The role of large players in currency crises*

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1 Introduction

Episodes of currency crisis and financial market turbulence raise the question of what role, if any, large traders such as hedge funds (HFs) and other highly leveraged institutions (HLIs, such as proprietary desks of commercial and investment banks) play in determining and propagating financial volatility.

Some policy-makers and analysts have expressed concern that the existence of large players in small markets ('big elephants in small ponds') may contribute to triggering currency 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. While phenomena such as herding behavior (defined as buying or selling an asset as other participants buy or sell at the same time), momentum trading (buying an asset when its price rises and selling it when it falls), noise trading, bandwagon effects, short-termism, excess sensitivity to news, etc. can occur in financial markets even if all agents are small and atomistic and have no market power, large players are deemed to play a key role in influencing market dynamics and contributing to asset prices overshooting because of their size, reputation, and ability to take large speculative positions. For example, it has been suggested that the knowledge that large players have taken sizable short positions on a currency or equity market may scare other investors from taking contrarian positions, even if fundamentals warranted such contrarian trading.

Specifically, concerns about the aggressive, and 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 that 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.

For the 1998 crises, the conclusions of this group's report pointed at the potentially relevant impact of large players. While the group could not reach a consensus agreement about the allegations of destabilization and distortions of market integrity, it found circumstantial evidence of aggressive trade practices and a material role of large players in currency and financial crisis episodes. Notably, the conclusions of the Market Dynamics Study

Group, published in April 2000 (FSF (2000)), were somewhat different from a previous official study on HFs, namely a 1998 study by the International Monetary Fund (IMF (1998)). The IMF study, limited to the events in Asia up to late 1997, had concluded that HFs had not played a major role in the early market turbulence in South-East Asia.

In light of the results of the report 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.

In the context of our study, the definition of *large player*, that is a player with market power, is not mechanically related to size, as measured by the value of asset holdings or to market share. Players with equal size can in fact differ as regards their ability to influence the portfolio strategies of other agents in the market, due, for instance, to differential access to superior information and/or special ability to process information for forecasting purposes. Conversely, being a highly leveraged trader may not be necessarily associated with a high reputation as regards information precision — the actions of such a trader may have only a limited influence on other market participants, who may be better suited to exploit information asymmetries and other market inefficiencies. Of course, there are a number of reasons to expect, on average, a positive association between size and reputation for quality of information. First, traders controlling a large portfolio of assets have more resources to devote to data collection and analysis, and to get access to superior information. Second, the fact that these traders grew large over time may be positively related to superior analytical skills. Yet, this is not necessarily true for all large traders in all circumstances.

This paper is organized as follows. We first present a stylized model of speculative attacks, analyzing how the presence of large investors affects the vulnerability of a country to currency crises. We show that large players play little or no role in models of speculative attacks with common knowledge. In these models, currency crises are the outcome of self-fulfilling shifts in expectations from 'good' to 'bad' equilibria, in situations where the economic fundamentals are neither too strong (ruling out devaluation altogether), nor too weak (so that a devaluation is unavoidable). Such theory, however, does not provide any light on the mechanism through which the activity of large players may lead to the realization of 'bad' equilibria, let alone the reasons why large players may be 'focal points' in swings of market sentiment.

A meaningful role for large traders in a speculative attack is instead singled out by a class of models with asymmetric and private information, that build on the insights of the 'global-games' literature (see Morris and Shin (2000) and Corsetti, Dasgupta, Morris and Shin (2000)). Revisiting the results of this literature: First, even abstracting from signalling, the presence of a large investor makes all other investors more aggressive in their strategies, in the sense that they are ready to liquidate their currency positions for stronger economic fundamentals relative to the case in which there are no large investors. Second, the impact of a large trader on the market is increasing in both her size and the precision of her information. Third, allowing for signalling significantly raises the influence of a large trader — as small investors tend to 'herd', responding to differences in the relative precision of information across agents of different size.

We conclude the theoretical section discussing several open issues and extensions of the model, including considerations of changes in liquidity in forex markets; the analysis of manipulation practices (cornering, 'talking one's book', spread of rumors); the effects of limited knowledge about the actions/trading of the large players (to the extent that large players prefer to hide their actions in the build-up of short positions to avoid price changes in thin markets, while subsequently announcing their positions to 'push' exchange rates via herding).

In the light of the results of Section 2, Section 3 provides an overview and an extension of the empirical literature on the behavior of large investors and their role in a number of market turbulence episodes. A number of sources, ranging from specialized press articles to academic case studies, have suggested that large HFs and HLIs may have possibly played some role in a number of episodes of market turmoil in the 1990s such as: the ERM crisis in 1992-93; the 1994 U.S. bond market turbulence; the 1994-1995 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; the 'Russia to Brazil' contagion episode in the summer-fall of 1998. In our discussion we focus on several of these events.

There is an important premise to our assessment of crisis episodes. While herd-like behavior may have exacerbated swings in capital flows and the en-

suing changes in asset prices, a large set of investors, domestic and foreign, small and large, highly leveraged and not, all contributed to market volatility. Thus, while it is important to study the specific role that large highly leveraged institutions might have played in these episodes, it is crucial to consider their role in the broader macroeconomic context in which these events occurred. In fact, most of these events occurred against the backdrop of deteriorating economic fundamentals and structural weaknesses in many of the economies under pressure.

2 Modelling the role of large traders in speculative attacks: recent developments and open issues

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 in the foreign exchange markets. Our main questions are: is the dynamics of speculative attacks significantly affected by the presence of large players? If yes, in what ways? What underlies a large player's ability to influence the market? Recent literature has investigated these questions within the analytical framework of an economy in which a single large trader coexists with a continuum of atomistic speculators (see Corsetti et al. (2000)). Using the same strategy, this section reviews and contrasts alternative modelling strategies.

After setting up a stylized analytical framework, we first review models that interpret a crisis as a switch from one rational expectations equilibrium to another, under the assumption of common knowledge about the information on the fundamentals. Second, we turn to global-games models based on incomplete information. We conclude with a discussion of open issues, pointing at a new generation of models synthesizing desirable features from different approaches.

2.1 A unified analytical framework

To begin with, we describe a simple specification of an economy whose features are common to different theories, so as to provide a unified analytical

framework for our exposition. 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 can be mobilized by (small and large) speculators attacking the currency. We normalize ℓ as to lie between 0 (nobody attacks the currency) and 1 (the whole market attacks the currency). To motivate this normalization, 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. As a stylized way to model heterogeneity in agents' size, we allow for a single large player who can mobilize resources up to λ. Under our normalization of the size of the market, the combined mass of small traders' resources then amounts to $1 - \lambda$.

As the focus of the analysis is on speculative attacks, the reasons why the monetary authorities may want to relinquish the peg are not explicitly analyzed in the model. It may be helpful to keep in mind the example of an economy endowed with a stock of international reserves, where the central bank is willing to defend the exchange rate 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 (non-borrowed and borrowed) reserves in defending the exchange rate. Conversely, the critical level is high when fundamentals are weak (θ is low). Even a mild speculative attack can convince the central bank to abandon the peg.

The condition for a currency collapse is therefore:

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

A collapse will always occur if θ is negative, it will never occur if $\theta \geq 1$. It may occur for $0 \leq \theta \leq 1$, depending on whether the currency is attacked by a sufficient mass of speculators.

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. So, if an

agent attacks the currency but the currency does not collapse, her *ex-post* payoff will be $-t$, that is the loss due to transaction costs incurred when speculating. If, instead, the currency collapses, the *ex-post* payoff per unit of domestic currency will be $1 - t$. If the agent does not attack, the payoff is identically equal to 0. Note that, for simplicity, we assume that the *ex-post* payoff is independent of the state of fundamentals — as will be apparent in what follows, the extension to the general case would confirm and strengthen our results.

We abstract from intertemporal considerations and focus on one-period models. In most of our study, agents take their speculative positions independently and simultaneously. In one section, however, we will discuss a model that allows for a sequential-move game among speculators. The timing is as follows: A) Agents have a uniform ignorance prior about θ, i.e. θ is uniformly distributed over the real line.[1] At the beginning of the period, they receive an informative signal about the state of the fundamental. B) After receiving their signal, agents take their speculative positions ℓ in the foreign exchange market at given prices. C) The state of the economy θ is revealed. D) The central bank either defends or devalues the exchange rate according to (1).

2.2 Models with multiple equilibria

2.2.1 A benchmark model

We first discuss models of currency and financial crises that stress the role of multiple equilibria and rational panics. Consider the following specification of the information structure. Previous to trading, *all* agents receive the same public signal about θ:

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

where the probability distribution function of the signal is symmetric and smooth (we write H for the cumulative distribution function), with $E\eta = 0$.

[1] 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 (2000, section 2) for a discussion of the latter point.

Note that agents do not know the exact state of the domestic fundamental. Yet, given the uniform prior about θ, their posterior distribution of the fundamental is H, with mean y and standard deviation τ.

To calculate the expected payoff (per unit currency) of an agent, one needs to specify her conjecture about the positions taken by the rest of the market. So, conditional on all agents attacking the currency ($\ell = 1$), the expected payoff from attacking for individual i can be written as:

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

Conditional on nobody else attacking ($\ell = 0$), instead, the expected payoff from attacking is:

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

Note that the first expression is larger than the second: individual payoffs are strategic complements, i.e. they are increasing in the action taken by other agents in the economy.

Rearranging the above expressions, it can be shown that individual speculators optimally adopt 'trigger strategies', defined as follows. If everybody else is attacking, the maximum value of the public signal at which an agent will attack is:

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

Thus, conditional on $\ell = 1$, agents will attack if and only if $y \leq y^*$. By the same token, if everybody else refrains from attacking ($\ell = 0$), the threshold value for an agent to choose to attack is:

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

Conditional on $\ell = 0$, an agent will attack if and only if $y \leq \underline{y}^*$. Note that, for $t \leq 1$, these two thresholds will be higher than 1 and 0, respectively.

In this model, a speculative attack by all agents can be an equilibrium only if $y \leq y^*$. A scenario in which no agent attacks can be an equilibrium only if $y \geq \underline{y}^*$. Since $y^* \geq \underline{y}^*$, a unique equilibrium will obtain either when $y \leq \underline{y}^*$ or when $y \geq y^*$. In the first case, the signal about fundamental is so bad that the individual expected payoff from attacking is positive regardless of

the action taken by the rest of the market. Everybody attacks the currency. In the second case, the expected payoff is negative even if everybody else attacks the currency. Nobody speculates.

Multiplicity of equilibria will occur for intermediate values of the fundamental, i.e. $\underline{y}^* \leq y \leq y^*$. For a given public signal y, the economy may or may not be hit by a speculative run on the currency, depending on which equilibrium private agents coordinate their expectations on. What triggers the switch between equilibria is however left unexplained in the model: such a switch is assumed to be driven by exogenous uncertainty.[2]

Note that logic of this model requires a strong assumption of common knowledge not only of the public signal on the fundamental, but also of the actions undertaken by every individual in the market. For $y < y^*$, it is rational for each individual to participate in the attack only if everybody else attacks the currency. But this means that, in equilibrium, each individual must somehow know the actions taken by other agents.

2.2.2 Large traders in models with multiple equilibria

Can this model provide a framework to analyze the role of large players? The reason why investors' size could matter is the fact that, while small traders have measure zero, i.e. they ignore the impact of their (infinitesimal) position on the overall demand for foreign currency, nobody can ignore the position of a large trader moving a discrete amount of resources λ.

To recast the model so as to allow explicitly for the presence of a large trader, the expected individual payoffs should be made conditional on the action of this trader separately from the rest of the market. The equilibrium could then be redefined in terms of a game between the large trader and the continuum of small agents (similar to the two-agent example in Obstfeld (1996)). Yet, with common knowledge, these changes in specification would not make a difference as regards the results of the analysis. Multiplicity will occur for the same intermediate values of the signal about the fundamentals as derived above, while the switch from one equilibrium to another will still be driven by exogenous uncertainty.

[2] 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 is smaller than 1.

To avoid misunderstandings of this theory, the fact that in equilibrium the small traders take exactly the same side of the market as the large ones should not be taken as an indicator of the signalling ability of large traders. In this theory, an attack by large traders does not represent a 'focal point', at least not more than any other possible event somewhat relevant for the coordination of agents' expectations on a particular equilibrium. This is not to deny that signalling and 'focal points' may be relevant in the equilibrium selection. But these elements require quite a different approach, taking a step away from the assumption of common knowledge of the signal about the fundamental.

2.3 Models with incomplete information

2.3.1 The global-games approach to currency speculation

Different from the previous model, some theories of currency and financial crises stress incomplete information as a more plausible starting point for understanding speculation. In this section, we analyze an approach 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 paper by Morris and Shin for a continuum of agents, including a contribution to the theory of currency crises (Morris and Shin (1998)).[3] 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 section will discuss 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. Notably, even if the noise of

[3]These contributions have been widely interpreted as a case for uniquess of equilibrium in speculative attack models, to be contrasted with the multiple equilibrium view discussed above. While it is true that the equilibrium in Morris and Shin (1998) is unique, their approach has other, equally important theoretical dimensions. In particular, it is a step towards modelling beliefs in speculative markets, so as to understand the determinants of their swings. In models with multiple equilibria, swings of beliefs are not modelled, but are assumed to be driven by exogenous uncertainty. We should note here that global-games models do not rule out the existence of multiple equilibria (see Morris and Shin (2000)). Moreover, as shown below, the approach is flexible enough to derive a first, meaningful theory of size and information differentials in speculative markets.

the private signals becomes very small, the individual information about the fundamentals will never be common knowledge among traders. Thus, upon receiving her own signal, the representative trader can guess the value of θ, the average signal reaching the other traders in the economy, as well as their estimates of θ. She cannot, however, count on the other traders to know her information and guesses — these will have to rely exclusively on their own information to form their beliefs. This departure from the assumption of common knowledge of the fundamentals, no matter how small, is crucial for the results that follow.

2.3.2 A benchmark model with small-traders only

We start our analysis 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; differently from the previous section, however, there is no public signal common to all agents; rather, each small trader in the continuum receives a private signal:

$$x_i = \theta + \sigma\varepsilon_i \tag{7}$$

where the distribution of ε_i is smooth and symmetric — let F denote the cumulative distribution function. While there is no public information about θ, the distribution of the fundamental θ as well as of signals x_i is common knowledge.[4]

[4]To clarify the implications of removing the assumption of common knowledge, 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 will be distributed in an interval of size β on each side of x_i, i.e. $\theta \in [x_i - \beta, x_i + \beta]$. Allowing for the realization of θ to fall on an extreme of this interval, agent i also knows that all other agents will get a signal at most as far as 2β from his own. In other words, agent i cannot exclude that the signal of agent j will be equal to $x_j = x_i + 2\beta$. But if agent j receives a signal as far as 2β from x_i, agent j will conclude that θ is in interval of size 2β around $x_i + 2\beta$. If this is the case, agent j will not be able to exclude that agent i's signal x_i is 4β distant from its actual position. But this means that, iterating the argument above, agent i cannot exclude that agent j believes that agent i own beliefs about agent j's signal will be 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 his own signal. She also knows that all other agents get a signal within an interval of 2β. Yet, 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 fundamental and signals wonder quite far away from where the fundamentals and the signals actually are. This is

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

$$\ell(x^*, \theta) = \Pr\left[x_i \leq x^* \mid \theta\right] = F\left(\frac{x^* - \theta}{\sigma}\right). \tag{8}$$

Now, we know that a crisis will occur when ℓ is larger than θ:

$$\ell(x^*, \theta) = F\left(\frac{x^* - \theta}{\sigma}\right) \geq \theta \tag{9}$$

Thus, the maximum value of the fundamental at which the crisis will occur when agents follow an optimal trigger strategy around x^* satisfies:

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

Agents know that the currency will collapse for any realization of the fundamentals worse than θ^* itself, i.e. for any $\theta \leq \theta^*$. Thus, the expected profit from an attack — conditional on receiving the signal x_i — is:

$$(1-t)\Pr\left[\theta \leq \theta^* \mid x_i\right] - t\left(1 - \Pr\left[\theta \leq \theta^* \mid x_i\right]\right) = F\left(\frac{\theta^* - x_i}{\sigma}\right) - t \tag{11}$$

As agents will attack if and only if their expected profit is non negative, that is:

$$F\left(\frac{\theta^* - x_i}{\sigma}\right) - t \geq 0, \tag{12}$$

it follows that the minimum value of the signal at which they will attack satisfies:

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

This expression, together with (10), gives us a system of two equations in two unknowns (x^* and θ^*) that completely characterizes the model.

the reason why Carlsson and Van Damme refer to this class of games as 'global games'.

It is easy to see that the equilibrium[5] in trigger strategies is unique. From equation (13) above, it follows that

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

so that the threshold value for the fundamental is:

$$\theta^* = F(-F^{-1}(t)) = 1 - t \tag{15}$$

Note that $1-t$ is also the proportion of agents attacking the currency at $\theta = \theta^*$. Using this result in (10) yields a closed form solution for the individual threshold:

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

A well-known feature of this model is that its equilibrium is unique,[6] in the sense that agents would optimally select the unique trigger strategy characterized above over any other possible strategy (see Morris and Shin (2000) and Corsetti et al. (2000) for a proof, based on iterated deletion of strictly dominated strategies).[7]

Observe that, with smooth and symmetric distribution functions, if $t \leq 1/2$, $F^{-1}(t) \leq 0$. Hence $x^* \geq \theta^*$. Moreover, if we let the noise in the

[5]This 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 her 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 her conditional expected payoff (utility).

[6]The equilibrium is unique in the sense that agents choose a unique trigger for their signal. With a continuum of agents, there is no aggregate uncertainty, so there is also a unique level of the fundamentals that will trigger a crisis. In equilibrium, however, conditional on a realization of the fundamental, agents may and will choose different actions, depending on the realization of their signals. In other words, there will be heterogeneity in the behavior of investors — to be contrasted with the strong result of multiple equilibrium models where everybody takes the same action in equilibrium.

[7]Uniqueness of the equilibrium crucially depends on the structure of information. As shown by Morris and Shin (2000), were agents to receive both a private and a public signal, there is some crucial threshold for the relative precision of these two signals beyond which the equilibrium in trigger strategies is no longer unique. In other words, provided the public signal is precise enough, there is more than one trigger that satisfy the equilibrium conditions. Despite the presence of private information, we are back to the case discussed under the assumption of common knowledge.

private signal go to zero, the private agents' trigger point will tend to coincide with the threshold value for the fundamental: $x^* \to \theta^*$. As agents become more confident about the information content of their signal, the level of the optimal trigger decreases towards the threshold value θ^*.

2.3.3 Introducing a large trader

In the global-games model of speculative attacks by Corsetti et al. (2000), a continuum of small traders coexist with a single large trader. The small traders observe private signals x_i with the properties stated above. The large trader also receive a private signal x_l defined as follows:

$$x_l = \theta + \sigma_l \varepsilon_l \tag{16}$$

where ε_l is distributed according to a smooth and symmetric density function l (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, on average, large traders have superior information. On the other hand, even if large traders are better informed on average, one cannot exclude that under some circumstances the ranking of information favors small traders. It is therefore interesting to analyze both cases. In the model, it is assumed that all agents in the market are aware of their relative information precision, i.e. the distribution of the signals, including the relative size of σ and σ_l, are common knowledge.

To derive the equilibrium, suppose that all the players play trigger strategies.[8] From the previous subsection, we know the expected mass of small traders attacking the currency is equal to the probability that any particular agent receives a signal below the optimal trigger x^* — that is, given x^*, the proportion of small traders attacking the currency for any given θ is given by (8). Now, the small traders only amount to a percentage $1-\lambda$ of the market. Thus, the condition for a crisis to occur as a result of a speculative attack

[8] We refer to Corsetti et al. (2000) for a proof that trigger strategies will be optimally selected even if agents were allowed to choose other types of strategies.

by small traders only needs to be rescaled by $1-\lambda$:

$$(1-\lambda)\,F\left(\frac{x^*-\theta}{\sigma}\right)\geq\theta \tag{17}$$

so that, irrespective of whether the large trader also attacks the currency, the value of the fundamentals below which the currency will collapse satisfies:

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

This is not the only relevant threshold on the fundamentals, however, since now the total mass of agents attacking the currency may also include the large trader. If this attacks, the financial resources mobilized by speculators will be increased by λ — that is, a speculative position by a large trader will make the currency collapse for a fundamental $\bar{\theta}$ stronger than $\underline{\theta}$. This stronger value of the fundamentals will solve:

$$\lambda+(1-\lambda)\,F\left(\frac{x^*-\bar{\theta}}{\sigma}\right)=\bar{\theta} \tag{19}$$

So, when the fundamental is below $\underline{\theta}$, the currency will collapse whether or not the large trader participates in the attack. When the fundamental is between $\underline{\theta}$ and $\bar{\theta}$, the currency will collapse if and only if also the large trader speculates against the currency. With a large trader, we have two relevant threshold for the fundamentals instead of a single one (θ^*).

