by the ratio σ/σ_l. For a given λ, a high degree of large trader's information accuracy (i.e., an arbitrarily small σ_l) reduces the uncertainty about the behavior of the large player itself and increases the expected payoff of the small agents for any given signal. Small traders thus become more aggressive in the market (i.e., they attack at a higher threshold x^*). Interestingly, a large player with relatively low precision of information can still exert some influence on market participants' behavior, but the extent of its influence is much lower.

Note the difference between the prediction of this model and the main conclusion of the model with multiple equilibria. In the latter model, a large trader increases the vulnerability of a peg independently of the behavior of small traders—recall that the presence of a large trader only affects the lower threshold $\underline{y}^*$ of the signal, increasing it by an amount equal to the trader's size. However, for signals in the upper end of the region of multiple equilibria, the large trader makes no difference. In the global-games model, however, the impact of a large player on the market outcome depends crucially on her influence on the behavior of small traders. Moreover, the large player makes a difference for strong fundamentals: It is the upper threshold $\overline{\theta}$ that is increasing in λ as, for a bigger λ, both the large and the small traders bet against the currency for stronger values of their signals x_l^* and x^*.

Thus, although multiple equilibrium models shed light on the effects of a large trader when fundamentals are relatively weak, the global-games model shows that the presence of a large trader may make a difference in economies with relatively strong fundamentals. Together, these two classes of models show that, in some circumstances, pegs that may not (or would not) collapse in the absence of a large trader may well be expected to crumble if one big elephant steps into a small pond.

Signalling and Herding

An important lesson from the above model is that a large trader can increase the fragility of a peg even when the market can at best guess the large trader's actual portfolio position and information. Her mere presence influences the equilibrium portfolio strategies in the market as a whole, especially when the large trader has more precise information. We may reasonably expect this influence to increase further if the large trader is given the opportunity to let the market learn its positions or information.

Consider the following problem of dynamic coordination with learning—an example that can be framed in a modified version of the above model.[14] After receiving their signals about the state of the fundamentals, both the large and the small traders can now choose between moving first or waiting one period before taking a speculative position in the foreign exchange market. The state of the economy θ is revealed after all agents have built up their positions, and the payoffs are independent of the timing of the move, so that there are no costs to waiting. Late movers can observe the trading flow generated by early movers, raising the possibility of signalling (by assumption, there is no other form of communication).

Should small traders move first? To the extent that their size is infinitesimal, small traders' individual positions do not influence trading flows in any appreciable way. As each small trader ignores the impact of its own action on the market, it cannot hope to affect the market by moving first. However, small traders may obtain some informational benefit by waiting. Thus, it can be concluded that small traders will weakly prefer to be late movers. It is plausible to assume that, if indifferent whether to be early or late movers, small traders will move late.

Now, since the large trader knows that small traders have no reason to move early, it will never learn anything by waiting. Still, its portfolio position cannot be ignored by the market. Instead, by letting people know its portfolio position, it may increase the probability that its strategy will be successful. Thus, a large trader weakly prefers to move early. Once again, it is plausible to assume that, if indifferent about the timing of the move, the large trader will move early.[15]

From here on, the analysis follows the same steps outlined in the previous subsection, but with an important qualification: Now the decision taken by small traders is conditional on the action taken by the large trader. Conjecture that the large trader chooses to attack only if its signal is lower than x_l^*, where, as in equation (22), this threshold is defined by

$$\Pr(\theta \leq \overline{\theta} \mid x_l = x_l^*) = t \tag{30}$$

14. We draw once again on Corsetti et al. (2000). The example comes from a class of models discussed in Dasgupta (2001).

15. A large trader's incentive to move first is strong when its estimate of the fundamentals is not too good or too bad, leading it to believe that an attack will be successful only if many small traders join. Conversely, if the private signal x_l is bad enough, the large trader may expect a currency collapse regardless of speculation by small traders. In this case, as there is no cost in waiting, the large trader will be indifferent whether to attack early or late (the same consideration applies for signals x_l that are sufficiently good).

If the large trader does not attack, its inaction signals that, based on its own information, it finds the economy to be strong (that is, $x_l > x_l^*$). However, those small traders that receive a bad signal about the fundamentals may nonetheless choose to attack the currency, thinking that enough small traders will join the attack and cause a collapse. Consequently, there will be an optimal threshold $\underline{x}^*$, below which small traders attack the currency even when the large trader has not taken a speculative position against it. This optimal threshold is defined by

$$\text{(31)} \qquad \Pr(\theta \leq \underline{\theta} \mid x_l > x_l^*, x_i = x^*) = t$$

if a finite solution to this equation exists. Otherwise, if the left-hand side of the above equation is strictly larger (smaller) than the right-hand side, $\underline{x}^*$ is set equal to $+\infty$ $(-\infty)$.

Of course, when the large trader attacks the currency, it signals to the small traders a quite different assessment of the strength of the economic fundamentals (as $x_l \leq x_l^*$). Relative to the previous case, small traders are willing to attack for a wider range of signals they receive. The optimal trigger conditional on an attack by the large trader, denoted $\overline{x}^*$, is defined by

$$\text{(32)} \qquad \Pr(\theta \leq \overline{\theta} \mid x_l \leq x_l^*, x_i = \overline{x}^*) = t$$

if a finite solution to this equation exists. Otherwise, $\overline{x}^*$ is set equal to $+\infty$ or $-\infty$, depending on whether the left-hand side of the above equation is larger or small than the right-hand side.

Through its influence on the trigger strategies of small traders, the large investor induces some herding in the market; for a given distribution of private signals, its position affects the number of agents taking the same side of the market. The extent of herding will depend on the equilibrium value of the two thresholds above. If these are not finite, there will be a stronger form of herding: the position of the large trader will determine the position of all other agents in the market.[16]

To illustrate this point, suppose the signal of the large trader is arbitrarily precise relative to the signals received by the rest of the market. In this case there are no finite solutions for the triggers of small traders, but $\underline{x}^* = -\infty$ and $\overline{x}^* = +\infty$, while $\underline{\theta}$ and $\overline{\theta}$ converge to 0 and 1, respectively. In equilibrium, a large trader with superior information effectively leads the pack of the small traders with no defection: each small agent ignores its own private signal and always takes the same side of the market as the large trader (we return to this in the next section).[17]

In the limiting case $\sigma/\sigma_l \rightarrow \infty$, herding does not depend on the size λ of the

16. The thresholds of the fundamentals below which the currency collapses solve $(1 - \lambda)\Pr[x_i \leq \text{x}^* \mid \theta = \underline{\theta}] = \underline{\theta}$ if the large trader has not attacked the currency, and $\lambda + (1 - \lambda)\Pr[x_i \leq \overline{x}^* \mid \theta = \overline{\theta}] = \overline{\theta}$ otherwise.

17. See Dasgupta (1999) for a theoretical discussion of herding in coordination games.

large investor. As long as $\lambda > 0$, even a relatively small player can have the strongest impact as long as the market regards its information as arbitrarily precise. That is to say, the only dimension in which size is important is the signalling ability associated with it, that is, the fact that the market does not ignore the influence of its actions on the equilibrium outcome.

Size makes a difference, however, when the large trader's information is less than arbitrarily precise, and becomes very important if the ranking of information precision tilts in favor of small players. To see this, suppose that a large player without precise information gets a relatively bad signal on the fundamentals. By moving first and attacking the currency, it cannot hope to affect significantly the beliefs of the other agents, which know that its information is relatively inaccurate. Yet, by moving first, the large trader can reduce the small traders' uncertainty about its action in equilibrium. Small agents will decide their optimal behavior knowing it has (or has not) thrown its resources on the market. If it attacks, for a larger λ, a smaller resource gap remains to be filled for a speculative attack to be successful.

To summarize, the dynamic effects of a large trader are related *both* to information about the fundamentals and to the size of resources already devoted to an attack. In the limiting case (the information of the large trader is extremely accurate), the first factor overshadows the second. However, for some lower degree of precision of information, we may expect the second factor to dominate.

5.2.4 Open Issues

Do Large Players Destabilize Markets?

In the long-standing academic and policy debate on whether speculation is destabilizing, the role of large players is a particularly hot item. One view is that large traders and arbitrageurs able to collect and process superior information improve the efficiency of the price mechanism. Also, because of their ability and willingness to take leveraged positions, HLIs can be an important source of market liquidity. The alternative view emphasizes their role as catalysts of market panic and short-termism. The literature provides many example in which market efficiency is jeopardized by the behavior of noisy traders even when they are atomistic, let alone when the size of their speculative positions make them primary suspects as market "agitators."

Indeed, an oft-voiced concern is that the presence of large players may not lead only to short-term, high-frequency excess volatility of exchange rates and other asset prices, but also to persistent and destabilizing deviations of asset prices from their equilibrium values, with negative effects on real economic activity. This is the case, for instance, if the actions of large players can trigger currency crises that would not have otherwise occurred, or force monetary authorities to prevent a currency collapse at the cost of hiking interest rates and halting growth.

In fact, it is rather difficult to prove that any specific economy fits this description. Some have argued, however, that Hong Kong in 1998 was the nearest case of an economy whose fundamentals were generally sound, in spite of some macro weaknesses, but that came close to the collapse of its currency board regime as a result of aggressive speculation against its forex and stock markets. In this example, only a controversial direct intervention of the authorities in the equity market prevented a break of the peg and further sharp falls in its equity market (see section 5.3.3). However, the effects of defending the peg with high interest rates, likely exacerbating the recessionary effects of the Asian crisis on the domestic economy, were quite costly. While it remains controversial to assess whether the actions of large players have a destabilizing impact (and counterfactuals are hard to assess when fundamentals interact with complex market dynamics), the welfare costs of *potential* destabilization have been a matter of concern for policy makers in small and medium-sized economies.

In the models discussed above, the mere presence of a large trader makes all other agents more aggressive and ready to bail out for stronger values of the fundamentals. Although the analysis does not explicitly address welfare issues, it is compatible with models in which the economy ends up being worse off after a currency collapse. We should note that the above analysis rests on the key assumption that the large trader *profits* in the event of a devaluation. This may not always be the case. As large traders take speculative positions in many different markets, it is plausible that, under some circumstances, they may actually lose because of currency instability. To mention but one example, in 1998 several large financial institutions were reportedly long in Russian assets. Given the size of their portfolios and the relative thinness of the market for such assets, a precipitous unwinding of long positions would have exposed these institutions to heavy losses. Attempts to hedge these positions through forward purchases were thwarted when the fall of the ruble led counterparts to default on their contracts.

This example suggests that, in some situations, large traders may well prefer exchange rate stability to a devaluation. To analyze this case in the theoretical model presented in this section, one needs to allow for a more general payoff function, reflecting the initial portfolio positions of large players. In this case the presence of a large trader may end up making small players less (instead of more) aggressive in the currency market, thus reducing the likelihood of speculative attacks and sharp currency devaluations.

Do Large Players Have Substantial Market Impact?

One may claim that the estimated total size of large players' activity (say, HFs' net currency positions) is too small, relative to the depth of the forex market and the amount of international reserves available to the governments, to be a determining factor in a currency crisis.[18] But if markets think that large players have access to superior information, the model presented above suggests that even modest short positions by HFs may lead a large number of other investors to herd. As many investors mirror the behavior of large funds, the overall buildup of short positions against a currency is a multiple of the cumulative positions of these funds—indeed, large enough to trigger a currency crisis.

In this respect, the FSF (2000) study suggests that, in the 1990s, some macro HFs had built a very strong reputation in terms of information precision and ability to forecast macro developments. In addition, anecdotal evidence suggests that many financial institutions stood ready to provide credit to HFs as well as services in executing forex trade, at least in part as a way to track the investment strategy of these funds. Information about what HFs were doing was indeed considered a valuable asset by a wide range of investors.

We should note here that small agents may try to infer the action by informed large traders even when they do not have information about order volumes. Under the plausible assumption that large trades tend to affect prices, small agents without knowledge of order volumes can exploit the information implicit in price movements by buying when prices are rising and selling when prices are falling. In other words, price changes are interpreted as signals that large players are buying or selling. This case for *positive feedback* strategies, however, crucially depends on the degree of asymmetric information in the market. One may think that strong asymmetries are not likely in foreign exchange markets, because the information about macroeconomic variables is mostly public. However, in the case of emerging markets, certain players with privileged access to policy makers are usually believed to have better information than average market participants, as well as superior skills in analyzing public data.

Two factors play a key role here: leverage capacity and overall market liquidity. As regards the first factor, some players, such as HFs, are less restricted than others (such as institutional investors) in taking large leveraged positions. In a speculative attack, these agents could mobilize massive resources up to a multiple of their capital base.

As regards market liquidity, the evidence suggests that forex liquidity drops significantly in periods of turmoil (see FSF 2000). Thus, while the overall cumulative short position by HFs may be small relative to the depth and liquidity of the market in normal times, its relative size may increase significantly when market liquidity shrinks during crisis periods. This effect is particularly strong under institutionalized fixed exchange rate regimes

18. Note that another large player in any forex market dynamics is the monetary authority, which may affect currency values through its intervention in the forex market. What usually distinguishes monetary authorities from other large players is the objective function: maximization of the country's welfare function for the former, and profit maximization for the latter. However, in some episodes, even monetary authorities in emerging economies have allegedly engaged in currency trading for balance-sheet purposes.

such as currency boards, because these regimes limit the overall degree of liquidity in the financial system. Even medium-sized sales of domestic currency to purchase foreign currency can dry up liquidity very quickly, leading to interest rate spikes such as the ones in Hong Kong in 1998 and in Turkey and Argentina in late 2000. It should be stressed that a drying-up of liquidity is an endogenous feature of an equilibrium with speculative attacks. In the model above, for instance, it is an implication of the herding result, as the speculative position by a large informed agent makes all agents take the same side of the market.

Do Large Players Intentionally Foster Herding?

The above theoretical analysis vindicates the view that large players can effectively behave like market leaders by signaling their investment strategies ("talking one's book"), driving a large number of traders toward shorting a particular currency or asset market. Nonetheless, this result by no means implies that herding is *always* in the interest of large players, nor that we should expect them to engage systematically in signalling games, revealing their positions and information to the rest of the market. In fact, major market participants may well try to prevent herding while they build (or unwind) their short positions. It is only when positions have been built that herding by other agents (taking short positions or selling the currency outright) may become advantageous, as a way to increase the pressure on the exchange rate and push a currency peg to break.

Suppose a large player is planning to short a currency or an equity index in expectation of a future fall in prices warranted by weakening fundamentals. In order to minimize any effect from its trading on current prices, its preference would be to build its positions secretly. The same consideration applies to the case of a large player that is trying to unwind its short positions, because herding would generate adverse upward pressures on prices. Actually, if anything, a large player that is shorting an asset or unwinding a short position may prefer the other agents to take a contrarian trading position, so as to minimize price movements.

In other words, when building a position, a large player has a clear interest in trading at prices that do not reflect its private information. Only *after* it has built up its position does its benefit if its information becomes public, as prices would then move in the desired direction. At that point, there is a clear incentive to engage in signaling, as analyzed in the period model presented above.[19]

19. This issue is in part debated in the literature on optimal trading strategy. In the model by Easley and O'Hara (1987), for instance, large trading size signals that some informed agent is trading on the basis of superior information. These authors argue that an investor trading on superior information will nonetheless prefer to take large positions at any given prices. The alternative view, presented by Barclay and Warner (1993), is that informed traders do not want to let the market learn their information by observing their position. Thus they engage in "stealth trading," for instance, by placing multiple medium-size orders). Of course, the reaction by small players will crucially depend on which trades (large or small) they perceive to be more informative; see Lee, Lin, and Liu (1999) for a discussion of this issue.

We note here that the goal of building a speculative position without moving prices is helped by the presence of public authorities committed to stabilizing prices—as is the case in a fixed exchange rate regime. It is still true that early herding may be bad news for speculators: Early speculative pressure on the currency may translate into higher interest rates and forward prices, raising the costs of shorting positions in that currency. Thus, there are still advantages to keeping early moves secret. However, price stabilizing schemes, such as fixed rate regimes, usually lead domestic authorities to provide a large amount of liquidity at current prices. Under a flexible exchange rate regime, instead, attempts to build large short positions without affecting prices require other investors to take the other side of the market (playing contrarian and being long) as monetary authorities are not committed to providing foreign currency at a fixed price. Again, only once such positions have been taken does noisy signalling become profitable by pushing exchange rates down.

Do Large Players Inhibit Contrarian Trade?

In the model discussed under "Signalling and Herding" in section 5.2.3, strong herding only occurs in the limiting case when the large trader is arbitrarily better informed than the rest of the market. Otherwise, there will always be some agents who are willing to take contrarian trading positions based on their own beliefs about the sustainability of the existing regime. It is worth stressing that small agents do not necessarily lose when taking long positions in the currency against the large one. Even when the large trader has superior information, its private information may not reflect the true state of the economy.

