‘Large’ vs. ‘small’ players: A closer look at the dynamics of speculative attacks

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Abstract

Recent speculative attacks have directed attention to the role of “large players”—e.g. hedge funds and other highly leveraged institutions—and their effects on the currency markets. New theory has asked whether the presence of large players can increase volatility in the foreign exchange market. Findings indicate that large players will be especially important if they control superior information. Other researchers have, however, argued that large and small players might face e.g. different costs. We address empirically the role of large players before and during three periods of speculative pressure in the Norwegian krone market using weekly data on net flows of foreigners (large players) and locals (small players). Large players, and especially the positions of large players in the forward market, do seem to be an important determinant for the timing of speculative attacks. Furthermore, we do not find that the alleged information advantage of large players matter for the trading patterns of small players. Small players move well in advance of the large players, consistent with a hypothesis that they have larger costs of speculation.

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1 Introduction

The problem of connecting currency crises to fundamentals has given room for a serious discussion of possible manipulation of exchange rates. It has become a ritual among many politicians to denounce hedge funds and other highly leveraged institutions for manipulating exchange rates in periods of speculative pressure. Special attention has been given to “foreigners”. In this paper we look at the role of local and foreign investors during three periods of speculative attacks in the Norwegian foreign exchange market. Anecdotal evidence suggests that the foreign investors are leveraged institutions, or “large players”, while locals can be seen as “small players”. This seems particularly reasonable for periods of speculative pressure since “the rest of the world” naturally are able to raise more funds for speculation. This distinction that can also be traced in the theoretical literature on the subject.

We address the question of large and small players using weekly data on the trading in foreign exchange by Norwegian banks with (i) Norwegian customers and (ii) Foreigners. The data differentiates between spot and forward trading and covers more than 90 per cent of all trading in NOK.\(^1\)

It is of special interest that the sample covers three episodes that can be defined as “speculative attacks”. This includes one attack on a fixed exchange rate, in December 1992, and two attacks on a managed float regime, in January 1997 and in August 1998. The Norwegian managed float regime might itself be of special interest: as fixed exchange rate regimes are being abandoned they are often substituted by flexible peg regimes.\(^2\) By speculative attack we mean events where speculators take positions in the belief that monetary authorities will change the exchange rate regime in the near future. Implicit is the calculation that a policy shift will imply a change in the currency rate.\(^3\)

The combination of a long data set containing information of disaggregated currency flows and the feature that the series covers a number of relevant episodes make our data set unique. To our knowledge only a small number academic papers exist on the topic of the role of large players. Wei and Kim (1997) study the importance of large players using the Treasury Bulletin reports. They find that trading of large players add to the volatility of exchange rates, and argue that hedge funds act like “noise traders” in the Korean market. Corsetti, Pesenti and Roubini (2001) use the same

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\(^1\)Some parts of these data are previously studied by Rime (2001).

\(^2\)See e.g. Calvo and Reinhart (2000) who argue that even if a country officially adopts a “flexible” exchange rate, they often tend to limit the fluctuations of the exchange rate.

\(^3\)In the empirical applications we identify the speculative attacks using a “crisis-index”, see section 3.
data, and compile more informal information about a number of speculative events. They find support for the role of large players and some indications of asymmetric information. DR[Caï, Cheung, Lee and Melvin (2001) also use the Treasury Bulletin data and find that trading of large players contribute to volatility during the unwinding of the yen-carry trade in 1998. On the other hand, Tabellini (1994), in a discussion of the ERM-crisis, suggests that a important difference between foreign and local players is different incentives to speculate.

Unlike the studies above, we have information about net positions of both large and small players in the periods around a speculative attack. Further, while other studies have based their findings on the correlation between the returns of highly leveraged institutions and various currencies, without any actual knowledge of the exact exposure the respective funds have in a particular currency, we can observe the total market for the currency under investigation. A last point is that while the former studies that have focused on the Asian markets, we focus on a small European economy. This adds a new dimension to the empirical findings in this field.

We believe our study contribute to a better understanding of the actual dynamics of a speculative attack—at least for a small, open economy with a developed and liberalised market for foreign exchange. Our results suggest that large players is important for understanding the timing of speculative attacks. Informational herding do not seem to be important. Rather, the behavior of local investors is more in line with the hypothesis of Tabellini. Locals move well in advance of the attack, indicating that they have higher costs of speculation. This higher cost can be due to less liquid portfolios, as in Tabellini, closer relationship to local public, or higher risk aversion.

In section 2 we will present some of the model frameworks that has been introduced in the literature and discuss some empirical implications. Section 3 contains a description of our data and the institutional framework of the exchange rate regime. Section 4 describes the empirical methodology and our results. In the end we conclude.

2 Theory and empirical implications

Recently a theoretical literature has emerged that take the heterogeneity of players seriously. In the so-called “third-generation” literature on currency crises there is now a discussion of how interaction in financial markets can help us understand the emergence of currency crises (see Corsetti et al., 2001,
for an overview). Heterogenous players and differential information is also addressed in the growing literature on the microstructure approach to foreign exchange (see e.g. Lyons, 2001). Studies from other market settings suggest that heterogeneity among the market players may be important in understanding volatility. For instance, Grinblatt and Keloharju (2000, 2001a,b) studies the Finnish stock market and find significant differences between domestic and foreign investors.

We begin this section by giving a brief description of a standard model of speculative attacks. This framework has been modified by Morris and Shin (1998) to allow for differential information, and later Corsetti, Dasgupta, Morris and Shin (2000) and Corsetti et al. (2001) to allow for the discussion of the importance large traders. They look at two specific questions. First, do the presence of a large trader in itself affect the probability of a speculative attack? Second, how is the probability of a speculative attack affected if large and small players have different information?

Large and small players might however differ on other dimensions than information. One could e.g. think that size might affect portfolio preferences or costs of speculation. Based on observations stated in Tabellini (1994) we discuss whether such differences might have other implications for expected behaviour by large and small players than differences with regard to information. We end with a summary of empirical implications.

