Just follow the old lady: The central bank as a guide for the FX-market[1]

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Abstract

The microstructure literature has two possible implications for the pricing of assets: (i) the institutional setting of trading might influence prises, and (ii) trading itself might convey information about prices. The second implication has received increased attention in later years, as more information on volume in the FX-market has become available. If flows do influence market behaviour, an interesting extension on this literature would be the question of whether large players can signal their information to the market through flows. This hypothesis has been investigated in some recent theoretical papers. However, few empirical papers have been able to look at such instances. This paper looks at a special case of signalling to the market. Over a period of six years Norges Bank was active in the FX-market, purchasing currency for the Norwegian Petroleum Fund. These purchases can be interpreted as interventions in the market that stabilised expectations of the exchange rate. Over the period the Norwegian exchange rate followed a relatively stable path. When the policy was discontinued, the volatility of the exchange rate increased dramatically.

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1 Introduction

If uncertainty about the future level of the exchange rate is high coordination failure might arise, e.g. due to trading by noise traders, like chartists or technical analysts. Under such circumstances prices can diverge from the underlying economic fundamentals. Sarno and Taylor (2001) argue that sterilised central bank interventions might play a role as a coordinating factor for investors who base their trading on fundamental trading strategies. This relates to the recent literature on microstructure in the FX-market, which indicates that trading itself might convey information about prices (see e.g. Lyons, 2001).

I review a very special example of central bank behaviour. Since 1996 Norges Bank (the central bank of Norway) has been responsible for converting public funds denominated in Norwegian kroner (NOK) into foreign currency. The money was to be invested in an international investment fund, the Norwegian Petroleum Fund. From 1996 to 2001 the amount converted was directly related to the government's own forecast of public finances. From the beginning of 2002 this relationship no longer exists, due to a change in accounting practices. I argue that how the currency conversion was conducted is important to understand both the relative stability of NOK in the period from 1993 to 2001 as well as the strong appreciation of NOK that took place from January 2002 to July 2002. I see this as an example of the possible coordinating effects of central bank behaviour.

Norway is a large producer of oil, and has during the 1990's become one of the worlds five leading oil exporters. Much of the profit in the Norwegian petroleum sector is collected by the Norwegian government. The Norwegian government might either save this money, or use it to increase current spending. Uncertainty about how the income will be spent can create uncertainty about the dynamics of the exchange rate. In a standard macroeconomic setting, an increase in government spending should lead to an appreciation of the Norwegian currency, as demand for local goods and services increase more than the demand for foreign goods and services. An expected increase in government spending should lead to an expected real appreciation. If inflation is stable, a real appreciation should be reflected as a nominal appreciation. Forward looking expectations should imply that the current exchange rate reflects future expected government expenditure. However, the extent of expected appreciation will depend on how much of the petroleum revenue the government will spend each year. Although one does know that expenditure will increase over time, one does not know what will happen this year, next year, or the year after that. If the government postpone an increase in government spending, expected appreciation will be small in the short and

medium term. Such uncertainty will possibly reduce the risk premium in the medium term, making NOK a less attractive investment.

Uncertainty might increase the volatility of the exchange rate. If investors are not risk neutral, uncertainty can reduce the incentive to take speculative positions based on fundamental analysis. But it might at the same time increase the potential of misguided perceptions. This point is made by a number of authors (see e.g. De Grauwe, 1996, ch. 7-9). If an asset price begins to move, and there is uncertainty about fundamentals, traders using fundamental strategies can no longer be expected to assure that the price do revert to fundamentals in the short or medium term.

Assume however that the government can give a credible signal of short term behaviour to the market. This reduce short term uncertainty. With lower short term uncertainty, fundamental traders can more easily break trends created by noise trading. The result is a more stable exchange rate.

I look at the period from 1993 to the summer of 2002. Expected future government revenue from the petroleum sector was extensive in 1993, and has been increasing over time. Despite this, the Norwegian exchange rate remained relatively stable towards European currencies over the period from 1993 to the end of 2001.

Up till March 2001 the use of petroleum revenue in the current budget was mostly a reflection of the business cycle. Petroleum revenues were a tool for counter-cyclical fiscal policy. Any surplus was to be accumulated in the Norwegian Petroleum Fund. The Norwegian Petroleum Fund is only invested in foreign currency. Investments in the Fund required transactions in the currency market. These transactions were handled by Norges Bank.

There was uncertainty about the long term strategy for the use of future oil revenues and the capital accumulated in the Petroleum Fund. There was also uncertainty about the short term use of petroleum revenues. Such numbers are stipulated in fiscal budgets, but budgets are revised over time. Further, if an increased use of petroleum revenues would lead to a less stable or appreciating exchange rate, the government could have incentives to understate their actual intensions.[1]

This paper argues that short term uncertainty was reduced because Norges Bank followed a policy of purchases and sales in the currency market that actually reflected the government's projections of its own policy. The flows became a tool for stabilising market expectations. I show that that there is an empirical relationship between the purchases of currency by Norges Bank

[1]Note that petroleum revenues accrue in foreign currency. All Norwegian taxes are paid in NOK. As long as the government invest only a fraction of total tax revenue from the petroleum sector abroad, net income measured in NOK would be increasing in the exchange rate, when the exchange rate is defined as the price of foreign currency in NOK.

and the exchange rate over the period from 1993 to 2001.

The regulation of long term use of petroleum income was changed with a government decree issued March 29, 2001. The decree contained a budget rule, according to which a four per cent real return on the Petroleum Fund could be used every year. This did not only imply an increase in the current use of petroleum revenues, it also implied an expected further increase in the use of petroleum revenues in the years to come, as the Petroleum Fund is expected to grow over the next 10-30 years.

January 1, 2002 the procedure of currency exchange for the Petroleum Fund was changed as well. From this date Norges Bank's purchases no longer had any direct link to government projections of spending. During the six first months of 2002 the exchange rate appreciated with about 8 per cent towards the euro. By late 2002 the exchange rate had stabilised at a level 6-10 per cent below its previous fluctuation band.

The information channel "closed" due to a technical change in government budgeting procedures. The link between the change in the currency exchange procedure and the appreciation of the currency need not reflect a relationship of cause and effect. How important this step was, given that the change in fiscal policy announced earlier in 2001, can never be fully determined. Curious coincidences are nothing new in the asset pricing literature. However, the combination of a seemingly reasonable relationship between the Norges Bank purchases in the preceding period and the timing of the two break points, should at least warrant a closer investigation into this aspect of exchange rate management.