Indeed, there is circumstantial evidence that, on a number of occasions during the 1997–99 period, some HFs experienced heavy losses as the majority of market investors traded against them. In some episodes, the losses followed HFs' attempts to bet on exchange rate stability or appreciation by taking long positions on currencies under speculative pressure (such as the alleged long positions by some large funds on the Indonesian rupiah in the winter of 1997). Clearly, it is possible that large investors engage in strategic games against each other. If so, differences in information and beliefs about the evolution of fundamentals in a market would play a much larger role than a stylized theoretical model with only one large trader and a mass of small traders may suggest.

Still, one cannot rule out the possibility that, despite differences in information and opinions, the size and reputation of large players taking aggressive positions in the market may, at times, drive out contrarian investors. As compared with the usually high leverage capacity of hedge and investment funds, for instance, risk aversion and credit constraints may effectively limit the amount of stabilizing speculation that individuals and other institutions can provide. In other words, in a speculative attack against a currency, small investors who are risk averse and credit constrained may refrain from contrarian trading, even if they believe that fundamentals do not warrant a devaluation. Paradoxically, these investors may end up taking the same short positions as the large institutions initiating the attack.

While plausible and realistic, these conjectures should nonetheless be analyzed systematically in models of speculative attacks explicitly allowing for credit constraint and risk aversion. Differences in leverage and attitude toward risk need not mechanically imply that small investors stay on the sideline or follow a large player in a lemminglike fashion.

The theory of speculative attacks with large traders should also be developed so as to explain, rather than assume, differences in the size of the speculative positions taken by economic agents. When trading size is endogenous, individual agents know that choosing a large position helps solve the coordination problem inherent in a speculative attack—for the reasons discussed above, the chances of success are increasing in the magnitude of speculation. However, agents choosing a large speculative position also have more at stake. A risk-averse agent's marginal willingness to speculate can decrease rapidly as its open position grows. There are therefore two contrasting forces shaping the optimal speculative behavior of investors, one suggesting larger, the other smaller portfolio positions.

In general, herding phenomena result from the complex and, at times, unpredictable interaction of decisions of a large number of players, both small and large. Whether domestic and foreign investors herd, whether domestic investors herd more or less than foreign ones, whether offshore (and highly leveraged) foreign investors herd more or less than onshore foreign investors, and whether larger investors are leaders of the pack are all empirical questions that must be addressed in case studies.

Can Large Players Manipulate Markets?

The basic question addressed by the literature on market manipulation is whether it is possible for a trader to buy an asset, drive the price up, and then sell the asset at this inflated price, thereby earning a profit (see, e.g., Kyle 1984; Vila 1987, 1989; Jarrow 1989; Bagnoli and Lipman 1998; Benabou and Laroque 1990; Kumar and Seppi 1992). Although most of this literature does not directly address large players, these studies highlight potentially important issues to complement our analysis above.

Conceptually, one can distinguish between three types of market manipulation (see Allen and Gale 1992):

1. Action-based manipulation, based on actions that change the actual or perceived value of the assets. This includes actions by insiders (such as owners and or managers) as well as insider trading.
2. Information-based manipulation, based on the release of false information or the spread of false rumors.

3. Trade-based manipulation, which occurs when a trader attempts to manipulate a stock simply by buying and then selling, without taking any publicly observable action to alter the value of the firm or releasing false information to change the price. This form of manipulation includes attempts to corner the market for a good or an asset.

Because investors do not control national policy making, action-based manipulation seems unlikely in international currency markets. Information-based manipulation (rumor spreading) is a somewhat more interesting possibility. Information-based manipulation models, however, require that the manipulators have a real or perceived information advantage. The presence of inside information pertaining to the value of corporate securities makes this assumption highly plausible in stock markets, but it is harder to envision in foreign exchange markets. Still, even in these markets, there could be particular conditions in which rumors and leaks, say, about the actions of reputable players, may have strong effects that do not occur in normal times.

While trade-based manipulation is in principle the most relevant issue for the purpose of this paper, it is not clear that such manipulation can be profitable. Buying a stock tends to push its price up, while selling it tends to push the price down. Consequently, if a large trader who attempts to manipulate a market through trade ends up buying high and selling low, how can she make a profit?[20] For a large trader with market power to profit from trade manipulation it is necessary that other (small) agents trade on the opposite side of the market. However, if the manipulator makes net relative profits, these agents will lose. Who would take a position that implies net expected losses or negative risk-adjusted returns?

Market manipulation appears to be profitable only in particular circumstances, when there are agents with an informational disadvantage or agents who have to sell or buy for some exogenous reason, perhaps receiving benefits that compensate them for the losses in the trade.[21] In the contribution by Allen and Gorton (1992), for instance, traders with superior information can inflict losses on a specialist, thanks to exogenous trades by agents who face binding liquidity constraints. The authors of this study correctly observe that the welfare implications of this example of trade manipulation are ambiguous: why should policy makers care if some investors make money at the expense of less informed specialists?

Market corners are another form of trade-based manipulation. For instance, a trader may obtain control of a sufficiently large share of the supply of an asset that must be delivered in the futures or forward market.[22] This

20. Indeed, Jarrow (1992) shows formally that profitable manipulation is impossible in an efficient market.

21. Theoretical examples are given by Kyle (1985), Jarrow (1992), Allen and Gorton (1992), Allen and Gale (1992), and Kumar and Seppi (1992).

22. As in the cases of the Salomon Brothers' Treasury market corner and the Hunt Brothers' corner of the silver market.

type of manipulation may not be feasible in markets, such as the forex, where the relevant assets are not in fixed supply. Finally, we should note that the issue of collusion, alleged to be a factor in recent market dynamics episodes, has not been systematically studied by the literature on manipulation.

Based on this overview of the literature, we can only attempt a preliminary assessment of the theoretical case for market manipulation by large players in the forex market. The key observation is that successful manipulation requires relatively strict informational and behavioral conditions. For example, an individual fund should be large enough or leveraged enough to be able to corner the market for a particular currency. Alternatively, if no player was large enough to affect markets by itself, manipulation would require collusion among investors. In the absence of outright collusion, some HFs would have to lead the trading strategies of a sufficient number of traders—perhaps by verbal manipulation, "talking down" a currency to encourage other market players to sell short. Although such convergence of strategies is possible, there is currently no evidence that it occurred in any of the turbulence episodes of the 1990s.

Manipulation is hard to prove even when it is clear that a large agent talked down a currency or market. Suppose that a major market participant, believing that a currency is overvalued, places global macro bets shorting that currency and publicly announces its views to this effect. Because there is a broad range of uncertainty on whether a currency is overvalued, how can one prove that the large agent's public statement is a form of market manipulation?

We conclude this section by noting that, although the social impact of manipulation of individual equities may be ambiguous (because it leads to a redistribution of wealth from less informed specialists to more informed investors), successful manipulation of currency markets may have serious welfare implications. Price movements away from fundamentals could be associated with large and undesirable real effects such as employment losses and fiscal and monetary imbalances. Moreover, wealth would be redistributed from vulnerable emerging-market economies to powerful international investors.

5.3 Large Players and Currency Markets: Empirical Studies

A key lesson of the 1997–99 episodes is that no single factor can entirely explain the volatility in cross-border capital flows, nor the large swings in asset prices that capital volatility sometimes causes. Corporate, financial, and policy weaknesses in emerging markets are often exacerbated by adverse monetary and macroeconomic developments in advanced economies; countries with different domestic fundamentals have been equally vulnerable to shifts in market sentiment among international investors. As a result, small countries that have been the recipients of international capital have also been increasingly worried by forces beyond their control in international capital markets.[23] No wonder the role of HFs and other HLIs in global financial crises has been closely scrutinized and often criticized, especially during the second half of the last decade.

The evidence on the portfolio strategies of HFs and HLIs and their impact in currency turbulence episodes is mixed. IMF (1998) finds some evidence that HFs, acting as market leaders, helped precipitate the ERM crisis in 1992, although they appear to have done so in response to economic fundamentals. Regarding the same episode, Fung and Hsieh (1999b) show that the 25 percent net asset value (NAV) gain of the Quantum Fund in September 1992 can be explained by its position against the British pound.[24] However, this episode hardly proves that a single large player can cause the collapse of an otherwise sound currency. It is generally agreed that the pound was overvalued in 1992 and that a devaluation was necessary to restore the competitiveness of the U.K. economy.[25] Although specific HFs might have contributed to triggering the fall of the pound, this episode hardly fits the view that speculators successfully forced a devaluation not justified by fundamentals.[26]

More recently, the authorities of a number of countries—such as Malaysia, Hong Kong, and Australia—have claimed that the HFs' role was significant in several recent crises: Such funds have been accused of leading market dynamics, intentionally causing herding, and manipulating currencies and other asset markets. However, some studies, especially IMF (1998) and other research (see Brown, Goetzmann, and Park 2000; Fung, Hsieh, and Tsatsaronis 2000), have expressed skepticism. A typical argument made in these studies is that HFs were "at the rear of the herd of investors rather than in the lead." This view is partly at odds with the conclusions of the more recent FSF official study (FSF 2000) of the 1998 turmoil, which focused on a sample of small and medium-sized economies such as Hong Kong, Australia, New Zealand, South Africa, Singapore, and Malaysia. Whereas the IMF study concluded that HFs had played only a minor role in 1997, FSF found a more significant impact of HFs and prop desks in the episodes of turmoil in 1998.

23. See Schadler et al. (1993) and Mussa et al. (1999) for emerging-market experience with volatile capital flows and some possible policy responses.

24. The authors infer the directional exposure of the Quantum Fund to several currencies from data on its weekly or daily net asset values.

25. The debate on the 1992–93 crisis of the European Monetary System is assessed in Eichengreen and Wyplosz (1993), Buiter, Corsetti, and Pesenti (1998a, b), and Eichengreen (2000).

26. In other episodes, notably the 1994 bond market turbulence, IMF (1998) shows that HFs as a group bet on a decline in interest rates, realizing substantial losses when they instead rose. Fung and Hsieh (1999a) and Fung, Hsieh, and Tsatsaronis (2000) show that the Quantum Fund took positions in anticipation of a strengthening of the U.S. dollar against the yen in February 1994, then suffered sharp losses as the yen appreciated. They also consider the performance of several large macro HFs in the episodes of market turmoil in 1997–98. We return to these case studies below.

Some preliminary evidence about the performance of HFs for the period 1997–98 is presented in figures 5.1–5.4, where we plot the time series of the NAVs of four large macro HFs,[27] in parallel with the Standard & Poor's 500 index and the yen/dollar exchange rate.[28] Over this period, large macro HFs were reported to be taking substantial long positions in the U.S. equity market; they may also have been involved in the "yen carry trade" (borrowing in yen to finance positions in other currencies or assets), as argued by Fung and Hsieh (1999b).

For the Quantum fund, figure 5.1 suggests a strong correlation between the NAV and the Standard & Poor's 500 index in the first eleven months of 1997. The comovement is loose afterwards. Parallel movements between the yen/dollar exchange rate and the NAVs of the four HFs are apparent in the fall of 1998, in coincidence with the rally of the yen. Over the same period, the NAVs of these funds also seem to be affected by the fall in the U.S. equity markets following the turmoil generated by the Russian crisis and the near-collapse of Long-Term Capital Management (LTCM).

A striking feature of the performances of these four funds during the 1997–98 period is the size of fluctuations. The Jaguar Fund's NAV rose by 100 percent between the beginning of 1997 and August 1998 but lost 25 percent of its value between August 1998 and the end of 1998. The Emerging Growth Fund rose by 40 percent between January and May 1997, then fell sharply, remaining on a downward trend until the end of 1998, when its NAV was about 40 percent below its level at the beginning of 1997. The Quasar Fund was volatile but on average rose by about 50 percent between the beginning of 1997 and August 1998; after that, it plunged by 50 percent. By the end of 1998, its NAV was at the same level as at the beginning of 1997. The Quantum Fund rose by about 30 percent between the beginning of 1997 and November 1997, but then it was mostly on a downward trend, approaching, at the end of the sample, a level close to the one at the beginning of 1998. Overall, the performance of three of these four funds in the 1997–98 period was far from exceptional: Two funds had on average zero returns over the period, while one lost almost 40 percent of its value. The fourth fund gained over 40 percent over the same period.

In what follows we provide a reassessment of the foreign exchange strategies of large players in light of our theoretical analysis. A few selected case studies on turbulence episodes in emerging markets are preceded by an analysis of the evidence on the aggregate foreign currency positions of large market participants in advanced economies.

27. These are the Quantum Fund, the Quasar International Fund, the Emerging Growth Fund of the Quantum Group, and the Jaguar Fund. They were among the largest macro HFs in the industry over the period considered. Data on their weekly (Wednesday) NAVs have been collected from the *Financial Times*.

28. Similar charts appear in Fung, Hsieh, and Tsatsaronis (2000), who consider the performance of the HFs only up to 1997.

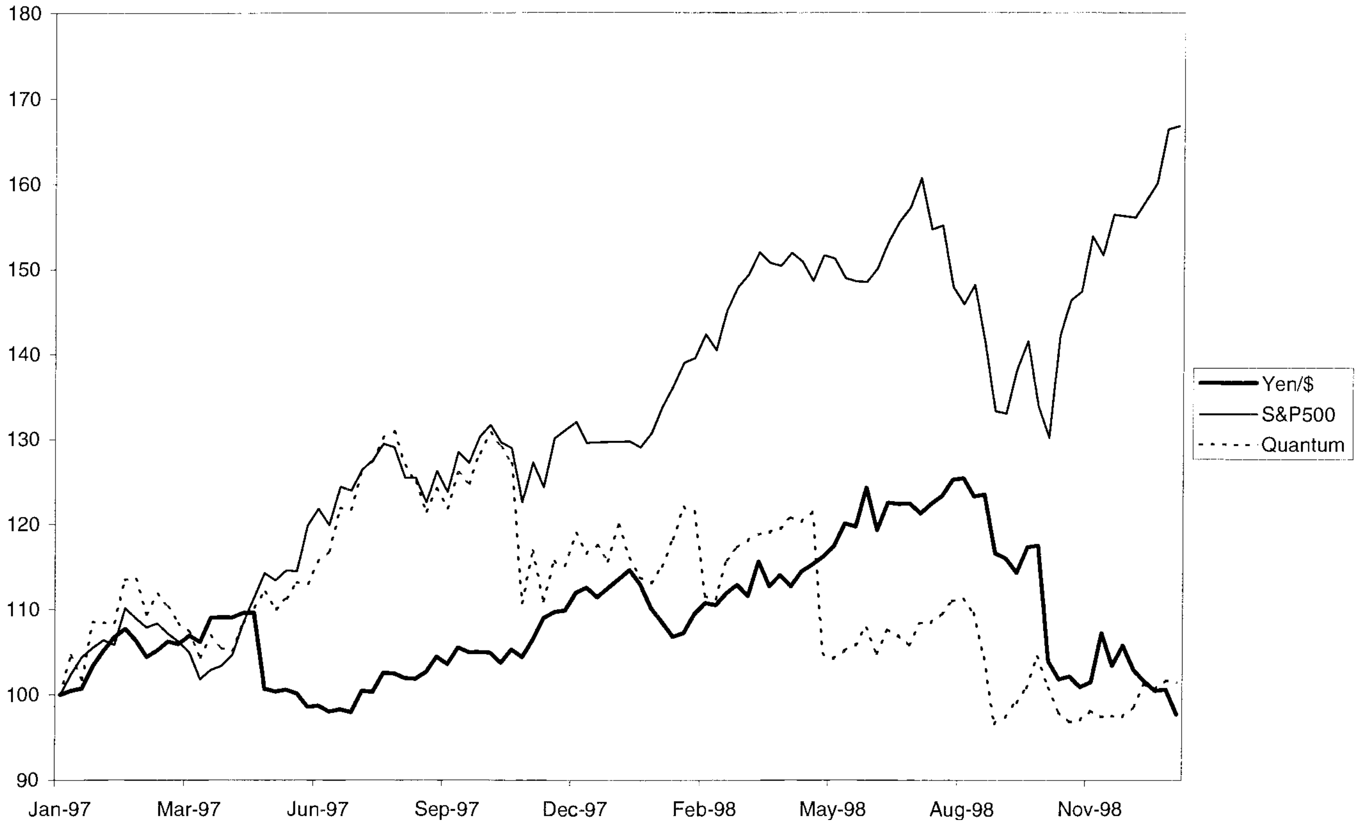

Fig. 5.1 Quantum net asset value, S&P 500 index, yen/$ exchange rate
Source: Financial Times and DRI