2.1 How to understand speculative attacks

One of the conclusions from the literature on speculative attacks is that speculative attacks tend to be successful only for a certain range of fundamental outcomes (Obstfeld, 1996, is a central contribution on this issue). Assume that the government has a stock of international reserves to defend the exchange rate regime.\footnote{The standard model will assume a fixed exchange rate. However, the model is applicable even in a floating rate regime if the central bank does take measures to reduce volatility. As stated in Calvo and Reinhart (2000) many countries that formally have introduced a floating exchange rate in fact stabilises their rates within a target zone.} The central bank will allow the currency to float if reserves reach a predetermined level. This level, indexed by $\theta$, depends on the level of fundamentals. Strong fundamentals implicate a high willingness to defend the exchange rate, and therefore a high $\theta$. Weak fundamentals implicate a low willingness to defend the exchange rate and therefore a low $\theta$.

Investors can choose to sell the currency or not to sell the currency. The share of the market that sell the currency is indexed by $l$, where $1 \geq l \geq 0$. 

The standard model will assume a fixed exchange rate. However, the model is applicable even in a floating rate regime if the central bank does take measures to reduce volatility. As stated in Calvo and Reinhart (2000) many countries that formally have introduced a floating exchange rate in fact stabilises their rates within a target zone.
The currency collapses if a share of the market, $l$, attack the currency, and $l \geq \theta$.

We can identify three outcomes:

- $\theta < 0 \Rightarrow$ collapse occur by definition,
- $\theta > 1 \Rightarrow$ collapse will never occur, or
- $0 \leq \theta \leq 1 \Rightarrow$ collapse might occur depending on whether enough speculators take positions against the currency.

If investors could observe the true value $\theta$ the choice of whether or not to attack a currency would depend on the expected payoff from such an action. Taking a position against a currency entails a cost $0 < t \leq 1$. If one attacks a currency that does not collapse, one is left with the payoff $(−t)$. If the currency collapses one gets $(1 − t)$.

However, investors only observe a noisy signal $\hat{\theta}$ of the state of the fundamentals $\theta$. The following timing is assumed: (i) agents observe $\hat{\theta}$, (ii) agents take, independently and simultaneously, decisions about whether to take speculative positions. $l$ is determined, (iii) the true $\theta$ is revealed, and (iv) the central bank either defends or devalues dependent of $l \geq \theta$.

The solutions to this problem involves complex game theory. The complexity will depend on assumptions about the the participants in the game and the information structure of the participants.

Assume an infinite number of infinitely small investors. If information is symmetric everyone observes the same signal, but the signal is a noisy version of the true outcome. In this case the model will allow for multiple equilibria. The outcome will depend on how many investors who choose to attack the currency at an observed level of $\hat{\theta}$. The currency will collapse if $l(\hat{\theta}) \geq \theta$. The exact relationship between $l$ and $\hat{\theta}$ can not be calculated. However, Corsetti et al. (2001) show that one can identify two limiting cases that will identify a “window of uncertainty”—i.e. the outcomes of $\hat{\theta}$ where multiple solutions do exist. This window is limited by an upper value of $\hat{\theta}$, $y^*$, and a lower level of $\hat{\theta}$, $\underline{y}$.

$y^*$ is the level where all investors must attack if the expected return from speculative behaviour shall be positive. The lower level, $\underline{y}$, is the lowest observed value of the signal where the marginal investor is not certain to make money by taking a speculative position.

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6The expected return will reflect the cost of speculation and the probability that the true value of $\theta$ is lower than the share of the market that takes part in the attack.
2.2 Size

Corsetti et al. (2000) and Corsetti et al. (2001) modify the model above by introducing a large player.\footnote{We need point out that the models presented in these papers focus on one large player. A more realistic case would introduce a number of large players operating simultaneously. If there is a game situation between large players, this can well affect the results.} If one assumes that financial resources available in the market are indexed to be between zero and 1, they define a large player as a single player that can mobilise \(\lambda \leq 1\). The rest of the market controls \((1 - \lambda)\). They describe the typical large player as a hedge fund or an other highly leveraged institution. It is important to point out that size here is not a question of market capitalisation, rather it is a question of funds available for speculation in the currency markets.

The probability of a speculative attack depend on the upper level of the zone that defines the range of fundamentals where an attack either might or might not occur. A relevant question is therefore how the presence of a large trader will increase the level \(y^*\). An increase in \(y^*\) implies that an attack might take place at a stronger level of fundamentals than if no large player was present.

Corsetti et al. (2000) find that while an increase in the size of \(\lambda\) does not unambiguously increase the probability of a speculative attack, the critical level of a speculative attack will never be smaller than the critical level of a speculative attack with no large player.

Corsetti et al. (2001) clarify this by introducing a large player in the above example where all information is public, and all players face the same uncertainty. In this case the presence of a large player will not affect the level of \(y^*\) at all.

If information is not public, a large player increases the probability of attack because the presence of a large player make small players more aggressive. The large player becomes a coordination mechanism in the market, and increases the incentive to take aggressive positions. However, Corsetti et al. (2000) find that this effect is limited if the large player has no informational advantage.

2.3 Information

An important issue is whether large players should be expected to have an informational advantage over small players. One reason might be that the large players have more resources available. Corsetti et al. (2000) point out that if a large player is seen as a coalition of small players, it seems obvious that the large player posses more precise information than the small players.
do. One might also argue that the large player have easier access to inside information, e.g. through more regular meetings with public officials. DR[?] suggest that large banks have an information advantage due to access to larger customer order flows.

If a large player have better information than small players, the large players potential to coordinate a speculative attack increases. This effect is strongest if the large player can signal its position to the small players. Corsetti et al. (2000) present a sequential move game. If we have a two period game and the large player has the most precise information, the small player have no incentive to move in the first period. Because small players can not influence the positions of any other player, and therefore have nothing to learn from moving first, they will not move first.