The possibility to use central bank purchases of currency for coordinating purposes is implicit in the recent microstructure literature on foreign exchange. The starting point of this literature was the observation that dealers in the foreign exchange market tend to focus on flows when making opinions of price movements (see Lyons, 1995). This has lead authors to investigate to which extent trading reflects changes in discount factors of traders. If trading volume gives information about changes in the perceptions of traders, observing the flow of trades is important to understand the formation of exchange rates.

Vitale (2002) argues that the central bank can signal policy objectives through trading in the FX-market and thereby stabilise the economy. He states that

1. "foreign exchange intervention may represent an independent instrument of policy making, as it can be an effective channel through which policy makers can *signal* their intentions, reduce agents' uncertainty on future policy decisions and hence stabilise the national economy; [and]

2. the institutional arrangements governing the instruments of policy making influence such a stability gain, for this is more pronounced when foreign exchange intervention and monetary policy fall under the jurisdiction of two different governmental agencies." (Vitale, 2002, p. 2)

He provides a framework where policymakers have a "target exchange rate". However the rate is not known with certainty by the market. Policymakers can announce the level of this target rate. But such announcements will lack have credibility. Vitale (2002) argues that interventions can help policymakers to "buy credibility". Through intervening in the markets, policymakers are setting money behind their words.

The driving point in Vitale's argument is that interventions are costly, and therefore credible. At the same time they are an efficient signalling mechanism. Through the inter-dealer trading the market fast aggregates up information. Trading with a small number of dealers can efficiently relay information to the whole market.

Vitale (2002) focuses on "interventions". Sarno and Taylor (2001), p. 839, define an intervention as an incident where

> "the authorities buy or sell foreign exchange, normally against their own currency and in order to affect the exchange rate."

This paper will focus on aggregate trading by the central bank. Some of this trading is preannounced, and most transactions are by purpose implemented so as to affect the exchange rate as little as possible. This need not indicate that they have no effect on the market. Vitale (2002), p. 3, argues that

> "precise public announcements on the policy objectives will lack credibility, as the policy makers possess an incentive to lie, and cannot be used. Imprecise statements can instead be credibly employed, but since different announcements are *per se* all the same, in the sense that they are all equivalently *inexpensive*, multiple signals of different informative quality can be used at the same time. On the contrary, we see that this problem of multiplicity of the equilibria does not emerge if a potentially *expensive* signalling mechanism is employed."

Talk is in the end only talk. It is expensive action that matters. And actual transactions are examples of such action. If the government has long term goals, the fact that they follow their stated intentions on a day-to-day basis will confirm their trustworthiness.

As such this paper goes one step beyond the traditional literature on "interventions". This is about guiding the markets over a long term perspective, not just about making short term adjustments in the exchange rate. To understand this aspect, all sales and purchases from the central bank are of importance.

An other difference from much of the literature on interventions is that my focus is on "preventive" behaviour, more than ex post guidance. Under the period of investigation Norway was practicing a "managed float regime". This study might reveal one of the features of such a regime. In a managed float the central bank must focus on preventing volatility more than reducing volatility ex post. This is an example of a reasonably successful preventive policy.

The paper proceeds as following. Section 2 provides a description of the Norwegian FX-market, and how behaviour of Norges Bank might have affected this market. Section 3 reports some empirical results on the importance of central bank behaviour for the period 1993-2001. Section 4 discusses the events of 2001-2002. Section 5 concludes.

2 Norges Bank—a central bank in a country flush with oil revenues

20 per cent of Norwegian GDP, and 40 per cent of Norwegian exports, are generated in the petroleum sector. The number of employees in the Petroleum sector is about 0.7 per cent of total employment in Norway. [2]

Revenue from an export sector with high ground rent can be seen as a "foreign currency gift". It is standard macroeconomic theory to assume that inflow of foreign currency should lead to a real appreciation of the receiving economy, as the demand for home goods will increase more than than the demand for foreign goods, leading to a relative loss in terms of trade.

The affect on the real exchange rate will depend on how much of this revenue is taken into the local economy. A real appreciation can take place through price inflation or nominal currency appreciation. With a floating exchange rate, the net increase in demand for the local currency should lead to a nominal appreciation. Over time, some of increase in demand should be reflected as higher local price inflation. In Norway both effects have been present. The Norwegian price level has increased with about 5 per cent on

[2] Income from the oil sectors made up 15.4 per cent of GDP in 1999 and 24.4 per cent of GDP in 2000. Income from oil and gas exports made up 35.3 per cent of total exports in 1999, and 47 per cent of total exports in 2000. All numbers from The Royal Norwegian Ministry of Petroleum and Energy (2002).

the German price level over the period 1993-2001. However, this is probably not enough to alleviate the whole need for real appreciation.

In this section we first discuss how to interpret the relationship between currency transactions of the central bank and the exchange rate. In the second part we focus on the policy followed by the Norwegian government and Norges Bank in the from 1993 to 2001.

2.1 Reserves and purchases to the Petroleum Fund—a portfolio approach

Net financial holdings of a financial asset summed over all sectors in the economy must be zero—investments made by one group must be reflected as loans taken up by another group.[3] In other words: one agent's assets are the liabilities of another agent. This must hold for foreign and domestic currency. Let F^g by Norges Banks's holdings of foreign currency, F be domestic holdings of foreign currency, and F^* be foreign holdings of foreign currency. We must have that

