

# Chapter 8 - What can financial economics teach us about exchange rates?

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*This article looks at two new directions in financial economics - behavioural finance and the microstructure approach to foreign exchange - in order to cast light on mechanisms driving exchange rate movements. Changes in the Norwegian krone exchange rate during 2002 and 2003 are used as an example. The conclusion is that deviations from the “equilibrium exchange rate” may be persistent, and that it is reasonable to assume (in contrast to standard macroeconomic assumptions) that participants in the foreign exchange market have different information sets, and that this can affect the determination of the exchange rate.*

## 1. Introduction

An exchange rate is the price of one country's money, for example euro, measured in another country's currency, for example, Norwegian krone. One would therefore expect that exchange rates depend on fundamental macroeconomic conditions (so called fundamentals), such as interest rates, inflation, economic growth, etc., in the two countries in question. Interest rates indicate the return on financial assets in the respective currencies. Inflation means that money loses its purchasing power. Economic growth says something about increases in the demand for money, among other things, for transaction purposes. This applies to both the foreign currency and to the Norwegian krone. Despite the fact that an exchange rate in many ways is a simple concept, international research has unfortunately shown that it is very difficult to find stable relationships between the exchange rate and economic variables. This also applies to movements in the krone exchange rate in recent years. The Norwegian krone appreciated sharply through 2002, by around 10 per cent against the euro, and has since (May 2003) de-

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preciated by around 10 per cent. This chapter will attempt to cast light on mechanisms in the foreign exchange market in terms of financial economics. Hopefully this might also shed some light on the fluctuations of the Norwegian krone.

The fact that it is difficult to explain exchange rate movements is, however, not as odd as it first may seem. The value of a foreign exchange investment depends on future exchange rates. The exchange rate is therefore determined by market participants' expectations regarding future exchange rates. After all, we invest in order to get a return in the future. These expectations are based on information. If the information is such that we expect that the exchange rate will be stronger (appreciate) in the future, it is in our interest to buy e.g. Norwegian krone. If a sufficient number of people expect the krone to appreciate, demand for Norwegian krone will increase and the current price of the krone will rise. Moreover, participants have to take risk into consideration. If an investment is deemed to be very risky, the investor is not that interested in paying as much. If the risk of holding foreign currency increases, the value falls. Thus we can write the exchange rate of a foreign currency as follows<sup>2</sup>

$$P_t = \frac{\overbrace{E_t}^{\text{Expectation}} \left[ \overbrace{V_{t+1}}^{\text{"Value"}} \mid \overbrace{I_t}^{\text{Info.set}} \right]}{1 + \underbrace{r_t}_{\text{interest rate}} + \underbrace{\rho_t}_{\text{risk premium}}} \quad (1)$$

where  $P_t$  is the exchange rate in period  $t$ ,  $E_t[\cdot]$  shows that there is an expectation,  $V_{t+1}$  is the correct value in the next period,<sup>3</sup>  $I_t$  is the relevant information on which the expectation is based,  $r_t$  is the risk-free interest rate and  $\rho_t$  is the compensation for taking risk.<sup>4</sup>

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<sup>2</sup> The foreign currency, for example euro, is seen as a 'product', and its value measured in, for example, Norwegian krone. If euro is expected to rise in value, or is assumed to be less risky, we have to pay more Norwegian krone for each euro.

<sup>3</sup> For the interested reader: You can think of  $V_{t+1}$  as the value of the currency, including the interest yield. You then get UIP, adjusted for the risk premium, by taking the logarithm of equation (1).

<sup>4</sup> Here the risk premium is formulated as the compensation demanded for investing in foreign currency. If the foreign currency is deemed to be very risky, the future value of the currency is discounted at a higher rate and the foreign currency is worth less. If foreign currency is very risky you need return in excess of the home return  $(1+r_t)$  in order to make the foreign investment.

The problem with explaining exchange rate movements is that neither expectations, nor the information that forms the basis of these expectations, nor market participants' assessment of risk are things that we can observe directly. In addition, all three vary over time, making it even more difficult to establish stable relationships. There are more puzzles involved in international exchange rate research than there are satisfactory answers. The most important puzzle is linked to the fact that the variables that we believe to be important, such as interest rates, inflation and economic growth, are apparently not that important on horizons of less than one year. It is also a puzzle that the substantial *fluctuations* in the exchange rates do not seem to affect the macroeconomy. Paradoxically, it would seem that for horizons of less than one year,<sup>5</sup> macroeconomic conditions have no major effect on the exchange rate and that the exchange rate has no major effect on macroeconomic conditions. In addition, it is also possible that in the case of Norway, the restructuring of monetary policy to a floating exchange rate in spring 2001 was a new experience where market participants found that what they thought they knew about the exchange rate no longer applied. In other words, it created uncertainty about the structure of the market.