Corsetti et al. (2000) further show that if the large player is going to attack it is a dominant strategy for the large player to make a move in the first period. The signalling approach might be influential even if small players can not observe the actual positions taken by large players. If a change in the position of the large players either affect the level of the exchange rate within the target band or affect the behaviour of the central bank, large players can still signal their belief to the market.

2.4 Cost of speculation

The two papers discussed above focus on two possible distinctions between players: their size and their ability to obtain information. However, it might be reasonable to assume that large and small players behave differently for other reasons than the two stated above. Small traders often have a different currency exposure of their cost-income structure than large investors, and can therefore have more incentive to hedge their positions in the currency market. More important might be the disincentive to speculation in home markets. Taking a speculative position will be equal to take a position against the central bank. A central bank has little power to control a large player. However, the bank is able to take measures that are to the disadvantage of small players.8

That different players have different incentives to take speculative positions against a currency is not incorporated in Corsetti et al. (2001). However, Tabellini (1994) provides an interesting discussion on different incentives to speculation. Tabellini argues that a government will protect a fixed exchange rate for at least a couple of days after a launch of a speculative at-

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8This point was made by Michael Dooley and Robert Chang in the discussion of Corsetti et al. (2001).
tack. Investors with liquid positions in a fixed currency tend to believe that they can get their money out at the fixed rate even if a speculative attack occurs. \[9\] In the mean time they take advantage of high interest rates in the fixed currency. Investors with a long-term horizon do however tend to move their positions out of the fixed currency in advance of the speculative attack. This may be due to less liquid assets in their portfolios. Tabellini argues that one could observe Italian investors moving money out of ITL during the spring of 1992, DR[long before the actual attack]. Large, mainly foreign investors did however continue to move money into ITL as Italian interest rates were higher than e.g. German interest rates. During the speculative attack on ITL in August 1992 foreign investors were active.

In the Tabellini-story the information must be assumed to be symmetric. However, small players have an incentive to move in advance of large players, as small players may have different portfolio choices or references than large players. The inability of small players to hold very liquid positions increase their cost with regard to currency speculation. They therefore have to act as fundamental traders, taking a long term perspective.

In the period of attack, large players should be much more important than small players. Small players have already made changes to their positions. In fact, small players might attempt to gain from short term overshooting, and therefore be expected to take the opposite position of large players.

2.5 Summarising empirical implications

We have described three dimensions. There are markets with and without a large player. Some players, presumably the large, can be better informed. Finally, some players, presumably the small, may experience higher of costs accumulated by taking part in a speculative attack.

Let us first focus on size. From the discussion above we see that simply the presence of a large player can be expected to affect the behaviour of small players. It is however not reasonable to believe that one can identify any developed financial market where the existence of a highly leveraged institution can be ruled out. So testing whether markets behave differently with and without a large player is probably not feasible.

However, as the discussion above imply, the role of large players depends on how the market works. In the case where large players have more precise information we find that large players have incentive to be first movers. If we have data on the positions of large and small players this is a testable

\[9\] This type of behavior can occur both in rational models (see ?) and in non-rational, or behavioral, models (see ?, for a survey).
## Table 1: Summarising the hypotheses, assuming the presence of a large player

<table>
<thead>
<tr>
<th></th>
<th>Large and small players have equal cost of speculation</th>
<th>Large players have smaller cost of speculation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Symmetric information</strong></td>
<td>No group leading the other</td>
<td>Small players move first</td>
</tr>
<tr>
<td></td>
<td>Both groups join attack</td>
<td>Large players dominate attack</td>
</tr>
<tr>
<td><strong>Asymmetric information</strong></td>
<td>Large players move first</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Small players dominate attack</td>
<td></td>
</tr>
</tbody>
</table>

*Note: Asymmetric information assumes that large players have better information than small players.*
hypothesis. Second, we can assume that if large players move first, small players will be important in determining the timing of the attack. Large players move first. When small players move, the speculative attack occurs.

This case distinguishes itself from the case with symmetric information and the case with symmetric information and unequal costs. If costs are equal and information symmetric, we expect no group to be leading other groups, and no group to be of more importance than others during a speculative attack. However, in the case where small players have higher costs of speculation, the roles will be reversed. Small players will have incentive to be first movers, to reduce the risk of being left with positions during a speculative attack. Large player on the other hand might have incentives to be late movers, as they attempt to cash in on e.g. interest rate differentials. During the speculative attack large players will be dominant, and small players might in in fact be reversing positions. The empirical implications are summarised table 1.

As one can see from table 1 we have not discussed the case of asymmetric information and unequal costs. This case is, to our knowledge, not previously discussed in the literature. However, our intuition is that if large players have smaller costs than small players this will only amplify the conclusions of the asymmetric information/equal cost case.¹⁰

3 Data

In this paper we will use data of net currency flows in the Norwegian market. The data show changes in the portfolios of local and foreign investors. The data can be disaggregated by the address of the trading party, i.e. we can differentiate between net flows of traders with address abroad (foreigners) and net flows of traders with address in Norway (locals). We can also differentiate between spot and forward purchases.

First, we describe the data. We then discuss under what circumstances we believe foreign investors are large players, while local investors are small players. Last, we look at the macroeconomic setting, with a special emphasis on how to identify periods of speculative attacks.

¹⁰ Note that if small players have the information advantage things will probably change radically. However, as discussed above, the literature assumes it as unreasonable to believe that small players have superior information.
3.1 Flow variables

3.1.1 General overview

Beginning in week 1 1991 Norges Bank has registered a weekly time series that reveal the net amount of currency traded between Norwegian reporting banks and foreign (i.e. address abroad) and local (i.e. address in Norway) customers.\textsuperscript{11} Net amount traded between customers and banks over all banks, plus the change in banks net positions, must equal the net amount the banks trade with Norges Bank. As we have no information about initial flows, the level of the series are set to zero in week 46 1992. The change in the series reflect changes in portfolio holdings.