$$F^g + F + F^* = 0. \tag{1}$$

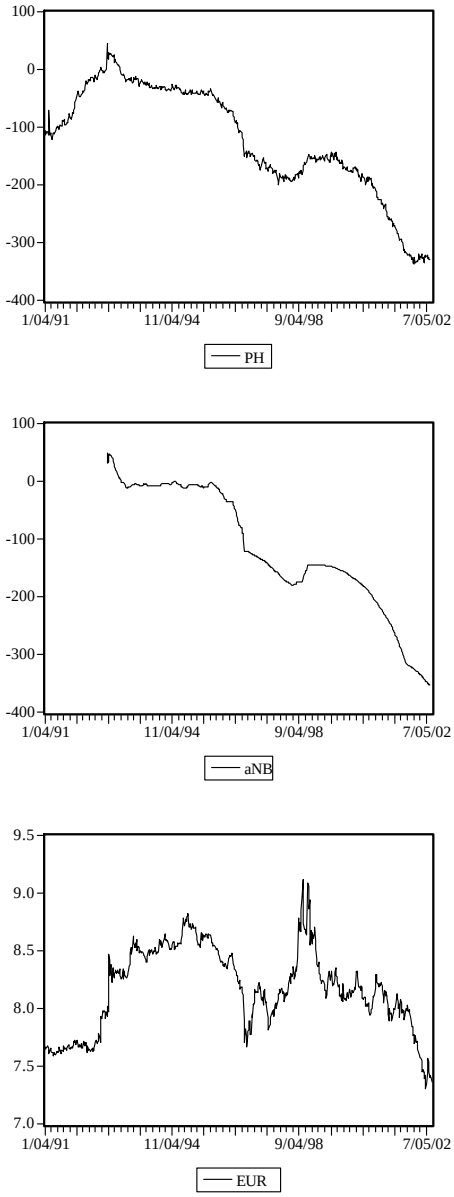
Beginning in week 47 1992 Norges Bank has published a weekly time series that reveal the third party counterparties in trades with Norges Bank.[4] Norges Bank register net amount of currency traded between Norwegian reporting banks and foreign (defined as address abroad) and local (address at in Norway) counterparties. 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. I also have data for the trades between customers and banks for the period from January 1991 to November 1992. The series are displayed, together with the NOK/EUR-rate, in figure 1. PH is change in private holdings of foreign currency. A more negative number indicates that private customers hold more NOK. NB is the change in Norges Bank's holdings of foreign currency. Mark that a more negative number reflects an increase in holdings of foreign currency by Norges Bank. The level of the displayed series accumulated numbers, and the levels of all holdings are set to zero in week 46 1992. The change in the series reflect actual changes.

The total series range from January 1991 to August 2002.

[3] A good introduction to the portfolio choice literature of exchange rates is found in Rødseth (2000), ch. 2.

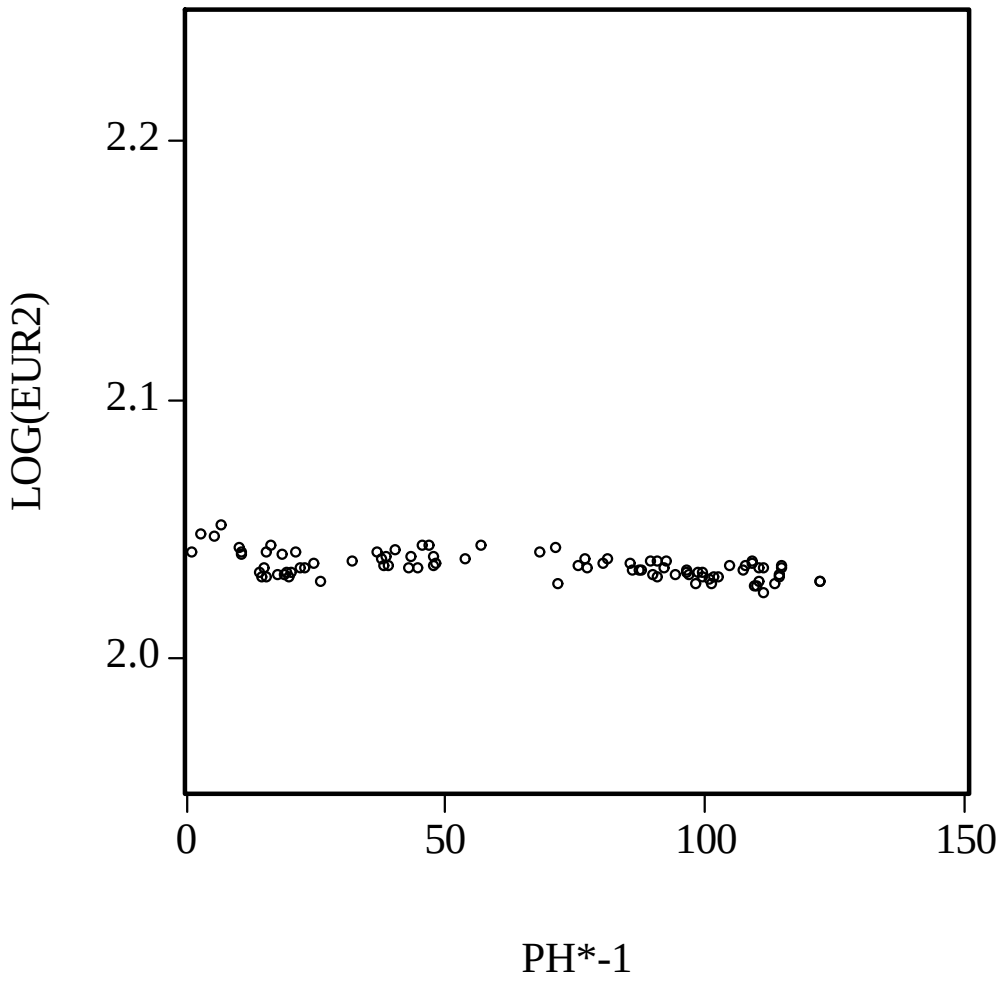
[4] Norges Bank of course make their do all transactions with banks operating in the Norwegian market. These banks do however not take actual positions in NOK. The data reveal who the third party customers of the banks.

Figure 1: Supply of foreign currency to Norges Bank and the exchange rate, January 1991 to end of August, 2002



PH is the accumulated change in private holdings of foreign currency. (Accumulated change because we do not know the initial position. The position is set to zero in week 46, 1992). A more negative number indicates that private customers hold more NOK. aNB is the accumulated change in Norges Bank holdings of foreign currency. A more negative number indicates that Norges Bank hold more foreign currency. Both flow series are in billion NOK. EUR is the NOK/EUR exchange rate. For observations before January 1, 1999, I use DEM instead of EUR.

Figure 2: Supply of foreign currency to Norges Bank and the exchange rate, January 1991 to end of August, 1992 (fixed rate regime)



PH is change in private holdings of foreign currency. A more negative number indicates that private customers hold more NOK. The flow series is in billion NOK. *EUR* is the NOK/EUR exchange rate. For observations before January 1, 1999, I use DEM instead of EUR.

- On an aggregate level the series reflect the amount of central bank trading.
- The series disaggregate volume between locals and foreigners.
- We can see total central bank activity in the market. However, I can not distinguish between "official interventions" and other activity.