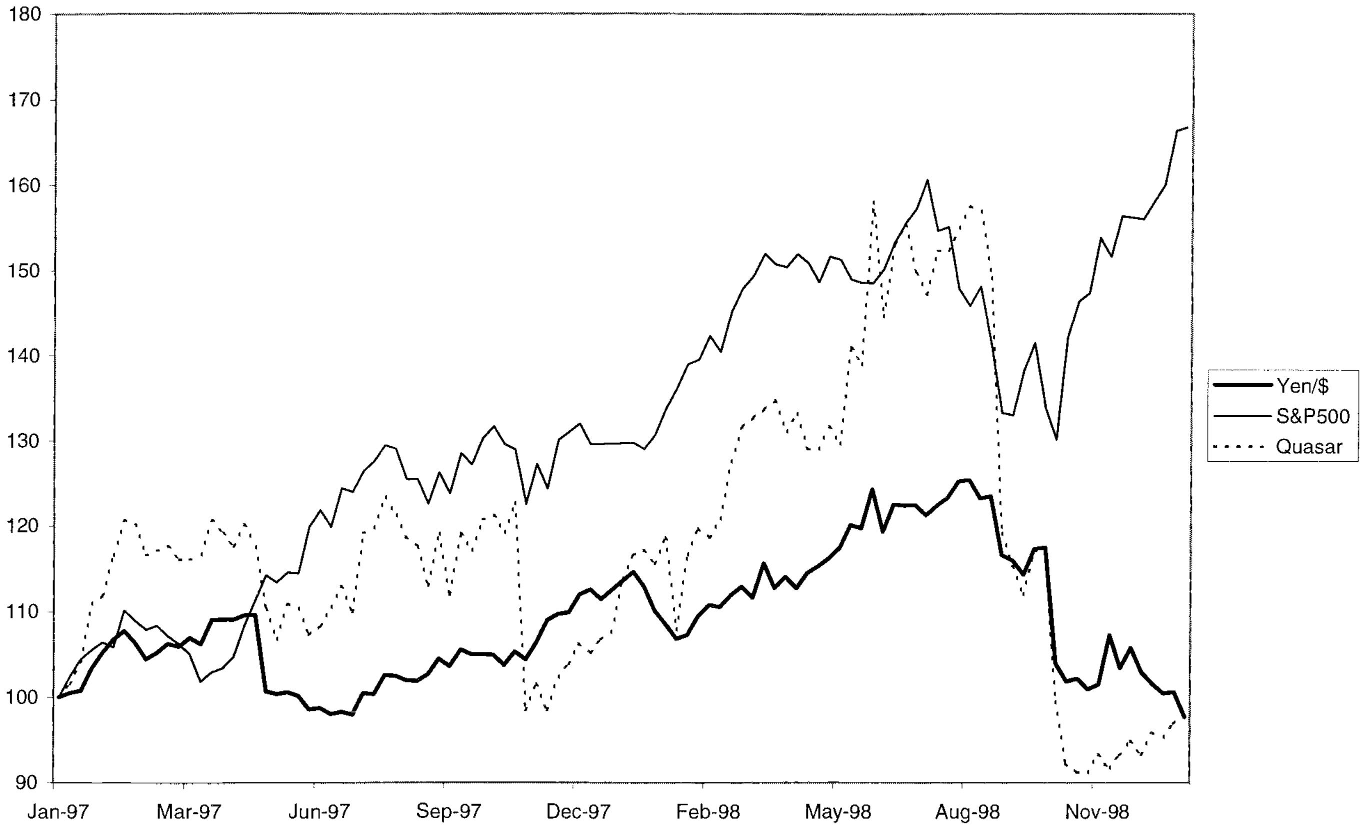

Fig. 5.2 Quasar net asset value, S&P 500 index, yen/$ exchange rate
Source: Financial Times and DRI

Fig. 5.3 Emerging growth net asset value, S&P 500 index, yen/$ exchange rate
Source: Financial Times and DRI

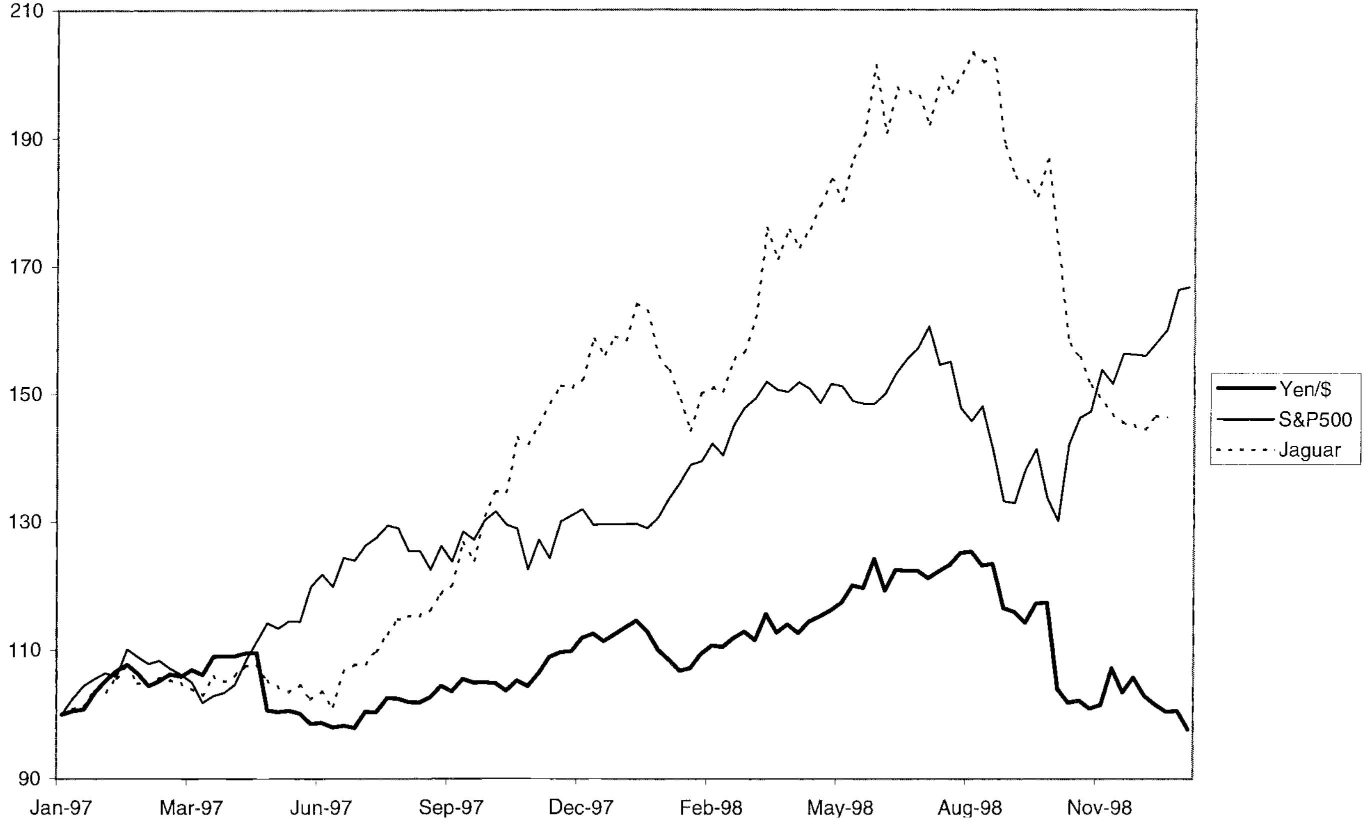

Fig. 5.4 Jaguar net asset value, S&P 500 index, yen/$ exchange rate

Source: Financial Times and DRI

5.3.1 The Treasury Foreign Currency Reports of Major Market Participants

We have argued before that a number of elements may contribute to a financial institution's market power—asset size and leverage ability, visibility and reputation for superior information. In this section we investigate the links among these elements, focusing on the currency market. Do large players affect the price of foreign currency? Can they have access to better information than average market participants? Can they count on superior forecasts of future exchange rate developments? Do they consistently take long (short) positions in currencies whose value tends to appreciate (depreciate) over time? To address these questions, at least on a preliminary basis, we analyze the evidence on the foreign currency positions of the largest participants in the U.S. forex market.

Major foreign exchange market participants are required by law to file weekly and monthly reports on their holdings of foreign currency.[29] An institution qualifies as a major participant if, on the last business day of either March, June, September, or December during the previous year, it had more than the equivalent of $50 billion in foreign exchange contracts on its books. Contracts include sales and purchases in the spot, forward, futures, and options markets. Actual currency holdings (deposits) and any other foreign currency–denominated securities are not included in the reports. U.S.-based institutions file a consolidated report for their domestic and foreign subsidiaries, branches, and agencies. Subsidiaries of foreign entities operating in the United States file only for themselves, not for their foreign parents. Market participants with foreign currency holdings of less than $50 billion but greater than $1 billion need only file a quarterly report.

In their weekly Treasury Foreign Currency (TFC) reports, major participants indicate the amounts of foreign currency outstanding at the close of business each Wednesday.[30] The currencies included in the reports are the Canadian dollar, German mark, Japanese yen, Swiss franc, pound sterling, and, since 1999, the euro. Also since 1999, reporting institutions approximate all other currency positions under the aggregate entry "U.S. dollar." Data are organized into four categories: foreign exchange spot, forward, and futures purchased; foreign exchange spot, forward, and futures sold; net options position delta equivalent value long or [short]; net reported dealing position long or [short]. The first two categories represent the outstanding amounts of foreign exchange that the reporter has contracted to receive or deliver. Contracts are reported on a gross basis, and when the contracts provide for the exchange of one currency for another, both the purchase and the sale are reported. Options (third category) are reported if

29. 31 United States code 5315; 31 Code of Federal Regulation 128, Subpart C.

30. The reports are filed no later than noon on the Friday following the Wednesday to which the report applies.

the aggregate notional principal amount of contracts purchased and sold exceeds \$500 million equivalent. Options are reported in terms of net "delta equivalent," an estimate of the relationship between an option's value and an equivalent currency hedge, that is, the amount of currency with the same gain or loss characteristics as the option for small movements in the exchange rate.[31] The fourth category is defined as the actively managed net dealing position monitored and used by each reporter for internal risk management purposes. Estimates of net dealing position typically come from internally generated reports.

Based on the TFC reports, since 1994 the Treasury Bulletin publishes information on the weekly, monthly, and quarterly foreign currency position taken by all large players collectively. No information is released on single participants' positions, and data on their net dealing positions are unavailable even at the aggregate level. A previous study (Wei and Kim 1999) has used this data set, covering the sample period 1994–96. Our paper covers the entire sample available at the time of writing, January 1994 through June 2000. In 1996 thirty-six reporters qualified as major participants; of these, twenty-nine were commercial banks and the remaining seven were other forms of financial institutions, including HFs. By 2000, the number of reporters was down to twenty-five, of which eighteen were banking institutions.

Table 5.1 provides summary statistics on major participants' weekly positions, all expressed in millions of U.S. dollars.[32] Gross sales and purchases of foreign currency are rather large (for instance, sales of Japanese yen average \$1,459 billion, and purchases of marks average \$1,252 billion) but net positions are relatively small across currencies (net positions in yen are about \$20 billion in absolute value, and net positions in marks are on average \$7.5 billion). The limited size of net relative to gross positions is partly due to large market participants' role as intermediaries: Reported foreign currency transactions typically involve two offsetting operations, such as a purchase of foreign currency from the market on behalf of a client and the sale of foreign currency to the client itself. However, limited net positions also indicate unwillingness by major participants to maintain large speculative positions at high (weekly) frequency. It is worth noting, however, that large players' net positions have increased over time, on average, across all currencies in the sample except the Canadian dollar.

Figures 5.5–5.11 plot the weekly time series of aggregate net foreign currency positions, defined as purchases minus sales of foreign exchange spot,

31. Technically, the "delta equivalent" value represents the product of the first partial derivative of an option valuation formula with respect to the price or rate of the underlying contract, multiplied by the notional principal of the contract.

32. We consider data on positions in German marks only until the end of 1998. After 1999, positions in marks are reported only if the institution separately manages the exchange rate risk of the euro and the legacy currencies; otherwise, all legacy currency amounts are reported as euro-denominated contracts.

Table 5.1 **Summary Statistics on the Treasury Foreign Currency Position Data**

	1994–2000				
	Observations	Mean	Standard Deviation	Minimum	Maximum
U.K. pound					
Purchased	337	622,847	165,994	339,847	917,309
Sold	337	611,583	159,274	339,060	906,447
Net options position	337	1,208	1,563	–5,473	6,243
Net foreign currency position	337	12,472	8,551	–2,576	40,193
Swiss franc					
Purchased	337	334,790	62,349	216,129	519,961
Sold	337	339,857	65,951	215,423	531,052
Net options position	337	3,191	3,073	–4,473	10,394
Net foreign currency position	337	–1,876	3,823	–15,385	14,936
Japanese yen					
Purchased	337	1,429,063	219,094	870,624	2,100,231
Sold	337	1,459,080	225,300	882,762	2,121,832
Net options position	337	10,142	3,625	2,824	23,085
Net foreign currency position	337	–19,876	11,933	–57,232	–704
Canadian dollar					
Purchased	337	173,793	40,995	87,799	246,798
Sold	337	171,609	42,452	86,141	248,266
Net options position	337	–1,929	1,092	–4,410	995
Net foreign currency position	337	256	2,716	–11,423	7,179
	1997–2000				
U.K. pound					
Purchased	182	755,470	96,081	568,827	917,309
Sold	182	737,607	95,455	550,143	906,447
Net options position	182	1,330	1,924	–5,473	6,243
Net foreign currency position	182	19,193	5,561	4,284	40,193
Swiss franc					
Purchased	182	361,052	65,812	216,129	519,961
Sold	182	365,670	71,133	215,423	531,052
Net options position	182	2,054	3,246	–4,473	8,340
Net foreign currency position	182	–2,564	4,771	–15,385	14,936
Japanese yen					
Purchased	182	1,573,070	186,778	1,175,914	2,100,231
Sold	182	1,611,159	184,751	1,202,603	2,121,832
Net options position	182	11,602	3,580	4,868	23,085
Net foreign currency position	182	–26,487	12,141	–57,232	–870
Canadian dollar					
Purchased	182	205,602	18,538	159,173	246,798
Sold	182	204,945	20,030	154,471	248,266
Net options position	182	–1,936	1,394	–4,410	995
Net foreign currency position	182	–1,279	2,424	–11,423	4,719
	1994–96				
U.K. pound					
Purchased	155	467,122	63,818	339,847	631,167
Sold	155	463,606	61,889	339,060	622,839
Net options position	155	1,065	971	–1,640	3,209
Net foreign currency position	155	4,580	2,672	–2,576	12,291

Table 5.1 (continued)

	1994–2000				
	Observations	Mean	Standard Deviation	Minimum	Maximum
Swiss franc					
Purchased	155	303,952	40,233	247,431	449,426
Sold	155	309,547	42,788	250,865	458,367
Net options position	155	4,527	2,213	803	10,394
Net foreign currency position	155	–1,068	1,980	–7,897	3,942
Japanese yen					
Purchased	155	1,259,971	102,189	870,624	1,477,491
Sold	155	1,280,511	105,852	882,762	1,500,136
Net options position	155	8,427	2,852	2,824	13,996
Net foreign currency position	155	–12,113	5,013	–25,856	–704
Canadian dollar					
Purchased	155	136,443	25,747	87,799	204,644
Sold	155	132,465	24,595	86,141	198,807
Net options position	155	–1,920	564	–3,215	–526
Net foreign currency position	155	2,058	1,770	–1,015	7,179
		1994–98			
German mark					
Purchased	259	1,252,768	126,035	1,025,474	1,694,490
Sold	259	1,248,805	116,520	1,026,360	1,643,567
Net options position	259	3,519	5,386	–12,705	11,892
Net foreign currency position	259	7,481	12,606	–10,647	50,989
		1994–96			
German mark					
Purchased	155	1,214,599	103,602	1,025,474	1,557,578
Sold	155	1,215,384	101,510	1,026,360	1,547,771
Net options position	155	6,529	2,644	–1,728	11,892
Net foreign currency position	155	5,744	9,237	–7,616	25,603
		1997–98			
German mark					
Purchased	104	1,309,654	135,209	1,102,822	1,694,490
Sold	104	1,298,617	120,066	1,109,383	1,643,567
Net options position	104	–968	5,315	–12,705	7,834
Net foreign currency position	104	10,069	16,099	–10,647	50,989
		1999–2000			
Euro					
Purchased	78	1,707,470	126,408	1,470,427	1,994,301
Sold	78	1,714,560	124,464	1,478,126	1,996,041
Net options position	78	–3,919	2,879	–9,953	2,451
Net foreign currency position	78	–11,009	10,916	–33,426	23,001
		1999–2000			
U.S. dollar					
Purchased	78	5,198,645	188,140	4,549,910	5,665,935
Sold	78	5,228,695	177,475	4,598,793	5,657,587
Net options position	78	3,175	6,119	–9,481	17,290
Net foreign currency position	78	–26,875	17,362	–70,953	20,912

Notes: Data are reported in millions of U.S. dollars. Purchased (sold) refers to spot, forward, and futures contracts purchased (sold) in that currency. Net options position is the net delta-equivalent value of the total options position. Net foreign currency position is calculated as net contracts purchased plus net options position.