As with macroeconomic models for the exchange rate, traditional finance theory has not proved to be particularly well suited to explaining movements in the exchange rate. Below we will therefore try to cast light on more recent changes in the exchange rate on the basis of two new theoretical directions within financial economics: behavioural finance and the microstructure approach to the foreign exchange market.<sup>6</sup> The microstructure approach to foreign exchange is based more on information economics, but still within the context of rational participants, than standard macroeconomic approaches to foreign exchange. Behavioural finance, on the other hand, studies the implications of what happens when some participants do not behave “rationally” and how we can understand this. These two approaches have shown some promising results. We will start by looking at the microstructure approach.

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<sup>5</sup> This has been called the determination puzzle (see Frankel & Rose 1995) and the disconnect puzzle (see Obstfeld & Rogoff 2000) and is a relatively general phenomena for countries with floating exchange rates. The extent to which it will apply to Norway with a floating exchange rate regime, remains to be seen.

<sup>6</sup> See Lyons (2001) and Barberis & Thaler (2003) for good introductions to microstructure theory and behavioral finance. Shleifer (2000) includes reprints of Andrei Shleifer's work on behavioral finance, among others those quoted here. Thaler (1991) contains articles from the "Anomalies" column in *Journal of Economic Perspectives*, which discuss economics in the light of deviations from rationality.

## 2. Microstructure approach to foreign exchange

Macroeconomic exchange rate theories, be they “new open” economy variants or 1970s vintage, usually make three assumptions: *(i)* all relevant information is commonly known, *(ii)* all participants are the same and *(iii)* the structure of the foreign exchange market is of no significance to exchange rate formation. Naturally, no one believes this to be true, but the hope is that breaches of these assumptions only have negligible implications. The microstructure approach to foreign exchange focuses on deviations from these three assumptions and thus far has focused on the assumption that all information is commonly known, in particular.

The first indication that differences in information may be of importance to the foreign exchange market is the substantial volume of trade. According to BIS (2002), the volume of spot trading in the Norwegian foreign exchange market was nearly \$57 billion in April 2001. In the same month, total import and export amounted to \$7.4 billion. When all information is common knowledge and everyone agrees on the implications of this information for the exchange rate, new information will shift the supply and demand curves immediately so that a new (equilibrium) exchange rate is achieved without any trading taking place. Standard macroeconomic models for the exchange rate can therefore not explain why there is as much trade in the foreign exchange market as there in fact is.

All the same, the assumption that all relevant information is common knowledge appears, at the outset, to be reasonable. Given that exchange rates are determined by fundamental macroeconomic conditions, it seems reasonable to assume that all relevant information is commonly known. Hence, in order to understand what may constitute private information in the foreign exchange market, thereby breaching the common knowledge assumption, we need to be more specific about what participants could have private information about (see Figure 1). The columns in the matrix refer to the numerator (return) and the denominator (discount rate) in equation (1) and thereby to what the information includes. The rows can be seen to refer to the “quality” of the information.

Figure 1 Sources of private information

	Risk-neutral valuation	Discount rate
Concentrated information	Interest rate changes, interventions	
Dispersed information	Expectations, interpretations of public information	Risk premium (risk aversion, portfolio shift)

Normally, private information about returns on securities is regarded as concentrated return information, represented by the upper left-hand cell in the figure. This corresponds to (part of) the denominator in equation (1). Inside information in stock markets is an example of this. The insider has information that dominates that of all others. This sort of information is not the most relevant in the foreign exchange market. It is rare that anyone outside the central bank knows what changes are to be made to interest rates before they are announced. In the foreign exchange market, it is the small pieces of information that are dispersed amongst the participants (bottom line) that are most relevant. The reasoning here is that no one has superior information, as is the case with inside trading in equity markets, but rather that everyone has their bit of information.<sup>7</sup> The information may be how participants interpret announcements ( $E_t[\cdot]$  the expectations element), which variables they react to ( $I_t$ , the information element), or portfolio shifts that give rise to risk premiums ( $\rho_t$ ). The task of a financial market is to aggregate information like this so that the exchange rate reflects as much relevant information as possible.

For every transaction there is of course both a buyer and a seller. The order flow comprises “signed” transactions. The action of the initiator of a transaction, buying or selling, determines the sign. If a participant takes the initiative for a transaction and sells euro (base currency) for krone, the order is given a negative sign; if the initiator buys euro and sells krone, it is given a positive sign.<sup>8</sup> So even though there is a buyer for each sale, the order flow does not necessar-

<sup>7</sup> The participants' information sets  $I_t$  are different, but not necessarily such that one person's information embraces everyone else's.