Next, consider the expected payoff of the large trader. This agent knows that, if she attacks, the currency will collapse for any $\theta\leq\bar{\theta}$. Clearly, she will attack as long as the expected profit per unit of currency conditional on her signal is positive, i.e. as long as:

$$\Pr\left[\theta\leq\bar{\theta}\mid x_l\right]-t=L\left(\frac{\bar{\theta}-x_l^*}{\sigma_l}\right)-t\geq 0 \tag{20}$$

The highest value of the signal at which she will attack, that is her trigger x_l^*, thus solves:

$$L\left(\frac{\bar{\theta}^*-x_l^*}{\sigma_l}\right)=t \tag{21}$$

Calculating the expected payoff of the typical small trader is not as easy. Small traders know that the currency will collapse for sure for any realization

of the fundamental worse than $\underline{\theta}$, but, when θ is between $\underline{\theta}$ and $\bar{\theta}$, a collapse will only occur conditional on the large player participating in the attack — that is, if and only if the large traders receives a signal worse than x_l^*. The expected profit from an attack conditional on the signal x_i must therefore be written keeping these different regions of the fundamental separated from each other. Now, conditional on the signal x_i, the posterior density over θ for a small trader is:

$$\frac{1}{\sigma} f\left(\frac{\theta - x_i}{\sigma}\right). \tag{22}$$

The expected payoff to attack conditional on signal x_i is:

$$\begin{aligned} & \Pr\left[\theta \leq \underline{\theta}^* \mid x_i\right] + \Pr\left[\underline{\theta}^* \leq \theta \leq \bar{\theta}^*, x_l \leq x_l^* \mid x_i\right] - t \\ = \; & \frac{1}{\sigma} \int_{-\infty}^{\underline{\theta}} f\left(\frac{\theta - x_i}{\sigma}\right) d\theta + \frac{1}{\sigma} \int_{\underline{\theta}}^{\bar{\theta}} f\left(\frac{\theta - x_i}{\sigma}\right) L\left(\frac{x_l^* - \theta}{\sigma_l}\right) d\theta - t \end{aligned} \tag{23}$$

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

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

$$z \equiv \frac{\theta - x^*}{\sigma}, \;\; \underline{\delta} \equiv \frac{\underline{\theta} - x^*}{\sigma} \;\; \text{and} \;\; \overline{\delta} \equiv \frac{\bar{\theta} - x^*}{\sigma}. \tag{24}$$

whereas it can be shown that both $\underline{\delta}$ and $\overline{\delta}$ are monotonically decreasing in x^*. Using the newly defined variables, the threshold for the large player (x_l^*) is:

$$x_l^* = x^* + \sigma\overline{\delta} - \sigma_l L^{-1}(t) \tag{25}$$

while the optimal threshold for the small players,[9] x^*, is the unique solution[10] to the following equation:

$$F(\underline{\delta}) + \int_{\underline{\delta}}^{\overline{\delta}} f(z) L\left(\frac{\sigma}{\sigma_l}\left(\overline{\delta} - z\right) - L^{-1}(t)\right) dz - t = 0 \tag{26}$$

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

2.3.4 How does a large trader increase financial fragility? The role of size and information precision

Differently from the economy with small traders only, the model has no closed form solution. Corsetti et al. (2000) study the limiting properties of the model, by letting agents become arbitrarily well informed about the fundamentals. Interestingly, the model is flexible enough in the limit, to allow for different parametrization of the relative precision of information between types of agents. In what follows, we discuss in detail only the case in which the information of the large trader is arbitrarily more precise than

[9]The conditional, gross (before transaction costs) expected payoff to attacking, given the signal x^*, becomes:

$$\begin{aligned} & \frac{1}{\sigma}\int_{-\infty}^{\underline{\theta}} f\left(\frac{\theta - x^*}{\sigma}\right) d\theta + \frac{1}{\sigma}\int_{\underline{\theta}}^{\overline{\theta}} f\left(\frac{\theta - x^*}{\sigma}\right) L\left(\frac{y^* - \theta}{\sigma_l}\right) d\theta \\ = & \int_{-\infty}^{\underline{\delta}} f(z)\, dz + \int_{\underline{\delta}}^{\overline{\delta}} f(z) L\left(\frac{\sigma}{\sigma_l}\left(\overline{\delta} - z\right) - L^{-1}(t)\right) dz \end{aligned}$$

[10]Observe that the function on the left hand side of this equation is continuous and strictly increasing in both $\underline{\delta}$ and $\overline{\delta}$, variables that are in turn a continuous and strictly decreasing function of x^*. Thus, the left hand side of the equation is a continuous and strictly decreasing function of x^*. To prove uniqueness of the equilibrium in trigger strategies, we simply note that the left hand side of the above equation is positive for sufficiently small x^*, while becomes negative for sufficiently large x^*. Thus, there is a unique x^* solving (13).

the information of the rest of the market, that is, $\lim \sigma/\sigma_l = \infty$.[11]

In this case, evaluating the behavior of (26) we observe that for any $\theta \leq \bar{\theta}$, that is for any $z \leq \bar{\delta}$, the probability that a precisely informed large trader chooses to attack is equal to one. We can thus write:

$$F(\underline{\delta}) + \int_{\underline{\delta}}^{\bar{\delta}} f(z)\, dz = F(\bar{\delta}) = t \tag{27}$$

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

To solution of the model is then:

$$\bar{\delta} = \frac{\bar{\theta} - x^*}{\sigma} = F^{-1}(t) \tag{28}$$

$$\lambda + (1-\lambda) F\left(\frac{x^* - \bar{\theta}}{\sigma}\right) = \lambda + (1-\lambda) F\left(-F^{-1}(t)\right) = \bar{\theta} \tag{29}$$

from which one can derive:

$$\begin{array}{rcl} \bar{\theta} & \rightarrow & \lambda + (1-\lambda)(1-t) \\ x^* & \rightarrow & \bar{\theta} + \sigma F^{-1}(t) \\ x_l^* & \rightarrow & \bar{\theta} + \sigma_l G^{-1}(t) \end{array} \tag{30}$$

These expressions establish a first important result. In equilibrium, $\bar{\theta}$, x_l^* and x^* are all increasing in the size of the large player, λ. A larger λ makes both the large and the small traders more aggressive, in the sense that they optimally choose to attack for higher and higher values of their signal.

In particular, relative to the benchmark with small traders only, the presence of a large, relatively informed trader increases the financial fragility

[11] Corsetti et al. (2000) characterize the equilibrium also for the opposite case in which $\lim \sigma/\sigma_l = 0$.

of the market, by making small traders willing to attack the currency for stronger values of (estimated) fundamentals. To see this, take the limit of the above expressions for $\sigma \to 0$ and $\tau \to 0$ so as to obtain

$$\begin{aligned} \bar{\theta} &\to \lambda + (1-t)(1-\lambda) \\ x^* &\to \lambda + (1-t)(1-\lambda) \\ x_l^* &\to \lambda + (1-t)(1-\lambda) \end{aligned} \tag{31}$$

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 $1-t$ of traders attacks the currency. Now, suppose that each small trader is taken away a share λ of her resources, 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 $(1-t)(1-\lambda)$. Yet, at $\theta = 1-t$, the large trader with arbitrarily precise information will always attack the currency, using the full amount of the resources given to her. In other words, taking away one dollar from small traders decreases speculation by t dollars, while giving it to a large trader increases speculation by the full dollar amount. 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 minimum threshold of the fundamentals at which the currency collapses. But this means that, in the presence of a large trader, the region of the fundamentals where the currency collapses becomes wider, increasing the vulnerability of the peg to speculative attacks.

Key to this interpretation is the superior accuracy of the large trader information. What if her information is less precise than that of the small players? Will the size of the large trader still be a factor in determining the fragility of the market (despite inferior information)? Interestingly, the answer to this question is a qualified yes. When $\lim \sigma/\sigma_l = 0$, the influence of an uninformed large trader on the small traders' strategies is either nul or moderate, crucially depending on the size of λ. If λ is small enough, small traders can safely ignore her presence. Intuitively, her noise behavior is offset, in equilibrium, by the net positions taken by the bulk of the market. Yet, if λ is 'large', her behavior — however erratic — must be factored in by all market participants. Her presence still makes all traders more aggressive, although to a lesser extent than in the case discussed above.

To sum up, the simultaneous-game model discussed above stresses two key

elements for a theory of speculative attacks with large traders. The first is size. In the model, λ is positive 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 fundamental. Consistently, the threshold x^* — that is, the maximum estimated value of the fundamental at which small traders are willing to attack the currency — is also increasing (in some limit cases non decreasing) in λ.

The second element is the relative precision of information reaching the different players, as indexed by the ratio σ/σ_l. For a given size λ, increasing the accuracy of the large trader information (i.e. decreasing σ_l) lower the noise faced by the small traders, as it contains the judgement 'errors' of the large speculator due to her imprecise signals. By reducing the uncertainty about the large player behavior, a lower σ_l increases the expected payoff of the small agents at any given signal. Small traders thus become more aggressive in the market (i.e. they attack at a higher threshold x^*).

An important lesson from the model analyzed so far is that *a large trader can increase the fragility of a peg even when the market can at best guess her 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 his positions and/or information.

2.3.5 Signalling and herding

Following Corsetti et al. (2000), consider the following modification of the model above. After receiving their signals, both the large and the small traders can choose to 'move first', knowing that late movers can observe their portfolio position. The state of the economy is revealed after all agents have taken their positions, and the payoffs are independent of the timing of the move, so that there are no costs to waiting before taking a position. We stress that here 'signalling' means that the portfolio position by early movers can be observed by late movers. There is no other form of communication.

Now, by definition, small traders shall ignore the impact of their action on the equilibrium outcome. They cannot hope to affect the market by moving first, while they can obtain some informational benefit by waiting. Thus

small traders will always prefer to be late movers. Now, the large trader knows that small traders will not move early. Thus, she will never learn anything by waiting. Yet, by letting people know about her position, she may increase the probability that her strategy will be successful. Motivated by these considerations, the analysis is carried out under the assumption that the large trader always choose to move first, while small traders are always late movers, that is, they speculate knowing the position taken by the large trader.

The analysis follows the same steps outlined above, with the important difference that now the decision taken by small traders will be conditional on the action taken by the large trader. To see this, suppose that the large trader chooses to attack only if her signal is lower than y^*, where, as before, this threshold is defined by

$$\Pr\left[\theta \leq \bar{\theta} \mid x_l = x_l^*\right] = t \tag{32}$$

If the large trader does not attack, her inaction signals to the small traders that, based on her own information, she finds the economy to be quite strong (that is, $x_l > x_l^*$). Yet, 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. So, 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

$$\Pr\left[\theta \leq \underline{\theta} \mid x_l > x_l^* \text{ and } x_i = \underline{x}^*\right] = t \tag{33}$$

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

Of course, when the large trader attacks the currency, she signals to the small traders a quite different assessment of the strength of the economic fundamentals (as $x_l < x_l^*$). 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

$$\Pr\left[\theta \leq \bar{\theta} \mid x_l < x_l^* \text{ and } x_i = \overline{x}^*\right] = t \tag{34}$$

if a finite solution to this equation exists. Otherwise, it 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.

An important observation is that, through her influence on the trigger strategies of the small traders, the large investor induces some degree of 'herding' in the market, in the sense that, for a given distribution of private signals, her position will affect 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 strong manifestation of herding, in the sense that the position of the large trader will determine the position by all other agents in the market.

Finally, the thresholds of the fundamentals below which the currency collapses solve:

$$(1-\lambda)\Pr\left[x_i \leq \underline{x}^* \mid \theta = \underline{\theta}\right] = \underline{\theta} \tag{35}$$

if the large trader has not attacked the currency, and:

$$\lambda + (1-\lambda)\Pr\left[x_i \leq \overline{x}^* \mid \theta = \bar{\theta}\right] = \bar{\theta} \tag{36}$$

otherwise. As in the case of the model with simultaneous moves, there is no closed form solution to this model, but one can analyze limiting properties.

A striking result is obtained from this model when the signal of the large trader is assumed to be 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, so that in equilibrium $\underline{x}^* = -\infty$ and $\overline{x}^* = +\infty$, while $\underline{\theta}$ and $\bar{\theta}$ converges 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 her own private signal and always takes the same side of the market as the large trader (we return on this in the next section).[12]

Most important, herding does not depend at all on the size λ of the large investor. Even a relatively small player can have the strongest impact as long as the market regards her information is arbitrarily precise. That is to say, the only dimension in which size is important is the signalling ability associated with it, i.e. the fact that the market does not ignore the influence of her actions on the equilibrium outcome.

[12]See Dasgupta (1999) for a theoretical discussion.

Size makes a difference, however, as soon as the large trader information is less than arbitrarily precise, and becomes more and more important as 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, she cannot hope to affect significantly the beliefs of the other agents about the state of the economy — these in fact know that her information is relatively inaccurate. Yet, by moving first, the large trader can still reduce the small traders' uncertainty about her action in equilibrium. Small agents will decide their optimal behavior knowing she has (or has not) thrown her resources on the market. If she attacks, the larger λ, the smaller is the resource gap to fill for a speculative attack to be successful.

So, an important conclusion is that signalling effects are related to *both* information about the fundamentals and the 'size' of resources already thrown into a speculative attack. In the limiting case in which the information of the large trader is extremely accurate, the first item overshadows the second. But for any lower degree of precision of information, it is the second item that becomes more important.

2.4 Open issues

2.4.1 Does the presence of large players destabilize foreign exchange markets?

In the long standing academic and policy debate on whether speculation is destabilizing, large players are a particularly hot item in the list of competing views. The literature provides many example in which market efficiency is jeopardized by the behavior of *atomistic* noisy traders. The fact that the speculative positions of large traders are often clearly identifiable in speculative attacks make them primary suspects as market 'agitators'.

Indeed, the presence of large players may not just lead to short-term high-frequency excess volatility of exchange rates and other asset prices; under some conditions it may also lead to a more persistent and destabilizing deviation of asset prices from their equilibrium values and negative effects on real economic activity. This is the case, for instance, if the actions of large players trigger a currency crisis that would have not otherwise occurred, or force monetary authorities to prevent a currency collapse at the cost of

recession-inducing high interest rates. While it is hard to prove that any specific economy fits this description, some have argued that Hong Kong in 1998 was the nearest case of an economy whose fundamentals were overall sound, in spite of some macro weaknesses, but came very close to a potentially destabilizing collapse of its currency board regime as a result of aggressive speculation against its forex and stock market.

What eventually prevented a break of the peg and further sharp falls in its equity market was a controversial direct intervention of the HKMA in the equity market. But the effects of defending the peg with high interest rates were quite costly, as such interest rate hike most likely exacerbated the already recessionary effects of the Asian crisis on the economy. Thus, 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 effects), 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 fundamental. While 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. Yet, 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 be always the case. As large traders take speculative positions in many different markets, it is plausible that, in 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 positions, 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.

In a situation like the one suggested by this example, large traders may well prefer exchange rate stability to a devaluation. Because of the initial portfolio positions, the payoff function is different from what the formal model above assumes. Re-running the model under different assumptions about the payoff function, it is possible that the presence of the large trader will make small ones less (instead of more) aggressive in the currency market,

thus reducing the likelihood of speculative attacks and devaluation.

2.4.2 Are large players too small to significantly affect the forex market?

Some may claim that the estimated total size of large players (say HFs) is too small — relative to the size of the forex market and the size of the country's foreign reserves — to be a determining factor in a currency crisis.[13] This claim runs against a key result from theory. If one takes the view that large players are perceived to have superior information, then the model presented above shows 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 build-up 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 HF 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 will 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

[13]Note that another large player in any forex market dynamics is the monetary authority that 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; 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.

information in the market. Now, one may think that strong asymmetries are not likely in foreign exchange markets, given that the information about macroeconomic variables is mostly public. However, it is not infrequent that, especially in the case of emerging markets, some players with privileged access to policy makers are believed to have better information than the average market participants, as well as superior skills in analyzing and processing public data.

Two factors are crucial in determining the size of a large player's position in the market: leverage capacity and the overall liquidity in the market. As regards the first factor, some players such as HFs are less restricted than other investors (such as institutional investors) in taking large leveraged positions. In a speculative attack, these funds could mobilize massive resources up to a multiple of their capital base.

As regards market liquidity, the evidence suggests that the forex liquidity drops significantly in periods of turmoil (see FSF (2000)). So, while the overall size of short positions by HFs may be small relative to the depth and liquidity of the foreign exchange markets 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 such as currency boards, as these regimes limit the overall free 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 the turmoil in late 2000 in Turkey and Argentina. 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.

2.4.3 Do large players intentionally foster herding?

The theoretical analysis discussed above vindicates the view that large players can effectively behave like market leaders by signaling their investment strategies ('talking one's book'), so as to focus the expectations and trading strategies of a large number of traders on shorting a particular currency or asset market.

Nonetheless, this result by no means implies that herding is *always* in the

interest of large players, and that we should expect large players to engage systematically in signalling games, revealing their positions and information to the rest of the market. In fact, it is actually plausible that large players may well try to prevent herding in the stages in which they are trying to build a short position or unwind it. It is only when positions have been build that herding by other agents (taking short positions or outright selling the currency) may become advantageous, as a way to increase the pressure on the exchange rate and push a currency peg to break.

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

In other words, when taking a position based on her own private information, a large player has a clear interest in trading at prices that do not reflect her own information. Only *after* she has built up his position, she benefits from her information to become public, as prices would then move in the desired direction. At that point, there is a clear incentive to engage in signalling — as analyzed in the period model presented above.[14]

We note here that the goal of building a speculative position without moving prices is helped by the presence of public authorities committed to stabilize 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

[14]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, they use multiple medium size orders). Of course, the reaction by small players will crucially depend on which trades (large or small) they perceived to be more informative (i.e. made by informed traders) — see Lee, Lin and Liu (1999) for discussion of this issue.

prices, raising the costs of shorting positions in that currency. Thus, there are still advantages from keeping 'early moves' secret. Yet, price stabilizing schemes, such 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 requires other investors to take the other side of the market (playing contrarian and being long) as monetary authorities are not providing foreign currency at a fixed price. Again, only when such positions have been built, noisy signalling to push exchange rates down may become profitable.

2.4.4 Do large players inhibit contrarian trade?

In the model discussed in Section 2.3.5, 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, her private information may still be off from the real state of the economy.

Indeed, there is evidence that, on a number of occasions during the market turmoil in the 1997-99 period, some HFs lost money as the majority of market investors traded against them. In some episodes HFs lost money by attempting to bet on exchange rate stability and/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 such as large HFs, prop desk of commercial and investments banks, money investment funds, engage in strategic games against each other. Then, differences in information and opinions 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.

Yet, one cannot rule out the possibility that, despite differences in information and opinions, the size and reputation of large players taking aggressive position in market may, at times, drive out contrarian investors. *Vis-à-vis* the usually high leverage capacity of hedge and investment funds, for in-

stance, risk aversion and credit constraints may effectively limit the amount of stabilizing speculation that individuals and other institutions can provide. In other words, it may be possible that, in a speculative attack against a currency, small investors who are risk averse and credit constrained may prefer not to trade contrarian, even if their perception of domestic fundamentals does 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 towards risk need not mechanically imply that small investors stay on the sideline, or follow a large player in a 'lemming'-like fashion, so that no contrarian-taking ever takes place.