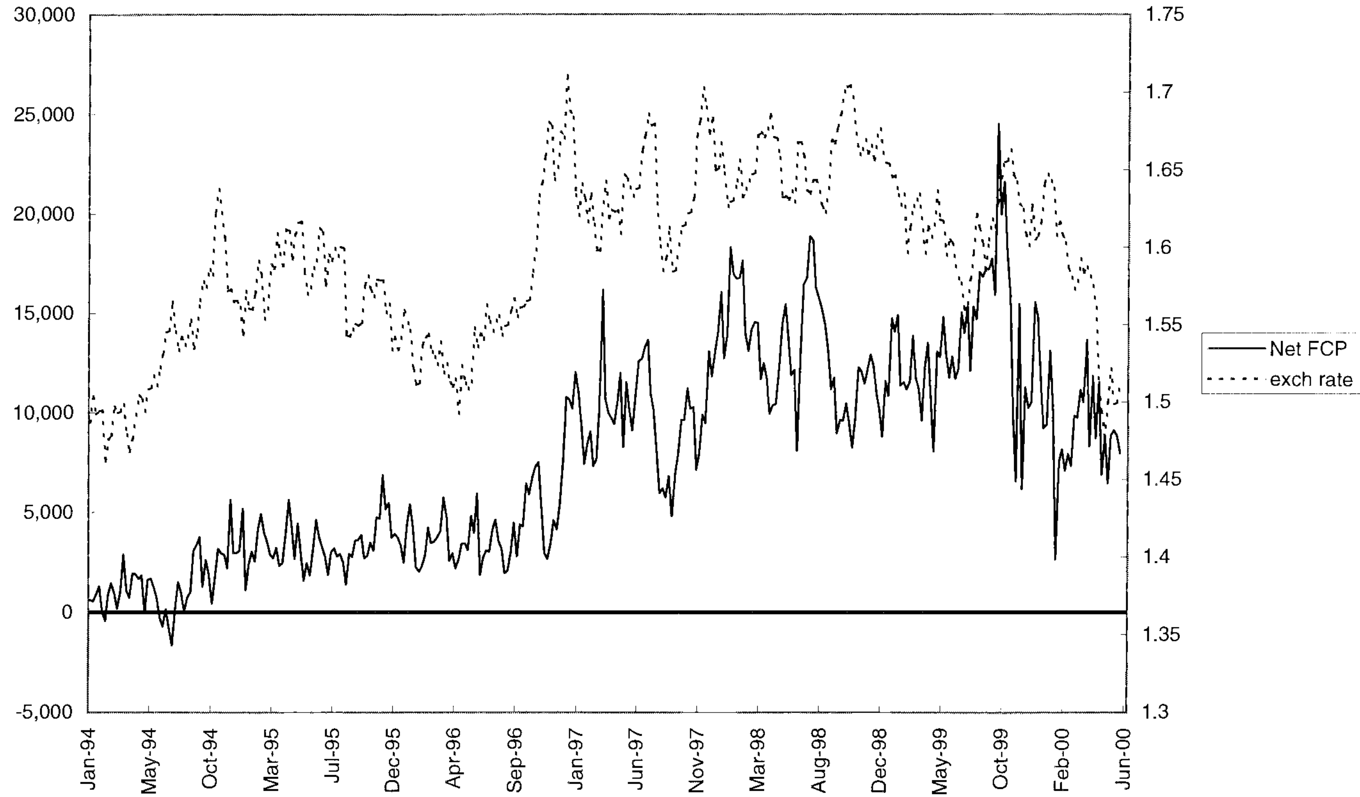

Fig. 5.5 **Net foreign currency position and exchange rate, U.K. pound (1994–2000)**

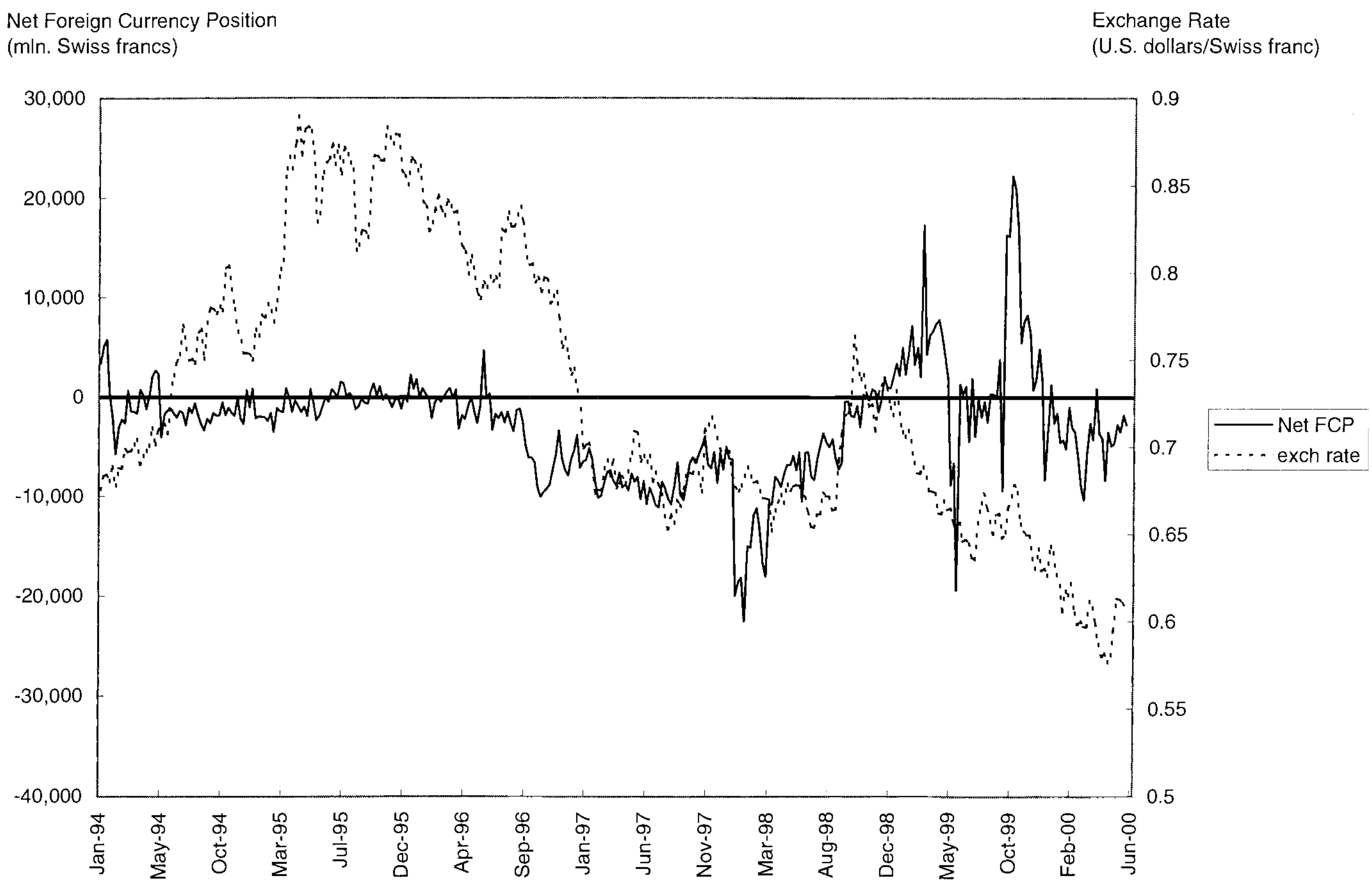

Fig. 5.6 Net foreign currency position and exchange rate, Swiss franc (1994–2000)

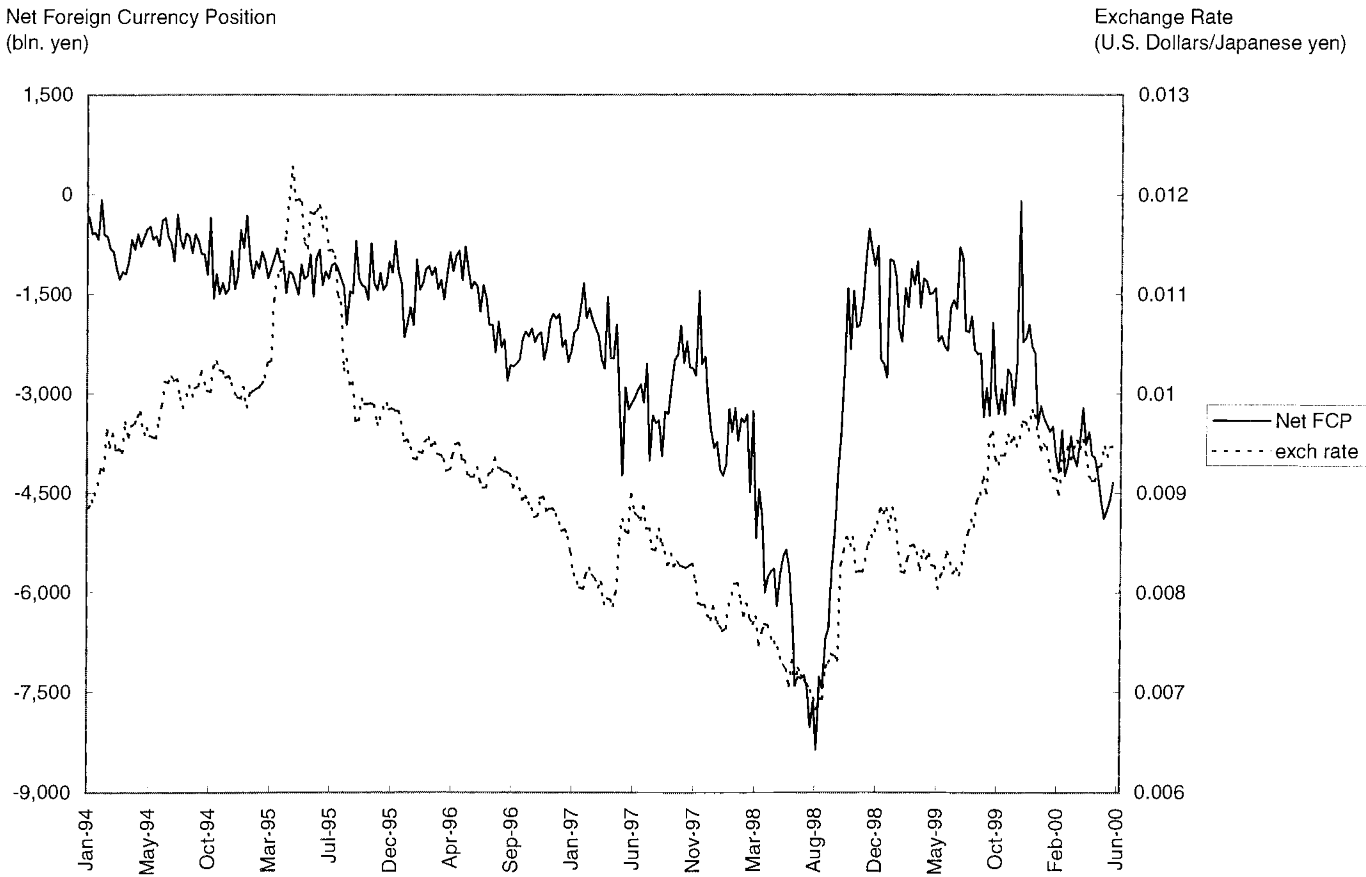

Fig. 5.7 Net foreign currency position and exchange rate, Japanese yen (1994–2000)

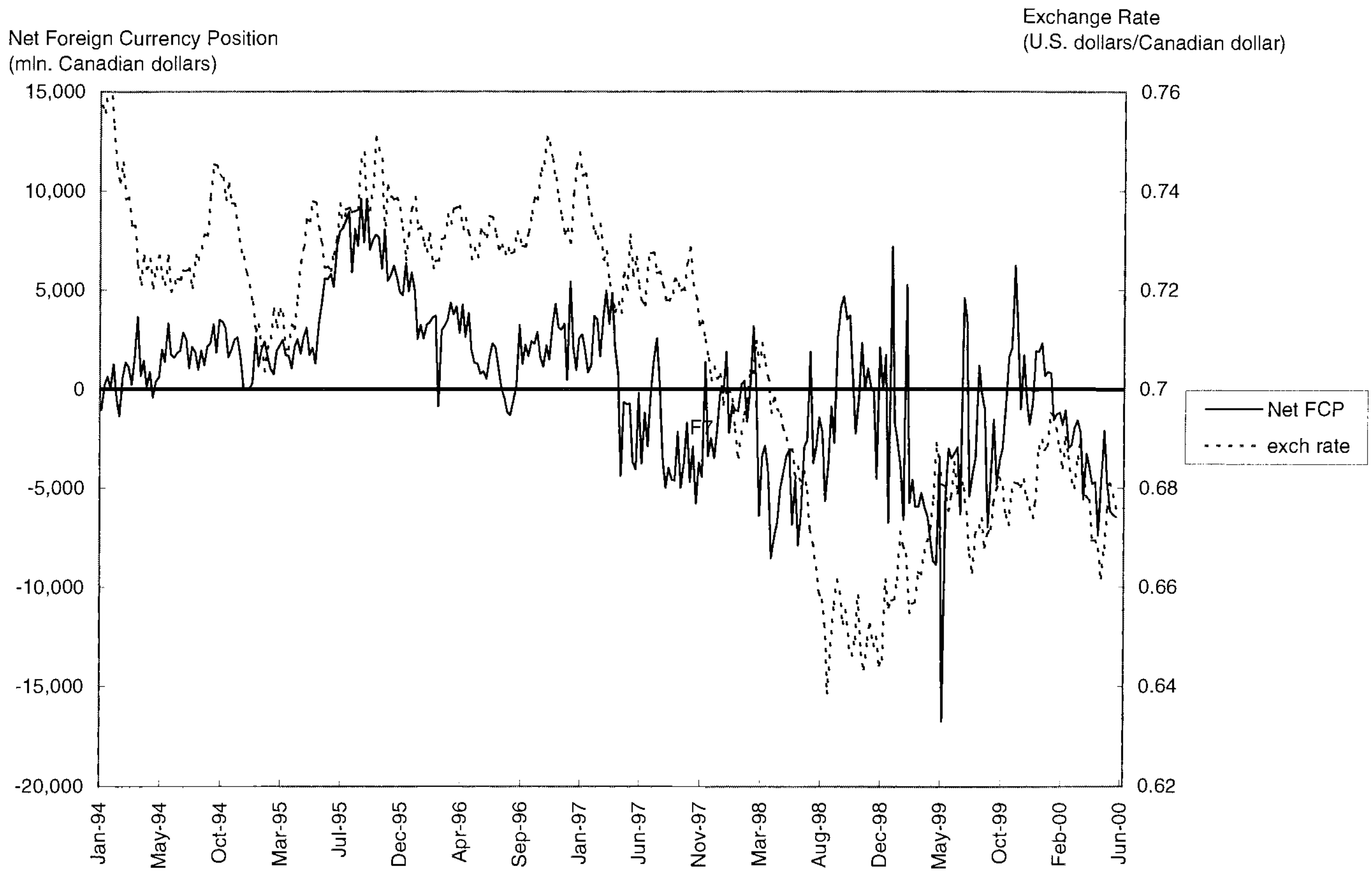

Fig. 5.8 **Net foreign currency position and exchange rate, Canadian dollar (1994–2000)**

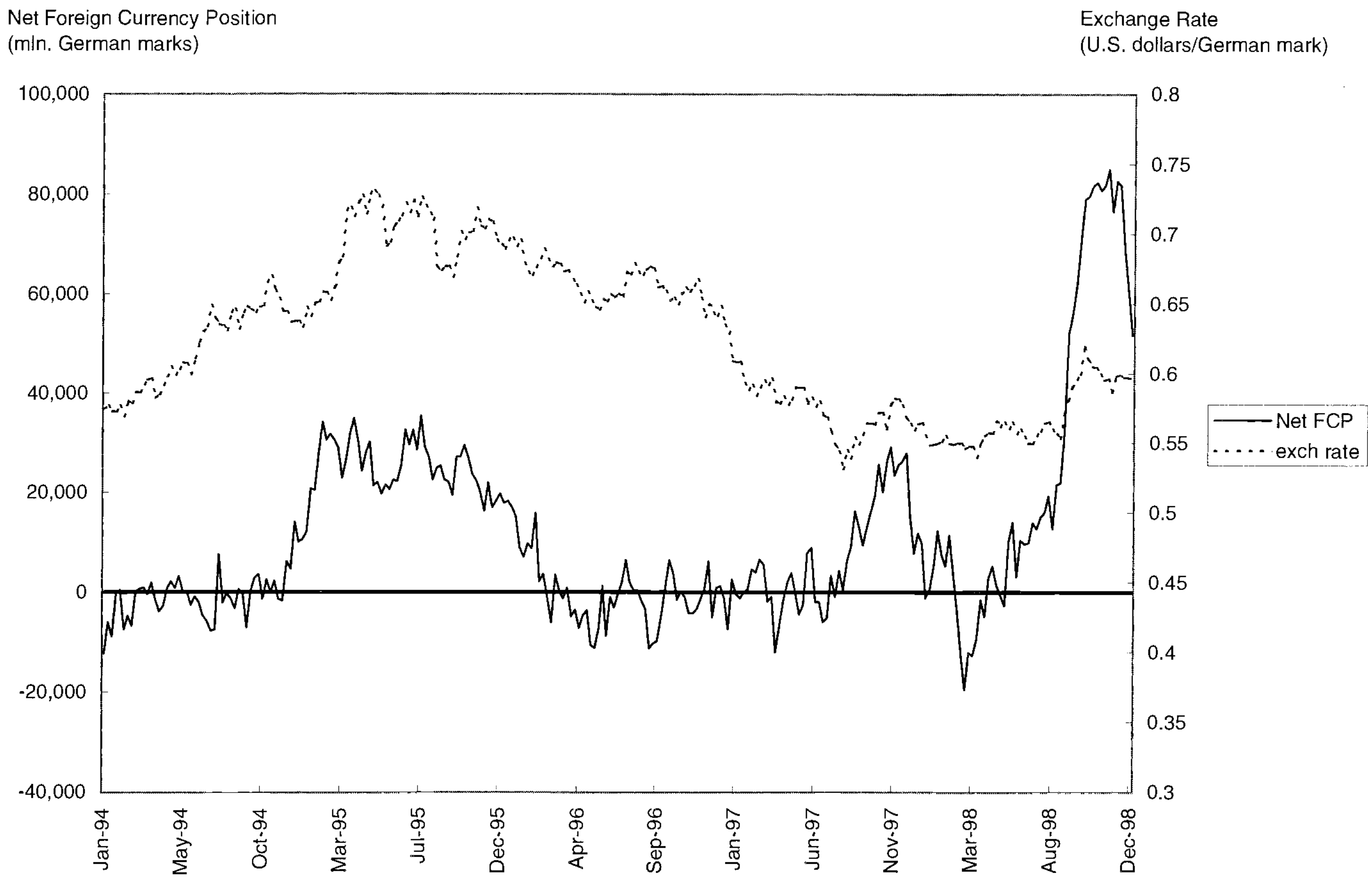

Fig. 5.9 Net foreign currency position and exchange rate, German mark (1994–98)