A change in foreign plus local holdings will not perfectly match the change in Norges Bank’s holdings. The reporting banks work as intermediaries in the foreign exchange market. However, such “market makers” generally do not speculate in currency fluctuations. Instead they profit from the spreads in trading (see Lyons, 2001, for a discussion). This propositions seems to hold also for these data. We will therefore ignore the role of the reporting banks in the following analysis.

Special attention must be given to the role of Norges Bank in this sample. Supply of currency to the central bank can take two forms. It can either be reflected as

1. changes in foreign reserves, or be

2. other purchases made by the central bank.

An intervention is normally understood as a change in reserves. In our data, starting in January 1996, a large part of the transactions observed are purchases of foreign currency for the Norwegian Petroleum Fund. The Petroleum Fund is a Norwegian government investment fund that is only invested in foreign currency. Its operation has been handled by Norges Bank.

Norges Bank does not publish explicit records on their interventions. However, we do know the size of total transactions by the Bank and the size of the annual transfer to the Petroleum Fund. Based on this information we can calculate approximate yearly interventions. This indicates that Norges Bank was intervening strongly in 1996 and 1998. In 1996 Norges Bank was alleviating appreciationary pressure by selling NOK. In 1998 Norges Bank was alleviating depreciationary pressure by purchasing NOK.

The total series range from January 1991 to August 2002. We can summarise the features:

\textsuperscript{11}From week 47, 1992 these data have been made publicly available.
On an aggregate level the series reflect supply of foreign currency to the central bank.

The series disaggregate volume between locals and foreigners, and between spot and forward transactions. However, the data does not distinguish between swap transactions and other transactions.

We can see total central bank activity in the market. However, we cannot distinguish between “official interventions” and other activity.

3.1.2 Foreign holdings vs. local holdings

We can differentiate between change the positions of locals and foreigners. It is not obvious that this differentiation is interesting. The relative holdings of each currency as a percentage of wealth will of course be different. But with the exception of wealth, the factors determining changes in the portfolio are common to foreigners and locals alike.\textsuperscript{12}

In this study we will focus on three very specific events (see below). Trend shifts due to relative changes in wealth is therefore of less importance. Instead we believe that it is reasonable to argue that foreigners and locals are different. More specifically we believe that “foreigners” to some extent can be seen as “large players”, while locals will be “small players”.

Several sources can be taken in support of this view. First, we have discussed this issue with several traders at the division of market operations in Norges Bank. According to these sources, foreigners that take positions in the Norwegian market are mainly large investment banks, either taking speculative positions at their own book, or speculating on behalf of others. These traders confirm that the trading strategies of foreign investors differ substantially from the trading strategies of locals. Rime (2001) reports similar evidence after conferring with traders in large Norwegian banks.

Second, there is information pointing to a small number of large foreign players taking special interest for the Norwegian exchange rate in periods of high volatility. A number of newspaper reports refer to the role of foreigners in periods of speculative pressure. For instance, on November 5 1996, the leading business newspaper in Norway (Dagens Næringsliv) reports that foreign analysts “believe in stronger NOK”.\textsuperscript{13} Already on the next day, Norges Bank lowered the folio rate. According to newspapers, Kjell Storvik (the

\textsuperscript{12}This under the assumption that for both countries we have low inflation and little correlation between inflation and the exchange rate. As we look at developed economies, these assumptions are reasonable.

\textsuperscript{13}Mathiassen (1996).
governor of the bank) hoped that this would reduce the interest for NOK among foreign investors.\textsuperscript{14} November 29 the Dagens Næringsliv states that

[f]oreigners have again thrown themselves over the Norwegian krone. ... People in the market with whom the paper have spoken, believe that the strengthening is a result of foreign investors now believing NOK is so cheap that is a good buy.\textsuperscript{15}

After the Russian moratorium in August 1998 Norway experienced a situation of strong depreciationary pressure. According to Dagens Næringsliv August 25, 1998 rumors claimed that Chase Manhattan was taking speculative positions to force Norges Bank to increase their interest rates to stabilise the exchange rate. Analysts in the market did however not believe that Chase was the only investors taking such positions. A market analyst states that other, especially foreign, investors are expected to be involved.\textsuperscript{16} However, there were rumors that Chase had inside information after having met with high ranking officials in the Norwegian Ministry of Finance. Chase confirmed such talks, although at the same time denying any involvement in the speculative pressure. A senior economist in the bank, Hans Günther Redeker, stated that they had warned the Norwegian Ministry of Finance of possible volatility under a meeting in the beginning of August.\textsuperscript{17}

Last, while we have reasons to believe that Norwegian banks have earned money taking speculative positions in other currency markets, the same banks might have other incentives with regard to the Norwegian market. As the Norwegian market is small and transparent it would be fairly easy to identify a Norwegian investor located in Norway taking speculative positions against the NOK. For this reason alone we can probably assume that Norwegian banks probably do not initiate speculation against the NOK.\textsuperscript{18} Norwegian based investors who want to speculate against NOK would probably choose to do so from an non-Norwegian address. This should probably increase our ability to use “locals” and “foreigners” as defined by Norges Bank to differentiate between large and small players.

\textsuperscript{14}Dagens Næringsliv (1996).
\textsuperscript{15}Haug (1996).
\textsuperscript{16}Bjerkholt (1998). Note however that Chase, through the purchase of Chemicals, a former market maker in the Norwegian bond market, has long been involved in Norway.
\textsuperscript{17}Erikstad and Mathiassen (1998).
\textsuperscript{18}That being said, nothing should stop Norwegian banks from making a profit if others have started a speculative attack.
3.2 Currency crisis and exchange rate regimes

In the literature on currency crises it has become standard to use a “crisis index” to identify events with special pressure on the exchange rate (see e.g. Eichengreen, Rose and Wyplosz, 1995, for a description). When used on monthly data the index contains the change in the exchange rate, the change in the short term interest differential and the change in the level of reserves, all weighted to assure that the relative variance of the series are the same. The index contains interest rates and reserves to capture the fact that a “crisis” in a fixed exchange rate need not mean a change in the exchange rate. If the monetary authorities adjust interest rates and/or intervene sufficiently, a speculative attack might be fended off. However, a crisis has still occurred.