The theory of speculative attacks with large traders should also be developed so as to explain, rather then 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 solving the coordination problem inherent in a speculative attack — for the reasons discussed above, the chances of success are increasing in the magnitude of speculation. Yet, agents choosing a large speculative position have also more at stake. A small degree of risk aversion can rapidly decrease the marginal willingness of speculating as one's 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 are the results of the interaction of decisions of a large number of players, both small and large, who interact in asset market in complex and, at times, unpredictable ways. 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, whether larger investors are leaders of the pack are thus all empirical questions that have to be addressed in empirical studies.

2.4.5 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 a stock/asset, drive the price up and

then sell the stock at this higher price, thereby earning a profit.[15] Although most of this literature does not directly address the role of 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, that is 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, that is manipulation based on releasing false information or spreading false rumors.

3. Trade-based manipulation, that 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.

Since 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, while inside information is harder to envision in the context of foreign exchange markets. Yet, even in these markets, there could be particular conditions in which rumors and leaks, say, about the actions of players with high reputation, may have strong effects that do not occur in normal times. 'Verbal manipulation' could for instance contribute to herding.

While trade-based manipulation is in principle the most relevant issue for the purpose of this paper, it is not even clear that such form of manipulation can ever be profitable. Buying a stock tends to push its price up, while selling it tends to push the price down. So, if a large trader who attempts to manipulate a market through trade ends up 'buying high' and 'selling low',

[15] See Kyle (1984), Vila (1987, 1989), Jarrow (1989), Bagnoli and Lipman (1990), Benabou and Laroque (1990), Kumar and Seppi (1990).

how can she make a profit?[16] 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. But 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-based manipulation appears to be profitable only in particular circumstances, when there are agents with an informational disadvantage, or agents who have to sell/buy for some exogenous reason, perhaps getting benefits that compensate them from the losses in the trade.[17] 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. Interestingly, the authors of this study correctly observe that the welfare implications of this example of trade-manipulation are ambiguous: some investors make money at the expense of less informed specialists. Why should policy makers care about these types of market manipulation and do something about them?

Market corners are another form of trade-based manipulation. For instance, a trader may obtain the control of a sufficiently large share of the supply of an asset which must be delivered in the futures or forward market.[18] This type of manipulation, however, 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 possible factor in recent market dynamics episodes, has not been systematically studied by the literature on manipulation.

Based on the overview of the literature, we can only attempt to make a preliminary assessment of the theoretical case for market manipulation by large players in the forex market. The key observation is that the informational and behavioral conditions for successful market manipulation are relatively strict. For example, to argue that HFs and HLIs have manipulated markets, one would need to demonstrate that, in the episodes under scrutiny, an individual fund was large enough or leveraged enough to be able to corner

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

[17] Theoretical examples are given by Hart (1977), Kyle (1985), Jarrow (1992), Allen and Gorton (1992), Allen and Gale (1992) and Kumar and Seppi (1992).

[18] See the cases of Salomon Brothers' Treasury market corner and Hunt Brothers' corner of the silver market.

a particular currency or market.

Alternatively, if no player was large enough by itself to affect markets, one would need to prove collusion among some investors. Or, in the absence of outright collusion, one would need to prove that some HFs were effectively leading the trading strategies of a large enough number of other traders — perhaps by 'verbal manipulation', i.e. by 'talking down' a currency or a market and so convince other market players to sell short. While such convergence of strategies may be in principle possible, there is yet no evidence that it has occurred in any of the turbulence episodes of the 1990s.[19]

Most important, it is very hard to prove manipulation, even when there is clear evidence that a large agent 'talked down' a currency or market. Suppose that a large agent, believing that a currency is overvalued, places global macro bets shorting that currency, and publicly announces her views to this effect. Since 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? This is quite different from spreading false rumors about a stock that might occur in the equity market.

We conclude this section with a note on the welfare implications of manipulation. While these may be ambiguous for the case of individual equities (as they lead to a redistribution of wealth from less informed specialists to more informed investors), the potential welfare effects of successful manipulation in currency markets are far more important. There could be large, undesirable real effects from price movements away from fundamentals, associated with loss of employment and fiscal and monetary imbalances. Moreover, the redistribution of wealth would go from vulnerable emerging market economies to international investors.

3 Large players and currency markets: Empirical studies

There is no single factor that can fully account for the volatility in cross-border capital flows, nor for the current account reversals and the large swings in asset prices that capital volatility sometimes cause. Corporate, financial and policy weaknesses in emerging markets are often exacerbated by adverse

[19] See the overview in Section 3.

monetary and macroeconomic developments in advanced economies; countries with different domestic fundamentals have been equally vulnerable to autonomous shifts in market sentiment among international investors. As a result, small countries that have been the recipients of international capital have also been increasingly concerned with being buffeted by forces beyond their control in integrating capital markets.[20] Among the issues raised by the recent experience, a widespread debate has focused on the role of HFs and other HLIs in recent episodes of currency crisis and market turmoil has been widely debated, especially during the 1997-1999 Asian and global financial crisis.

The evidence on the currency strategies of HFs and HLIs and their role in market turbulence episodes is mixed. On the one hand, the authorities of a number of countries — for example Malaysia, Hong Kong, Australia — have claimed that HFs played a significant role: such funds have been accused of leading market dynamics, causing herding behavior and, even, trying to manipulate currencies and other asset market. On the other hand, IMF (1998) and other research[21] has reached skeptical conclusions as regards any specific role allegedly played by HFs during the 1997 turmoil in Asia. A typical argument made in these studies is that HFs were 'at the rear of the herd of investors rather than in the lead'.

Partially different conclusions were reached in a more recent official study (FSF (2000)), that extended the analysis to the 1998 turmoil, including a number of small and medium sized economies such as Hong Kong, Australia, New Zealand, South Africa, Singapore and Malaysia in the sample. Whereas the IMF study had come to the conclusion that HFs had played only a minor role in 1997, the HLI study group found a more significant role of HFs and prop desks in the latter episodes of turmoil in 1998.[22]

In this section, we reassess the role played by HFs and other highly leveraged players in the 1997-98 episodes in the light of the theoretical analysis performed in this paper. The section is organized as follows. We start with a general introduction to the literature on HFs and their trading strategies.

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

[21]See Brown, Goetzmann, and Park (1998) and Fung and Hsieh (1999).

[22]For example, circumstantial evidence was found of some aggressive trade practices. These included aggressive shorting of currencies and other assets, spreading rumors and false information, and placing large trades at less liquid times of the day such as lunchtime.

Next, we analyze the evidence on the aggregate foreign currency positions of large market participants in advanced economies. Finally, we consider some recent evidence on the role played by large players and HFs in the episodes of market turmoil in 1997-98.

3.1 General studies on HFs

The academic literature on HFs is rather small in volume, a major constraint to research being the relatively limited availability of data on quantities and positions.[23] It is clearly difficult to assess the empirical validity of widespread opinions (or prejudices) on the behavior of HFs. To mention but one example, one can think of the complexities involved in testing whether the significantly lower regulatory burden on HFs allows these funds to engage in much higher degrees of leverage relative to mutual funds, as systematic data on leverage are not publicly available.[24] In what follows we provide an overview of the available literature, as an introduction to the assessment of the role of large players in currency turbulence.

HFs are typically considered 'large players' by antonomasia. Yet, there is a broad distribution in the size of HFs. According to a recent study based on a sample of 547 HFs (Ackerman, McEnally and Ravenscraft (1999)), the average size (measured by the amount of the fund's net assets under management) of an HF was $108 million in December 1995. While the smallest fund in the sample managed assets equal to $0.1 million, global macro funds and event-driven funds were significantly larger than the average: the largest fund had a size of $4.27 billion.[25] It is worth noticing that, in evaluating the 'size' of a HF, large amounts of leverage can interact with a sizable capital base.

To what extent are HFs 'different' from other types of funds and financial institutions? Fung and Hsieh (1997) provide some evidence according to which HFs portfolio behavior is dramatically different from mutual funds, supporting the claim that HFs tend to adopt highly dynamic strategies,

[23] Fung and Hsieh (1999b) provide a recent 'primer' on hedge funds.

[24] See IMF (1998) for some estimates of leverage by hedge funds.

[25] Moreover, there is a significant degree of concentration in the industry. Fung, Hsieh and Tsatsaronis (1999) show that 27 large HFs and CTA funds control 49.5 percent of the assets in the sector.

rather than variants of *buy-and-hold* strategies.[26] To the extent that the HFs' portfolios are not correlated with mutual funds' portfolio, it may well be possible that HFs act as contrarians and, thus, contribute to reduce price volatility rather than increase it. In a subsequent study (Fung and Hsieh (1998)), these authors shows that, while the dynamic trading strategies of HFs may provide diversification gains relative to portfolio allocations based on *buy-and-hold* strategies, such strategies also increase the exposure to extreme (or *tail*) events, raising the possibility of 'diversification implosion' and large losses.

Do HFs outperform competitors? If they do so, is it because they take on more risk? While superior HF performances have been found by Hennessee (1994) and Oberuc (1994), more recent studies have related performances to investment styles and portfolio behavior specific to HFs. Brown, Goetzman and Ibbotson (1997) examine the performance of the offshore HF industry over the period 1989 through 1995 using yearly data on both discontinued and currently operating funds. HFs do provide positive systematic risk-adjusted returns, but such superior performance does not seem to be related to superior managerial skills, nor there is evidence of performance persistence.[27]

Ackerman, McEnally and Ravenscraft (1999) analyze HFs' performance by using data on monthly returns for both U.S. and offshore funds over a relatively short sample period (1994-95). Controlling for survival bias and other data-conditioning biases, they find that HFs are significantly riskier than their mutual funds counterparts: average total risk is 27% higher for HFs. But HFs have a clear risk-adjusted performance advantage over mutual funds: the average HF Sharpe ratio is 21% higher than the comparable mutual fund Sharpe ratio. However, HFs are unable to systematically outperform the market when absolute or total risk-adjusted returns are considered. The superior performance of HFs over mutual funds appears to the related to organizational features: higher incentive fees are associated with higher

[26]The paper by Fung and Hsieh (1997) finds five dominant investment styles in HFs, which are deemed to provide an integrated framework for *style analysis*. The latter term refers to the use of statistical techniques — essentially some variants of factor analysis — to classify the trading style strategy of different investors.

[27]These authors develop endogenous style categories for relative fund performance measures, and find that repeat-winner and repeat-loser patterns in the data are largely due to style effects in the data. It is also possible that the positive excess returns experienced by HFs may stem from survival-related conditioning bias.

risk-adjusted returns.

Differently from the previous study, Edwards and Liew (1999) do not find that HFs follow more risky strategies: the standard deviations of monthly returns for HFs are lower than the corresponding measures for broad indexes of the U.S. stock market. Based on the Sharpe ratio, these authors also find higher risk-adjusted returns for HFs over a longer time horizon than the one considered in the previous study (1989-1998). However, these superior performance turns out not to be significant when using another common measure of risk-adjusted returns, Jensen's alpha.[28]

Liang (1998) finds that the average HF returns are related positively to incentive fees, the size of the fund, and the lockup period. In the period January 1994 through December 1996, HFs offer better risk-return trade-offs than mutual funds: they have higher Sharpe ratios, lower market risks, and higher abnormal returns The author argues that HF strategies dominate mutual fund strategies, concluding that HFs provide a more efficient investment opportunity for investors.

Do HFs move in parallel with each other? Using daily data from the U.S. futures market (over the 1992-1994 sample period), Kodres and Pritsker (1997) test herding among several classes of large market players, such as broker-dealers, foreign banks, commercial banks, pension funds, mutual funds, and HFs. A necessary but not sufficient condition for herding is defined as the propensity of large participants to buy (or sell) futures when other large participants buy (or sell) as well. They find statistically significant positive comovement of positions for several contracts and several institutional groups. The evidence on HFs shows that, while they tend to mirror the positions of each other (herding), as a group they nonetheless engage in *negative feedback* trading (i.e. they take contrarian positions relative to the price trend) in six of the seven futures contracts considered in the study.

IMF (1998) extends this work to test whether other market participant's change their positions simultaneously with the HFs. When statistically significant correlations are found, they are negative rather than positive; i.e. institutional groups alter their positions in the opposite direction. Yet these results are to be interpreted with some caution, as the sample only includes a

[28] *Jensen's alpha* is the amount by which the average return on an asset exceeds what would be predicted by the capital asset pricing model (i.e. a return measure adjusted for the asset's systematic risk relative to stock market returns).

few HFs, and HFs are not particularly active in the future market considered in the study.

There is not much empirical evidence on whether small investors follow the trading behavior of large players, i.e. whether large investors are 'leaders of the pack' in herding phenomena. An exception is a study by Lee, Lin and Liu (1999) on the Taiwan stock market. This study considers three types of investors: big individual investors, institutional investors and small individual investors. They find that big individual investors are the most influential players in this market; their trading affects stock returns and the trading behavior of small individual investors. Small investors appear to herd, as they tend to follow the actions of big individual investors, and engage in positive feedback trading, as they tend to buy stocks with positive returns. Conversely, institutional investors do not appear to herd (i.e. they do not follow the behavior of big individual investors), nor do they engage in positive (or negative) feedback trading.

IMF (1998) find some evidence that HFs played a leading role in precipitating the ERM crisis in 1992 by acting as market leaders, although they appear to have done so in response to economic fundamentals. As regards the same episode, Fung and Hsieh (1999b) show that the 25% net asset value (NAV) gain of the Quantum Fund in September 1992 can be explained by its positions against the British pound.[29]

But 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 UK economy. While 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.[30]

In other episodes, notably the 1994 bond market turbulence, IMF (1998) show that HFs as a group bet that interest rates would decline and lost substantial sums when they instead rose. Fung and Hsieh (1999a) and Fung, Hsieh and Tsatsaronis (2000) show that Quantum had a substantial bet in

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

[30]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).

favor of a strengthening of the US dollar against the yen in February 1994; but over the course of a weekend, the yen appreciated by 3.3% and Quantum lost 5.2%. They also consider the performance of several large macro HFs in the episodes of market turmoil in 1997-98. We will return below on these and other case studies of the behavior of HFs and other international investors in the 1990s.

It is useful at this point to provide some preliminary evidence about the performance of HFs. For the period 1997-98, Figures 1-4 plot the time series of NAVs of four large macro HFs,[31] in parallel with the S&P500 index and the yen/dollar exchange rate.[32] Over this period, large macro HFs were reported to be taking substantial long positions in the U.S. equity market; they may have also 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).

Figure 1 suggests a strong correlation between the NAV of the Quantum Fund and the S&P500 index for the first 11 months of 1997. The comovement is much looser afterwards. Parallel movements between the yen/dollar exchange rate and the NAVs of the four HFs are evident 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 LTCM.

A striking feature that appears from these graphs is the sizable fluctuations in the performances of these four funds during the 1997-98 period. The Jaguar Fund's NAV rose by 100% between the beginning of 1997 and August 1998, but lost 25% of its value between August 1998 and the end of 1998. The Emerging Growth Fund rose by 40% between January and May 1997, then fell sharply, remaining on a downward trend until the end of 1998, when its NAV was about 40% below the level at the beginning of 1997. The Quasar Fund was volatile but on average rose by about 50% between the beginning of 1997 and August 1998; after that, it plunged by 50%, so that by the end of 1998 its NAV was at the same level as at the beginning of 1997.

[31] 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*.

[32] Similar charts appear in Fung, Hsieh and Tsatsaronis (1999), who consider the performance of the HFs only up to 1997.

The Quantum Fund rose by about 30% 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% of its value. Only the fourth fund gained over 40% over the same period.

3.2 The Treasury Foreign Currency reports of major market participants

We have argued before that a number of features contribute to making a financial institution 'large' — including asset size, leverage ability, visibility and superior information. In this section we focus on the currency market and investigate to what extent are these dimensions interlinked. Do big players affect the price of foreign currency? Have they access to better information than their competitors? Are they better forecasters of future exchange rate developments? Do they consistently take positions in currencies whose value tends to appreciate over time? To answer 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[33] to file weekly and monthly reports on their holdings of foreign currency. An institution qualifies as a 'major' participant if, on the last business day of either March, June, September or December during the previous year, had on its books more than $50 billion equivalent in foreign exchange contracts. The contracts considered 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 U.S. file only for themselves, not for their foreign parents. Market participants whose foreign currency holdings are less than $50 billion but exceed $1 billion must only file a quarterly report.

In their weekly Treasury Foreign Currency (TFC) reports, major partic-

[33] 31 United States Code 5315; 31 Code of Federal Regulation 128, Subpart C.

ipants indicate the amounts of foreign currency outstanding at the close of business each Wednesday.[34] 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 represents the outstanding amounts of foreign exchange which 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 the aggregate notional principal amount of contracts purchased and sold by the reporter 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.[35] 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 weekly, monthly and quarterly aggregate large players' foreign currency positions. No information is released as regards the single participants' positions, and data on their net dealing positions are unavailable even at the aggregate level. A previous study (Wei and Kim (1997)) has used the Treasury dataset, covering the sample period 1994-1996. Our paper covers the entire sample available at the time of writing, that is January 1994- June 2000. In 1996 there were 36 reporters who qualified as major participants; of them, 29 were commercial banks and the remaining 7 other forms of financial institutions including HFs. By 2000 the number of reporters was down to

[34]The reports are filed no later than 12pm on Friday following the Wednesday to which the report applies.

[35]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.

25, of which 18 were banking institutions.

Table 1 provides summary statistics on major participants' weekly positions, all expressed in million U.S. dollars.[36] Gross sales and purchases of foreign currency are rather large (for instance, purchases of Japanese yen are in the order of $1429 billion on average, and sales of marks are on average $1249 billion) but net positions are relatively small across currencies (net positions in yen are slightly above $20 billion in absolute value, and net positions in marks are on average below $8 billion). The limited size of the net positions may stem from the role of intermediation played by large market participants: 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. Also, limited net positions indicate unwillingness by major participants to maintain large speculative positions at high (weekly) frequency. Notice however that large players' net positions have increased over time, on average, across all currencies except the Canadian dollar.

Figures 5-11 plot the weekly time series of aggregate net foreign currency positions, defined as purchases minus sales of foreign exchange spot, forward and futures, plus net options positions, all expressed in million of local currency (except for the contracts in yen, expressed in billion). The figures also plot the relevant exchange rates, expressed as U.S. dollars per unit of local currency. Simple visual inspection leaves the impression that, to some extent, the two series tend to move in parallel: when a currency strengthens against the dollar, large players systematically increase the purchases and reduce the sales of that currency, unwinding their net positions in dollars.

For example, in Figure 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 JPY 2 trillion (about $16 billion at the prevailing exchange rate) to over JPY 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 (Figure 9), the cycle of appreciation relatively to the U.S. dollar in the first half of 1995 and depreci-

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

ation in the second half of that year appears to be correlated with a build-up of long positions in marks that were then reversed in the latter period. Another cycle is evident from September 1998 to the spring of 1999, when the swing of the mark is again associated with a large build-up of long positions in late 1998 and their unraveling in the first months of 1999. 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 (Figure 10) seems to be associated with larger short positions on this currency until the summer of 1999 but not afterwards.

Note that, in interpreting these correlations, causality can go either way. On the one hand, large players may affect the price of the currency simply because of the sheer magnitude of their overall 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.[37] For sensitivity analysis we exclude from the sample potential outliers[38] and consider two sub-samples, 1994-96 (as in the Wei and Kim (1997) study) and 1997-2000. Table 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 sterling, the Canadian dollar, the yen, the Swiss franc and the euro. The link is however weaker in the case of the German mark, as the coefficient is statistically significant only at the 10 percent level; it is however significant at the 5% 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 sub-sample, with the notable exception of

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

[38]The outliers are identified visually as: 5/19/1999 (Canadian dollar), 9/15/1999 (Swiss franc), 7/31/1996 (Japanese yen), 1/6/1999 and 2/23/2000 (euro).

the yen. Outliers play little role in these results.

The relation between the exchange rate and net position is also significant when we introduce lagged values of the latter variable in the regression. In Table 2 we report results based on regressing the Wednesday exchange rate on both current and one-week lagged net positions. The coefficients of the both net positions are significantly positive in the cases of the pound, the Canadian dollar, and the yen (in the latter case, the result is sensitive to the presence of outliers), as well as in pooled regressions. In other words, past net positions help predicting current exchange rates:[39] large players tend to take long positions in currencies which are and remain strong for a while — a result reflecting some degree of persistence in exchange rates. 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).