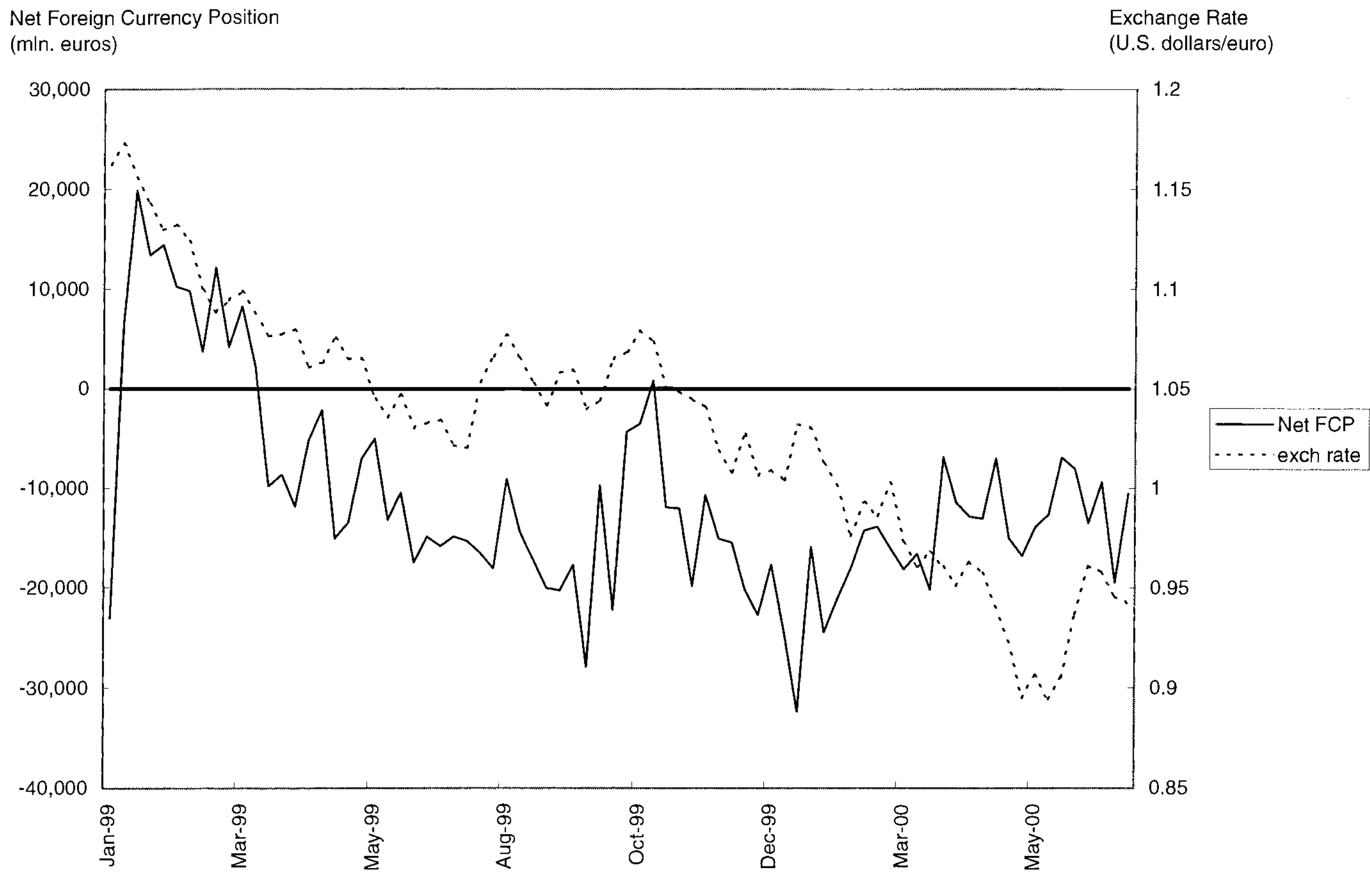

Fig. 5.10 Net foreign currency position and exchange rate, euro (1999–2000)

Fig. 5.11 Net foreign currency position, U.S. dollars (1999–2000)

forward, and futures, plus net options positions, all expressed in millions of local currency (except for the contracts in yen, expressed in billions). The figures also plot the relevant exchange rates, expressed as U.S. dollars per unit of local currency. Visual inspection of these figures leaves the impression that the two series tend to move in parallel: When a currency strengthens against the dollar, large players systematically increase their purchases and reduce their sales of that currency, unwinding their net positions in dollars.

For example, in figure 5.7, the weakening of the yen relative to the U.S. dollar from the fall of 1997 through the summer of 1998 is strongly correlated with increasing net short positions on the yen, rising from about ¥2 trillion (about $16 billion at the prevailing exchange rate) to over ¥8 trillion (about $56 billion). The rally of the yen between August and October 1998 is also associated with a sharp and rapid unwinding of major participants' short positions. In the case of the German mark (fig. 5.9), the cycle of appreciation against the U.S. dollar in the first half of 1995 and depreciation in the second half of that year appears to be correlated with an initial buildup of long positions in marks and their subsequent reversal. Similar episodes are noticeable for the pound, the euro, the Canadian dollar, and the Swiss franc. There are, however, exceptions: Notably, the weakening of the euro in 1999 (fig. 5.10) seems to be associated with larger short positions on this currency until the summer of 1999 but not afterwards.

Obviously, the direction of causality is not clear. On the one hand, large players may affect the price of the currency simply because of the size of their net positions. On the other hand, large players observe current exchange rates and take into account the perceived strength or weakness of the currency in determining their net position at the close of business, substantially extrapolating some persistence in the behavior of the exchange rate over the very short term. Superior information by large players may also explain why current positions appear at times to be associated with contemporaneous and future exchange rate levels.

To provide formal statistical evidence on these correlations, we regress the current (Wednesday) exchange rate on the foreign currency position denominated in local currency.[33] For sensitivity analysis we exclude from the sample outliers[34] and consider two subsamples, 1994–96 (as in the Wei and Kim 1999 study) and 1997–2000. The first column of table 5.2 reports the results. In general, the regressions provide evidence in support of a strong positive link between exchange rates and simultaneous net positions. The results are particularly striking in the case of the pound, the Canadian dollar, the yen, the Swiss franc, and the euro. The link is weaker in the case of the German mark, as the coefficient is statistically significant only at the 10

33. For sensitivity analysis, we also regress the exchange rate on currency positions converted into U.S. dollars. The results are substantially similar.

34. The outliers are identified visually as 5/19/1999 (Canadian dollar), 9/15/1999 (Swiss franc), and 1/6/1999 (euro). Outliers play little role in our results.

Table 5.2 **Regressions of Level Exchange Rate on Net Foreign Currency Position**

	Net FCP		
	Current	One-Week Lag	Net FCP lag
U.K. pound			
1994–2000	69.0**	33.5**	37.8**
	(4.46)	(11.50)	(11.50)
1994–96	109.0**	71.5**	47.6*
	(18.9)	(28.0)	(28.0)
1997–2000	22.4**	9.3	18.3
	(9.06)	(13.00)	(13.10)
Canadian dollar			
1994–2000	40.1**	23.7**	21.7**
	(3.60)	(5.47)	(5.49)
1994–96	9.39**	6.90	4.40
	(3.53)	(6.95)	(6.89)
1997–2000	9.83*	6.20	6.70
	(5.44)	(6.49)	(6.44)
Excluding outliers			
1994–2000	41.6**	25.4**	20.5**
	(3.70)	(5.76)	(5.62)
1994–96	9.39**	6.90	4.40
	(3.53)	(6.95)	(6.89)
1997–2000	10.4*	6.6	6.5
	(5.74)	(6.95)	(6.56)
Swiss franc			
1994–2000	28.8**	18.9	12.6
	(7.58)	(13.30)	(13.30)
1994–96	25.2	35.9	–5.4
	(18.3)	(29.9)	(30.2)
1997–2000	1.8	4.2	–3.0
	(3.93)	(6.76)	(6.76)
Japanese yen			
1994–2000	4.17**	1.90**	2.42**
	(0.3)	(0.9)	(0.9)
1994–96	3.99**	2.30	2.50
	(1.2)	(2.0)	(2.0)
1997–2000	1.98**	0.70	1.34*
	(0.294)	(0.785)	(0.785)
German mark			
1994–98	3.19*	–6.7	10.2
	(1.68)	(6.65)	(6.69)
1994–96	19.9**	2.6	17.9**
	(1.84)	(5.38)	(5.36)
1997–98	3.83**	–0.1	4.0
	(0.703)	(3.13)	(3.15)

Table 5.2 (continued)

	Net FCP		
	Current	One-Week Lag	Net FCP lag
Euro			
1999–2000	30.7**	26.5**	9.4
	(6.2)	(8.6)	(8.5)
Excluding outliers			
1999–2000	33.4**	26.5**	9.4
	(5.9)	(8.6)	(8.5)

Notes: The first column reports results of the regression of the level exchange rate (US$ per unit of foreign currency) on the current net foreign currency position (in millions of local currency, except for billions of Japanese yen). The second column reports results including the one-week lag of the net foreign currency position (Net FCP_lag). Coefficient estimates and standard errors (reported in parentheses) are multiplied by 10^7. Constants are not reported.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

percent level; it is significant at the 5 percent level if we regress the exchange rate on net positions expressed in U.S. dollars. Breaking the sample into two periods does not significantly alter the results; in general, the *t*-statistics fall in the most recent subsample, with the notable exception of the yen.

The relation between the exchange rate and net position is also significant when we introduce lagged values of the latter variable. In the second column of table 5.2 we report results based on regressing the Wednesday exchange rate on current and one-week lagged net positions. The coefficients of both regressors are significantly positive in the cases of the pound, the Canadian dollar, and the yen. In other words, past net positions help to predict current exchange rates:[35] Large players tend to take long positions in currencies that are strong and remain so for a while—a result reflecting some degree of persistence in exchange rates.[36]

Are net positions associated with changes (rather than levels) of exchange rates over time? If a significant relation were found between net positions and movements of the exchange rate, two interpretations would be possible. On the one hand, if large players had superior information, they should be able to anticipate currency movements, selling short before depreciation. On the other hand, large players could affect the movement of the exchange rate simply because of the size of their trading.

Table 5.3 reports the results of regressing the ex post exchange rate de-

35. Separate regressions, not reported here, show that the correlation between current positions and future levels of the exchange rate holds significantly for horizons up to two months for most currencies.

36. Also, this result is not inconsistent with an interpretation according to which large players' positions today influence other market participants' behavior, leading them to take similar net positions over time (a form of momentum trading).

Table 5.3 Regression of Log Difference Exchange Rate on Net Foreign Currency Position

	Horizon (Days)						
Currency	1	2	3	5	10	20	60
U.K. pound							
1994–2000	0.40	–0.10	–0.50	–0.60	–1.10	–2.10	–9.49**
	(0.498)	(0.748)	(0.897)	(1.030)	(1.47)	(1.99)	(2.89)
1994–96	–2.0	–0.2	–2.0	–2.3	–2.7	4.8	–30.6**
	(2.08)	(3.20)	(3.94)	(4.69)	(6.49)	(8.53)	(12.70)
1997–2000	2.00*	2.77*	3.00	3.00	5.00	8.01*	12.80**
	(1.11)	(1.64)	(1.89)	(2.18)	(3.14)	(4.31)	(6.08)
Canadian dollar							
1994–2000	–0.80	–1.20*	–0.90	–0.20	–0.20	1.00	8.43**
	(0.471)	(0.656)	(0.849)	(0.958)	(1.320)	(1.780)	(2.910)
1994–96	–0.8	–0.3	0.4	1.3	1.6	5.8	–0.3
	(0.857)	(1.200)	(1.790)	(2.030)	(2.790)	(3.960)	(6.590)
1997–2000	–0.3	–1.4	–1.4	–1.5	–2.3	–2.6	10.4**
	(0.817)	(1.140)	(1.360)	(1.540)	(2.110)	(2.750)	(4.460)
Excluding outliers							
1994–2000	–0.827*	–1.150*	–0.700	–0.400	–0.500	1.200	8.440**
	(0.486)	(0.677)	(0.878)	(0.988)	(1.360)	(1.840)	(3.000)
1994–96	–0.8	–0.3	0.4	1.3	1.6	5.8	–0.3
	(0.857)	(1.200)	(1.790)	(2.030)	(2.790)	(3.960)	(6.590)
1997–2000	–0.3	–1.3	–1.0	–2.0	–3.1	–2.5	10.6**
	(0.862)	(1.210)	(1.440)	(1.620)	(2.220)	(2.910)	(4.710)
Swiss franc							
1994–2000	–1.38**	–2.17**	–1.70	–1.30	–2.70	–5.110*	–10.70**
	(0.646)	(0.993)	(1.170)	(1.420)	(2.020)	(2.870)	(5.080)
1994–96	0.9	2.0	1.8	0.5	0.6	7.6	81.5**
	(2.3)	(3.28)	(4.05)	(4.84)	(7.07)	(10.1)	(18.6)
1997–2000	–1.41**	–2.86**	–2.69**	–2.00	–3.99*	–8.20*	–24.00**
	(0.647)	(1.050)	(1.170)	(1.490)	(2.100)	(2.870)	(4.340)
Japanese yen							
1994–2000	–2.30	1.00	9.73**	2.50	1.80	–2.50	–54.10**
	(2.6)	(4.1)	(5.0)	(5.8)	(8.4)	(12.5)	(23.1)
1994–96	–2.8	7.7	24.8	44.6**	81.4**	169.0**	487.0**
	(10.0)	(15.8)	(18.6)	21.8	(31.5)	(49.1)	(96.0)
1997–2000	–1.8	1.2	10.5	1.9	–1.2	–10.4	–85.2**
	(3.77)	(5.83)	(7.16)	(8.34)	(12.20)	(17.70)	(29.60)
German mark							
1994–98	0.388**	0.400	0.400	0.500	0.800	0.900	–2.200
	(0.174)	(0.274)	(0.331)	(0.389)	(0.545)	(0.799)	(1.430)
1994–96	0.5	0.6	0.8	0.5	1.1	1.6	0.9
	(0.371)	(0.551)	(0.683)	(0.785)	(1.110)	(1.600)	(2.940)
1997–98	0.30	0.30	0.40	0.60	0.90	1.00	–2.77*
	(0.182)	(0.314)	(0.371)	(0.453)	(0.625)	(0.934)	(1.590)
Euro							
1999–2000	–0.80	–0.70	–1.00	–2.00	–3.20	–6.49**	–5.60
	(0.7)	(1.0)	(1.1)	(1.5)	(2.2)	(2.9)	(4.1)
Excluding outliers							
1999–2000	–0.80	–0.90	–1.20	–2.00	–3.40	–6.94**	–6.40
	(0.7)	(1.0)	(1.1)	(1.6)	(2.2)	(2.9)	(4.1)

Notes: The table reports the coefficient of the regression of the log-difference exchange rate (US$ per unit of foreign currency) on the net foreign currency position. Coefficient estimates and standard errors (reported in parentheses) are multiplied by 10^7. Constants are not reported.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

preciation rate on lagged net positions. As above, for sensitivity analysis we report estimates for the two subsamples and excluding outliers. We consider different time horizons for the rate of depreciation: one day (Thursday on Wednesday), two days, three days (Monday on Wednesday), five days (Wednesday on Wednesday), two weeks, four weeks, and twelve weeks. The results are, to say the least, mixed.