The disaggregation will not be used in this paper (see e.g. Bjønnes, Rime and Solheim, 2002, for an application using this feature of the data).

Central bank transactions in the FX-market can take two forms. It can either be

1. changes in foreign reserves, or
2. other purchases made by the central bank.

An intervention is normally understood as a change in reserves. However, in this case, much of the transactions observed in the data is concerning *purchases of foreign currency for the Norwegian Petroleum Fund*.

Standard portfolio choice theory has implications for the scatter plot of the exchange rate and the flow series. As I only have the PH series for the whole time span, I use this series for the illustrations.

The first scatter plot covers the period from January 1991 to September 1992. Figure 2 indicates that the regime was a "pure fix" in 1991 and 1992. Norges Banks holdings of foreign currency would adjust with no adjustment in the exchange rate. The second scatter plot covers the period from January 2002 to August 2002. Figure 3 indicates that from January 2002 the policy can be described as a "pure float". In this period Norges Bank does not change its net holdings of foreign currency despite large changes in the exchange rate.[5]

The third plot covers the period from May 1993 to December 2001. Over the period from 1993 to 2001 the regime can be described as a "managed float". As we can see in figure 4 the exchange rate was relatively stable over the period, although there are periods of volatility. During the periods of volatility central bank interventions are limited. However, for the period as a whole there is a trend in the relationship between the total purchases of

[5]This interpretation is slightly novel. Most Norwegians analysts would argue that the change from a fixed to floating exchange rate happened sometime between January 1999 and April 2001 (see section 2.3.1 below). However, as can be most clearly seen in figure 5, any clear cut regime shift is not visible in the time series before the end of 2001. Further, if one accepts the argument of this paper, an important feature of the managed float was not removed before by the end of 2001.

foreign currency by the central bank and the exchange rate. One way to look at the argument in this article is to see it as an investigation of this trend.

2.2 The petroleum sector and government revenue

A significant part of the extractions rights in the Norwegian sector are controlled directly by the government. During the 1980's, when new fields were licensed, the Norwegian state retained a share in these fields, typically around 30 per cent. These shares was organised in a system called the "State's Direct Financial Interests", SDFI. SDFI's extraction rights are operated on behalf of the government by professional oil firms, and administered by the state owned holding company Petoro.[6] SDFI will pay its share of the investments in the field, and retain a similar share of the revenue from the oil field. Currently SDFI's investments account for about 30 per cent of total investments in the Norwegian sector of the North Sea.

The rest of the extraction rights are controlled by private firms.[7] The firms operating in the North Sea are taxed with a a flat rate of 78 per cent on all profit generated in the offshore oil extraction.[8] All Norwegian taxes are paid in NOK.

Income from the oil sector, which includes income from SDFI and income from oil taxes, accounted for 7.4 per cent of government revenues in 1999 and 20.2 per cent of government revenues in 2000. It has been decided that if the government has a surplus, the part of the surplus generated by revenue from the oil sector shall be invested in a government investment fund called The Petroleum Fund. The Petroleum Fund is invested only in foreign currency assets. 40 per cent of the holdings are in shares.

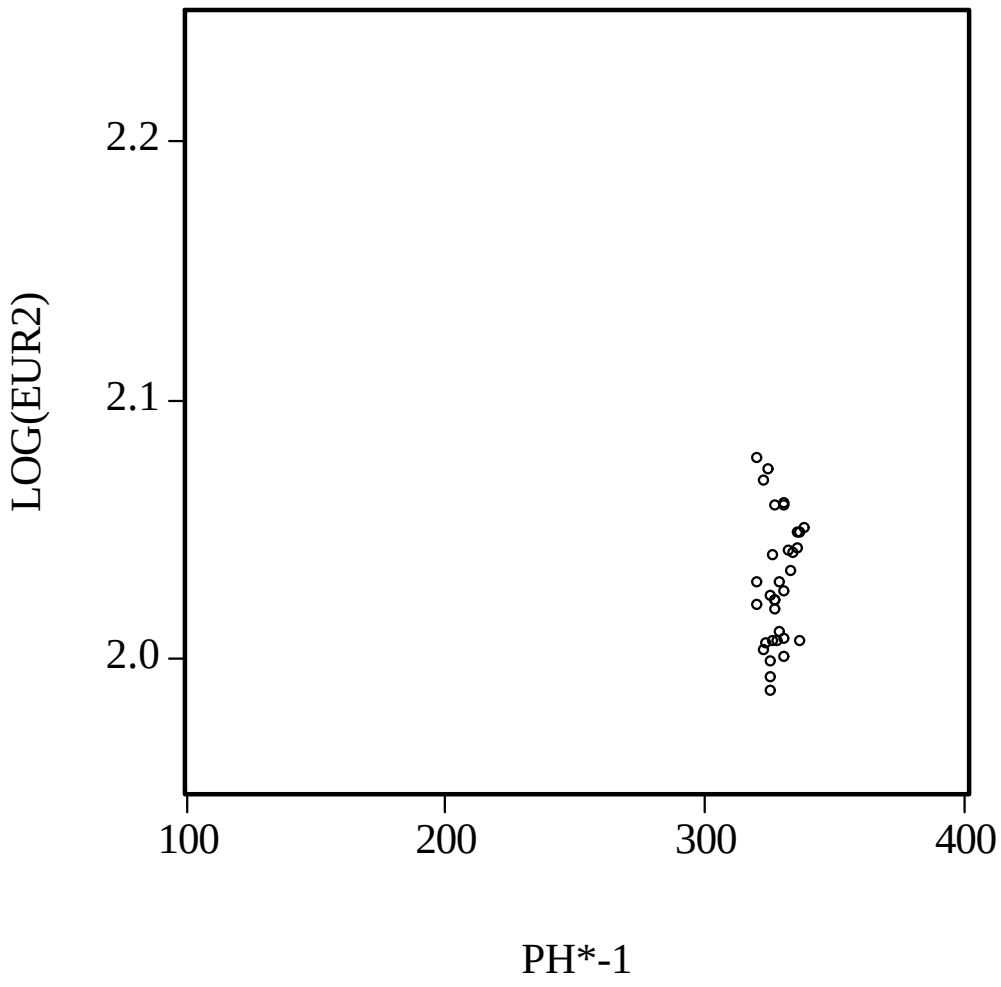
The Petroleum Fund is currently under the administration of Norges Bank. The Fund has three purposes. First, by investing abroad the intention is to reduce the short term oil dependence of the Norwegian economy. Second, the belief is that by investing the money in foreign markets through a well defined investment fund, chances are it is easier to hold the government accountable for the whereabouts of these savings. Last, it is a question of

[6] Until the privatisation of Statoil (see next footnote), SDFI was administered by Statoil.