We do not have data on official interventions on a weekly basis. We have information on total purchases and sales made by the central bank on a weekly basis. However, it is impossible to separate interventions from the other currency trades (e.g. for the oil fund). We therefore create the index only containing changes in the exchange rate and changes in the interest rate. We measure events as weeks when the absolute value of the index exceeds the mean plus two standard deviations.

The events identified are grouped into three specific cases, all related to the previously mentioned “crises” (see table 2). The first “group” of events begin with an event identified in week 38 1992. In the period between week 38 1992 and week 3 1993 there are in all a total of four “events”. The “official event” is the week when the official devaluation took place. This happened in week 50, 1992. As can be seen from table 2 the second batch of events begin in week 1 1997. In the period between week 1 1997 and week 15 1997 there are a total of three “events”. The last batch of events begin in week 33 1998. There is a total of seven events, with the last occurring week 1 1999.

Figure 1 shows the NOK/EUR rate and the Norwegian folio rate from the beginning of 1990 until the end of 2000. The shaded areas show the twelve month period starting exactly one year before the last event of a crisis. In our tests presented in the next section, the shaded areas represent our estimation periods. The exact crisis periods defined by the crisis index are shaded with dark grey.

In figure 1 we see that during 1991 and 1992 there are only very small fluctuations in the exchange rate. During this period the NOK was fixed to the ECU. The exchange rate was stable around a level of 7.65 until October 1992. Under the speculative pressure during the fall of 1992 Norges Bank repeatedly increased their folio rate to reduce capital outflow, as can be seen in figure 1. After the speculative attack December 10 1992 the rate stabilized in the interval between 8.3 and 8.4, implying a change of about 10 per cent.
Table 2: Crises index

<table>
<thead>
<tr>
<th>Crisis</th>
<th>First observation</th>
<th>Official crisis</th>
<th>Last event</th>
<th>Number of events</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997-crisis</td>
<td>1 1997 appreciation</td>
<td>1 1997</td>
<td>15 1997</td>
<td>3</td>
</tr>
</tbody>
</table>

Events are cases where the value of INDEX exceeds the mean of index +/- 2 standard deviations of INDEX. NOK/EUR is measured as NOK/DEM prior to 1999.
from middle rate to middle rate. Officially the exchange rate was now a free float. It was however a float within bounds, but the bounds were not published nor strictly enforced. Norges Bank had an obligation to stabilize the exchange rate, but such stabilization should be in a medium term sense. Extreme measure to hold the exchange rate within bounds in the short term was not to be used. This feature is itself of interest: as fixed exchange rate regimes are being abandoned they are often substituted by flexible peg regimes.

Also during the managed float regime Norges Bank actively used the fo-

\[\text{Figure 1: Norges Bank’s folio rate and the exchange rate: 1992-93 and 1996-99}\]
folio rate to stabilize the exchange rate. In the 1997-crisis there was a strong appreciative pressure which led the central bank to decrease the folio rate. There were some evidence about increasing inflationary pressure. Market participants expected a switch from managed float to inflation targeting which would result in higher short-term interest rates and a strengthening of the currency.

The 1998-crisis took place at the same time as Russia declared a debt moratorium, which was the starting point of a period with substantial financial turbulence. Also this time, market participants expected a switch from managed float to inflation targeting. At this time inflation targeting would result in lower short-term interest rates and thus a weaker currency.

After a change of governor in January 1999 Norges Bank repeatedly made clear that its main commitment was to price stability, not short term exchange rate stability. In March 2001 Norway officially introduced an inflation target of 2.5 per cent.

4 Discussion of empirical findings

We have identified four explicit hypotheses. Further we have identified three specific events where we want to test these hypotheses. In the following we will present each of these events. However, we begin this section with a precautionary note.

4.1 The problem of potential instability

What kind of relationship should we expect to find between our observations and the exchange rate? Both the microstructure trading model of Evans and Lyons (2002) and the models of speculative attack discussed here suggest that the relationship should be weak in periods of calm.\(^{21}\) As for the attack models, in calm periods the fundamentals are in the no-attack region. As for microstructural models, in calm periods there is less information to aggregate, and elasticity of demand is very high.

In periods of stress however, the theories indicated in section 2 do indicate that observing portfolio shift might tell us something about the exchange rate. If the model holds we should expect to find a relationship between the flows we observe and the exchange rate during these periods.

\(^{21}\)However, also in such periods can there be a relationship between Norges Bank’s purchases of currency for the Petroleum Fund and the exchange rate (see Solheim, 2002, for a discussion of this aspect).
We focus on explicit time periods as identified in section 3. This should limit the problem of parameter instability. The coefficients will change if the sample change. However, the sample is determined by a standard crisis index, and hence “objective” on these regards.

4.2 The 1992-event

The 1992-event has the features of a “traditional” currency crisis. Norway had a firm commitment to a fixed rate between NOK and ECU, with a fluctuation band of $\pm 2.5$ per cent. In August first Finland and Italy, and later Great Britain, was forced to abandon their fixed pegs. Sweden withstood an attack in September, but chose to devalue in late November. December 10 1992 Norges Bank let the NOK float.

In figure 2 we see the levels of net positions in spot and forward for local and foreigners in the period from May 1992 to January 1993. One of the most striking features of this figure might be how stable these positions are throughout the first part of 1992. The only position that reveal a change is foreign forward. Here we see a trend out of NOK-holding from early August 1992. The holdings do however stabilise in October 1992.

First in November 1992 does it evidence of speculative activity occur in our series. It takes two forms: locals sell NOK spot and foreigners sell NOK forward. This is as one should expect. Locals have a larger part of their portfolio in NOK, and should therefore be able to sell NOK spot. Foreigners hold presumably a more limited amount spot. To profit on the expected devaluation they sell NOK forward.