<sup>8</sup> The "product" is euro and is paid for with Norwegian krone. This is a useful perspective from which to understand why the krone weakens when the exchange rate *appreciates*: when the price of a product rises, the product (euro) is worth more, which means that the means of payment (krone) is worth less. Participants in the foreign exchange market talk about buying euro rather than selling krone, in the same way that we never sell krone when we buy a pizza.

ily add up to zero over a period. The aggregation of information occurs, among other things, when market participants observe the order flow in the market.<sup>9</sup> If the reason for the initiator to sell euro for krone is that he has reason to expect that the krone will increase in value (i.e. appreciate, but the exchange rate will fall), then observing this order flow will provide useful information and result in a strengthening of the krone (exchange rate declines; the sign for the order flow, negative, is therefore intuitive). In a microstructure model, therefore, a trader can learn what information other people have by observing the order flow. There may of course be other reasons behind the order flow, e.g. risk management or liquidity trading, but this does not diminish the value of the information, only adds noise to it.

Testing of this type of theory has been difficult due to the lack of data. The IT revolution in the foreign exchange market in recent years has, however, made it easier to record observations of order flows. Evans & Lyons (2002) have estimated a model for daily exchange rate movements that includes both order flows and changes in interest rates, which can explain over 60 per cent of exchange rate fluctuations. This is extremely high compared with most other empirical studies of exchange rate movements.<sup>10</sup> Furthermore, they find that most of the changes are due to the order flow and that changes in interest rates explain very little. The effect of the order flow has the same sign as the theory suggests - they find that a daily net order flow of \$1 billion strengthens the dollar by 0.5 per cent in relation to the Deutsche Mark. This is also economically significant, as the average net order flow over the period was \$3.9 billion.<sup>11</sup>

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<sup>9</sup> Market makers in banks are responsible for exchange rate determination, and therefore also the aggregation of information. Market makers can observe order flows, whereas normal customers cannot.

<sup>10</sup> Bjørn Naug's article in this collection is another example, however, not based on a particular theory model.

<sup>11</sup> Rime (2000) has corresponding results for the Norwegian market, but does not have the same degree of explanatory power.

However, most important is that the bulk of the effect is permanent.<sup>12</sup> The implication of this is that the information provided by the order flow is *relevant* and not just short-term noise. The theory of efficient financial markets can help us to understand that the effect of relevant information must be permanent. If a financial market is efficient the associated asset price can be expressed with the help of a random walk model. Efficient exchange rates aggregate all available relevant information; so given the available information, the best we can say about future exchange rates is that it is the same as today (corrected for interest rate differentials according to UIP). Or, to put it another way, movements in the exchange rate (in excess of UIP) cannot be predicted. Otherwise, not all available information would be reflected in the exchange rate. As soon as new information becomes available, e.g. from order flows, then the exchange rate will jump to its new level and be expected to stay there. Let us imagine that it is common knowledge that order flow is only of temporary importance, in other words, that market participants know that a given price change will be reversed after a time. This could not happen in an efficient market, as everyone would then know that the price would return to some level. Rather, when they then used the information to set prices for the day, they would set the price to the permanent level thereby removing any arbitrage opportunities. Hence, in an efficient market, the effect of useful information should therefore be permanent. Information that is not relevant should not have any role in determining exchange rates. There may of course be information that does have a temporary effect, e.g. price changes to induce position balancing, but it cannot be said that this is common knowledge. Furthermore, note that we do not claim that the foreign exchange market is efficient, but only point out that the impact of relevant information will be permanent. There may, however, be other pieces of information that are not fully reflected in the price.

Now, let us go back to what kind of information the foreign exchange market has to aggregate and therefore to what might be behind the order flow. This has yet to be studied satisfactorily, but recent research can give us an idea. (i) The balance of trade: underlying the aggregated figures in the trade balance there are a number of individual transactions in the foreign exchange market. Large banks can therefore get an idea of the trade balance long before the

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<sup>12</sup> Rime (2001) looks at a longer sample of weekly sales and purchases of currency in the USA and finds that a measure of cumulative order flows and the exchange rate cointegrate (Engle & Granger 1987), which implies that the effect on the exchange rate is permanent. Killeen, Lyons & Moore (2001) have also found support for cointegration.