[7] Two of the largest operator in the Norwegian sector are the Norwegian firms Statoil and Norsk Hydro. Statoil was set up as a publicly owned production company for the Norwegian sector. Up till 2001 the shares in Statoil was 100 per cent held by the Norwegian government. The Norwegian state currently holds 81.8 per cent of the shares in Statoil, and about 44 per cent of the shares in Norsk Hydro. These firms do however compete for licences in the Norwegian sector at similar terms as other oil companies, and operate on standard profit maximising conditions.

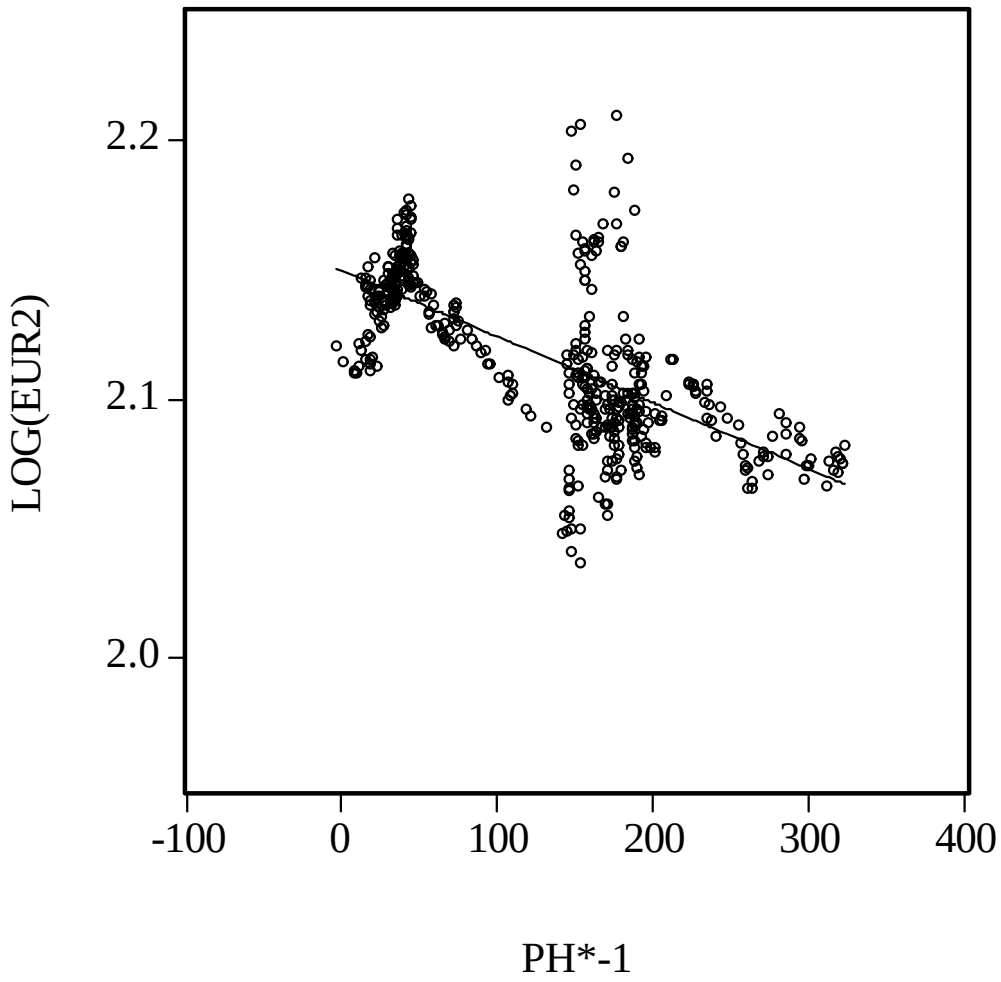
[8] The Norwegian company tax is 28 per cent. There is an additional 50 per cent surcharge on revenues generated from offshore oil extraction.

Figure 3: Supply of foreign currency to Norges Bank and the exchange rate, January 2002 to end of August, 2002 (floating rate regime)



OF is change in private holdings of foreign currency. A more negative number indicates that private customers hold more NOK. The flow series is in billion NOK. *EUR* is the NOK/EUR exchange rate.

Figure 4: Supply of foreign currency to Norges Bank and the exchange rate, April 1993 to end of December, 2001 (managed float regime)



OF is change in private holdings of foreign currency. A more negative number indicates that private customers hold more NOK. The flow series is in billion NOK. *EUR* is the NOK/EUR exchange rate. For observations before January 1, 1999, I use DEM instead of EUR.

portfolio diversification. The Norwegian state is heavily exposed to fluctuations in the oil price, due to its involvement in the petroleum sector. Investing petroleum revenues in foreign financial markets increase the diversification of the asset holdings.

2.2.1 Effects of the Petroleum sector on supply and demand for NOK

Revenue in the oil and gas producing sector is generated in foreign currency, as the oil markets are denominated in USD, and gas contracts are made in USD, GBP or EUR. As mentioned, oil taxes are paid in NOK. Oil companies exchange revenues in foreign currency into NOK. These payments are concentrated on two dates, which are April 1 and October 1. However, as the tax regime has remained relatively stable the taxes due should in general be possible to predicted, within the uncertainty generated by the oil price. The oil firms should therefore be able to smooth timing of exchange over time. The government estimates its yearly surplus based on budget predictions. In general we can assume the budget to be in a deficit if there was no oil revenue. Since 1996 this deficit has however not exceeded total oil taxes. It follows that the surplus has exceeded the size of the net income generated by SDFI. Income from SDFI is therefore transferred directly to the Petroleum Fund.[9] Expenses imposed by SDFI are exchanged in the private market.

The following describes how the system worked up until December 31, 2001.[10] Let the budget deficit with no oil income be BB. Let oil taxes be OT, and let net income from SDFI be NSD. The transfer to the Petroleum Fund, PF, is then given as

$$PF = OT + NSD - BB. \tag{2}$$

As NSD was transferred directly into the fund in foreign currency, this does not affect the the FX-market. However, the government needed to exchange the net balance, NB,

$$NB = PF - NSD = OT - BB, \tag{3}$$

into foreign currency. This procedure was operated by the department for market operations in Norges Bank, the same department that conducts market interventions.