Are net positions associated with changes (rather than levels) of exchange rates over time? Such a correlation, if found in the data, may have two interpretations. On the one hand, if large players have superior information, they short should be able to anticipate currency movements, selling short before depreciation. On the other hand, large players may affect the movement of the exchange rate simply because of the size of their trading. If a significant relation is found between net positions and movements of the exchange rate, both hypotheses are possible. However, if no relation is found, evidence supports neither the view that large players have superior forecasting ability nor the view that they have significant market power.

Table 3 reports the results of regressing the ex-post exchange rate depreciation rate on lagged net positions. As above, for sensitivity analysis we report estimates for the two sub-samples 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, 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)

[39]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.

there is at least one statistically significant, positive coefficient for the mark, the pound (in the 1997-2000 subsample), and the yen (3 days, excluding the outliers). There is a statistically significant relation, but with the wrong sign in the case of the Swiss franc and the euro. In most cases, the coefficients are not significant, and sometimes have the wrong sign.[40] The results do not improve by lengthening the horizon of the depreciation.[41]

To sum up, while 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. Yet, there is some stronger evidence than in Wei and Kim (1997) that exchange rates changes are correlated with the net positions of large players (recall that the Kim and Wei study was limited to the 1994-1996 period, while we extend the sample up to the year 2000). Overall, the evidence in this section suggests that, due to either size or informational advantages, the net positions of large players are significantly correlated with exchange rates.[42]

[40]Similarly, Wei and Kim (1997) do not find any positive association between large participants' position in a foreign currency and its subsequent appreciation. A non-parametric approach finds some weak support for a positive association, but not on a systematic basis.

[41]When twelve weeks are considered, there is a strongly significant relation for the pound, the Canadian dollar, the Swiss franc, the euro and — excluding the outliers — the yen. The problem is that, with the only exception of the Canadian dollar, the sign is always negative: i.e. 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.

[42]Wei and Kim (1997) consider the absolute value of the options positions and find that it Granger-causes exchange rate volatility. A possible interpretation is that large participants' positions in currency derivatives do not have a stabilizing effect in the currency market. However, it should be pointed out that major participants may predominantly play a role of intermediation as far as their option positions are concerned. In other words, the delta equivalent of the reporters' options are likely to reflect their customers' need and fears, and it is not very plausible that large players make bets on the direction of exchange rates from their portfolio of foreign currency options. Granger-causality tests using the spot, forward and futures positions by large participants also reveal that increases in the absolute values of large players' positions are associated with subsequent increases in exchange rate volatility. The authors interpret these results as casting doubt on the view that large participants have better information about the future movements of exchange rates.

3.3 The pressures on the Thai baht in the spring-summer of 1997

We now turn to several case studies of currency crisis in which allegedly HFs and other large traders 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.[43]

Based on an assessment of economic fundamentals, it is now clear that the currency was overvalued and an adjustment was likely to occur. The country had run large current account deficits for almost a decade and the currency had appreciated in real terms. The financing of these imbalances had occurred through short-term unhedged liabilities, thus making the country vulnerable to a liquidity run. Also, there were serious weaknesses in the financial system that eventually led to a severe 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. While a currency correction was probably necessary and eventually unavoidable, it is still relevant to consider the role that large players may have played in the fall of the currency. The analytical model presented in this paper suggests that a country with weak fundamentals may be vulnerable to the market dynamics generated by short positions taken by large players: other smaller players may react to the actions taken by the large player by becoming more aggressive in their speculative behavior.

The issue is thus whether large HFs were leaders of the pack in this particular currency crisis episode. The IMF (1998) study reached the conclusion that HFs were at the 'rear' rather than leaders of the pack.[44] But this conclusion appears partly at odds with the information available in the IMF study itself and other evidence. This study suggests that some large HFs took in fact significant short positions against the Thai baht in the spring of 1997, presumably based on an economic analysis of the Thai fundamentals suggesting that the currency was overvalued and that the current account deficit was not sustainable. IMF (1998) estimates that the net short position of the HFs in Thailand was about $7 billion.[45] Fung, Hsieh and Tsatsaronis

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

[44]See also Eichengreen and Mathieson (1999).

[45]This are estimates of direct forward transactions with the Bank of Thailand. Short

(2000) estimate somewhat smaller short positions against the Thai baht for twelve HFs: about $5 billion at the end of June 1997.[46]

Short position-taking by large macro funds is indirectly confirmed by some econometric evidence presented in Table 4.A. We took weekly values of the NAV of four large macro HFs[47] and we regressed the NAV against the S&P500, the yen/dollar exchange rate and the value of the Thai baht for the February to July 1997 period when the baht was under pressure.[48] As argued before, the first two regressors control for the hypothesis that these funds had significant investments in the US 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 S&P index and the yen/dollar rater also enter significantly in these regressions with the expected sign.[49]

Short positions of $7 billion (as estimated by IMF (1998)) by large traders represent only a quarter of the Bank of Thailand's $28 billion forward book at the end of July 1997. This means many investors — other than HFs — must have shorted the baht by the time of the fall of the currency in July. According to the IMF study, while "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

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)).

[46]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 Hsieh and Fung (1999) there is not evidence that the Quantum fund had shorted the baht during September 1997 when this currency fell sharply.

[47]These are the same considered in Figures 1-4 and Section 3.1.

[48]For the Jaguar Fund the sample period is the full 1997-98 period as we found significant effects of all regressors throughout the sample.

[49]The S&P index is not included in the Emerging Growth Fund as this fund invests mostly in emerging markets. Indeed, the S&P regressor is not significant when included in the regressions.

some capital controls to limit the speculation against its currency.[50]

Ultimately, the conclusion in the IMF study that HFs were at the rear of the herding pack is not strongly justified by the data. While enough information is not available to make a full assessment of the sequence of events and movements of different players, a plausible interpretation is that large macro HFs detected rather early the macro and fundamental weaknesses of the baht and the likelihood of a devaluation. Since the build-up of short positions started in February and continued through May, one could as well argue that HFs moved first in building up their positions and were followed next by a wide range of other domestic and international investors.

On the basis of our analysis in Section 2.4.2, the argument that the HFs' alleged short positions of $7 billion were 'small' needs to be qualified. If the $7 billion positions had been built by the time of the May attack (after the May 15 capital controls 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. While the eventual fall of the baht was certainly triggered by the 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.

3.4 The 'double play' hypothesis in Hong Kong

In 1998, the currency and other asset markets in Hong Kong were subject to 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.[51] Allegedly, large traders were attempting a 'double play': first shorting the equity market then shorting the currency, using sales of local currency to spike domestic interest thus making the equity shorts profitable.

In the view of the authorities, the 'double play' allegedly proceeded as

[50] 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)).

[51] Hong Kong Monetary Authority (1999), Hong Kong Monetary Authority and Reserve Bank of Australia (1999) and Tsang (1998).

follows. First, HFs shorted the Hong Kong (spot) stock market as well as the Hang Seng Index futures. HFs allegedly 'pre-funded' 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 US dollars and spot sales of HK$, 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.

To defend the currency board arrangement, the Hong Kong Monetary Authority (HKMA) would have been forced to intervene in the foreign exchange market, drying up market liquidity and causing a correspondingly large increase in interest rates. This monetary tightening would have predictably caused a sharp drop in equity prices, providing positive returns for the short positions in the stock market taken by the HFs and other investors.

To avoid this stock market collapse, the HKMA would have alternatively been forced to keep interest rates low and allow a devaluation to occur. Again, the HFs would have reaped large gains, this time through their positions in the currency markets. So speculators would have gained either through their shorts in the stock market or their shorts in the forex market. Possibly, they could have profited in both markets if they had been able first to lead to a fall in the stock market, cash in their profits and get out of their HK$ positions before the collapse of the exchange rate.[52]

Ultimately, however, the HKMA chose neither of these options, using monetary tightening to prevent a devaluation and purchasing sizable amounts of equity positions in August 1998 to support stock prices.[53] In the 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

[52]Chakavorti 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 suggest that a simultaneous shorting of the two markets could result from an increase in the probability that a devaluation may occur and poor economic fundamentals. They also explicitly model the effects of central bank intervention in the stock market (as done in Hong Kong).

[53]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% of the Hong Kong market capitalization and about 30% of the free float in the market.

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)).

Detailed evidence on the double play hypothesis and the overall market turmoil in Hong Kong in 1998 was limited until an assessment of these events was undertaken in the aforementioned HLI Working Group report (FSF (2000)). A problem with assessing the evidence was that, even if many investors were shorting both the Hong Kong stock market and its currency, that would have not implied by itself that 'manipulation' was occurring.

The macroeconomic conditions of Hong Kong and East Asia in the summer of 1998 (a sharp recession in Hong Kong, the entire East Asian region in a severe financial and economic crisis, the yen fall, the threat of a currency devaluation in China) might have led investors to be concerned about Hong Kong's stock market and believe that the currency peg may not hold with full certainty, in spite of the strong commitment of the Hong Kong authorities to maintain the currency board. So, shorting the stock market and the currency may have been a rational strategy for many investors, domestic and foreign, HLIs, HFs and otherwise. In other terms, there is an the observational equivalence between the hypothesis of rational investors shorting a currency and a stock market given expected weakening in economic fundamentals, and the hypothesis of a double play driven by attempted 'manipulation'.

The results of the FSF study and other evidence on this episode are consistent with several aspect of our theoretical analysis of the role of large players. First, economic fundamentals were weak. Second, large macro HFs appear to have detected early on such weaknesses and started to build large short positions against the currency. According to some estimates, HLIs' short positions against the HK$ were close to US$ 10 billion (6 % of GDP), and perhaps much above that figure according to other estimates (FSF (2000)). Third, some large macro HFs that had shorted the currency also took very large short positions in the equity markets, and their positions were correlated over time.[54] Fourth, knowledge that large HFs were building short

[54] "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

positions spread in the markets and other investors started to herd. Fifth, according to the local authorities (HKMA (1999) and Tsang (1998)), unsubstantiated rumors and false information about the health of the financial sector and the possibility of a devaluation were being spread in the local press and in financial market to push down the stock market, spike interest rates and put pressure on the currency. Sixth, there is some 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), pp.130-131).

Indirect evidence that some large macro HFs may have been shorting the Hong Kong currency and equity markets can be provided by econometric tests. We regress the NAV of four large macro HFs against the S&P500, the yen/dollar rate, the Hang Seng equity index and a short-term interest in Hong Kong (the 3-month HIBOR) for the May to September 1998 period. If a fund was shorting the equity market, the NAV should negatively depend on the equity index. Also, since Hong Kong had a fixed exchange rate, 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 a increase in the forward exchange rate and increase the NAV of a portfolio that has shorted the currency. Results are presented in Table 4.B and C, 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.[55]

HKMA intervention. At end August, four hedge funds accounted for 50,500 contracts or 49% 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), page 131).

[55]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.

3.5 The Malaysian ringgit

The role played by macro HFs in the fall of the ringgit, the Malaysian currency, remains controversial. On one side, the local authorities argue that their presence made a significant difference. On the other side, some studies (IMF (1998) and Brown, Goetzmann, and Park (1998)) seem to suggests that their role was minor.

It is obvious that, as in the case of many other currencies in the region, the pressures on the ringgit were indeed driven by fundamental weaknesses in the economy, a large current account deficit and a structurally weak financial system. Financial and trade contagion from the fall of other ASEAN currencies also contributed to weakening the ringgit. The more substantial and relevant issue is, rather, whether HFs were 'leaders of the pack' or not in the circumstances that triggered the fall of the ringgit and the continued pressures on the currency throughout 1997 and 1998, and whether other investors herded on heels of these funds.

How large were HFs short position against the ringgit? The aforementioned IMF study suggests that their positions were relatively small at the time — July 1997 — when the pressure on the currency started to rise after the devaluation of the baht. Fung, Hsieh and Tsatsaronis (2000) reach similar results; using returns data on 12 HFs, they estimate that short positions against the ringgit by these funds amounted to less than $1 billion in June and July 1997.[56]

A study by Brown, Goetzmann, and Park (1998) reaches analogous conclusions. They develop estimates of the changing positions of the largest ten currency funds in the Malaysian ringgit. They find that net long or short positions in the ringgit or its correlates did fluctuate dramatically over the last four years but were not associated with moves in the exchange rates. They find that neither current nor one-month-previous ringgit returns vs. the U.S. dollar over the crisis periods can be explained by HF positions.

[56] In related study Fung and Hsieh (1999) infer the directional exposure of the Quantum Fund to several currencies from data on its weekly or daily NAVs. Analysis of Quantum's NAV for the third quarter of 1997 suggest that this fund was highly correlated with the S&P index but not with the values of the Malaysian ringitt during this period. There is no evidence that Quantum had shorted the ringitt during September 1997 when the currency fell sharply. The authors conclude that "the charges by Malaysian prime minister Mahathir Mohammad, that Quantum forced the devaluation of the Asian currencies, are not substantiated by the evidence".

More generally, they find that there have been 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, the authors did not have access to data on net positions but inferred them from observed returns, so that serious measurement errors are possible. For example, the data collected by the authors suggests that the gross foreign currency positions on the ringgit were indeed very large, at times close to 200% of Malaysian GDP. Thus, either the derived data on positions from returns are subject to significant measurement error or, if they are correct, given their large size it may be difficult to argue that such large positions had no potential effects on the value of the Malaysian currency. If one had to take at face value, the estimates of the authors, HFs had in February 1996 a short position greater than $200 billion, clearly a gross mismeasurement. Or, at the end of June 1997 when the pressure on the currency started to mount, HFs short positions reached a new peak of $100 billion (again a gross overestimate that however may signal actual significant short positions).

Ultimately, the study leaves open the possibility that large traders built sizable positions at the time of the start of the speculative pressure against the currency (late June and early July 1997), consistent with a view that HFs took large positions before other domestic and foreign investors started to short the currency. In this regard, the FSF (2000) study came to the conclusion — based mostly on circumstantial evidence — 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), p.133).

Formal econometric tests (see Table 4.D) suggest that two of four funds' NAVs were significantly correlated with movements of the ringgit after controlling for the S&P and the yen/dollar rate, suggesting the possibility of short positions on the currency.[57]

[57]In the regressions the sample period for the Jaguar Fund is 1997-1998 while it is February-July 1997 for the other three funds.

3.6 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 two papers (Reserve Bank of Australia (1999) and Hong Kong Monetary Authority and Reserve Bank of Australia (1999)). The Australian view is nuanced. The Australian authorities accept the point that a moderate depreciation of the Australian dollar might have been justified by fundamentals in the June and August 1998 episodes of currency pressure. In the first case, the pressure on the Hong Kong and Chinese currencies deriving from the weakness of the Japanese yen and concerns about the spread and deepening of the Asian crisis required a depreciation of the Australian currency to ease the pressure on the economy. In the latter episode, the Russian collapse was expected to lead to a fall in commodity prices that would have hurt the Australian economy and thus required some currency depreciation.

In spite of this fundamental pressure for a depreciation, the Australian view is that large macro HFs manipulated their foreign currency markets to achieve a depreciation well in excess of what was justified by fundamentals. They argue that, while the Australian dollar exchange rate market is very liquid and has one of the highest turnover rates among OECD countries, HFs were trying to affect their forex market in a number of ways. First, while individual HFs' capital is not very large, their ability to leverage their capital allowed them to take very large positions in currencies considered to be weak. Second, a few large HFs were allegedly effective in becoming leaders for a wide set of funds by signaling their short positions in the Australian dollars. Third, HFs were supposedly able to borrow large amounts of Australian dollar funds from Australian banks to speculate against the currency. As a result, HFs were able to take very large short positions against the Australian dollar and effectively corner the foreign exchange market.

Reportedly, the short positions of HFs and other investors against the Australian dollar were very large 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) stopped the attempt by the funds to push the value of the Australian dollar well below what was warranted by economic fundamentals.

The Australian case is interesting as the country had a regime of flexible

exchange rates, not the traditional fixed rate regime that had often been the target of speculative attacks. A systematic study of the Australian episode appears in (FSF (2000)). The study suggests that HLIs built up speculative short positions against the Aussie dollar from late 1997 onward. Such position-taking accelerated in April and May 1998, and by the end of May the currency had fallen 24% below its peak in late 1996. By June 1998, when the pressures on the currency increased, short positions of HFs and other HLIs were estimated to be in the order of $10 billion or more, about 2% of GDP.

Aggressive trading, shrinkage of liquidity, spread of rumors, contrarians moving to the sidelines, and herding along the HLI positions were among the patterns found in this episode: "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), p.128).

3.7 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, as in Australia, the country had a semi-flexible exchange rate regime; yet the authorities heavily intervened in the forward market to defend its currency when strong speculative pressures emerged in the spring of 1998. Second, as in Hong Kong, it may have experienced a 'double play'. But in this case it was the bond and forex markets, rather than the equity and forex markets, that were experiencing the dual pressure. Third, according to FSF (2000) prop desks of large international financial firms, rather than just large

macro HFs, played a role in financial market pressure.

As in previous episodes, macro policy was overall sound but the economy also suffered from a number of weaknesses in the spring of 1998. These included a fall in the price of gold and other export commodities, political uncertainty, an outlook deterioration leading to a downgrade of GDP growth forecasts. While until April 1998, many non- resident investors including HLIs had built long positions in South African assets (especially government bonds), the above weaknesses triggered a major reversal of capital flows, with non-resident outflows estimated at about 24 billion rand in May/June 1998.

These speculative pressures led — between April and August — to a 25% fall of the rand, a 40% of the equity market, and sharp increases in the yields on medium term bonds from 12.9% to 21.6%. The central bank initially responded to the pressure on the currency by aggressively intervening in the forward market in May and June (selling about $8 billion of reserves forward). Total short foreign exchange positions were estimated to be about $ 8-9 billion (approximately 7% of GDP), thus equivalent to the forward intervention. At the same time short fixed income positions in the government bond market were easily built through borrowing in the large and liquid repo market. Some suggested that a double play took the form of aggressive sales of the currency to spike short-term interest rate and make profitable short positions in the bond market.[58]

The fall in the rand accelerated in June after the Reserve Bank stopped intervening and after the publication of the forward book showed that the Reserve Bank was now vulnerable to large losses from previous forward intervention. Aggressive trading was again reported to have taken place: "at 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), p.141)

3.8 The Financial Stability Forum study on market dynamics in turmoil episodes

In our analysis above we have often built upon the FSF (2000) study. As mentioned in the introduction, the HLI working group of the FSF performed

[58] All this information is based on FSF (2000).

a study of the role of large traders in the episodes of turmoil in 1998 in six case study economies (Hong Kong, Australia, New Zealand, South Africa, Singapore and Malaysia). The HLI study group found a significant role of HFs and prop desks in the episodes of turmoil in 1998.[59]

The overall analysis and results of this extensive study are consistent with some of the implications of our theoretical analysis. Although it was hard to reach a consensus on the controversial issues of market destabilization and manipulation, the group concluded that:

- "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.

[59]For example, circumstantial evidence was found of several aggressive trade practices in several of these episodes. "It was suggested by some market participants that HLIS may have attempted at times to influence the course of market prices to their own advantage. Such influence was thought principally to take the form of 'talking the book' and aggressive trading. Large positions and the possibility of still larger positions can be significant information in a market and some market participants saw HLIs as seeking to exploit their knowledge of their own positions. It is, of course, hard to distinguish mild 'talking one's book' from more objectionable behavior... Aggressive trading was reported to have taken a number of forms but its extent and impact are difficult to asssess. Given the importance of other participants' momentum trading, heavy trading by HLIs at illiquid hours, during lunchtime in the home market, or in quiet periods between major centers' active trading times, was viewed by some market participants as implying attempts to move rates rather than get transactions executed at the best price." (FSF (2000), p.120)

- "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 judgements 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), pp.125-126).