4.2.1 Estimation results

Referring to table 1, we have statements about how we expect timing of changes in flows to be related to changes in the exchange rate. To identify these kinds of patterns we will use the statistical concept of Granger causality. Granger causality is not an economic definition of causality, but might give a useful distinction with regard to e.g. forecasting. On this basis we believe that Granger causality is a useful concept to distinguish between our “stories”.

There is absence of Granger causality from $x$ to $y$ if an estimation of a variable $y$ on lagged values of $y$ and lagged values of $x$ are equivalent with an estimation of $y$ on only lagged values of $y$. Mathematically this can be expressed as

$$y_t = \alpha_0 + \sum_{i=1}^{k} \alpha_i y_{t-i} + \sum_{i=1}^{k} \beta_i x_{t-i} + \varepsilon_t$$

(1)
Figure 2: The exchange rate and the level of net positions: three Norwegian currency crises.

Note: all graphs of flows have a height of 50 billion NOK. A more negative number indicates a bigger net holding of NOK.
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Local spot does not cause $\Delta \log(\text{NOK/EUR})$</td>
<td>$\chi^2(4) = 60.73$ **</td>
<td>20.89 **</td>
<td>2.68 0.61</td>
</tr>
<tr>
<td>Local forward does not cause $\Delta \log(\text{NOK/EUR})$</td>
<td>$\chi^2(4) = 35.42$ **</td>
<td>3.06 0.55</td>
<td>0.14 1.00</td>
</tr>
<tr>
<td>Foreign spot does not cause $\Delta \log(\text{NOK/EUR})$</td>
<td>$\chi^2(4) = 6.15$ 0.19</td>
<td>8.10 0.09</td>
<td>4.89 0.30</td>
</tr>
<tr>
<td>Foreign forward does not cause $\Delta \log(\text{NOK/EUR})$</td>
<td>$\chi^2(4) = 45.01$ **</td>
<td>5.76 0.22</td>
<td>2.11 0.72</td>
</tr>
</tbody>
</table>

$\Delta \log(\text{NOK/EUR})$ does not cause local spot $\quad \chi^2(4) = 7.99$ 0.09 | 4.52 0.34 | 16.19 0.00 **

$\Delta \log(\text{NOK/EUR})$ does not cause local forward $\quad \chi^2(4) = 17.69$ ** 1.89 0.76 | 0.90 0.92

$\Delta \log(\text{NOK/EUR})$ does not cause foreign spot $\quad \chi^2(4) = 0.87$ 0.93 | 23.52 0.00 ** | 3.82 0.43

$\Delta \log(\text{NOK/EUR})$ does not cause foreign forward $\quad \chi^2(4) = 7.63$ 0.11 | 7.12 0.13 | 3.89 0.42

Note1: *-5 per cent, **-1 per cent
Note2: Estimations include change in 10 year bond spread to Germany and change in the oil price.
Note3: Estimations include 4 lags.
Note4: Estimation periods:
1997: 1996(1)-1997(15)
x does not Granger cause y if the joint hypothesis of $\beta_1 = \ldots = \beta_k = 0$ is not rejected.

When choosing the sample for the Granger causality test we take the crisis index as our starting point. We include the 52 preceding weeks to assure that we capture trends in advance of the event. We also include all observations during the “crisis”. This means that we end the sample with the same week as our “Last event”, as defined in table 2.

The results from the 1992-event is presented in table 3. We see that there is no evidence that changes in positions of local spot and local and foreign forward do not forecast changes in the exchange rate in this period. However, for local spot neither is there evidence that changes in the exchange can not forecast these positions. Table 4 reports Granger causality between local and foreign flows. We can not reject no causality from foreign flows to local flows, but can reject no causality from local flows to foreign flows.

This indicates that for this case there seems to be evidence that both groups, both locals and foreigners, where moving out of NOK in advance of the actual event. There is little reason to presume that one group is better informed than any other group. Given the setting — the speculative attack in Norway occurred after a history of turbulence in other European countries — this finding seems reasonable. However, if any group is “leading” it seems to be locals, not foreigners. Foreigners might be taking the more cautious position.

One question does however remain. Which group was most active during the actual crisis? To investigate this question we use the following strategy. We estimate changes in the exchange rate on contemporaneous changes in flows and two macro variables. We include all four flow variables in the regression. We then eliminate spot flows. The argument is that under a depreciation, most speculative activity is supposed to take place in the forward market. We then eliminate local forward flows. In the end we eliminate foreign forward flows.

The sample is selected after the following criteria. Our interest is what happens in the period including the actual speculative attack. We also need some observations before the actual event in the sample. What happens after the event has less interest—at this time we are in a new regime. We include 20 weeks before the first “event” in our index. We then include 4 weeks after the “official event” — identified as above.

We test the validity of these eliminations using an F-test. The results are presented in table 5. As we can see the first two eliminations are valid. The best regression does not include changes in spot positions, nor changes in local forward positions. However, we can not do a valid elimination of changes in foreign forward positions. This is an indication of the importance
of foreign forward positions as a driving variable in the actual event.

Last, we in table 6 we present the OLS regression of changes in the exchange rate in the above defined sample period, including changes in foreign forward positions. The findings confirm that the coefficient on the flow variable has the expected sign. The size effect is 0.2 per cent per billion NOK sold, or about 1.1 per cent per 1 billion USD equivalent. As a comparison Evans and Lyons (2002) report an effect from order flow to the USD/DEM exchange rate of about 0.5 per cent per 1 billion USD equivalent. Since this coefficient is increasing with uncertainty this makes sense.

4.3 The 1997-event

The 1997 event is very distinct form the 1992 event. First, it is an example of appreciationary pressure. There was evidence of increasing inflationary pressure. There was reasons to believe that if Norway had been an e.g. inflation targeting country, short term interest rates might have been substantially higher. The markets believed that if Norges Bank would abandon the managed float regime, they would do so in favour of an inflation target. This would imply an increase in short term interest rates, and a potentially steep appreciation of the NOK.