[9] See modification below.

[10] For a description of the current system, see chapter 4.

I define "order flow", OF, in this market as the excess demand for NOK generated by the government. Excess demand is the result of more money being exchanged from foreign currency into NOK, than from NOK into foreign currency. In this period OF was defined as

$$OF = OT - NB = BB. \tag{4}$$

The unknown factor for the financial markets was BB. However, the budget deficit had to be covered by a share of oil taxes before any transfer to the Petroleum Fund was made. So we can write the budget deficit net of oil revenue as a percentage of oil taxes,

$$BB = \beta OT, \quad 0 < \beta < 1. \tag{5}$$

We can now rewrite equation (3) as

$$NB = (1 - \beta)OT. \tag{6}$$

As a result, equation (4) can be written as

$$OF = \frac{1}{1-\beta}NB - NB = \frac{\beta}{1-\beta}NB. \tag{7}$$

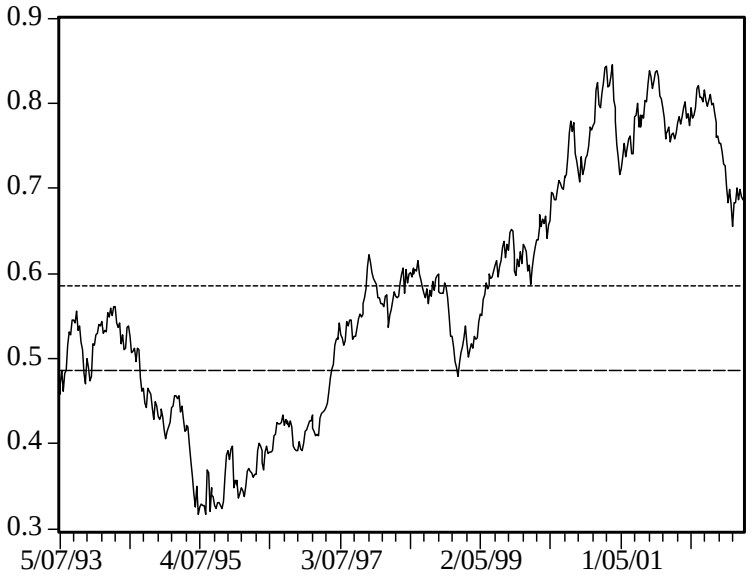
In this system, excess demand could be calculated as *the function of Norges Bank's purchases of currency.* The important point is equation (6). The market could calcualte expected oil taxes. However, they could not know for certain how much the government was going to use of these proceeds. Through observing NB the market could calculate β. This gave them an immediate update on their expectations.

Two things should be noticed. First, Norges Bank announced the approximate size of NB in advance. Further, NB was a reflection of already published budget estimates. The second point is of less importance. A budget gives an indication of a direction, however budgets are not exact documents. Further, they are revised over the year. Observing NB should give a more exact statement.

One the first point, one should assume that the effect of a sudden change in NB would precede the actual change in the flow. The important thing is however that stating how much currency one will buy is only credible if one thereafter actually makes the transactions. By observing NB the market could determine at a continuous basis whether expectations was up to date.[11]

Figure 5: The log of the NOK/EUR exchange rate (DEM before January 1, 1999) Band indicates mean for period January 1993-March 2001 +/- 0.05

Figure 6: The log of the DEM/USD exchange rate. Band indicates mean for period January 1993-March 2001 +/- 0.05



2.3 The managed float in practice

Over the period from May 1993 to December 2001 the NOK/EUR[12] fluctuated between 9.11 and 7.66, or within an interval of 17 per cent. The mean exchange rate over the period was 8.31. The maximum return from one week to another was 4.5 per cent, and the standard deviation of returns was 0.7 per cent.

These numbers do however not do full justice to the degree of stabilisation in the exchange rate in this period. Figure 5 shows the NOK/EUR exchange rate and a band of +/- 0.05 per cent around the mean in the period from January 1993 to March 2001.[13] As a comparison, the same method is used for the DEM/USD exchange rate in figure 6. One can point out that the German and American economies have more structural differences and less common trade than the Norwegian and German economies have. That might of course explain some of the difference. But DEM/USD is the most liquid currency cross in the world, and has a long history as a floating exchange rate. As we can see, compared with a "true floating rate", the Norwegian currency was reasonably stable.

2.3.1 Monetary policy

From 1990 to December 10 1992 Norway had fixed the exchange rate to the European currency unit (ECU).[14] After a speculative attack on December 10

[11]Up till 1999 the purchases by Norges Bank included the net income from SDFI. In this period we have

$$NB = NSD + OT - BB. \tag{8}$$

Let us define

$$BB = \beta_0(NSD + OT), \tag{9}$$

so that

$$NB = (1 - \beta_0)(NSD + OT). \tag{10}$$

However, at this time net income from SDFI was first exchanged into NOK. As a result net order flow could be written as

$$OF = OT + NSD - NB = \frac{1}{1-\beta_0}NB - NB = \frac{\beta_0}{1-\beta_0}NB \tag{11}$$