There is some indication that large players take positions against currencies that tend to depreciate. At very short horizons (from one to three days) there is at least one statistically significant, positive coefficient for the mark and the yen (three days). In the case of the pound, the coefficient is significant only at the 10 percent level and only in the 1997–2000 subsample. There is a statistically significant relation, but with the wrong sign, in the case of the Swiss franc. In many cases the coefficients are not significant, and some have the wrong sign. The picture does not change if we lengthen the horizon of the depreciation.[37] When we compare our results with previous studies, the evidence that exchange rate changes are correlated with the net positions of large players is only marginally stronger.[38]

To sum up, although high-frequency noise in exchange rate changes may explain the weak correlation between net positions and short-term changes in exchange rates, the level regressions point to persistent low-frequency movements ("long cycles" of exchange rates) associated with aggregate net positions. Overall, the evidence suggests that the net positions of large players are significantly correlated with exchange rates; this can be attributed to either size or informational advantages.

5.3.2 The Pressures on the Thai Baht in the Spring and Summer of 1997

We now turn to case studies of currency crises in which HFs and other large traders were alleged to have played a key role. The first episode we consider is the attack on the Thai baht, whose fall in the summer of 1997 started the Asian currency and financial crisis.[39]

An assessment of Thai economic fundamentals suggests that the currency was overvalued. The country had run large current account deficits for almost a decade, and the currency had appreciated in real terms. Exter-

37. When twelve weeks are considered, there is a strongly significant relation for the pound, the Canadian dollar, the Swiss franc, the euro, and the yen. The problem is that, with the only exception being the Canadian dollar, the sign is always negative—that is, large players systematically take long positions in currencies that, on average, tend to depreciate over the next quarter. One could interpret this result as implying some mean reversion in exchange rate returns.

38. Wei and Kim (1997) do not find any significant positive association between large participants' position in a foreign currency and the latter's subsequent appreciation. A nonparametric approach finds some weak support for a positive association, but not on a systematic basis. Recall that this study is limited to the 1994–96 period, whereas we extend the sample up to the year 2000.

39. For a reconstruction of the Asian crisis and the debate surrounding these events see Corsetti, Pesenti, and Roubini (1999).

nal imbalances had been financed through short-term unhedged liabilities, making the country vulnerable to a liquidity run. Also, there were severe weaknesses in the financial system that eventually led to a banking crisis. On the other hand, high growth, high investment and savings rates, and a prudent fiscal policy suggest that the country was not seriously mismanaged.

The analytical models discussed in the first part of this paper suggest that a country with weak fundamentals may be vulnerable to the market dynamics either generated or fed by short positions taken by large players. Smaller players react to the actions taken by the large player by becoming more aggressive in their speculative behavior. Thus, one question is whether large HFs were "leaders of the pack" in this particular currency crisis episode. On this issue, the IMF (1998) study is skeptical, arguing that the HFs were at the rear rather than at the head of the pack (see also Eichengreen and Mathieson 1999).

This conclusion appears to be somewhat at odds with the very information available in the IMF study, let alone other sources of evidence. For instance, IMF (1998) shows that some large HFs had already taken significant short positions against the Thai baht in the spring of 1997, presumably based on a negative economic assessment of Thai fundamentals (stressing the size and persistence of the current account deficit and the overvaluation of the exchange rate). The estimated net short position of the HFs in Thailand was about $7 billion.[40] Fung, Hsieh, and Tsatsaronis (2000) estimate that twelve HFs had about $5 billion in short positions against the Thai baht at the end of June 1997.[41]

The evidence on HFs' taking short positions before the eruption of the crisis is indirectly confirmed by the econometric results presented in table 5.4, part A. Using weekly data, we regress the NAV of four large macro HFs[42] against the Standard & Poor's 500 index, the yen/dollar exchange rate, and the value of the Thai baht in the period from February through July 1997—when the baht was under pressure.[43] As argued before, the first two regressors control for the hypothesis that these funds had significant in-

40. This is an estimate of direct forward transactions with the Bank of Thailand. Short positions may have been larger as "hedge funds may also have sold baht forward through offshore intermediaries, onshore foreign banks, and onshore domestic banks, which then off-loaded their positions (commitments to purchase) to the central bank. Hence, there is no way of accurately estimating their total transactions" (Eichengreen and Mathieson 1999).

41. Estimated short positions are lower after July 1997 as such funds took profits on their shorts and partially closed these positions. Thus, while HFs may have played a role in triggering the initial collapse of the baht, they played a lesser role in the continued fall of the currency throughout the summer and fall of 1997. For example, according to Fung and Hsieh (1999a) there is no evidence that the Quantum Fund had shorted the baht during September 1997, when this currency fell sharply.

42. These are the same considered in figures 5.1–5.4 and section 5.3.1.

43. For the Jaguar Fund the sample period is the full 1997–98 period, as we found significant effects of all regressors throughout the sample.

Table 5.4 **Hedge Fund Net Asset Value Regressions**

	S&P	Yen	Baht
	A. February 1997–July 1997		
Quantum	0.65**	0.08	0.25**
	(0.1)	(0.16)	(0.06)
Quasar	0.10	0.98**	0.29**
	(0.12)	(0.18)	(0.07)
Emerging growth	N/A	2.62**	0.31**
		(0.22)	(0.12)
Jaguar (1997–98)	0.72**	1.61**	0.29**
	(0.06)	(0.10)	(0.04)
	B. May 1998–September 1998		
	S&P	Yen	HIBOR
Quantum	0.51	0.32	0.00
	(0.38)	(0.74)	(0.12)
Quasar	1.08**	2.30**	0.14*
	(0.26)	(0.50)	(0.08)
Emerging growth	N/A	2.21**	–0.32**
		(0.51)	(0.09)
Jaguar (1997–98)	0.99**	1.64**	0.12**
	(0.05)	(0.10)	(0.02)
	C. May 1998–September 1998		
	S&P	Yen	Hang Seng
Quantum	0.22	0.79	0.16
	(0.35)	(0.57)	(0.15)
Quasar	0.28	3.75**	0.23**
	(0.23)	(0.37)	(0.10)
Emerging growth	N/A	1.87**	0.47**
		(0.42)	(0.11)
Jaguar (1997–98)	0.83**	1.20**	–0.28**
	(0.05)	(0.12)	(0.03)
	D. February 1997–July 1997		
	S&P	Yen	Ringgit
Quantum	0.90**	0.40**	0.27
	(0.14)	(0.19)	(0.38)
Quasar	0.22	1.20**	0.83**
	(0.15)	(0.20)	(0.40)
Emerging growth	N/A	2.60**	0.42
		(0.26)	(0.60)
Jaguar (1997–98)	0.49**	1.37**	0.50**
	(0.07)	(0.09)	(0.05)

Notes: Standard errors in parentheses. Constants are not reported.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

vestments in the U.S. equity markets and may have shorted the Japanese yen to fund positions in other markets (Fung and Hsieh 1999b). The results show significant effects of the Thai baht on the NAV of the four funds: The NAVs increase when the baht weakens. The Standard & Poor's index and the yen/dollar rate also enter significantly in these regressions with the expected sign.[44]

The overall short positions by large traders ($7 billion in the estimate by IMF 1998) represent only a quarter of the Bank of Thailand's $28 billion forward book at the end of July 1997. This suggests that many other investors besides HFs had built short positions in baht before the currency's fall in July. According to the IMF study, although "HFs apparently sold some long-dated forward contracts on the baht in February 1997, the bulk of their forward sales to the Bank of Thailand seems to have occurred in May" when significant speculative pressure on the currency started to build up and Thailand introduced some capital controls to limit the speculation against its currency.[45]

On balance, the conclusion in the IMF study that HFs were at the rear of the pack is not strongly supported by the data. Although lack of information prevents a full assessment of the sequence of events and movements by players of different sizes, a plausible interpretation is that large macro HFs detected rather early the fundamental weaknesses of the baht and the likelihood of a devaluation. Since the buildup of short positions started in February and continued through May, one could argue that HFs actually moved first and were followed by a wide range of domestic and international investors.

On the basis of our analysis in the second part of section 5.2.4, the argument that the HFs were "small" in the baht market (short positions for $7 billion against $25 billion at the central bank) needs to be qualified. If the HFs' short positions had been built by the time of the May attack (after the capital controls of 15 May and the spikes in offshore rates, it became much more expensive to short the currency), they would have accounted for a large fraction of the forward book of the central bank by the end of May. Although the eventual fall of the baht was certainly triggered by fundamental weaknesses in the economy, the evidence is not inconsistent with the view that HFs moved first and their presence made other investors more aggressive in their trading strategies.

44. The Standard & Poor's index is not included in the Emerging Growth Fund because this fund invests mostly in emerging markets. Indeed, the Standard & Poor's regressor is not significant when included in the regressions.

45. In one week in May, the central bank intervened by selling about $15 billion. Since this intervention was in the forward market, this information did not become public until August 1997. Smaller speculative attacks had occurred in January, February, and March (see Ito 1999).

5.3.3 The "Double Play" Hypothesis in Hong Kong

In 1998, the currency and other asset markets in Hong Kong felt significant speculative pressures as the Asian crisis worsened. Local authorities argued that large macro HFs were attempting to influence Hong Kong's forex and equity markets (Hong Kong Monetary Authority [HKMA] 1999; HKMA and Reserve Bank of Australia 1999; Tsang 1998). Allegedly, large traders were implementing a "double play": shorting the equity market, then shorting the currency, so as to lead monetary authorities either to abandon the fixed exchange rate or to increase interest rates sharply, or both, and profit from falling stock prices.

In the view of the Hong Kong authorities, the double play proceeded as follows. First, HFs shorted the Hong Kong (spot) stock market as well as the Hang Seng Index futures. HFs allegedly prefunded their Hong Kong dollar needs via swaps with multilateral financial institutions that had heavily borrowed in 1997 and 1998. Next, by using forward purchases of U.S. dollars and spot sales of Hong Kong dollars, they tried to induce a devaluation. Apparently, the size of the short positions of these HFs in the forex and stock markets were very large.

Suppose that, to defend the currency board arrangement, the Hong Kong Monetary Authority (HKMA) had intervened in the foreign exchange market only, drying up market liquidity and causing a correspondingly large increase in interest rates. The monetary tightening would have caused a sharp drop in equity prices, to the benefit of the HFs and other investors who had taken short positions in the stock market.

Suppose instead that, to avoid this stock market collapse, the HKMA had kept interest rates low, while allowing the exchange rate to devalue. Again, the HFs would have reaped large gains, this time through their positions in the currency markets. In either scenario, speculators would have gained from their positions in the stock market or in the forex market, or both.[46]

The HKMA, however, chose a different and unconventional option, consisting of monetary tightening to prevent devaluation and, in August 1998, sizable interventions in the stock markets to support stock prices.[47] In the

46. Chakravorti and Lall (2000) develop an analytical model of simultaneous speculative attack on currency and equity markets that is designed to explain the double play hypothesis for Hong Kong. They identify the conditions under which a simultaneous shorting of equity and currency/money markets is a potentially profitable strategy. The model suggests that a simultaneous shorting of the two markets could result from poor economic fundamentals and an increase in the probability that a devaluation may occur. They also explicitly model the effects of central bank intervention in the stock market (as occurred in Hong Kong).

47. In the two weeks between August 14 and 28, 1998, the HKMA purchased approximately US$15 billion of stocks and futures. This represented about 7 percent of the Hong Kong market capitalization and about 30 percent of the free float in the market.

view of the Hong Kong authorities, this radical action was necessary to inflict losses on speculators and give them sufficient cause to be wary of future attempts to corner the market. In the words of Financial Secretary Donald Tsang, the speculative attack "was a contrived game with clearly destructive goals in mind [to] drive up interest rates, drive down share prices, make the local population panic and exert enough pressure on the linked exchange rate until it breaks" (Tsang 1998).

The FSF (2000) study supports the double play hypothesis. Large macro HFs appear to have detected fundamental weaknesses early and started to build large short positions against the currency. According to available estimates, HLIs' short positions in the HK$ market were close to U.S.$ 10 billion (6 percent of GDP), but some observers believe that the correct figure was much higher. Several large macro HFs that had shorted the currency also took very large short positions in the equity markets, and these positions were correlated over time.[48] When the news spread that large HFs were building short positions, other investors followed.

Indirect evidence on the positions of HFs in the Hong Kong currency and equity markets can be provided by regressing the NAV of the four large macro HFs in our sample against the Standard & Poor's 500 index, the yen/dollar rate, the Hang Seng equity index, and a short-term interest rate measure in Hong Kong (the three-month Hong Kong Interbank Offered Rate [HIBOR]) for the period May to September 1998. A negative relation between NAV and the equity index is consistent with short positions of the fund in the Hong Kong equity market. Also, because Hong Kong kept the exchange rate fixed throughout the sample period, profitable short positions in the currency markets would show up as a positive coefficient on the short-term interest rate—interest rate hikes lead to an increase in the forward exchange rate, raising the NAV of a portfolio including short positions in the currency. Results are presented in parts B and C of table 5.4, where we find strong and significant effects of the expected sign (negative on the Hang Seng index and positive on the HIBOR) for one of the funds, and a significant effect of the HIBOR for another fund.[49]

According to the local authorities (Tsang 1998), unsubstantiated rumors and false information about the health of the financial sector and the pos-

48. "Among those taking short positions in the equity market were four large HFs, whose futures and options positions were equivalent to around 40 percent of all outstanding equity futures contracts as of early August prior to the HKMA intervention. Position data suggest a correlation, albeit far from perfect, in the timing of the establishment of the short positions. Two HFs substantially increased their positions during the period of the HKMA intervention. At the end of August, four hedge funds accounted for 50,500 contracts or 49 percent of the total open interest/net delta position; one fund accounted for one-third. The group's meetings suggested that some large HLIs had large short positions in both the equity and currency markets" (FSF 2000, 131).

49. The coefficients of the Hang Seng index on two other funds are significant but with the wrong sign. It is possible that losses inflicted on short equity positions by the Hong Kong intervention may account for this result.

sibility of a devaluation were being spread in the local press and in financial markets, apparently to push down the stock market, spike interest rates, and put pressure on the currency. The FSF (2000) study mentions circumstantial evidence of aggressive trading behavior in the forex market: "Aggressive trading practices by HLIs reportedly included concentrated selling intended to move market prices, large sales in illiquid offshore trading hours, and 'spoofing' of the electronic brokering services to give the impression that the exchange rate had moved beyond the HKMA's intervention level. There were frequent market rumors, often in offshore Friday trading, that a devaluation of the Hong Kong dollar or Chinese renminbi would occur over the weekend" (FSF 2000, 130–31).

However, the empirical findings do not provide, per se, evidence of market manipulation. Macroeconomic conditions in Hong Kong and East Asia in the summer of 1998 (a sharp recession in Hong Kong and a worsening financial and economic crisis in the entire East Asian region, with a falling yen and a threat of currency devaluation in China) were causing concern among investors about the Hong Kong stock market while raising doubts about the survival of the Hong Kong currency peg, in spite of the commitment by the authorities to maintain the currency board. Shorting both the Hong Kong stock market and its currency at that time could have been interpreted as a rational strategy for all investors, domestic and foreign, highly leveraged and not, behaving according to normal market rules and conventions. In other words, the hypothesis of rational investors' taking short positions in two markets (based on an assessment of economic fundamentals) and the hypothesis of a double play (suggesting market manipulation) are observationally equivalent.

5.3.4 The Malaysian Ringgit

The role played by macro HFs in the fall of the Malaysian ringgit remains controversial. Local authorities have forcefully argued that their presence made a significant difference. However, several studies (IMF 1998 and Brown, Goetzmann, and Park 2000) suggest that their role was minor.

As in the case of many other currencies in the region, the pressure on the ringgit was undoubtedly driven by fundamental weaknesses in the economy, namely a large current account deficit and a structurally weak financial system, as well as financial and trade contagion from the fall of other Association of Southeast Asian Nations currencies. Nonetheless, it is unresolved whether HFs were leaders of the pack in the circumstances that triggered the fall of the ringgit and the continued pressures on the currency throughout 1997 and 1998.

How large were HFs' short positions against the ringgit? The aforementioned IMF study suggests that their positions were relatively small at the time of the devaluation of the baht, July 1997, when pressures on the Malaysian currency started to rise. Fung, Hsieh, and Tsatsaronis (2000) reach similar conclusions, estimating that the combined short positions in the ringgit market by twelve HFs amounted to less than $1 billion in June and July 1997.

A study by Brown, Goetzmann, and Park (2000) reaches analogous conclusions. Using returns data, these authors derive estimates of the positions in the Malaysian ringgit over time by the largest ten currency funds. They find that positions in the ringgit did fluctuate dramatically in the second half of the 1990s but were not correlated with movements in the exchange rate. More generally, they identify periods when the HFs had very large exposures to Asian currencies, both positive and negative, but find no relation between these positions and current, past, or future movements in exchange rates.