official figures are presented, by observing the transactions of their import and export customers. (ii) Interpretation of announcements: all information is not aggregated through the order flow. Information about macroeconomic variables, such as changes in interest rates, may have a direct effect on prices as predicted by macroeconomic models, without there being any order flow. But if there is some uncertainty about the effect that a given change in interest rates might have on the exchange rate, market participants will be able to glean information about other people's interpretations by observing order flows. Such uncertainty does not seem unreasonable given the difficulties involved in explaining exchange rates with macroeconomic variables. (iii) Risk premiums: from time to time, investors may shift portfolios. Other participants in the market have to absorb this shift and therefore assume the risk. For them to assume this risk willingly, they have to receive compensation in the form of a risk premium. If someone buys Norwegian krone for euro (sells euro), then the recipient of euro will have to get a risk premium. From equation (1) we see that this would result in a fall in the exchange rate, which corresponds to an appreciation of the krone.

In what way can the microstructure approach help us to understand movements in the exchange rate? First of all, a significant permanent effect from the order flow implies that the assumptions underlying standard macroeconomic models are not correct. In particular, this shows that participants in the market have different information and expectations. This opens for the possibility that changes in macroeconomic variables may have effects other than those expected on the basis of standard macroeconomic theory. This only confirms what earlier research has shown: the foreign exchange market is difficult to understand. However, it does go a step further by pointing out possible sources as to why changes in the market are difficult to understand and that order flows can teach us something more about participants' expectations. In addition, if it is the case that market participants update their expectations based on observations of order flows, the result may be self-perpetuating waves of price and transaction patterns. In 2002, several banks reported that their order flow data showed a trend in Norwegian krone. This sort of herd behaviour is discussed in more detail below.

### 3. Behavioural finance

Traditional finance theories assume that participants always behave rationally.<sup>13</sup> Behavioural finance theory seeks instead to elucidate how participants *actually* gather, understand and process information and how they make their decisions. Results from psychology experiments are often used as a starting point. These results often show that participants do not behave in accordance with traditional theories of rational choice. Experiments show that participants often have an exaggerated belief in their own knowledge and abilities and make errors in expectations such as, for example, placing too much emphasis on observations from the recent past or events that have very little chance of occurring.<sup>14</sup> Or they do not sell loss positions when they should and simply follow “the fashion”. We will look in more detail at the part of behavioural finance that focuses on why the market does not adjust “incorrect pricing” when there are, or could be, irrational participants in the market.

In a well-functioning (efficient) market, the exchange rate is always “correct”.<sup>15</sup> Speculators, or traders, take care of this. If the exchange rate is too high, they sell and thereby push down the exchange rate, and if it is too low, they buy. In standard models, everyone will behave in this way because any deviation from the correct exchange rate represents a certain gain, an arbitrage opportunity. The exchange rate will therefore always be in equilibrium, because as soon as it deviates slightly, someone will try to make a gain. In 2002, the interest rate differential with other countries was substantial and positive, which according to the theory of uncovered interest parity (UIP) implies that the market expected the krone exchange rate to fall. If not, it would have been an opportunity for arbitrage as one could benefit from higher interest rates on Norwegian krone, without there being an expected loss on the exchange rate. The krone did not depreciate during the course of 2002. Why not?

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<sup>13</sup> Rational participants in financial economics maximize their expected utility and have rational expectations that are formed using Bayes' rule.

<sup>14</sup> It must be said that such experiments have been criticized for creating false environments. This means that the extent to which results are representative of actual economies is uncertain.

<sup>15</sup> Finance theory has two efficiency concepts: allocation efficiency, as in standard economics, and information efficiency. The latter is the most important concept in finance theory and says that exchange rates reflect all available information. The prices are therefore “correct.”

De Long, Shleifer, Summers & Waldmann (1990) have a model for how security prices can deviate from the “correct” price when there are irrational participants in the market. It is based on the assumption that (correlated) trading by irrational participants can force prices away from the correct level. Imagine being an investor in 2002. You might have thought: “The interest rate differential is very high and has been for a while, but the exchange rate has not fallen. I am going to sell as much as I can now! I’m sure that’s the best move!” The idea seems reasonable. However, the fact that the exchange rate still has not depreciated, when it seemed obvious to the trader that it should, may indicate that others perceived the situation differently. It may be that irrational participants are present in the market. In which case, the trader cannot rule out the possibility that the depreciation that he expects may not happen for some time. In the meantime, he will lose money and it is not even certain that incorrect prices will be adjusted in a market where some participants are irrational.<sup>16</sup> What at first appeared to be a certain gain proves to be less certain after all.