As a conclusion to the assessment of the 1998 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 had to reduce their leverage and their short positions 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, that caused losses to HLIs that had heavily shorted the yen to play the aforementioned 'carry trade' to finance positions in other markets. Also domestic actions in these economies put a squeeze on investors that had shorted the forex and other markets: the massive Hong Kong intervention in its equity

market; capital controls in Malaysia; a squeeze on bond-shorters in South Africa when South African long-term institutional holders of bonds jointly started to buy bonds and cut back lending to the repo market, thus forcing short sellers to cover their positions. In all these cases, 'unorthodox' policy action put a squeeze on speculative short positions.[60]

3.9 Evidence on herding, positive feedback trading, return momentum and reversals

Given the possible importance of herding and other types of market dynamics in the discussion of the role of large players in episodes of currency and financial turmoil, we conclude our study with a general overview of the empirical literature on these phenomena.

Initial empirical tests of herding, positive and negative feedback[61] models were performed in a domestic economy context. One of the main stylized results is that, while at short horizons of up to one year there is evidence of herding and positive feedback trading[62] and momentum in returns (i.e. positive autocorrelation of returns), at longer horizons there are significant return reversals (i.e. negative autocorrelation in returns).[63] These results

[60]See the 1999 IMF's International Capital Market Report (IMF 1999) for a more detailed discussion of these and other 'unorthodox' interventions in financial markets.

[61]Recall that positive feedback trading is defined as buying winners and selling losers, while negative feedback trading is defined as contrarian behavior.

[62]Lakonishok, Vishny and Shleifer (1992) use a data set of quarterly portfolio holdings of 769 all-equity pension funds between 1985 and 1989 to evaluate the potential effects of their trading on stock prices. At the level of individual stocks at quarterly frequencies, they find no evidence of substantial herding or positive feedback trading by pension fund managers, except in small stocks, Also, they do not find strong cross-sectional correlation between changes in pension funds' holdings of a stock and its abnormal return; thus, there is not evidence that institutional investors destabilize the price of individual stocks. Conversely, Grinblatt, Titman and Wermers (1995) find evidence of positive feedback trading in a sample of 274 mutual funds during the 1975-1984 period. Similar evidence on herding was found by Wylie (1997) for UK funds. Wermers (1998) finds much weaker evidence of herding among U.S. mutual funds in the 1975-1994 period. Edelen and Warner (1999) find further evidence of positive feedback trading by considering a data set of semi-weekly and daily flow data and return on U.S. equity funds.

[63]Momentum in returns (or positive autocorrelation in returns) at short horizons has been found by a large number of studies (Titman and Jagedeesh (1998) , Rouwenhorst (1998) , Asness, Liew and Stevens (1997)). Evidence of return reversals at longer horizons

are not fully compatible with full market efficiency as they suggest some predictability in asset returns. In the domestic context, such results are consistent with the view that fads and cycles of excessive investors' optimism and pessimism lead, in the short run, asset prices to overreact to news and move away from fundamentals; thus, negative autocorrelation at longer horizons is consistent with the need for a correction that brings asset prices back to their fundamental value.

More interesting and relevant for our purposes are international studies that include analyses of these phenomena in emerging markets and the role played by foreign (offshore, HFs, institutional) investors versus domestic investors.

A number of studies look at the relative portfolio behavior of domestic versus foreign investors and of individual investors versus institutional investors by considering the behavior of country funds. Frankel and Schmukler (1996, 1998) studied the relative role of domestic versus international investors in the Mexican crisis using closed end fund data. Their results suggest that domestic residents, not international investors, played the leading role in portfolio movements and capital outflows, suggesting the existence of an informational asymmetry favoring domestic investors. However, their data set does not allow them to distinguish between the behavior of institutional versus individual investors; also, they are not able to study positive feedback trading and herding behavior. A study by Hardouvelis, La Porta and Wizman (1994) on premiums and discounts on country funds suggests that investors experience significant swings in sentiments about foreign countries equity markets.

Herding, positive feedback trading and characteristics of assets returns have been recently studied for a number of small and emerging economies. The phenomenon of return momentum and return reversals, initially found for U.S. stocks, has also been found for other advanced economies markets and emerging markets.[64] Such results for emerging markets are consistent with a view of boom and bust cycles in international capital flows: excessive investors' optimism may lead to surges of capital flows to emerging markets that may turn out to be excessive; in turn, the adjustment of such asset

in a broad range of asset markets has been found in a number of studies (DeBondt and Thaler (1985), Lakonishok, Shleifer and Vishny (1994), Richards (1997)).

[64]Rouwenhorst (1998), Asness, Liew and Stevens (1997) and Richards (1995, 1996, 1997).

bubbles often takes the form of currency and financial crises that also lead to overshooting of asset prices relative to fundamentals. This overshooting eventually causes a recovery of asset prices that, while representing a mean reversion in return, may also turn out to be excessive relative to the movements in fundamentals. The boom-bust-boom cycle observed in Asia in the 1995-1999 period may be an example of such asset market dynamics.

Some studies also suggest that smaller economies may be more vulnerable to return reversals: for example Richards (1997), in his study of 16 advanced economies, finds that the largest winner-loser reversals are observed for two smaller markets (Norway and Denmark). This suggests that small open economies, such as emerging markets, may be more vulnerable to large swings in capital flows driven by changes in sentiment of domestic and foreign investors. However, Richards (1997) finds that even large markets such as the U.S. experience substantial return reversals.

Two recent studies on herding and positive feedback trading have looked at the experience of Korea. Choe, Kho and Stultz (1998) examine the impact of foreign investors on stock returns in Korea from November 30, 1996, to the end of 1997 using trade data. They find strong evidence of positive feedback trading and herding by foreign investors before the Korean economic crisis of 1997. The evidence of herding becomes weaker during the crisis period and positive feedback trading by foreign investors disappears. They find no evidence that trades by foreign investors had a destabilizing effect on Korea's stock market over their sample period. In particular, the market adjusted quickly and efficiently to large sales by foreign investors, and these sales were not followed by negative abnormal returns amplifying their impact.

Kim and Wei (1999a) compare the trading behavior of different categories of foreign portfolio investors in Korea before and during the currency crisis. First, non-resident institutional investors are positive feedback traders before and after the crisis, whereas resident investors are negative feedback (contrarian) traders prior to the crisis and switch to positive feedback traders during the crisis. Second, individual investors herd significantly more than institutional investors. Non-resident (institutional as well as individual) investors herd significantly more than their resident counterparts. Third, differences in the Western and Korean news coverage are correlated with differences in net selling by non-resident investors relative to resident investors.

One of the concerns about offshore investment funds (HFs and other offshore financial institutions) is their possible role in exacerbating volatility

in the markets in which they invest. Offshore investment funds are alleged to engage in trading behaviors that are different from their onshore counterparts. Because their behavior is less moderated by tax consequences, and because they may be subject to less supervision and regulation, the offshore funds may trade more intensely. They could also pursue more aggressively positive feedback trading or herding, contributing to greater volatility in the market.

Using a data set on actual month-end trading positions of foreign funds in the Korean stock market, Kim and Wei (1999b) compare the trading behavior in Korea by offshore funds with that of their onshore counterparts registered in the United States and the United Kingdom. First, they find evidence that the offshore funds trade more intensely than their onshore counterparts. Second, however, there is no evidence that the offshore funds engage in positive feedback trading. In contrast, there is strong evidence that the funds from the US and UK do so. Third, while offshore funds herd, they do so significantly less than the onshore funds from the US or UK. This study thus suggests that offshore funds were not a destabilizing force in the case of the Korea crisis.

This study has a number of potential limitations. First, as purchases of Korean stocks by foreign investors were restricted (in a number of dimensions) until late 1998, HFs and other offshore investors may have been limited in their ability to speculate in the Korean stock market. Second, the study does not consider the possibility that offshore funds were engaged in more complex trading strategies involving both positions in the Korean stock market and in their exchange and money markets.

Froot, O'Connell and Seasholes (1998, 1999) explore the behavior of daily, international portfolio flows into and out of 46 advanced and developing countries from 1994 through 1998. Their data are from State Street Bank & Trust (one of the world largest custodian banks) and encompass over 4 million trades by client institutions. This data set is unique as it includes detailed daily data on the actual trades of investors. However, it does not include trading by HFs as the data covers mostly large institutional investors from developed countries (pensions, endowments, mutual funds and governments).

There are a number of interesting results in this study. First, there are regional factors within the flows: there is a small but significant correlation in contemporaneous cross-country flows, and this correlation is stronger within regions. Such regional factors within flows have increased in importance over

time. Second, the flows are strongly persistent-the persistence decays only slowly over time; outflows are more persistent than inflows. Third, flows are strongly influenced by past returns, so that investor trend-following (positive feedback trading) is apparent. Fourth, flows have forecasting power for future emerging market returns, but not for developed country returns; this suggest that international investors appear to act on valuable private information on emerging markets.

Finally, international investors did not abandon emerging markets during the 1997-98 crisis as they remained net buyers of emerging market equities in the July 1997-July 1998 period. The net purchases, however, were at a significantly reduced rate: daily inflows to all emerging markets and Asia were 40% and 30% respectively relative to pre-crisis (1994-97) levels. The decline in emerging market prices in 1997-98 is explained by the statistical model developed in the paper: shocks to flows generate expectations of additional future flows; current prices increase in anticipation of further future flows; if future flows do not materialize, prices decline. Indeed, prices in Asia had been bid up in anticipation of future flows; when these flows significantly slowed down, prices declined.

In summary, the overall evidence is mixed and not conclusive. Phenomena such as noise trading, herding and momentum trading seem to occur in international asset markets and can be a cause of divergence of asset prices from fundamentals. While herding and positive feedback trading seem to occur from time to time, most empirical studies imply that foreign institutional investors and HLIs (proxied by offshore investors) do not appear to herd or be engaged in momentum trading more than other — including domestic — investors. Many of the available studies, however, do not include the episodes of currency and market turmoil in 1998 that were the subject of analysis of the FSF study. The latter found greater evidence of a range of market dynamics phenomena in the six case studies considered; however, the evidence was mostly circumstantial as detailed data were not available.

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.

The model presented in our paper provides a stylized but rigorous representation of how exchange rate stability is affected by the presence of large players. The analysis emphasizes how structural factors (such as the strength of economic fundamentals) and the market power of large traders (defined in terms of their asset size, their relative actual or perceived informational advantage, and their ability to influence other traders by 'signaling' and 'move first') jointly determine the fragility of a currency arrangement.

A number of other issues, raised by the empirical evidence, have been discussed in some detail at a less formal level: the role of risk aversion and leverage constraints in affecting small market participants' willingness to take contrarian positions against the large traders; the advantages of moving first and secretly in position-taking when the build-up of net positions leads to adverse price movements (such as increases in interest rates and forward rates); the relative benefits of 'talking one's book' and spreading 'rumors' once short positions have been taken; the effects of a reduction in market liquidity in periods of currency pressure on large traders' position-taking and unwinding; the relation between traders' size and their leverage ability; the possibility and benefits of aggressive trading practices and attempts to 'manipulate' currencies as a way to trigger a currency attack; the timing and dynamics of herding phenomena.

Empirical evidence on the role of large players includes general studies of HFs' behavior and strategies, herding phenomena, momentum trading, interactions between domestic and foreign investors or between small and large traders, and some studies of the episodes of turmoil in the 1990s. Our own work first suggests that, for major currencies, there is some association between the net positions of the large players and subsequent levels and movements of exchange rates. This evidence is consistent both with a view that large players may be better informed and that the size of their positions affect exchange rates. Moreover, we revisited episodes of currency turmoil in the 1990s and found circumstantial evidence suggesting that large players may have indeed affected market dynamics.

In sum, our analysis and reassessment of recent episodes of currency turmoil is consistent with many of the implications of the theoretical analysis and, in general, does not contradict the conventional wisdom according to which: large players are better informed or perceived to be better informed; are able to build sizable short positions via leverage; tend to move first based on an assessment of fundamental weaknesses; contribute to currency pressures in the presence of weak or uncertain fundamentals; 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 available to them; may recur to aggressive trading practices. Undoubtedly, future theoretical and empirical research will shed further light on many of the aspects here discussed.

We conclude with three observations. First, lately the role of large players in financial markets may have partly changed. Some large macro hedge funds and other HLIs have closed down or retrenched their operations.[65] 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. It is still too early to assess whether such liquidity shrinkage has occurred and what are its causes and consequences. But this is also another fertile area for further research.

Second, the disappearance of several large macro HFs after 1998 may have something to do with the ongoing phasing out of fixed exchange rate regimes; one after the other most non-institutionalized exchange rate pegs have been abandoned (Mexico, Asia, Russia, Brazil). Large macro bets against a peg are easier to make, in the sense that 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 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 the incentive to speculate, as well as the scope for sharp (thus profitable) adjustment. Indeed,

[65] 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 billlion of capital to its investors; several forex prop desks of large financial firm have been either closed or scaled down in their operations.

allegedly, large macro directional bets on the flexible exchange rates of the G3 economies were behind the 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 started to address these issues within the HLI working group of the Financial Stability Forum. 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 the issue of systemic risk, the recommendations of the report of this working group 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, collateral management techniques), better creditor oversight (greater intensity on firms that are falling short, periodic reaffirmation of compliance with sound practices), and enhanced 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 also 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.

References

[1] Ackerman, Carl, Richard McEnally, and David Ravenscraft (1999). "The Performance of Hedge Funds: Risk, Return, and Incentives." The Journal of Finance Vol.54, June, 833-874.

[2] Allen, Franklin and Douglas Gale (1992). "Stock-Price Manipulation." The Review of Financial Studies 5: 503-529.

[3] Allen, Franklin and Gary Gorton (1992). "Stock price manipulation, market microstructure and asymmetric information." European Economic Review 36: 624-630.

[4] Asness, Clifford S., John M. Liew and Ross L. Stevens (1997). "Parallels between the Cross-Sectional Predictability of Stock Returns and Country Returns." Journal of Portfolio Management, Vol. 23, 79-87.

[5] Bagnoli, Mark and Barton L. Lipman (1990). "Stock price manipulation through takeover bids", Working Paper, Graduate School of Industrial Administration, Carnegie Mellon University, Pittsburgh, PA.

[6] Barclay, M.J. and J.B. Warner (1993). "Stealth Trading and Volatility: Which Trades Move Prices?" Journal of Financial Economics, Vol. 34, 281-305.

[7] Benabou, Roland and Guy Laroque (1990). "Using privileged information to manipulate markets: Insiders, gurus, and credibility." Working Paper, MIT, Cambridge, MA.

[8] Brown, Stephen J., William N. Goetzmann, Roger G. Ibbotson (1997). "Offshore Hedge Funds: Survival and Performance 1989-1995." NBER Working Paper No.5909, January.

[9] Brown, Stephen, William Goetzmann, and James Park (1998). "Hedge Funds and the Asian Currency Crisis of 1997." NBER Working Paper No.6427, February.

[10] Buiter, Willem, Giancarlo Corsetti and Paolo Pesenti (1998 a). Financial markets and European monetary cooperation. The lessons of the

1992-93 Exchange Rate Mechanism crisis. Cambridge, UK: Cambridge University Press.

[11] Buiter, Willem, Giancarlo Corsetti and Paolo Pesenti (1998 b). "Interpreting the ERM crisis: country-specific and systemic issues." Princeton Studies in International Finance No.84, International Finance Section, Princeton University, March.

[12] Carlsson, H. and E. van Damme (1993). "Global Games and Equilibrium Selection." Econometrica 61, 989-1018.

[13] Chakravorti, Sujit and Subir Lall (2000). "The Double Play: Simultaneous Speculative Attacks on Currency and Equity Markets." Federal Reserve Bank of Chicago, December.

[14] Choe, Hyuk, Bong-Chan Kho, and René M. Stulz (1998). "Do foreign investors destabilize stock markets? The Korean experience in 1997." NBER Working Paper No. 6661, July.

[15] Corsetti, Giancarlo, Amil Dasgupta, Stephen Morris, and Hyun Song Shin (2000). "Does One Soros Make a Difference? The Role of a Large Trader in Currency Crises." Cowles Foundation Discussion Paper 1273, Yale University.

[16] Corsetti, G., P. Pesenti and N. Roubini (1999). "What Caused the Asian Currency and Financial Crisis?" Japan and the World Economy.

[17] Dasgupta A. (1999). "Social Learning with Payoff Complementarities." Yale University, http://www.econ.yale.edu/~amil/research.html

[18] DeBondt, Werner F.M. and Richard H. Thaler (1985). "Does the Stock Market Overreact?" Journal of Finance 40, 793-805.

[19] Easley, D. and M. O'Hara (1987). "Price, Trade Size, and Information in Securities Markets." Journal of Financial Economics, Vol. 19, 69-90.

[20] Edelen, Roger M. and Jerold B. Warner (1999). "Why Are Mutual Fund Flow and Market Returns Related? Evidence from High-Frequency Data?" Warthon School, mimeo.

[21] Eichengreen, Barry (2000). "The EMS Crisis in Retrospect." NBER Working Paper No.8035, December.

[22] Eichengreen, Barry, and Donald Mathieson (1999). "Hedge Funds: What Do We Really Know?" International Monetary Fund Economic Issues No.19, September.

[23] Eichengreen, Barry, and Charles Wyplosz (1993). "The unstable EMS." Brookings Papers on Economic Activity 1, pp.51-143.

[24] Edwards, Franklin R. and Jimmy Liew (1999). "Hedge Funds and Managed Futures as Asset Classes." The Journal of Derivatives, Summer.

[25] Financial Stability Forum (FSF) (2000). Report of the Market Dynamics Study Group of the FSF Working Group on Highly Leveraged Institutions, April, http://www.fsforum.org/Reports/RepHLI.html.

[26] Frankel, Jeffrey and Sergio Schmukler (1996). "Country Fund Discounts and the Mexican Crisis of December 94: Did Local residents turn Pessimistic Before International Investors?" NBER Working Paper No. 5714.

[27] Frankel, Jeffrey and Sergio Schmukler (1998). "Country Funds and Asymmetric Information." World Bank, February.

[28] Froot, Kenneth, Paul O'Connell and Mark Seasholes (1999). "The Portfolio Flows of International Investors." Harvard Business School Working Paper, August.

[29] Fung, William and David A. Hsieh (1997). "Empirical Characteristics of Dynamic Trading Strategies: The Case of Hedge Funds." Review of Financial Studies 10 (2), 275-302.

[30] Fung, William and David A. Hsieh (1998). "Performance Attribution and Style Analysis: From Mutual Funds to Hedge Funds." Fuqua School of Business, Duke University, February.

[31] Fung, William and David A. Hsieh (1999a). "Hedge Fund Risk Management." Fuqua School of Business, Duke University, February.

[32] Fung, William and David A. Hsieh (1999b). "A Primer on Hedge Funds." Journal of Empirical Finance, September, 309-31.

[33] Fung, William, David A. Hsieh and Tsatsaronis (2000). "Do Hedge Funds Disrupt Emerging Markets?" Brookings-Wharton Papers on Financial Services.

[34] Hardouvelis, Gikas, Rafael La Porta and Thierry A. Wizman (1994) "What Moves the Discount on Country Equity Funds" in Jeffrey A. Frankel, ed., The Internationalization of Equity Markets, University of Chicago Press, 345-397.

[35] Hartigan, J. (1983). Bayes Theory. Springer-Verlag.

[36] Hennessee, E.L. (1994). The Republic New York Securities Quarterly Hedge Fund Review, March.

[37] Hong Kong Monetary Authority (1999). "Capital Flows, Hedge Funds, and OTC Markets: An Emerging Markets Perspective." May.

[38] Hong Kong Monetary Authority and Reserve Bank of Australia (1999). "The Impact of Highly Leverage Institutions on Financial Markets".

[39] International Monetary Fund (1998). "Hedge Funds and Financial Market Dynamics." IMF Occasional Paper #166, May.

[40] International Monetary Fund (1999). International Capital Markets, September.

[41] Ito, Takatoshi (1999). "The Development of the Thailand Currency Crisis: A Chronological Review." Working Paper, Hitotsubashi University.

[42] Jarrow, Robert A. (1992). "Market manipulation, bubbles, corners and short squeezes." Journal of Financial and Quantitative Analysis 27(3), September, 311-36.

[43] Kim, Woochan, and Shang-Jin Wei (1999a). "Foreign Portfolio Investors Before and During a Crisis." NBER Working Paper No. W6968, February.