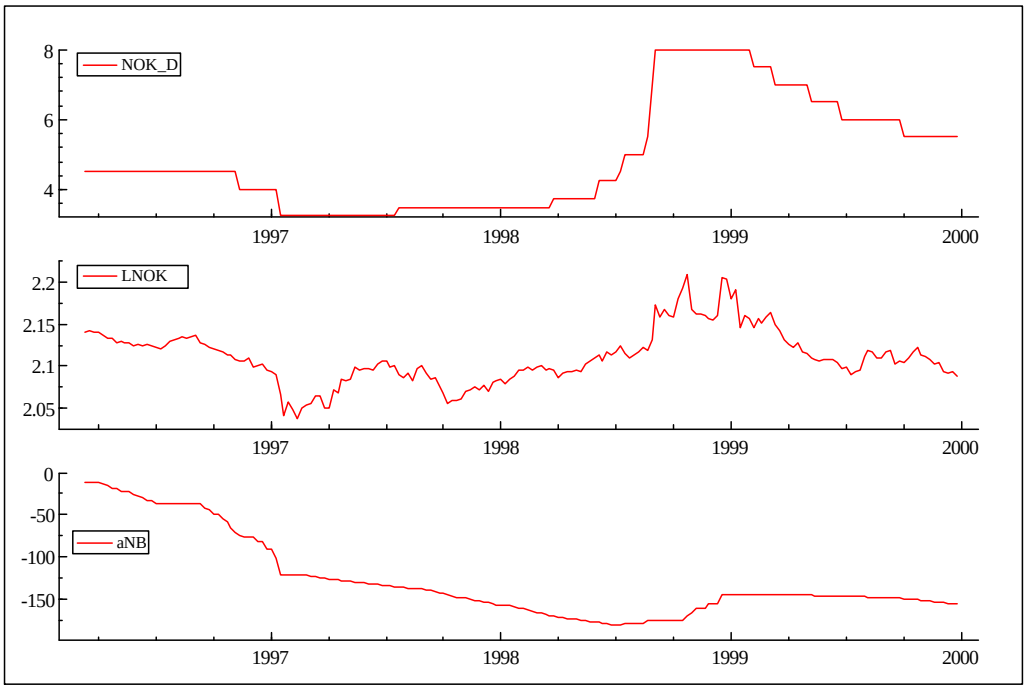
which is the same as in equation (7), just that the size of β has changed.

[12]As stated above, I use DEM for observations prior to January 1, 1999.

[13]The date is chosen because January 1993 was the first full month after the speculative attack in December 1992, and March 2001 is the month when Norway announced an explicit inflation target.

[14]The ECU was a currency basket, reflecting a weighted value of the currencies in the European Monetary System.

Figure 7: Norges Bank's folio rate, the exchange rate and accumulated purchases of NOK by Norges Bank, period: January 1996 to December 1999



1992 the exchange rate was allowed to float. It was a float within bounds, but the bounds were not published nor strictly enforced. Norges Bank had an obligation to stabilise the exchange rate, but such stabilisation 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.[15] This feature is itself of interest: as fixed exchange rate regimes are being abandoned they are often substituted by flexible peg regimes.[16]

In January 1997 and August/September 1998 Norway experienced "speculative attacks". Both attacks can probably be understood as a result of the markets expecting a change in monetary regime from a managed float to a floating exchange rate. Norges Bank's folio rate (the rate on bank's deposits in Norges Bank) and the exchange rate are illustrated in figure 7.

In the beginning of January 1997 there was severe appreciationary pres-

[15]The monetary policy regulation from May 6, 1994, stated: "... monetary policy instruments will be oriented with a view to returning the exchange rate over time to its initial range. No fluctuation margins are established, nor is there an appurtenant obligation on Norges Bank to intervene in the foreign exchange market."

[16]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.

sure. At this time the economy was growing fast. Interest rates were low. The expectation was that an inflation target regime would lead to higher interest rates. However, there might also well have been uncertainty at this point about the long term strategies for the Petroleum Fund. The accumulation in the Fund was in the early stages. How much revenue would be invested and how it would be used was still unclear. This might have contributed to a higher expected return on NOK. The attack in 1998 was triggered by events outside Norway. After the Russian moratorium in August 1998 investors pulled out of small currencies.

The was a change of governor in the Bank in January 1999. This change had some implications for monetary policy. The new governor made clear that made clear that the main commitment of Norges Bank was to price stability, not short term exchange rate stability. In March 2001 the Norwegian government officially introduced an inflation target of 2.5 per cent for the Bank. This development is reflected in figure 8, that depicts the 10 year and 3 month spread between Norwegian and German rates. As one can see, while the spread was low in the early 1990's, it shifted to a much higher level after 1998. However, this shift seems to have had only a limited effect on the NOK/EUR exchange rate.

2.3.2 The practice of transfers to the Petroleum Fund

The Petroleum Fund was set up by law in 1990. However, at this time Norway was in recession. In the years from 1990 to 1995 Norway was using of its net asset position. In 1993 and 1994 the Norwegian budget was in a deficit position even when petroleum revenue was included. For 1995 the total public surplus was recorded to 2 billion NOK. These were not transferred to the Fund.

Tables 1 and 2 relate actual observations to the terms defined in the previous section. Table 1 gives the actual transfers to the Petroleum Fund, and the actual government revenue in the form of oil taxes and transfers from SDFI. In table 2 we find the actual transfers to the Petroleum Fund and the amount of currency actually exchanged by Norges Bank.

As we can see from table 2 the actual net amount transacted by Norges Bank does not perfectly match the amount transferred to the Petroleum Fund. For the years 1999-2001 the discrepancy is due to the direct transfer from SDFI. However, for the years 1997-1998 the main source of the discrepancy is that NB contains both purchases for the Petroleum Fund and actual exchange interventions, or Norges Bank activity that can be expected

Figure 8: Interest rate differentials (iNOR-iDEM), 3 month and 10 year, and the exchange rate

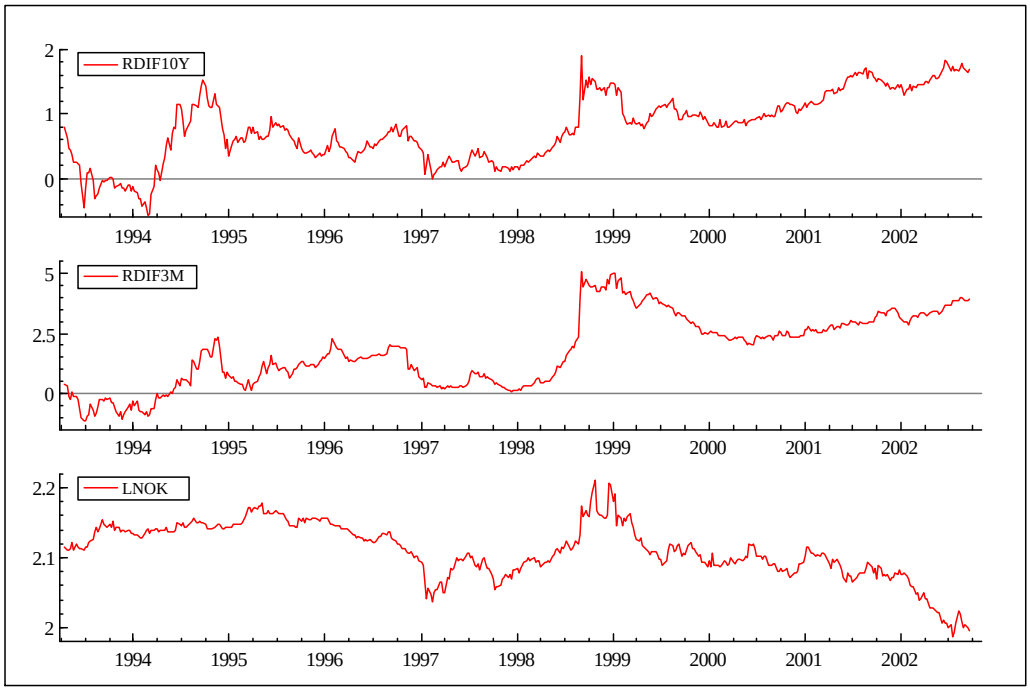


Table 1: Transfers from the Norwegian government to the Norwegian Petroleum Fund, net government income from the petroleum sector and net effect on the Norwegian economy. Numbers in billion NOK