Some aspects of this study, however, are problematic. Specifically, these authors did not have access to data on net positions but inferred them from observed returns, so serious measurement errors are possible. For example, some of their estimates imply that the gross foreign currency positions on the ringgit were at times close to 200 percent of Malaysian GDP. For instance, in February 1996 the estimated short position by HFs was greater than $200 billion. At the end of June 1997, when the pressure on the currency started to mount, the estimated HFs short positions reached a new peak of $100 billion. Now, either these estimates are subject to significant measurement error or, if correct, their size makes it difficult to argue that HFs' portfolios had no impact on the value of the Malaysian currency. Statistical tests suggest that, for two of the four funds in our sample, NAVs were significantly correlated with movements of the ringgit after controlling for the Standard & Poor's and the yen/dollar rate.[50]

Ultimately, even when one accounts for the apparent gross mismeasurement, the study leaves open the possibility that large traders built sizable positions at the start of the speculative pressure against the ringgit (late June and early July 1997). This is consistent with the view that HFs took large positions before other domestic and foreign investors began to short the currency. In this regard, and based mostly on circumstantial evidence, the FSF (2000) study came to the conclusion that "the ringgit came under heavy selling pressure around May 1997 during the pressures on the Thai baht. Leveraged institutions reportedly had substantial short positions at this time. Pressures continued after the authorities floated the ringgit in July" (FSF 2000, 133).

5.3.5 The Pressures on the Australian Dollar in the Summer of 1998

The view that HFs played a significant role in the pressures on the Australian dollar in the summer of 1998 has been presented in Reserve Bank of

50. See part D of table 5.4. In the regressions, the sample period for the Jaguar Fund is 1997–98, but it is February–July 1997 for the other three funds.

Australia (1999). The Australian view is nuanced. The Australian authorities accept that a moderate depreciation of the Australian dollar might have been justified by fundamentals in June and August of 1998. In June, the Australian currency was negatively affected by a weakening Japanese yen and by concerns about the spread and deepening of the Asian crisis. In August, the pressure on the Australian currency was triggered by the Russian collapse and expectations of falling commodity prices in a global slowdown.

Although acknowledging the rationale for a depreciation in light of these fundamental weaknesses, the Australian view was that large macro HFs manipulated foreign currency markets to force a depreciation well in excess of what was justified by fundamentals. The Australian authorities argued that, even though the Australian dollar exchange rate market was very liquid and had one of the highest turnover rates among Organization for Economic Cooperation and Development countries, HFs were nonetheless trying to manipulate it in different ways. First, HFs were supposedly able to borrow Australian dollar funds from Australian banks in large amounts in order to build speculative positions in the foreign exchange market. Second, a few large HFs were allegedly signalling their short positions in the Australian dollar market, effectively becoming leaders for a wide set of funds and financial institutions. As a result, by taking very large short positions against the Australian dollar while inducing other investors to follow a similar strategy, the HFs were effectively able to corner the market.

Reportedly, the overall short positions against the Australian dollar were sizable in the summer of 1998. Only a very aggressive intervention by the Reserve Bank of Australia in June and August (and eventually the unraveling of the yen carry trade) could stop what looked like a large speculative attempt to cause an unwarranted collapse of the currency.

An interesting feature of the Australian case is that the speculative attack hit a flexible, rather than a fixed, exchange rate regime. FSF (2000) provides a systematic study of the Australian episode, suggesting that HLIs built up speculative short positions against the Australian dollar from late 1997 onward. The speculative activity intensified in April and May 1998: By the end of May, the currency had fallen 24 percent below its peak in late 1996. In June 1998, the pressures on the currency increased, with short positions by HFs and other HLIs estimated at roughly $10 billion, about 2 percent of Australian GDP.

The study found evidence of aggressive trading, shrinkage of liquidity, the spread of rumors, the moving of contrarians to the sidelines, and herding along the HLI positions. In particular, "having already accumulated large short positions, a few HLIs—primarily large macro HFs—according to some market participants took actions in late May and early June to attempt to push the exchange rate lower. These actions reportedly included spreading rumors about an upcoming attack in the currency to deter buyers, and aggressive trading. A key feature of this latter was to concentrate large amounts of sales into periods of thin trading. These actions were reported by market participants to be designed in part to cause those who might have taken contrarian positions to withdraw from the market. One consequence was that exporters, who had been consistent buyers of Australian dollars at higher levels, not only stood aside and stopped buying at this time but some even began selling as the currency looked to fall to record lows" (FSF 2000, 128).

5.3.6 Financial and Currency Turmoil in South Africa in 1998

The case study of South Africa in 1998 is interesting for a number of reasons. First, the country had a semiflexible exchange rate regime, yet the authorities heavily intervened in the forward market to defend the currency when strong speculative pressures emerged in the spring of 1998. Second, as in Hong Kong, investors may have attempted a double play. In this case, however, the double play was staged in the bond and forex markets rather than in the equity and forex markets. Third, according to FSF (2000), the main role in the financial market was played by proprietary desks of large international financial firms, rather than large macro HFs.

As in previous episodes, macro policy was generally sound, but the economy was hit by a number of shocks at the time of the turmoil. In the spring of 1998, the economy was suffering from political uncertainty, a fall in the price of gold and other export commodities, and a confidence deterioration, all of which led to a downgrade of GDP growth forecasts. Until April 1998, many nonresident investors—including HLIs—had built long positions in South African assets (especially government bonds). A major reversal of capital flows occurred in May and June 1998, with outflows by nonresidents estimated at about 24 billion rand.

These speculative pressures led between April and August to a 25 percent fall of the rand, a 40 percent plunge of the equity market, and sharp increases in the yields on medium-term bonds from 12.9 percent to 21.6 percent. The central bank initially responded to the pressure on the currency by aggressively intervening in the forward market (selling about $8 billion of reserves forward in May and June). Total short foreign exchange positions were estimated to be about US$8–9 billion (approximately 7 percent of GDP), thus equivalent to total forward interventions. At the same time, investors could easily build short fixed-income positions in the government bond market by borrowing in the large and liquid repo market. As reported in FSF (2000), some suggested that a double play took the form of aggressive sales of the currency to spike short-term interest rates and profit from short positions in the bond market.

The fall in the rand accelerated in June after the reserve bank stopped intervening. The publication of the forward book showed that the reserve bank was then vulnerable to large losses from previous forward intervention. Attempts to influence the course of market prices to the HLIs' own advantage were once again reported to have taken place: "[A]t times trading was reported as very aggressive, including the sale of large parcels to the market at any price and greater than normal trading in periods of illiquidity, sometimes apparently with sustained price impact" (FSF 2000, 141).

5.3.7 The Conclusions of the FSF Study on Market Dynamics in Turmoil Episodes

In our analysis above we have often built upon the FSF (2000) study, an extensive study whose overall results are consistent with the key implications of our theoretical analysis. The ambivalent conclusions of this study provide an excellent summary of the complex and multifaceted debate on the role of HLIs in currency crises:

- "Under normal market conditions, HLIs do not threaten the stability of medium-sized markets. Together with other market participants, HLIs can play an important role translating views about the fundamentals into prices and face the same incentives as other market participants to avoid outsized positions. Because of their ability and willingness to take leveraged positions, HLIs can be an important source of market liquidity and can, over time, contribute positively to market development."
- "From time to time, HLIs may establish large and concentrated positions in small and medium-sized markets. When this is the case, HLIs have the potential to materially influence market dynamics. The size and duration of the effects can be amplified through herding or through other market participants moving to the sidelines and depend critically on the strength of the fundamentals and the behavior of 'ongoing' transactors in the domestic currency."
- "The judgment as to whether HLI positions are destabilizing has to be made on a case-by-case basis. Several members of the study group believe that large HLI positions exacerbated the situations in several of the case-study economies in 1998, contributing to unstable market dynamics and significant spillovers. These members of the group are of the view that HLI positions and tactics can at times represent a significant independent source of pressure. Some other group members do not think that there is sufficient evidence to advance such judgments on the basis of the 1998 experience, given the uncertainty prevailing in the markets at that time. They believe that the impact of HLIs on markets is likely to be very short-lived and that, provided fundamentals are strong, HLI positions and strategies are unlikely to present a major independent driving force in market dynamics."
- "The group is concerned about the possible impact on market dynamics of some of the aggressive practices cited in the case-study economies

> during 1998; it is not, however, able to reach a conclusion on the scale of these practices, whether manipulation was involved and their impact on market integrity. Some group members believe that the threshold for assessing manipulation can be set too high and that some of the aggressive practices raise important issues for market integrity. They are of the view that there is sufficient evidence to suggest that attempted manipulation can and does occur in foreign exchange markets and should be a serious source of concern for policy makers (FSF 2000, 125–26).

As a conclusion to the assessment of the 1990s crisis episodes, it is worth recalling that foreign exchange market pressures rapidly diminished in the late summer and early fall of 1998, when large HFs and other HLIs reduced their activity following a number of events: the Russian devaluation and default; the collapse of LTCM and the ensuing liquidity and credit squeeze in the financial markets of advanced economies; the sharp appreciation of the yen in September and October of 1998, which brought losses to those HLIs that had heavily shorted the yen and played the aforementioned carry trade. Also, "unorthodox" policy actions such as the massive Hong Kong intervention in its equity market, capital controls in Malaysia, and intervention against bond-shorters in South Africa contributed to a squeeze on the speculative short positions of HLIs.[51]

5.4 Conclusion

This paper has presented a theoretical and empirical analysis of the role of large players in currency crises. Our study contributes to an analytical literature that, while still in its infancy, is making significant progress in understanding how the existence of large players may affect foreign exchange market dynamics. On the empirical side, results are constrained by the fact that detailed data on major market participants' positions and strategies are limited. However, the evidence presented in our paper and in a number of recent studies sheds some light on the role played by large players in recent episodes of currency turmoil.

In sum, our analysis does not contradict the conventional wisdom that large players possess the following traits: they are better informed or perceived to be better informed, they are able to build sizable short positions via leverage; they tend to move first based on an assessment of fundamental weaknesses; they contribute to currency pressures in the presence of weak or uncertain fundamentals; they are closely monitored by smaller investors prone to herd on their observed or guessed positions, even when the small traders would act as contrarians based on the private information

51. See the 1999 IMF International Capital Market Report (IMF 1999) for a detailed discussion of these and other "unorthodox" interventions in financial markets.

available to them; and they may recur to aggressive trading practices. Undoubtedly, future theoretical and empirical research will shed further light on many of the aspects discussed here.

We conclude with three observations. First, the role of large players in financial markets may have recently changed. Some large macro hedge funds and other HLIs have closed down or retrenched their operations.[52] Perhaps in part as a consequence of this retrenchment, there is now some concern that liquidity in the forex market may have been reduced and greater asset price volatility may have emerged. However, it is still too early to assess whether such liquidity shrinkage has occurred and what its causes and consequences are.

Second, the disappearance of several large macro HFs after 1998 may in part be the result of the ongoing phase-out of fixed exchange rate regimes; one after another, most noninstitutionalized exchange rate pegs have been abandoned (Mexico, Asia, Russia, Brazil). Large macro bets against a peg are easier to make, since large short positions can be built at low cost when the monetary authority provides foreign currency at a fixed price. With flexible rates, instead, there is always a two-sided currency risk, and the costs of building short positions depend on whether, and to what extent, other agents (other than the central bank) are willing to take the opposite side of these transactions. Attempts to build speculative positions lead to continuous time movements in the exchange rate, reducing not only the incentive to speculate but also the scope for sharp (thus profitable) adjustment. Indeed, large macro directional bets on the flexible exchange rates of the G3 economies allegedly led to losses in 1999 and 2000, contributing to the eventual demise of some large macro HFs.

Third, the policy implications of the role of large players in market dynamics are complex and multifaceted. The official sector began to address these issues within the HLI working group of the FSF. This group considered both the implications of HLIs for systemic risk in global financial markets and the role of HLIs in market dynamics in small and medium-sized economies.

Regarding systemic risk, the recommendations of this working group's report mirrored many of the recommendations of the report of the U.S. President's Working Group on Capital Markets (1999). The recommendations included measures aimed at better risk management by HLIs and their counterparties (better credit assessments, better exposure measurement, establishment of credit limits, and collateral management techniques), better creditor oversight (greater intensity of scrutiny of firms that are falling short

52. LTCM was closed down following its near collapse in 1998; the Tiger Group funds were closed down in 2000 following a period of poor investment returns; the operations of the Quantum Group funds have been scaled down; the Moore Capital Group decided to return $2 billion of capital to its investors; and several forex prop desks of large financial firms have been either closed or scaled down in their operations.

and periodic reaffirmation of compliance with sound practices), and enhanced practices of public disclosure and reporting to authorities.

Regarding the issue of market dynamics in small and medium-sized economies, the HLI report also made a number of recommendations. First, the report noted that enhanced risk management practices could address some of the concerns raised by emerging markets by constraining excessive leverage. Second, it noted that trading on organized exchanges, requiring market participants to report to regulators, and possibly requiring position limits as well could alleviate some of the pressures caused by large and concentrated positions. Third, the FSF recommended that market participants themselves articulate guidelines for market conduct in the area of foreign exchange trading. These market guidelines would address the concerns of smaller and medium-sized economies about the trading practices that might have contributed to exacerbating market pressures in period of market turmoil.

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Comment Jaume Ventura

The paper by Corsetti, Pesenti, and Roubini studies how the presence of large investors affects the nature of currency crises. Its motivation is the alleged prominent role that some hedge funds and investment banks have played in recent episodes of this sort. Regardless of whether this is factually correct or not, I am convinced that the topic is of great interest. In this comment, I raise a few issues that the paper either overlooks or does not treat with sufficient clarity. To illustrate them, I use a bare-bones version of the model that removes all uncertainty (public and private) about fundamentals.

The simplest model is the "speculators" game. In this game, one or more investors command resources of mass 1. Let θ be the state of the country or fundamentals, and assume everybody observes it. Define $\ell \in (0,1)$ as the fraction of resources that are used to attack the currency. The currency collapses if and only if fundamentals are weak relative to the size of the attack, that is, if $\theta \leq \ell$. Investors have no intrinsic interest in the country. If they abstain from attacking the currency, their payoff is zero independently of whether the currency collapses. Investors see the country merely as an opportunity to make profits from inconsistent policy making. They can commit their resources to the attack by paying a per-unit cost of $t < 1$. If the currency collapses, they gain a per-unit profit equal to one. Otherwise their profit is zero. With these assumptions, we can write the payoff matrix of investors in table 5C.1:

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Table 5C.1 **"Speculators" Game**

	Collapse	No Collapse
ATTACK	$1 - t$	$-t$
NO ATTACK	0	0

Assume first that the unit mass of resources is uniformly distributed among a continuum of atomistic investors. If $\theta > 1$, the currency does not collapse regardless of the investors' actions. Knowing this, nobody attacks, and $\ell = 0$. If $\theta \leq 0$, the currency collapses regardless of the investors' actions. Knowing this, all investors attack and $\ell = 1$. In the range $0 < \theta \leq 1$, there are two possible equilibria. If investors believe nobody else will attack, then $\ell = 0$ and the currency does not collapse. If investors believe everybody else will attack, then $\ell = 1$ and the currency collapses. How do investors select the equilibrium when this happens? Simply assume there is a sunspot variable that coordinates them and takes one of two values, ATTACK and NO ATTACK, with probabilities π and $1 - \pi$, respectively. Under this assumption, if $0 < \theta \leq 1$ the currency collapses with probability π.

Assume next a fraction $\lambda < 1$ of the unit mass of resources is owned by a single large investor and the rest is uniformly distributed among the continuum of atomistic investors. How does this change in market structure affect the likelihood of a currency crisis? To develop some intuition, consider three alternative (and arbitrary) rules of behavior for the large investor:

1. *The large investor is a hawk.* Assume the large investor always attacks. If $\theta \leq \lambda$, the currency collapses. If $\theta > 1$, the currency does not collapse. If $\lambda < \theta \leq 1$, there are two equilibria. If atomistic investors believe that only the large investor will attack, then $\ell = \lambda$, and the currency does not collapse. If atomistic investors believe everybody else will attack, then $\ell = 1$, and the currency collapses. The presence of a hawkish large investor raises the lower threshold of the range of multiple equilibria. As $\lambda \to 1$, this range disappears as this threshold converges to 1.

2. *The large investor is a dove.* Assume the large investor never attacks. If $\theta \leq 0$, the currency collapses. If $\theta > 1 - \lambda$, the currency does not collapse. If $0 < \theta \leq 1 - \lambda$, there are two equilibria. If atomistic investors believe nobody else will attack, then $\ell = 0$, and the currency does not collapse. If atomistic investors believe other atomistic investors will attack, then $1 = 1 - \lambda$, and the currency collapses. The presence of a dovish large investor lowers the upper threshold of the range of multiple equilibria. As $\lambda \to 1$, this range disappears as this threshold converges to zero.