Figure 2 shows the exchange rate and the level of net positions during the period from August 1996 to February 1997. First, note that there is no movement in the forward positions over this period. Second, we see that the exchange rate was trending down from early September 1996. In the period from September to December locals accumulate spot positions as the exchange rate is appreciating. Foreigners do not change their net positions.

During the speculative attack in the first weeks of 1997, the central dates were January 6-7 1997, foreigners are buying NOK spot. At this time locals are selling NOK spot.

4.3.1 Estimation results

The Granger causality reported in table 3 tests confirm the impression from figure 2. The sample includes 52 weeks in advance of the first event indicated by the crisis index, and ends at the last event indicated by the crisis index. We see that one can dismiss that changes in local spot positions does not cause changes in the exchange rate. One the other hand, we can also dismiss that changes in the exchange rate does not cause changes in foreign spot positions. This result is even confirmed for the test of causality between

\[ \text{The average NOK/USD rate over the period from 1992-2000 was 7.4.} \]
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Foreign flows do not cause local spot</td>
<td>$\chi^2(8)$ 10.79 0.21</td>
<td>24.71 [0.08]</td>
<td>19.24 0.01 *</td>
</tr>
<tr>
<td>Foreign flows do not cause local forward</td>
<td>$\chi^2(8)$ 8.29 0.41</td>
<td>7.84 [0.45]</td>
<td>6.73 0.57</td>
</tr>
<tr>
<td>Local flows do not cause foreign spot</td>
<td>$\chi^2(8)$ 21.82 0.01 **</td>
<td>33.49 [0.00] **</td>
<td>9.43 0.31</td>
</tr>
<tr>
<td>Local flows do not cause foreign forward</td>
<td>$\chi^2(8)$ 19.94 0.01 *</td>
<td>9.30 [0.32]</td>
<td>16.95 0.03 *</td>
</tr>
</tbody>
</table>

Note1: *-5 per cent, **-1 per cent
Note2: Estimations include 5 lags of each variable.
Note3: “Foreign flows” are both spot and forward flows, “local flows” are both spot and forward flows. All flows are in changes.
Table 5: F-test

<table>
<thead>
<tr>
<th>Period</th>
<th>Model</th>
<th>F-stat.</th>
<th>prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992(18)-1993(2)</td>
<td>1 → 2</td>
<td>0.27</td>
<td>0.77</td>
</tr>
<tr>
<td></td>
<td>2 → 3</td>
<td>1.07</td>
<td>0.31</td>
</tr>
<tr>
<td></td>
<td>3 → 4</td>
<td>5.50</td>
<td>0.03 *</td>
</tr>
<tr>
<td>1996(32)-1997(5)</td>
<td>1 → 2</td>
<td>1.11</td>
<td>0.35</td>
</tr>
<tr>
<td></td>
<td>2 → 3</td>
<td>0.03</td>
<td>0.86</td>
</tr>
<tr>
<td></td>
<td>3 → 4</td>
<td>8.05</td>
<td>0.01 **</td>
</tr>
<tr>
<td>1998(13)-1998(38)</td>
<td>1 → 2</td>
<td>2.14</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>2 → 3</td>
<td>3.78</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td>3 → 4</td>
<td>5.41</td>
<td>0.03 *</td>
</tr>
</tbody>
</table>

Note1: *-5 per cent, **- 1 per cent
Note2: Test includes change in 10 year bond spread to Germany and change in the oil price.
Note3:
1 → 2: Take out spot (if depreciation) forward (if appreciation)
2 → 3: Take out remaining local flow
3 → 4: Take out remaining foreign flow
Note4: Estimated using OLS
Note5: Estimation periods:
1992: 1992(18)-1993(2)

flows, as can be seen in table 4. The direction seems to be from local flows to foreign flows.

In this case there is evidence in support of one group having potentially superior information. However, notice that this is the group of small players—not the large players as expected in most of the theoretical literature.

We now turn to contemporaneous correlation. We estimate changes in the exchange rate on changes in the 10 year bond spread, changes in the oil price and contemporaneous changes in net positions. The sample is from week 32 1996 to week 5 1997. As can be seen from table 5, it is a valid operation to eliminate change in forward positions. It is also valid to take out changes in local spot positions. As in the 1992-event, we find that changes in foreign positions have the strongest contemporaneous correlation with the crisis. The actual regression including changes in foreign spot positions is reported in table 6. The size effect of the change in net positions is slightly less than the effect found in the regression of changes in forward positions in the 1992-event. We here find the effect to be about 0.8 per cent per 1 billion USD equivalent.
Table 6: Regression of change in the exchange rate on change in flow

<table>
<thead>
<tr>
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<tbody>
<tr>
<td></td>
<td>Coef.</td>
<td>t-value</td>
<td>Part R²</td>
</tr>
<tr>
<td>Constant</td>
<td>0.002</td>
<td>0.88</td>
<td>0.02</td>
</tr>
<tr>
<td>D(int.dif)</td>
<td>-0.029</td>
<td>-2.67 *</td>
<td>0.18</td>
</tr>
<tr>
<td>D(log oil price)</td>
<td>-0.004</td>
<td>-0.06</td>
<td>0.00</td>
</tr>
<tr>
<td>D(foreign pos.)</td>
<td>0.002</td>
<td>2.35 *</td>
<td>0.14</td>
</tr>
<tr>
<td>R²</td>
<td>0.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test: AR 1- 3 F(3, 30) =</td>
<td>0.23</td>
<td>0.88</td>
<td></td>
</tr>
</tbody>
</table>

Note1: *-5 per cent, **-1 per cent
Note2: Estimated with OLS.
Note4: Estimation periods:
1992: 1992(18)-1993(2)
Note5: Interest differential is Norwegian minus German rate for 10 year government bonds.
4.4 The 1998-event

The 1998-event was caused by international circumstances. During the summer of 1998 the situation in Asia became more uncertain. Russia avoided a default in June. However, by the end of August 1998 Russia declared a moratorium on her debt payments.