[44] Kim, Woochan, and Shang-Jin Wei (1999b). "Offshore Investment Funds: Monsters in Emerging Markets?" NBER Working Paper No.7133, May.

[45] Kodres, Laura and Matthew Pritsker (1997). "Directionally-Similar Position Taking and Herding by Large Futures Market Participants." unpublished working paper, June.

[46] Kumar, Praveen and Duane J. Seppi (1990). "Future manipulation with 'Cash Settlement'." Journal of Finance, Vol. 47, 1485-1502.

[47] Kyle, Albert S. (1984). A Theory of futures market manipulations, in: Ronald Anderson, ed., The industrial organization of future markets (Lexington Books, Lexington, MA) 141-174.

[48] Kyle, Albert S., 1985, continuous auctions with insider trading, Econometrics 46, 1429-1445.

[49] Lakonishok, Josef, Andrei Shleifer and Robert Vishny (1992); "The Impact of Institutional Trading on Stock Prices"; Journal of Financial Economics; 32:23-43.

[50] Lakonishok, Josef, Andrei Shleifer and Robert Vishny (1994) "Contrarian Investment, Extrapolation, and Risk," Journal of Finance; Vol. 49, 1541-78.

[51] Lee, Yi-Tsung, Ji-Chai Lin and Yu-Jane Liu (1999) "Trading Patterns of Big Versus Small Players in an Emerging Market: An Empirical Analysis," Journal of Banking and Finance, Vol.23, 701-725.

[52] Liang, Bing (1998) "On the Performance of Hedge Funds," Financial Analysts Journal, July/August.

[53] Morris, Stephen and Hyung Shin (1998); "Unique Equilibrium in a Model of Self-Fulfilling Currency Attacks"; American Economic Review; 88:587-97.

[54] Morris, Stephen and Hyung Shin (2000); "Global Games: Theory and Applications," mimeo, Yale University.

[55] Mussa, Michael, Alexander Swoboda, Jeromin Zettelmeyer and Olivier Jeanne (1999) "Moderating Fluctuations in Capital Flows to Emerging Market Economies," unpublished, IMF, May.

[56] Oberuc, Richard (1994) "Performance of Hedge Funds Relative to Traditional Investments," Working Paper, LaPorte Asset Allocation System.

[57] Obstfeld, Maurice (1996). "Rational and Self-fulfilling Balance-of-Payments Crises." American Economic Review 76(1), March, 72-81.

[58] Reserve Bank of Australia (1999) "Hedge Funds, Financial Stability and Market Integrity", March.

[59] Richards, Anthony J. (1995) "Comovements in National Stock Market Returns: Evidence of Predictability But Not Cointegration," Journal of Monetary Economics, Vol. 36, 631-654.

[60] Richards, Anthony J. (1996) "Volatility and Predictability in National Stock Markets: How Do Emerging Markets Differ?," Staff Papers, International Monetary Fund, Vol. 43, September, 461-501.

[61] Richards, Anthony J. (1997) "Winner-Loser Reversals in National Stock Market Indeces: Can They Be Explained?," Journal of Finance, Vol.52, 2129-44.

[62] Rouwenhorst, K. Geert (1998) "International Momentum Strategies," Journal of Finance, Vol.53, 267-284.

[63] Schadler, Susan et al. (1993) "Recent Experiences with Surges in Capital Inflows," IMF Occasional Paper, No.108, Washington: IMF.

[64] Titman, Sheridan and Narasimhan Jegadeesh (1998) "Profitability of Momentum Strategies: An Evaluation of Alternative Explanations," University of Texas, mimeo.

[65] Tsang, Donald (1998) Speech at the Hong Kong Trade Development Council in Frankfurt, September 29, 1999.

[66] The President's Working Group on Financial Markets (1999), "Hedge Funds, Leverage, and the Lessons of Long-Term Capital Management", April, http://www.ustreas.gov/press/releases/docs/hedgfund.pdf,

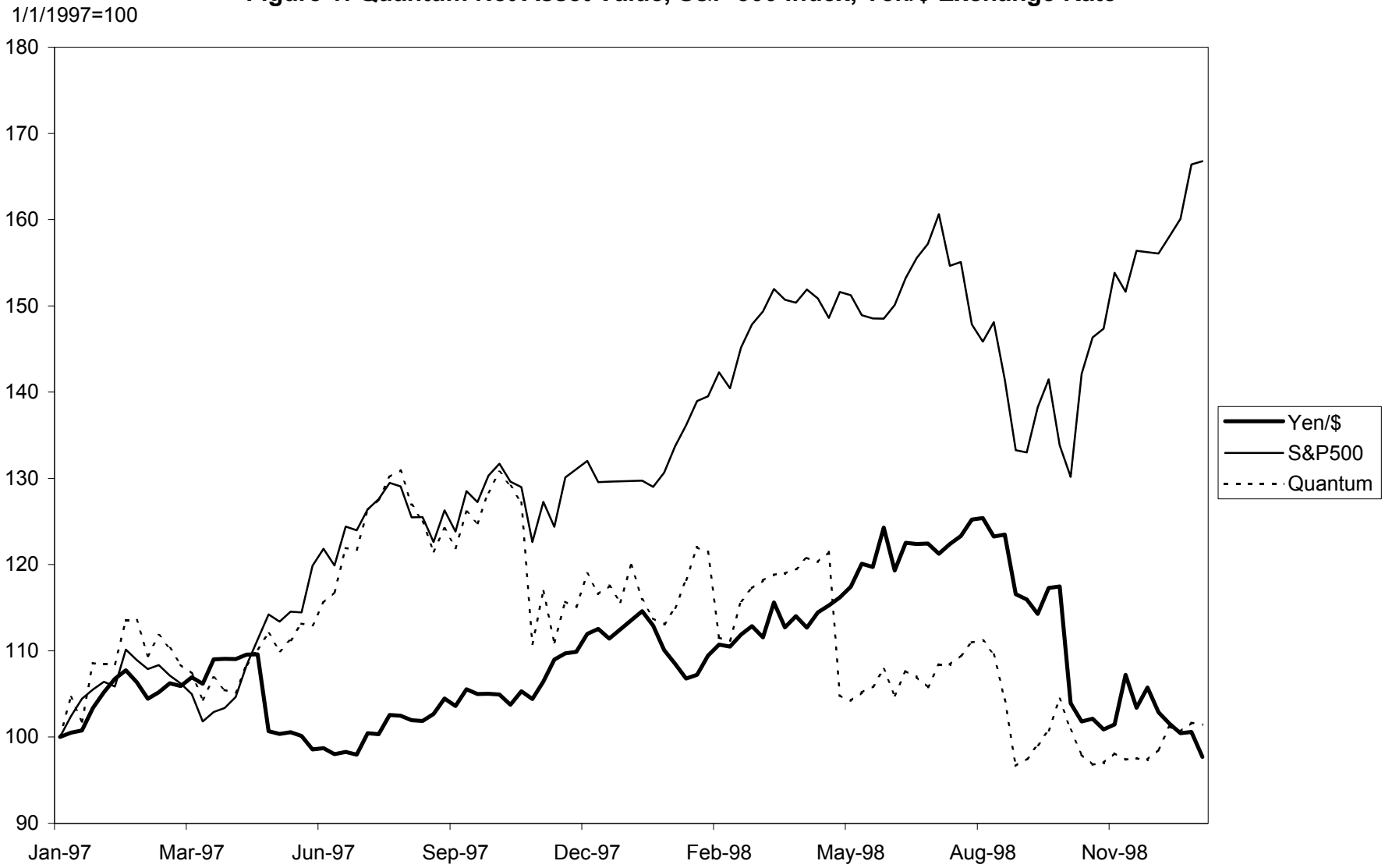
[67] Vila, Jean-Luc, 1987, The role of information in the manipulation of futures markets, CARESS Working Paper 87-26 (University of Pennsylvania, Philadelphia, PA).

[68] Vila, Jean-Luc, 1989, Simple games of market manipulation, Economics Letters 29, 21-26.

[69] Wei, Shang-Jin and Jungshik Kim (1997) "The Big Players in the Foreign Exchange Market: Do They Trade on Information or Noise?" NBER Working Paper No. W6256, November.

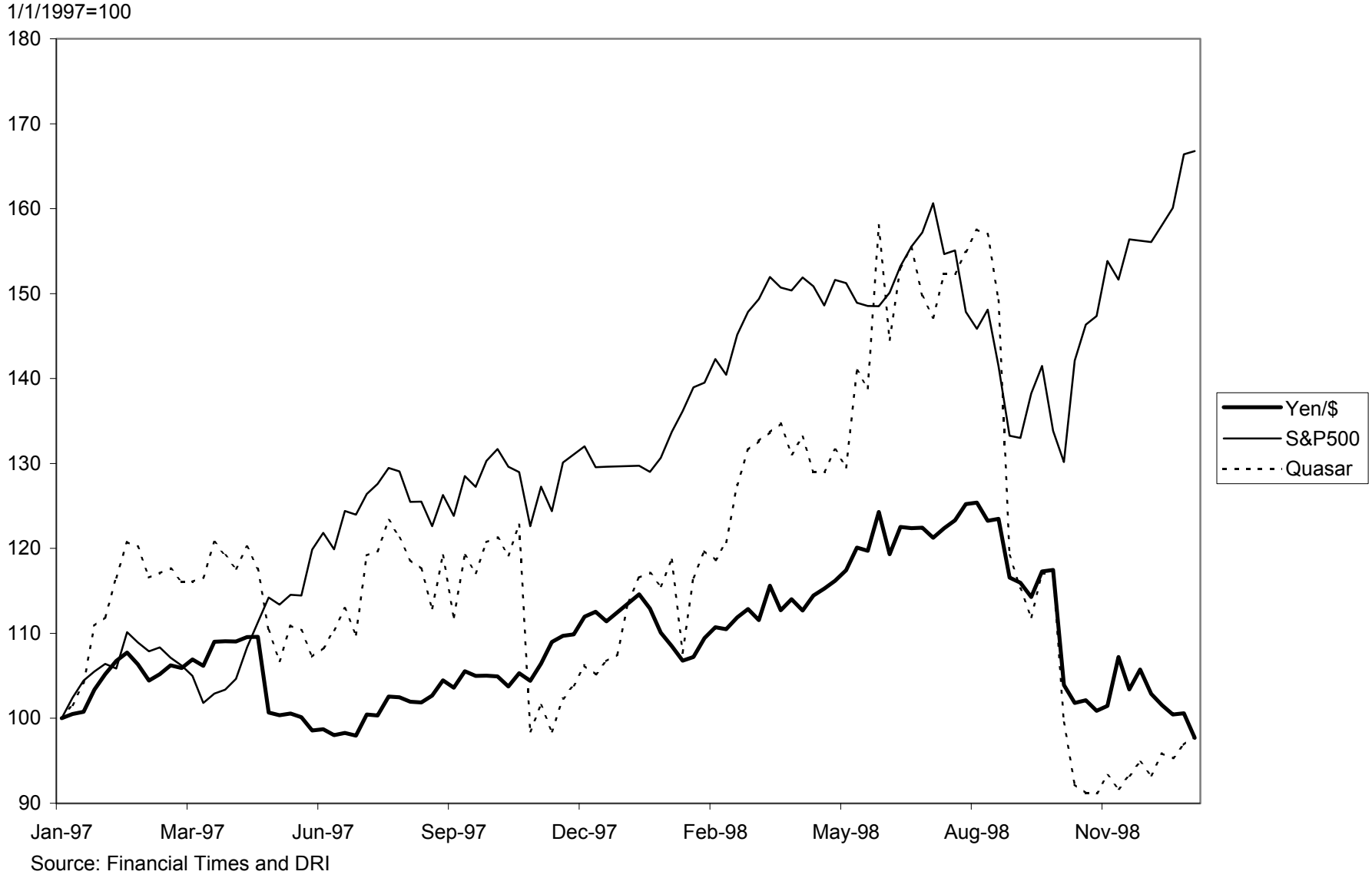
[70] Wermers, Russ (1998), "Herding, Trade Reversals, and Cascading by Institutional Investors," Working Paper, University of Colorado Boulder.

Figure 1: Quantum Net Asset Value, S&P 500 Index, Yen/$ Exchange Rate



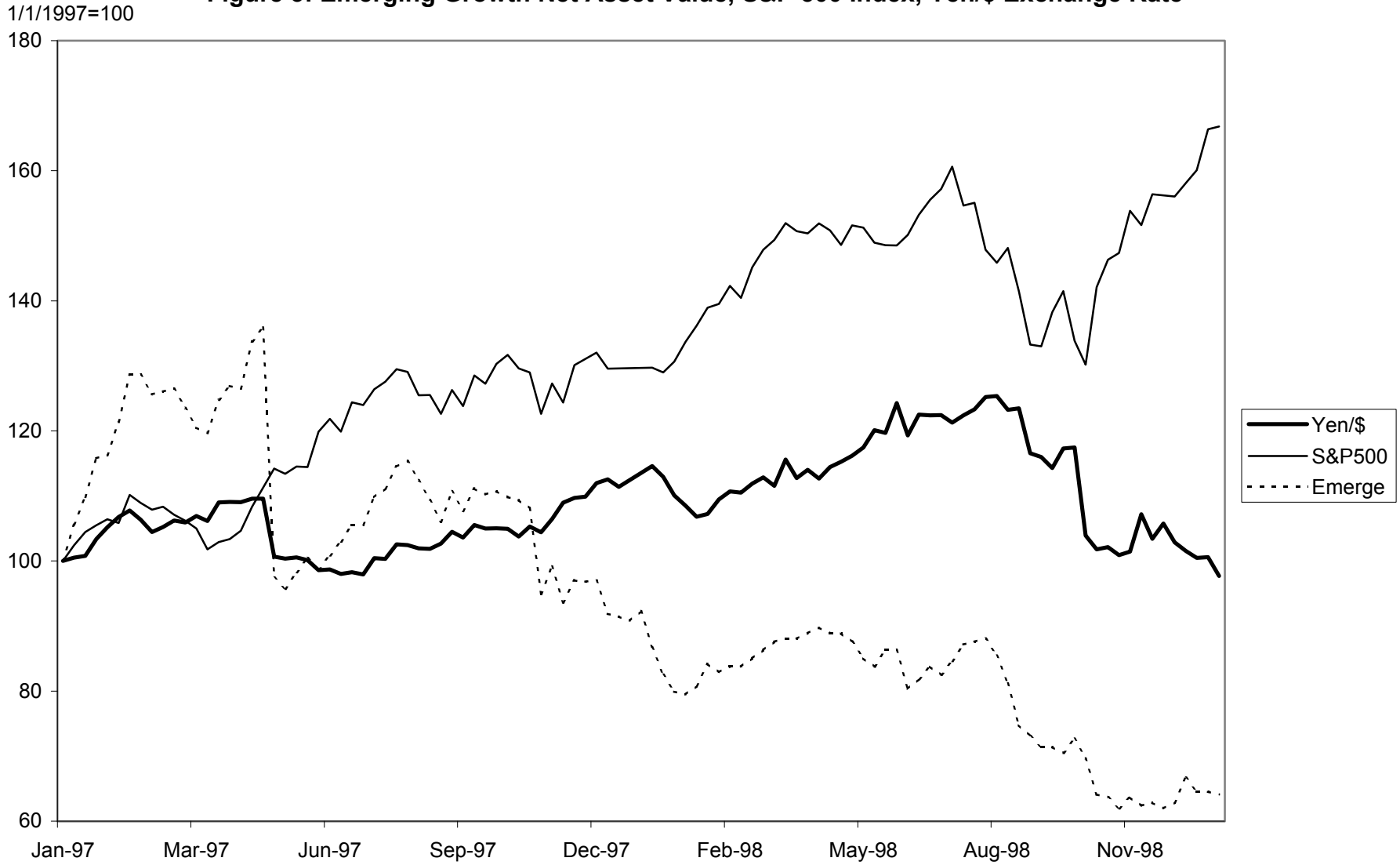
Source: Financial Times and DRI

Figure 2: Quasar Net Asset Value, S&P 500 Index, Yen/$ Exchange Rate



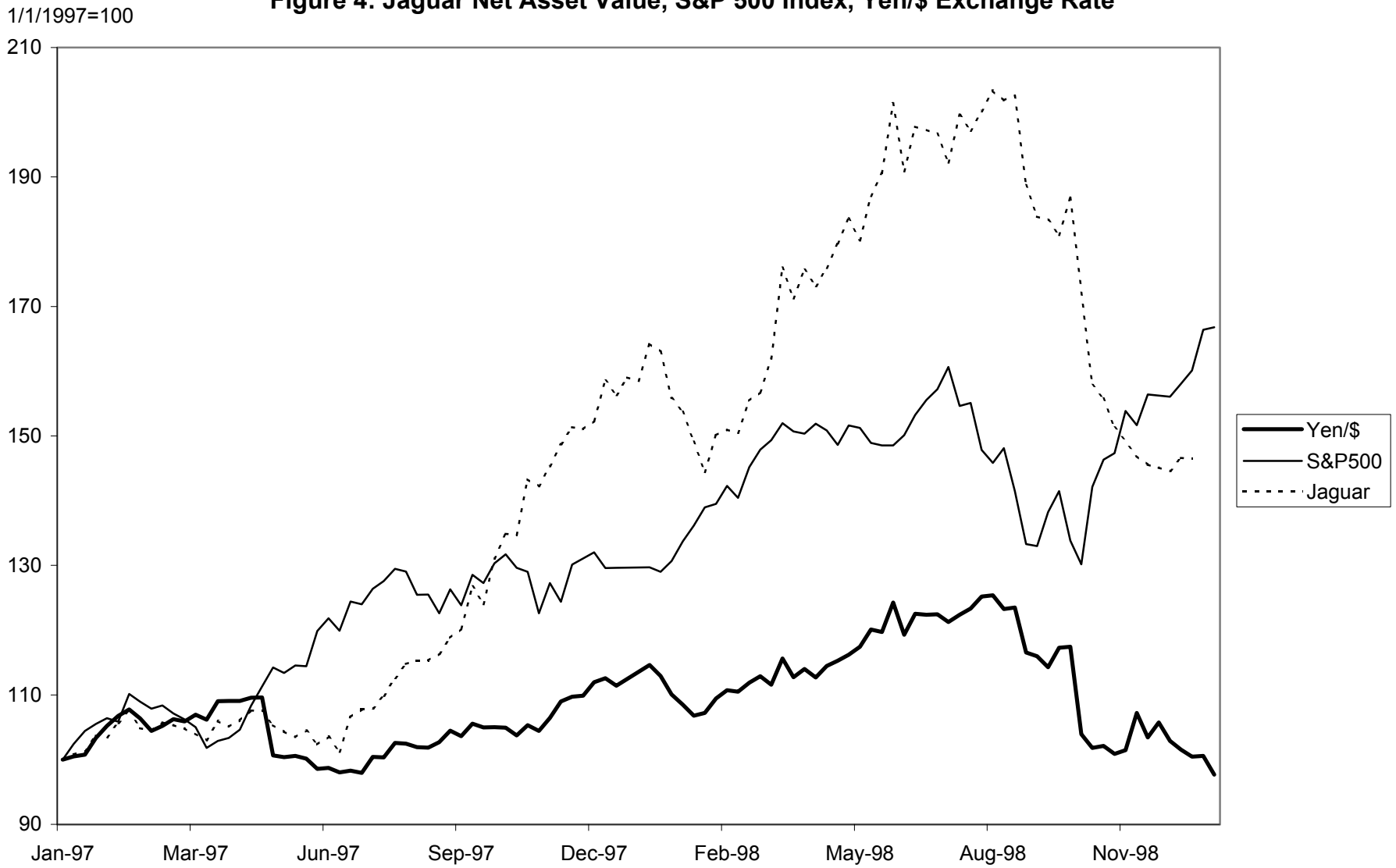
Source: Financial Times and DRI

Figure 3: Emerging Growth Net Asset Value, S&P 500 Index, Yen/$ Exchange Rate



Source: Financial Times and DRI

Figure 4: Jaguar Net Asset Value, S&P 500 Index, Yen/$ Exchange Rate



Source: Financial Times and DRI

Figure 5: Net Foreign Currency Position and Exchange Rate, UK Pound (1994-2000)