3. *The large investor follows the crowd.* Assume the large investor attacks only if it expects other investors to attack. If $\theta \leq 0$, the currency collapses. If $\theta > 1$, the currency does not collapse. If $0 < \theta \leq 1$, there are two equilibria. If investors believe nobody else will attack, then $\ell = 0$, and the currency

does not collapse. If investors believe everybody else will attack, then $\ell = 1$, and the currency collapses. The presence of a follow-the-crowd large investor has no effect on the equilibrium of the game.

What are these examples telling us? As λ grows, the large investor gradually replaces atomistic investors in the task of allocating resources.[1] If its investment strategy is more aggressive than those of the atomistic investors it replaces, more resources will be used to attack the currency in some range of the fundamentals. An obvious reason for this is that the resources transferred are now invested more aggressively. However, because the actions of investors are strategic complements, the presence of a more aggressive investor also leads other investors to be more aggressive. This brings me to the first point: *The effects of a large investor on the likelihood of a currency crisis depend on how aggressive its strategy is relative to those of the atomistic investors it replaces.*

None of the examples above describe the solution to the "speculators" game. They instead describe the solutions to three alternative games in which atomistic investors are rational speculators, but large investors are irrational in some specific ways. The only purpose of the examples was to develop intuition on how the behavior of a large investor affects the likelihood of a crisis and the behavior of other investors. Assume from now on that the large investor is rational and chooses its investment strategy optimally. Is this enough to tell us whether the large investor behaves more or less aggressively than the atomistic investors it is replacing?

Let's start by describing the actual solution to the "speculators" game. If $\theta > 1$, the currency does not collapse. If $\theta \leq \lambda$, the currency collapses because the large investor always attacks. If we assume that it does not, then its payoff is zero rather than $\lambda \cdot (1 - t) > 0$. If $\lambda < \theta \leq 1$, there are two equilibria. If investors believe nobody else will attack, then $\ell = 0$, and the currency does not collapse. If investors believe everybody else will attack, then $\ell = 1$, and the currency collapses. In this range the currency collapses with probability π. Note that the large investor chooses a more aggressive investment strategy than that of the atomistic investors it is replacing. In the range $0 < \theta \leq \lambda$ it chooses to attack with probability 1, whereas the (replaced) atomistic investors attack with probability π. For all other values of the fundamentals, the strategy of the large investor is identical to those of the (replaced) atomistic ones. Therefore, the presence of a large investor raises the likelihood of a currency crisis.

Is this a robust result? A simple modification of the game dispels any hope in this direction. In the "speculators" game, investors have no intrinsic interest in the country and only see in the latter an opportunity to profit

1. Naturally, this is in a figurative sense. I am analyzing a class of games indexed by λ. Within each game there is no transfer of resources among investors.

Table 5C.2 "Creditors" Game

	Collapse	No Collapse
ATTACK	0	0
NO ATTACK	$r - d$	r

from inconsistent policies. From their perspective, the best possible scenario is a currency collapse. Consider instead a "creditors" game, in which investors have already invested in the country a unit mass of resources. Perhaps they have lent to domestic banks or the government at an interest rate r higher than the world interest rate of zero. The risk, of course, is that the currency devalues by an amount $d > r$. In the "creditors" game, the best possible scenario for investors is that the currency does not collapse. If investors attack (i.e., sell their investments and leave the country), their payoff is the world interest rate regardless of whether the currency collapses or not. If they do not attack (i.e., keep their investments and stay in the country), their payoff is r if the currency does not collapse and $r - d < 0$ if it does. This is shown in the payoff matrix in table 5C.2.

As a description of recent currency crises, the "creditors" game seems at least as realistic as the "speculators" game. Moreover, in the absence of a large investor, both games exhibit the same equilibria.[2] However, the presence of a large investor leads to opposite results in both games. To see this, let's describe the solution to the "creditors" game: If $\theta \leq 0$, the currency collapses regardless of the actions of investors. If $\theta > 1 - \lambda$, the currency does not collapse because the large investor never attacks. If we assume that it does not, then its payoff is zero rather than $\lambda \cdot r > 0$. If $0 < \theta \leq 1 - \lambda$, there are two equilibria. If investors believe nobody else will attack, then $\ell = 0$, and the currency does not collapse. If investors believe everybody else will attack, then $\ell = 1$, and the currency collapses. Assuming that the same sunspot variable selects the equilibrium in both games, the currency collapses with probability π in the range of multiple equilibria. In the "creditors" game, the large investor chooses a less aggressive strategy than that of the atomistic investors it is replacing, and as a result the likelihood of a currency crisis decreases.

The common thread in these two games is that atomistic investors are nervous about the behavior of other investors. There is always a preferred outcome, but achieving it requires coordination. In the "speculators" game, the preferred outcome was to profit from policy inconsistencies. In the "creditors" game, the preferred outcome was to preserve good investment opportunities in the country. For some range of fundamentals, the large investor can decide market outcomes and effectively choose its preferred equilibrium. Because the incentives of small and large investors are aligned,

2. They even exhibit the same payoffs if $r = 1 - t$ and $d = 1$.

this equilibrium will also be preferred by atomistic investors. This leads us to the second point: *With atomistic investors, a coordination failure is possible in that the equilibrium chosen is "bad" from the investors' perspective. The presence of a large investor partially solves this coordination failure and raises the likelihood of achieving the equilibrium considered "good" from the investors' perspective.*

A natural generalization of this intuition applies in games in which there is conflict among investors. The simplest illustration of this point is a "mixed" game, in which a fraction ϕ of the unit mass of resources is owned by "speculators" (i.e., investors with the payoff matrix of the "speculators" game) and the rest by "creditors" (i.e., investors with the payoff matrix of the "creditors" game). If all investors are atomistic, the "mixed" game delivers the same equilibrium as the previous two games. However, the effects of a large investor depend on its type in an intuitive fashion. It is easy to check that the presence of a large investor lowers the range of multiple equilibria and raises the likelihood of achieving the equilibrium that is preferred by investors of its own type.[3]

The last issue I want to take on here is that of the interaction between the large investor and the government. In the games analyzed so far, governments can take no action that affects the likelihood of a currency crisis. In real episodes, governments do not passively wait until investors have made up their minds. On the contrary, they actively try to affect their decisions through announcements and promises of various sorts. Does the presence of a large investor affect the government's options to affect the resolution of a crisis?

Consider the "speculators" game again, but assume now that the government can bribe investors. More precisely, before investors choose their strategies, the government can credibly commit to pay them b if the currency does not collapse. Clearly, this bribe has no effect at all on the outcome of the game if the fundamentals are too strong or too weak, that is, if $\theta > 1$ or $\theta \leq 0$. Therefore, there is no point in the government's offering it in this case. The question I address here is whether the government can use a bribe to affect the outcome of the game when fundamentals are in the intermediate region, that is, $0 < \theta \leq \lambda$.[4] In this region, the bribe transforms the payoff matrix of investors as shown in table 5C.3.

3. More fun is possible if we allow for two large investors with different types in the "mixed" game. Assume that each of them commands a fraction λ of the resources of her type. Then the range of multiple equilibria is $\lambda \cdot \phi < \theta < 1 - \lambda \cdot (1 - \phi)$. As $\lambda \to 1$, the range of multiple equilibria disappears as both thresholds converge to ϕ.

4. It is crucial here that this bribe be contingent on the outcome of the game (or the collective actions of the investors) and not on each individual investor's action. If the latter type of conditioning were feasible, an intriguing possibility arises. Assume that, in the range $0 < \theta \leq 1$, the government promises a very large payment if the currency collapses to all those investors (large and small) that did not attack. If this promise is credible, the government has found a free lunch. Now the dominant strategy for all investors is never to attack when $0 < \theta \leq 1$, so the government has coordinated investors toward the desired equilibrium. Because the currency never collapses, this has been achieved at zero cost.

Table 5C.3 "Speculators" Game with a Bribe

	Collapse	No Collapse
ATTACK	$1 - t$	$b - t$
NO ATTACK	0	b

Assume first that all investors are atomistic and, within the range of multiple equilibria, they select the equilibrium with the now-familiar sunspot variable that leads them to attack with probability π and not to attack with probability $1 - \pi$.[5] Then the presence of a bribe does not influence the equilibrium of the game or the likelihood of a currency crisis. Why? Altering the incentives of investors makes no difference if the latter cannot coordinate their actions to reach their preferred outcome. Because the bribe would be ineffective, the government will never offer it in the first place.

Things can be quite different, however, if there is a large investor and the bribe is sufficiently attractive. Assume $b \geq 1 - t$. In this case, the solution of game is as follows: If $\theta \leq 0$, the currency collapses, whereas if $\theta > 1 - \lambda$, the currency does not collapse. If $0 < \theta \leq 1 - \lambda$, the currency collapses with probability π. If $b < 1 - t$, the solution of the game is the same as if there were no bribe. Therefore, a large enough bribe succeeds in reducing the likelihood of a currency collapse. If the government attaches enough value to sustaining the currency, the equilibrium bribe is $1 - t$. Otherwise, the equilibrium bribe is zero. What is going on? If the bribe is attractive enough, investors no longer prefer a currency collapse. They would rather take the bribe instead. If investors can coordinate their efforts even partially to reach their preferred outcome, the government has an incentive to use a bribe to align this preference with its own. When this happens, the large investor changes its strategy, and this reduces the likelihood of a currency collapse.[6]

In the presence of a large investor, the outcome of the "speculators" game is not robust to giving the government the option to offer a bribe, since the latter will be used to affect the incentives of the large investor and the outcome of the game. The same is not true for the "creditors" game, because the incentives of the government and the large investor are already aligned. Any government bribe would simply be a waste of resources and, recogniz-

5. This assumption now has some bite. The presence of the bribe has converted the "speculators" game into a Stackelberg game with the government as the leader. This game has a much larger set of equilibria, which includes strategies that condition the attack on the bribe, such as "if $b < b^*$, attack; otherwise, don't." In fact, there is an infinite number of equilibria! The sunspot variable effectively rules out all of these additional equilibria, so that we keep only the two familiar ones.

6. The bribe might be too expensive in this game. After all, it must be at least as high as the benefits that all investors receive if the currency collapses. There might be situations in which the government can target the bribe to reach the large investor without much of a giveaway to the atomistic ones. If this type of targeting is feasible, then the lowest bribe that would change the outcome of the game is $\lambda \cdot (1 - t)$ instead of $1 - t$.

ing that, the government does not offer one. This leads me to the third and final point: *The presence of a large investor tends to reduce the likelihood of a currency crisis, because the government can manipulate its incentives and use it to partially solve the coordination failure in such a way as to avoid a currency collapse.*

When we attempt to map the concept of a bribe to reality, two ideas come to mind. The first and obvious one is reforms. The government might have the ability to credibly commit to some costly policy changes that raise the profitability of foreign investments in the country. Notice, though, that these reforms must be made contingent on the currency's not collapsing. This seems somewhat to contradict actual events, because many countries wait to implement costly reforms until a crisis has already occurred.

A second possibility is to think of the bribe as a high interest rate. Because the value of loans falls after a currency collapse, a high interest rate can be seen as a bribe that is conditional on the currency's not collapsing. In this case, the simple model here gives us some insights regarding the effectiveness of raising the interest rate as a defense against a currency attack. If there is a large investor of the "speculator" type, this defense will succeed for some values of the fundamentals. If the large investor is of the "creditor" type or all investors are atomistic, this defense will never succeed.

Where do we go from here? In this comment, I have used a standard model of coordination failures to raise some questions and submit some conjectures on the role of large investors in currency crises. My hope is that more researchers will devote their time to this problem. Our knowledge of how market structure affects international capital flows is, to say the least, rudimentary, yet I suspect the payoff to research in this area might be quite large. Models of perfect competition have been unable so far to explain basic observations such as why long-term capital flows are so small, or why short-term capital flows are so volatile. Perhaps models of imperfect competition will have more success at this task. However, as the examples here show, sorting out the arguments and the facts is likely to prove a long and treacherous journey.

Discussion Summary

The discussion centered on two themes: the theoretical treatment of large players in the model and the empirical part of the paper.

Aaron Tornell raised the issue of there being more than one large player. There are usually several large actors in a given market, and the industrial organization literature suggests that the ways that a monopoly and an oligopoly work are markedly different. When there is more than one big player, the players interact strategically with each other, and the logic in the paper—which focuses on the interaction between the single large player and many small players—may not carry over in such a situation. He argued that we need a theory that is robust to the number of large players in the market.

Michael P. Dooley made the remark that the largest, highly leveraged, and nonfundamental speculator in these markets is the central bank. In the model's setting, one big player (a hedge fund) is followed by many small players, but in reality, the central bank fulfills the role of large player. As he playfully put it, the central bank sits there with a big hammer and threatens to crush the little players should they bet against it. He agreed with Tornell that the behavior of several large players needs to be modelled instead of the interaction of small players with a single large one.

Roberto Chang agreed with both and commented that the governments in most crisis countries did (or tried to) punish speculators severely. However, this behavior is not represented in the model; instead, the government is assumed to carry out a mechanical role.

Martin Feldstein commented on the role of large players. He said that we tend to think that large players play a negative role because they are effective in increasing the probability of crises, as suggested in the paper. But perhaps the large players are performing a useful role as potential discipliners. For example, they force some countries to move toward flexible exchange rates, and they make countries adopt more sensible domestic fiscal policies. *Federico Sturzenegger* disagreed with the role of large players; he said that the fact that the large players had moved out of the market suggests they could not do anything. *Rudi Dornbusch* gave a different explanation for the exit of hedge funds (large players) from the market: the big players are now old and rich enough!

Sebastian Edwards raised a related question regarding the exchange rate regime and large players. This paper argues that many large players have stopped operating partly due to the fact that a large number of emerging nations abandoned the pegged exchange rate system. The current view on exchange rate regimes is increasingly in favor of the two corner solutions. He asked whether countries that chose to have a fixed regime (in the form of dollarization or currency boards) are more likely to be affected by large players and are more subject to crises.

On the empirical part of the paper, Feldstein asked what the U.S. hedge fund data cover. What is "U.S." for this purpose? Moreover, if a hedge fund is offshore, how offshore can it be to evade being part of the data set?

Linda S. Goldberg suggested that the paper could do more hypothesis tests in the empirical part. For example, on the relationship between the net foreign borrowing position and exchange rates, what part of the change of net foreign position of large players is due to exchange rate movements, and what part is associated with their position? When looking at the dynamics of players and action, what incremental dynamics are expected for exchange rate movements based on the change of position? What are the timing and nature of the dynamics predicted by the theory? Can one do something over time by looking at different dynamics related to the change of composition of the players, or the change of relative sizes of players as predicted by the theory?

Tornell said that the paper only shows that large asset price changes are correlated with the position of some large firms. In order to say this is supportive to the theory of the paper, one should also show that there is no correlation between asset price changes and the position of small firms (as pointed out by *Min Shi*).

Sturzenegger raised a question on endogeneity in the relationship between the change of net foreign position and exchange rate, namely, how does exchange rate change affect the change of net foreign position? He also suggested that one could conduct some case studies, for example, on how large players make announcements and try to influence the market. These events could also be used to do hypothesis tests.

Kristin J. Forbes said that the paper focuses on the role of hedge funds in exchange rate markets only. One extension could be to look at the role of large hedge funds in equity markets. There are some assumptions in the model that do not apply to equity markets. For example, when one compares hedge funds and mutual funds in this market, it seems that mutual funds have superior information, greater transparency, and less leverage; more importantly, hedge funds can short, while other investors cannot. Therefore, it could be interesting to study the broader implications of the model regarding hedge funds in other markets.

Shang-Jin Wei mentioned the only three academic papers on the role of large players and argued that they do not provide supportive evidence for the role of large players. In the Korean case that Kim and Wei looked at, the offshore funds, which are mostly hedge funds, do not seem to be aggressive in the sense of pursuing momentum trading relative to non-offshore funds. The study by Brown, Goetzman, and Park (1998) of hedge funds based on payoff data does not suggest that hedge funds were playing a special role in the Asian crises. Moreover, the fact that Quantum and Tiger groups got off the market is consistent with the view that they are not doing particularly well on an ex post profit basis, which is also confirmed in the Korean case. Thus, his question was whether we are in the stage of identifying supportive evidence for the large player models.

Giancarlo Corsetti talked briefly on the theory. This is a very exciting field of research, and this paper is the first step toward understanding the role of large players. He said that there is a group of students and faculty working on various aspects of the topic—such as oligopoly, game-theoretical approach, risk aversion, credit constraint, and welfare—at Yale right now.

Paolo Pesenti agreed with Martin Feldstein on the positive role of large players. Major market participants can indeed help translate views about fundamentals into prices and can represent sources of market liquidity. Problems arise, however, when aggressive trading has a destabilizing impact, to the extent that highly leveraged institutions attempt to influence market dynamics to their own advantage.

On the "disappearance" of large players, Pesenti cited thirty-six reporters qualified as major market participants in 1996 (twenty-nine of which were commercial banks), but the number was down to twenty-five in 2000, with eighteen banking institutions.

Reference

Brown, Stephen J., William N. Goetzman, and James Park. 1998. Hedge funds and the Asian currency crisis of 1997. NBER Working Paper no. 6427. Cambridge, Mass.: National Bureau of Economic Research, February.