This event triggered massive international uncertainty. Investors withdrew money from small currencies, and countries with a high share of raw material exports where especially hard hit.

Again the Norwegian monetary policy was set into play. If Norway would have changed from a managed float to an inflation target at this point, one might well expect the short-term interest rate to fall. So if Norway gave up on the fixed exchange rate it was reasonable to expect a considerable depreciation.

4.4.1 Estimation results

In this case the timing is clearly determined outside Norway—the attack takes place in the same period as the Russian moratorium was announced. This is also reflected in the findings from the Granger causality tests, reported in tables 3 and 4. No change in net positions should be expected to forecast this change in the exchange rate. This results is confirmed. Also between flows the results are weaker than in the two previous episodes.

The external timing of the event should however not affect the contemporaneous correlation. Someone has to initiate the attack. We repeat the f-test from the two previous case studies. The results are reported in table 5. We find that it is valid to eliminate changes in net spot positions. Further, it is valid to eliminate changes in net local forward positions. However, it is not valid to eliminate changes in foreign forward positions.

The estimation reported in table 6 confirms that changes in foreign forward positions have the expected sign. However, the effect is smaller in this case. We now find an effect of approximately 0.2 per cent per 1 billion USD equivalent.

4.5 Theory and evidence

In table 1 we presented a matrix that summarised empirical implications of theory. All implications was under the assumption that a large player was present in the market. We can repeat the conclusions. If all players had symmetric information, we argued that

- no group would lead the other, and
• both groups would join the attack.

If the large player had more precise information than the small players, we argued that

• the large player would move first, and
• small players would dominate the attack.

However, if information was symmetric, and small players have a higher cost of speculation than large players, the implications would rather be to expect that

• small players move first, and
• large players dominate the attack.

How does this relate to our findings? First, we concentrate on the Granger causality tests. We can reject that foreign flows forecast changes in local flows for the 1992-93 and the 1996-97 crisis. We can reject that foreign forward positions do not forecast a change in local spot positions in the 1998-99 crisis. However, in this case we can neither reject the opposite proposition. On the other hand, we can reject that local flows do not forecast changes in foreign flows for any of the three events.

The Granger causality tests between the exchange rate and flows return similar results. We can not reject that foreign flows does not forecast changes in the exchange for both the 1996-97 and the 1998-99 event. We can reject this proposition for the 1992-93 event. However, this is true for local flows as well. Further, we can reject that local flows do not forecast the exchange rate in the 1997-98 event. In the 1998-99 event we can not reject that no flows forecast the exchange rate.

The 1992-93 event was to some extent a “chronicle of a death foretold”. Norway was the last of a number of European countries that devalued during the fall of 1992. In this case it is difficult to understand why large players should have superior information.

The 1996-97 event was on the other hand a true local event. If superior information should determine positions, we would expect it to be visible during this period. However, if anyone was moving first during 1996-97 it were local investors not foreign investors.

In the 1998-99 case the timing of the attack seems to have been determined by an outside event—the Russian moratorium. So it is no surprise that flows can not forecast the exchange rate in this period.
For the results on contemporaneous correlation the results are more clear. Foreign flows are the most important explanatory factor if we focus on the timing of speculative attacks in Norway.

How can we relate these results to our a priori hypotheses? Neither of the three possible combinations can be rejected outright. However, there is clearly very little support for the hypotheses implied by an assumption of superior information on behalf of large players. Large players do not seem to signal positions to small players. This is the case both directly and through the exchange rate. To the extent that other variables do reflect large player’s positions, small players seem to have the same influence.

Do the ability of small players to forecast the exchange rate in the 1996-97 event indicate that small players have a different cost structure from large players? This is not obvious, especially as we do not find similar results for the 1998-99 crisis. A conservative interpretation would be that the Granger causality tests point in direction of symmetric information between large and small players, with no obvious evidence of other differences.

However, the evidence on contemporaneous correlation do indicate that large players are the most important factor during the attack. A priori we believed that this might indicate that large players had less cost of taking speculative positions than small players. The results are contrary to what we would assume to find if large players had an information advantage.

5 Conclusion

To conclude, we believe that based on our evidence we can dismiss the hypothesis of an information advantage for large players in the Norwegian market. This is perhaps not a surprising conclusion, but neither is it an obvious conclusion. During all the events discussed in this study large foreign players have been denounced for manipulating the Norwegian exchange rate. There has been raised arguments of such players having unfair access to government and central bank decision makers. As far as we can see, such rumors are not reflected in our data.

So information is symmetric. It remains a question of whether large and small players are equal also on other accounts. We believe that there is weak evidence in support for the hypothesis of small players having larger costs than large players. To the extent that a crisis is “predictable”, small players will move their positions first. However, the most important evidence is that large players do seem to be the most important group during the actual speculative attack. If large and small players had equal roles, we would not expect this result.
If our findings are to be believed, they have possible implications for the discussion of international monetary reform. We identify the behaviour of “large players” as the most important determinant for the timing of a speculative attack. However, the behaviour of large players is not based on superior knowledge. Rather, their advantage is less cost in taking speculative positions.

It is not unreasonable to think that higher cost of speculation would reduce the incentive to speculate. In both “crises” under investigation in this paper the currency reverted to the value before the speculative attack within a year. Ex post it is difficult to justify the exchange rates seen during the speculative turbulence. Had the cost of speculation for large players been higher, these events would perhaps never have occurred.

Our results might therefore indicate that measures taken to increase the costs of short term speculation by highly leveraged institutions can reduce volatility in the currency market. Whether such measures are warranted however, would depend on whether the cost of regulation is less than the potential gain from reduced speculation. On that topic this paper has nothing to tell.

References