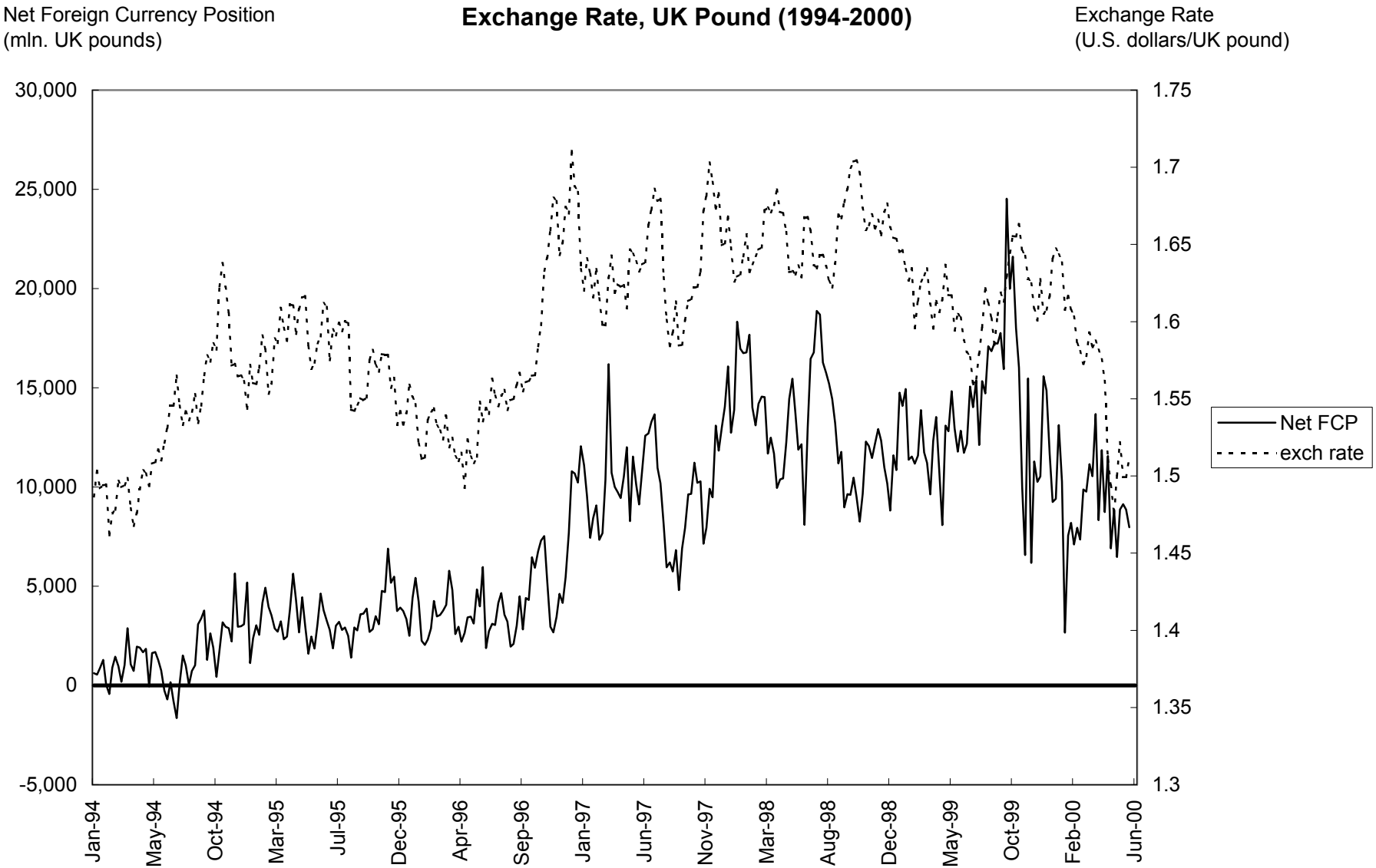


Figure 6: Net Foreign Currency Position and Exchange Rate, Swiss Franc (1994-2000)

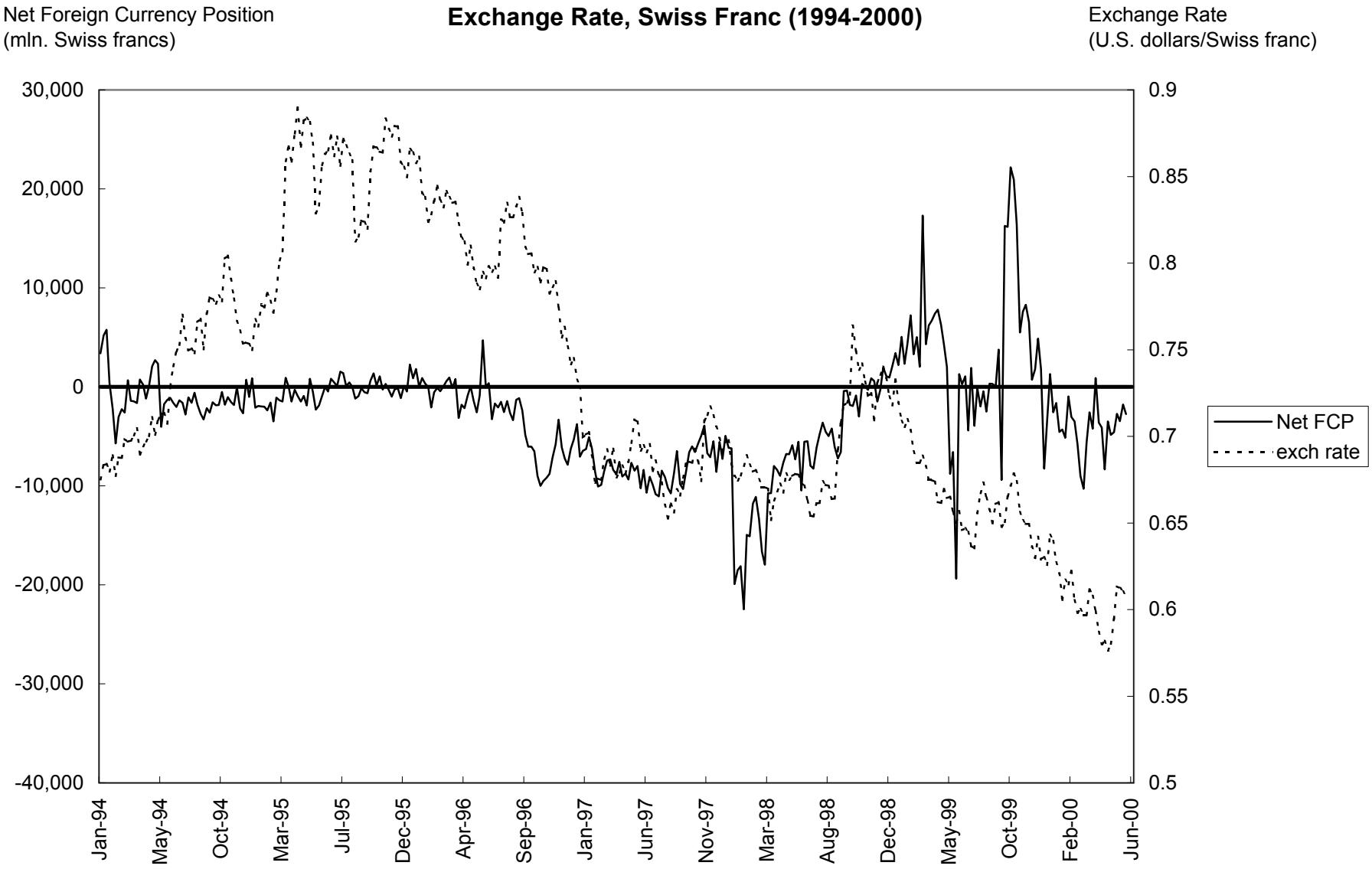


Figure 7: Net Foreign Currency Positon and Exchange Rate, Japanese Yen (1994-2000)

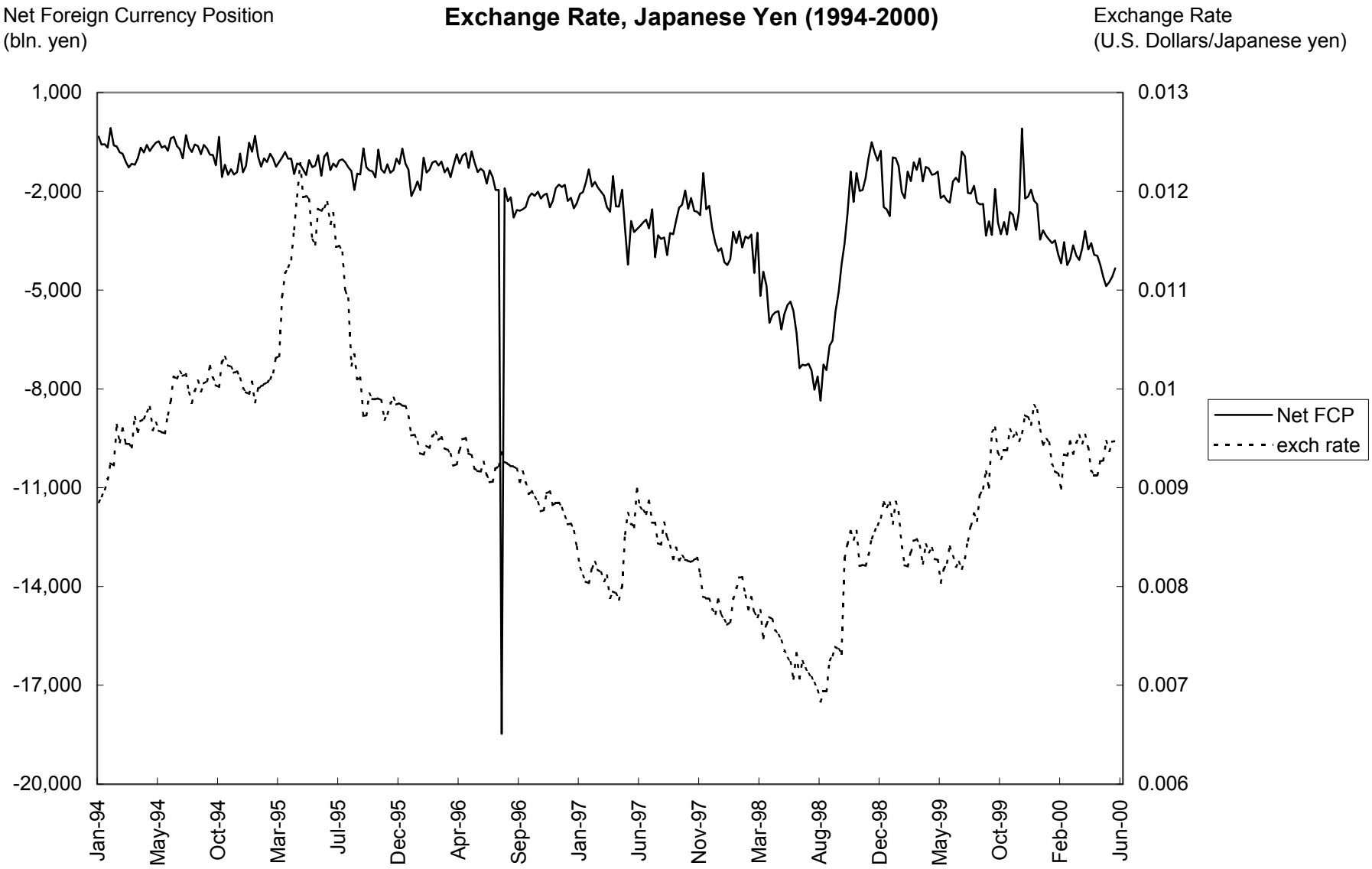


Figure 8: Net Foreign Currency Position and Exchange Rate, Canadian Dollar (1994-2000)

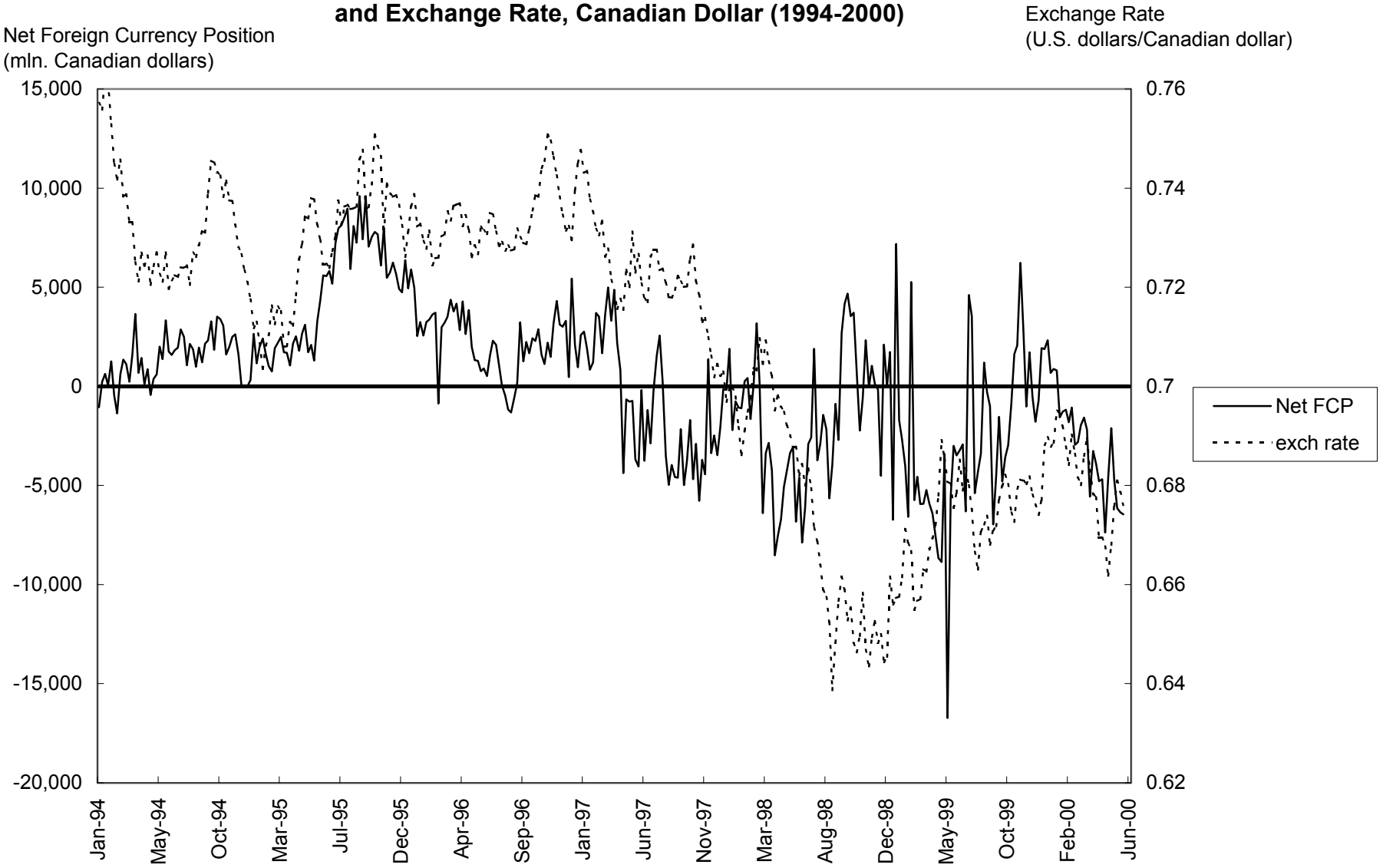


Figure 9: Net Foreign Currency Position and Exchange Rate, German Mark (1994-1998)

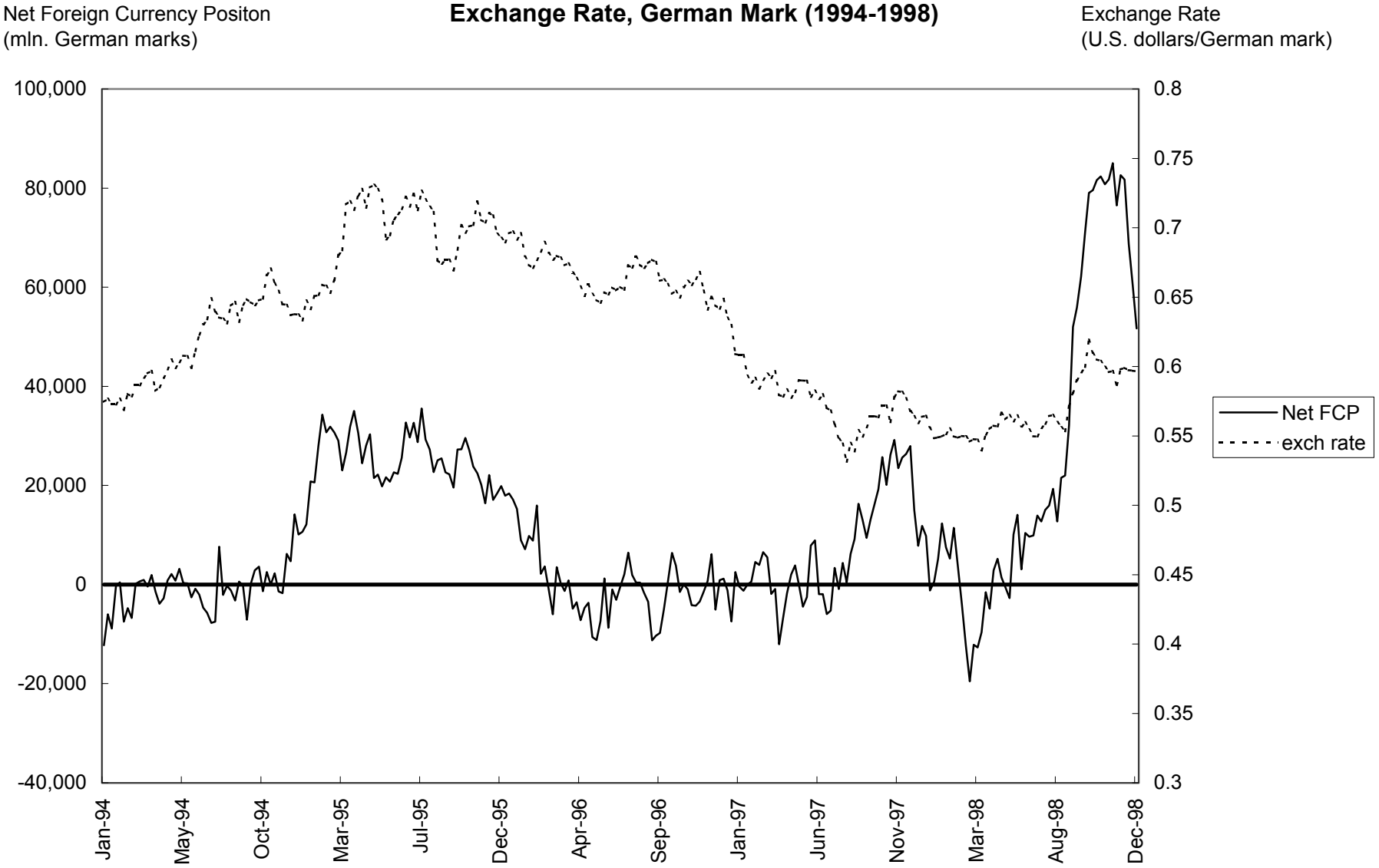


Figure 10: Net Foreign Currency Position and Exchange Rate, Euro (1999-2000)