Professional traders rarely speculate with their own money, but manage other people's money. This in itself creates two problems in terms of achieving efficient prices (see Shleifer & Vishny, 1997). First, remuneration on the basis of actual gains may mean that some arbitrage opportunities are not exploited. Arbitrage opportunities that have a high expected return, but that may appear to be particularly risky, will not be exploited because there is a risk that a poor outcome may ultimately result in the manager losing his job. Another example is that if the delegating authorities reassess the manager regularly, thus encouraging the trader to be shortsighted in his positioning, the trader will often fail to take advantage of arbitrage opportunities that may not necessarily be realised before the next assessment.

Behavioural finance has also documented *patterns* in mis-pricing. In the short run, asset prices often underreact to new information, i.e. move less than implied by a fundamental model, and overreact in the long run (before returning to fundamental value). The fact that the Norwegian krone did not depreciate during 2002 may be understood in light of this. Instead of appreciating in one big jump and then starting to depreciate, the krone appreciated in small steps in each period. Hong and Stein (1999) explain short-run underreaction and long-run overreaction

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<sup>16</sup> De Long, Shleifer, Summers and Waldmann (1990) show that it is not necessarily the case that irrational participants will be forced out of the market, as claimed by Friedman (1953).

in a model where some investors each have a private share of information about the true underlying fundamentals after an information event, hence only a share of the information can be incorporated into prices. Over time, however, they learn more and more about the information shares of others (who can keep a secret for ever?) and when all investors know all the information, i.e. the complete picture of the fundamentals, prices equal the fundamental value. As this takes time, there is underreaction in the short run. Overreaction is caused by trend-chasing investors who cannot observe whether there has been an information event or not. The gradual price process created by the informed investors gives the trend-chasers the impetus to join the trend and as they do not know the fundamental value, they may even push it past the fundamental value, thereby creating an overreaction. Barberis, Shleifer and Vishny (1998) explains the same phenomenon with a model where the investor makes mistakes about the underlying process governing fundamentals when observing prior developments. If there are several increases in a fundamental variable, they will believe that the underlying process is a trend process even if it is not. Could these kinds of mistakes or the failure to process all information help to explain the slow appreciation of the krone? The fact that so many banks reported that small investors were willing to move their savings to Norway may indicate that they believed the high interest rate differential would remain high for an unreasonably long period, i.e. governed by an unreasonable process.

And finally, “herd behaviour” must also be mentioned. This falls into the same category as “following fads”, but is given equal attention in models with rational participants. Such behaviour may also help to explain the appreciation of the Norwegian krone last year. There are two arguments in particular for herd behaviour being rational.<sup>17</sup> Let us assume that participants are uncertain about what is the “correct” exchange rate. The fact that others are buying Norwegian krone will then be a “signal” that the exchange rate will at least not depreciate. If you are sufficiently uncertain to begin with, this signal could be given more importance than any information you already have and you simply follow the crowd. In such a scenario, the behaviour of others is an information externality. It is also possible that others' behaviour entails a return externality. If a trader believes in an arbitrage position, but can get no one else to take it, there will be no return. The strategies of different traders are complementary: the return for speculating in one direction is greater if other people do the same. And if you tie herd behaviour in

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<sup>17</sup> See Brunnermeier (2001) for a relatively advanced presentation.

with behavioural finance, a trader seldom loses his job because he lost money in the same speculative trade in which all the other managers lost money.

So, to sum up, there are limits to how far we can rely on the market's ability to adjust “incorrect pricing” due to (i) the possible existence of irrational participants; (ii) the fact that traders act on behalf of others, and (iii) frequent assessment of traders. Deviations from the “correct” exchange rate may therefore be persistent. Furthermore, such deviations may be amplified by herd behaviour.

#### 4. Conclusion

We have discussed how two relatively new theories in financial economics, behavioural finance and the microstructure approach, may help to explain movements in the krone exchange rate. There are two main conclusions. The first is that realistic assumptions regarding the behaviour of participants in the exchange market give little reason to expect that deviations from an equilibrium exchange rate will be swiftly corrected. Several studies of stock markets show that such deviations may be persistent. And secondly, we should also look to sources other than macroeconomic variables in order to understand the movements in the krone exchange rate. In a market where participants can have different information, the order flow will be an important factor in understanding these movements. What underlies order flows will be an important area of research in the period ahead. A critic could justifiably question the relevance of this to the macroeconomy. Is not the nature of the mechanism described here so short term that it is not worth worrying about? It is true that empirical studies of both microstructure and behavioural finance use high frequency data, often daily or intraday observations. *The implications* of these studies are, however, not limited to the short run. Information aggregation, which is studied in the microstructure approach, has *permanent* effects on exchange rates. Similarly, the existence of irrational participants implies that risk premiums will be *permanently* higher in those markets compared with what is expected in standard models.

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