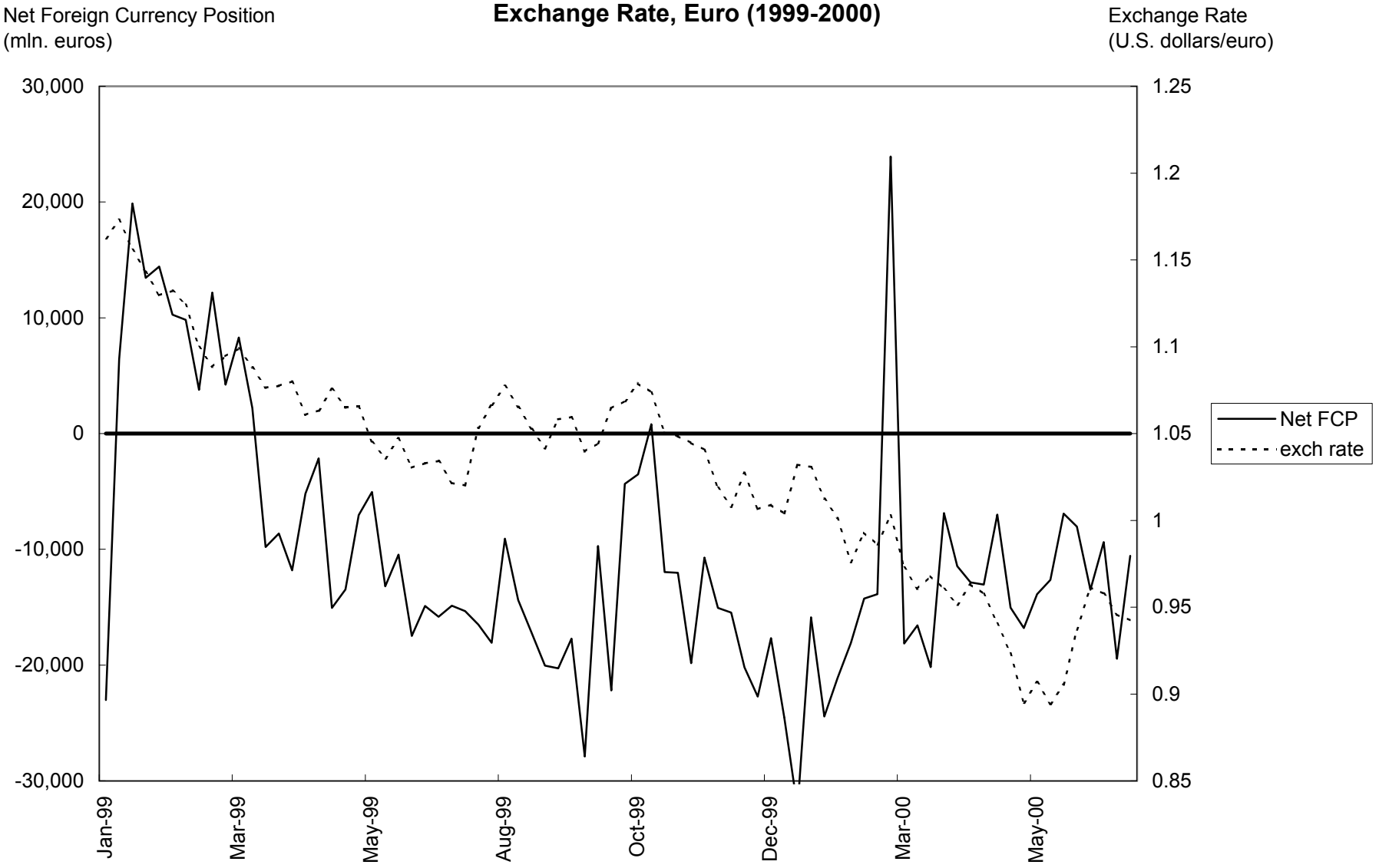


Figure 11: Net Foreign Currency Position, U.S. Dollars (1999-2000)

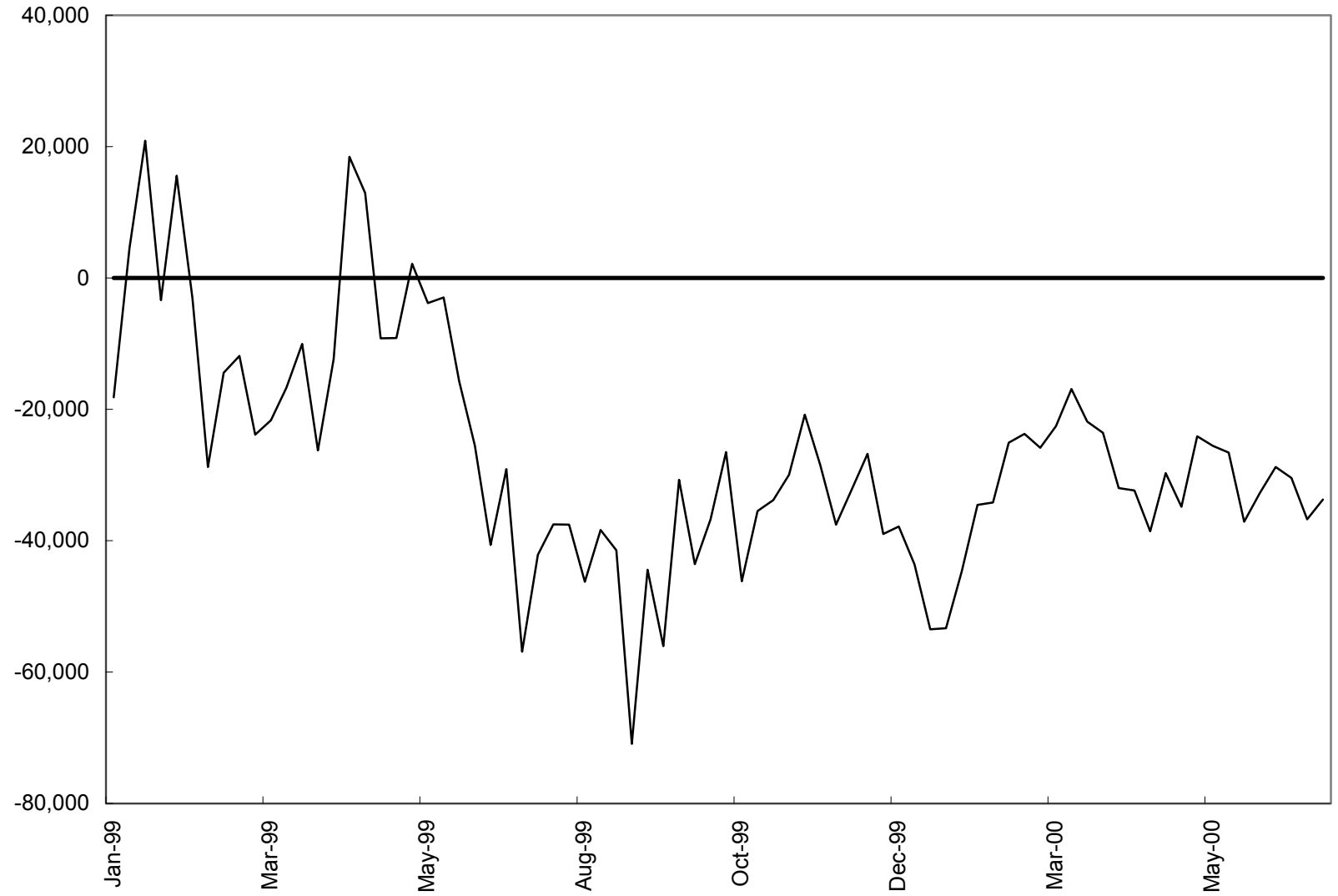


Table 1: Summary Statistics on the Treasury Foreign Currency Position Data*

	1994-2000					1994-1996					1997-2000				
	Obs	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
UK pound															
Purchased	337	622,847	165,994	339,847	917,309	155	467,122	63,818	339,847	631,167	182	755,470	96,081	568,827	917,309
Sold	337	611,583	159,274	339,060	906,447	155	463,606	61,889	339,060	622,839	182	737,607	95,455	550,143	906,447
Net Options Position	337	1,208	1,563	-5,473	6,243	155	1,065	971	-1,640	3,209	182	1,330	1,924	-5,473	6,243
Net Foreign Currency Position	337	12,472	8,551	-2,576	40,193	155	4,580	2,672	-2,576	12,291	182	19,193	5,561	4,284	40,193
Swiss franc															
Purchased	337	334,790	62,349	216,129	519,961	155	303,952	40,233	247,431	449,426	182	361,052	65,812	216,129	519,961
Sold	337	339,857	65,951	215,423	531,052	155	309,547	42,788	250,865	458,367	182	365,670	71,133	215,423	531,052
Net Options Position	337	3,191	3,073	-4,473	10,394	155	4,527	2,213	803	10,394	182	2,054	3,246	-4,473	8,340
Net Foreign Currency Position	337	-1,876	3,823	-15,385	14,936	155	-1,068	1,980	-7,897	3,942	182	-2,564	4,771	-15,385	14,936
Japanese yen															
Purchased	337	1,429,063	219,094	870,624	2,100,231	155	1,259,971	102,189	870,624	1,477,491	182	1,573,070	186,778	1,175,914	2,100,231
Sold	337	1,459,528	225,246	882,762	2,121,832	155	1,281,484	107,245	882,762	1,507,996	182	1,611,159	184,751	1,202,603	2,121,832
Net Options Position	337	10,142	3,625	2,824	23,085	155	8,427	2,852	2,824	13,996	182	11,602	3,580	4,868	23,085
Net Foreign Currency Position	337	-20,323	14,559	-173,015	-704	155	-13,086	13,843	-173,015	-704	182	-26,487	12,141	-57,232	-870
Canadian dollar															
Purchased	337	173,793	40,995	87,799	246,798	155	136,443	25,747	87,799	204,644	182	205,602	18,538	159,173	246,798
Sold	337	171,609	42,452	86,141	248,266	155	132,465	24,595	86,141	198,807	182	204,945	20,030	154,471	248,266
Net Options Position	337	-1,929	1,092	-4,410	995	155	-1,920	564	-3,215	-526	182	-1,936	1,394	-4,410	995
Net Foreign Currency Position	337	256	2,716	-11,423	7,179	155	2,058	1,770	-1,015	7,179	182	-1,279	2,424	-11,423	4,719

Table 1: Summary Statistics on the Treasury Foreign Currency Position Data* (cont.)

	1994-1998					1994-1996					1997-1998				
	Obs	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
German mark															
Purchased	259	1,252,768	126,035	1,025,474	1,694,490	155	1,214,599	103,602	1,025,474	1,557,578	182	770,123	634,121	6,927	1,694,490
Sold	259	1,248,805	116,520	1,026,360	1,643,567	155	1,215,384	101,510	1,026,360	1,547,771	182	764,871	625,759	7,609	1,643,567
Net Options Position	259	3,519	5,386	-12,705	11,892	155	6,529	2,644	-1,728	11,892	182	-1,051	4,043	-12,705	7,834
Net Foreign Currency Position	259	7,481	12,606	-10,647	50,989	155	5,744	9,237	-7,616	25,603	182	4,201	13,974	-10,647	50,989

	1999-2000				
	Obs	**Mean**	**Std. Dev.**	**Min**	**Max**
euro					
Purchased	78	1,707,984	127,198	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	-10,495	11,595	-33,426	23,981

	1999-2000				
	Obs	**Mean**	**Std. Dev.**	**Min**	**Max**
US 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:
1) Data are reported in million U.S. dollars.
2) Purchased (sold) refers to spot, forward, and futures contracts purchased (sold) in that currency.
3) Net options position is the net delta-equivalent value of the total options position.
4) Net foreign currency position is calculated as net contracts purchased plus net options position.

Table 2: Regressions of Level Exchange Rate on Net Foreign Currency Position*

	Net FCP		Net FCP	Net FCP_lag
UK pound				
1994-2000	69.0**		33.5**	37.8**
	(4.46)		(11.5)	(11.5)
1994-1996	109.0**		71.5**	47.6*
	(18.9)		(28)	(28)
1997-2000	22.4**		9.3	18.3
	(9.06)		(13)	(13.1)
Canadian dollar				
1994-2000	40.1**		23.7**	21.7**
	(3.6)		(5.47)	(5.49)
1994-1996	9.39**		6.9	4.4
	(3.53)		(6.95)	(6.89)
1997-2000	9.83*		6.2	6.7
	(5.44)		(6.49)	(6.44)
excluding outliers				
1994-2000	41.6**		25.4**	20.5**
	(3.7)		(5.76)	(5.62)
1994-1996	9.39**		6.9	4.4
	(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)		(13.3)	(13.3)
1994-1996	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	3.18**		1.81**	1.92**
	(0.269)		(0.374)	(0.374)
1994-1996	0.804*		0.7	0.76*
	(0.446)		(0.449)	(0.449)
1997-2000	1.98**		0.7	1.34*
	(0.294)		(0.785)	(0.785)
excluding outliers				
1994-2000	4.17**		3.65**	0.6
	(0.285)		(0.505)	(0.443)
1994-1996	3.97**		3.9**	0.3
	(1.2)		(1.3)	(0.47)
1997-2000	1.98**		0.7	1.34*
	(0.294)		(0.785)	(0.785)

Table 2: Regressions of Level Exchange Rate on Net Foreign Currency Position*

	Net FCP		Net FCP	Net FCP_lag
German mark				
1994-1998	3.19*		-6.7	10.2
	(1.68)		(6.65)	(6.69)
1994-1996	19.9**		2.6	17.9**
	(1.84)		(5.38)	(5.36)
1997-1998	3.83**		-0.1	4.0
	(0.703)		(3.13)	(3.15)
euro				
1999-2000	25.6**		22.5**	9.2
	(6)		(7.04)	(6.98)
excluding outliers				
1999-2000	33.3**		30.5**	4.0
	(5.92)		(7.79)	(7.22)
Pooled				
1994-2000			75.8**	66.1**
			(25.6)	(25.7)
1994-1996			63.7	52.2
			(73.6)	(73.5)
1997-2000			76.9**	67.7**
			(27.2)	(27.2)
excl. USD & EUR				
1997-2000			76.3*	80.2*
			(43.4)	(43.4)

Notes:

1) 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).

2) Coefficient estimates and standard errors (reported in parentheses) are multiplied by 10^7.

3) Constants are not reported.

4) 5 and 10 percent significance are denoted by ** and *, respectively.

Table 3: Regression of Log Difference Exchange Rate on Net Foreign Currency Position*

Currency	Horizon (days)						
	1	**2**	**3**	**5**	**10**	**20**	**60**
UK pound							
1994-2000	0.4	-0.1	-0.5	-0.6	-1.1	-2.1	-9.49**
	(0.498)	(0.748)	(0.897)	(1.03)	(1.47)	(1.99)	(2.89)
1994-1996	-2.0	-0.2	-2.0	-2.3	-2.7	4.8	-30.6**
	(2.08)	(3.2)	(3.94)	(4.69)	(6.49)	(8.53)	(12.7)
1997-2000	2*	2.77*	3.0	3.0	5.0	8.01*	12.8**
	(1.11)	(1.64)	(1.89)	(2.18)	(3.14)	(4.31)	(6.08)
Canadian dollar							
1994-2000	-0.8	-1.2*	-0.9	-0.2	-0.2	1.0	8.43**
	(0.471)	(0.656)	(0.849)	(0.958)	(1.32)	(1.78)	(2.91)
1994-1996	-0.8	-0.3	0.4	1.3	1.6	5.8	-0.3
	(0.857)	(1.2)	(1.79)	(2.03)	(2.79)	(3.96)	(6.59)
1997-2000	-0.3	-1.4	-1.4	-1.5	-2.3	-2.6	10.4**
	(0.817)	(1.14)	(1.36)	(1.54)	(2.11)	(2.75)	(4.46)
excluding outliers							
1994-2000	-0.827*	-1.15*	-0.7	-0.4	-0.5	1.2	8.44**
	(0.486)	(0.677)	(0.878)	(0.988)	(1.36)	(1.84)	(3)
1994-1996	-0.8	-0.3	0.4	1.3	1.6	5.8	-0.3
	(0.857)	(1.2)	(1.79)	(2.03)	(2.79)	(3.96)	(6.59)
1997-2000	-0.3	-1.3	-1.0	-2.0	-3.1	-2.5	10.6**
	(0.862)	(1.21)	(1.44)	(1.62)	(2.22)	(2.91)	(4.71)
Swiss franc							
1994-2000	-1.38**	-2.17**	-1.7	-1.3	-2.7	-5.11*	-10.7**
	(0.646)	(0.993)	(1.17)	(1.42)	(2.02)	(2.87)	(5.08)
1994-1996	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**	-2.0	-3.99*	-8.2**	-24**
	(0.647)	(1.05)	(1.17)	(1.49)	(2.1)	(2.87)	(4.34)
Japanese yen							
1994-2000	-1.9	0.9	6.9	3.1	2.6	0.3	-33.6*
	(2.29)	(3.54)	(4.3)	(5.05)	(7.37)	(11)	(20.3)
1994-1996	-1.0	1.6	2.2	9.8	15.0	28.9	86.9**
	(3.7)	(5.82)	(6.66)	(8.09)	(11.7)	(18.4)	(37.1)
1997-2000	-1.8	1.2	10.5	1.9	-1.2	-10.4	-85.2**
	(3.77)	(5.83)	(7.16)	(8.34)	(12.2)	(17.7)	(29.6)
excluding outliers							
1994-2000	-2.3	1.0	9.73*	2.5	1.7	-2.5	-54.1**
	(2.62)	(4.05)	(4.96)	(5.77)	(8.41)	(12.6)	(23.1)
1994-1996	-2.5	7.6	26.1	43.8**	81.6**	170**	489**
	(10.2)	(16.1)	(18.9)	(22.2)	(32.1)	(50)	(97.8)
1997-2000	-1.8	1.2	10.5	1.9	-1.2	-10.4	-85.2**
	(3.77)	(5.83)	(7.16)	(8.34)	(12.2)	(17.7)	(29.6)

Table 3: Regression of Log Difference Exchange Rate on Net Foreign Currency Position*

Currency	Horizon (days)						
	1	**2**	**3**	**5**	**10**	**20**	**60**
German mark							
1994-1998	0.388**	0.4	0.4	0.5	0.8	0.9	-2.2
	(0.174)	(0.274)	(0.331)	(0.389)	(0.545)	(0.799)	(1.43)
1994-1996	0.5	0.6	0.8	0.5	1.1	1.6	0.9
	(0.371)	(0.551)	(0.683)	(0.785)	(1.11)	(1.6)	(2.94)
1997-1998	0.3	0.3	0.4	0.6	0.9	1.0	-2.77*
	(0.182)	(0.314)	(0.371)	(0.453)	(0.625)	(0.934)	(1.59)
euro							
1999-2000	-0.9	-1.52*	-2.19**	-3.01**	-4.63**	-7.02**	-8.46**
	(0.604)	(0.878)	(0.989)	(1.41)	(1.99)	(2.7)	(3.76)
excluding outliers							
1999-2000	-0.9	-1.0	-1.4	-2.2	-3.7*	-7.17**	-6.99*
	(0.659)	(0.919)	(1.02)	(1.52)	(2.14)	(2.93)	(3.98)

Notes:

1) 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.

2) Coefficient estimates and standard errors (reported in parentheses) are multiplied by 10^7.

3) Constants are not reported.

4) 5 and 10 percent significance are denoted by ** and *, respectively.

Table 4: Hedge Fund Net Asset Value Regressions

Table A
February 1997-July 1997

	S&P	Yen	Baht
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	xx	2.62**	0.31**
	xx	(0.22)	(0.12)
Jaguar (1997-98)	0.72**	1.61**	0.29**
	(0.06)	(0.10)	(0.04)

Table 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**	2.3**	0.14*
	(0.26)	(0.5)	(0.08)
Emerging Growth	xx	2.21**	-0.32**
	xx	(0.51)	(0.09)
Jaguar (1997-98)	0.99**	1.64**	0.12**
	(0.05)	(0.10)	(0.02)

Table 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)	(0.1)
Emerging Growth	xx	1.87**	0.47**
	xx	(0.42)	(0.11)
Jaguar (1997-98)	0.83**	1.2**	-0.28**
	(0.05)	(0.12)	(0.03)

Table D

	S&P	Yen	Ringgit
Quantum	0.9**	0.4**	0.27
2/97-7/97	(0.14)	(0.19)	(0.38)
Quasar	0.22	1.2**	0.83**
2/97-7/97	(0.15)	(0.2)	(0.4)
Emerging Growth	xx	2.6**	0.42
2/97-7/97	xx	(0.26)	(0.6)
Jaguar	0.49**	1.37**	0.5**
1997-98	(0.07)	(0.09)	(0.05)

Notes:
1) Standard errors are in parentheses
2) Constants are not reported.
3) 5 and 10 percent significance are denoted by ** and *, respectively.