	PF	**OT+NSD**	**OT+NSD-PF**
1993	0	30 700	30 700
1994	0	27 500	27 500
1995	0	40 700	40 700
1996	47 476	74 200	26 724
1997	60 900	91 500	30 600
1998	32 837	44 700	11 863
1999	24 500	46 400	21 900
2000	150 000	164 400	14 400
2001	251 519	239 400	-12 119
Sum	**567 232**	**759 500**	**192 268**

PF: Actual transfers to the Petroleum Fund. Source: Norges Bank
OT: oil taxes. Source: Fact Sheet 2002
NSD: Net income from SDFI. Source: Fact Sheet 2002
As a comparison: GDP for Norway in 2001 was estimated to 1 500 billion NOK. The average NOK/USD rate for the period 1993-2001 was 7.49 NOK per 1 USD.

Table 2: Accumulated transfers from the Norwegian government to the Norwegian Petroleum Fund and accumulated purchases of foreign currency by Norges Bank. Numbers in billion NOK

	aPF	**aNB**
1995	0	0
1996	47 476	86 000
1997	108 376	151 400
1998	141 213	140 000
1999	165 713	149 600
2000	315 713	201 300
2001	567 232	313 200

aPT: Actual accumulated transfers to the Petroleum Fund. Source: Norges Bank
aNB: net accumulated purchases of currency by Norges Bank. Source: Norges Bank

Table 3: Approximate size of Norges Bank interventions. Numbers in million NOK

	PF	**NB**	**Interventions**
1996	47 476	86 000	38 524
1997	60 900	65 400	4 500
1998	32 837	-11 400	-44 237
Sum	141 213	140 000	-1 213

PF: Actual transfers to the Petroleum Fund. Source: Norges Bank
NB: net purchases of currency by Norges Bank. Source: Norges Bank

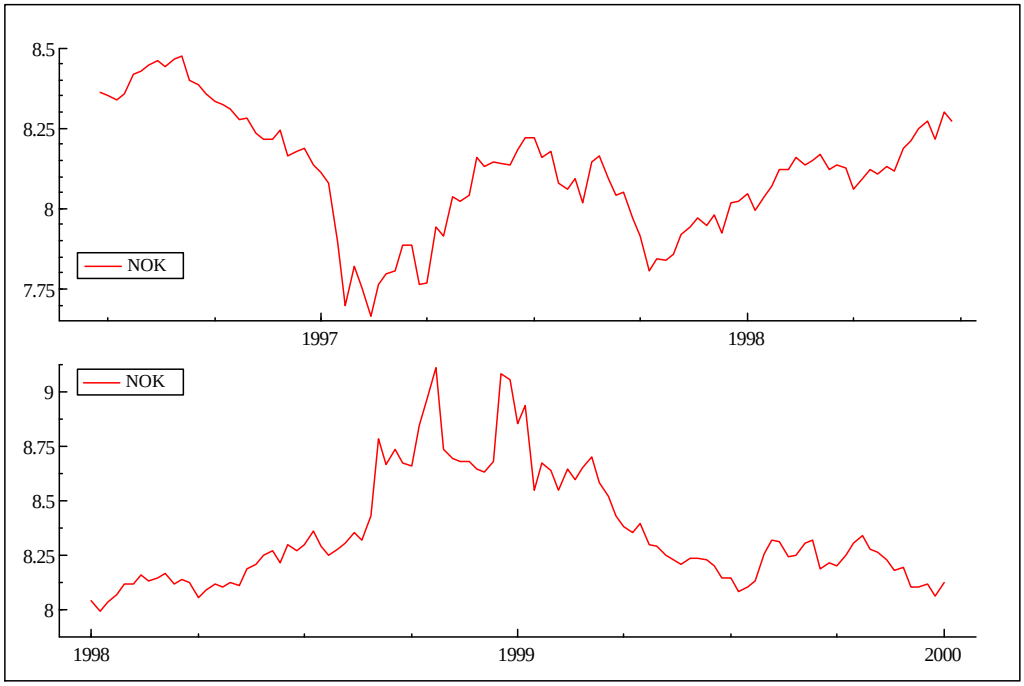
to have changed the foreign reserves of the Bank.[17] For 1996 and 1997 the amount purchased by Norges Bank exceeded the transfer to the Petroleum Fund. However, in 1998 the transfer exceeded the amount purchased.

During periods of speculative pressure Norges Bank made purchases in excess of those required by the Petroleum Fund. In these periods actual purchases of foreign currency by Norges Bank diverged from the rule in section 2.2. However, over the period 1995 to 1998 the transactions made by Norges Bank exactly matches the transfers to the Petroleum Fund. This implies that over the period 1995 to 1998 foreign reserves do not change much.

Norges Bank does not publish explicit records on their interventions. However, table 3 gives an indication of the size of interventions. As we can see, Norges Bank was intervening strongly in 1996 and 1998. We also see that the interventions take different directions. In 1996 Norges Bank was alleviating appreciationary pressure. In 1998 there was depreciationary pressure.

[17]Note that purchases for the Petroleum Fund do not affect foreign reserves.

Figure 9: The exchange rate, July 1996-June 1998 and January 1998-December 2000



Above I argue that the speculative attacks could be interpreted as expectations of a regime shift. Another interpretation is that the attacks in part were induced by uncertainty about supply and demand for NOK. E.g. during January 1997 there was strong appreciationary pressure. It is not unreasonable to believe that Norges Bank at this point had superior knowledge of the long term excess demand for NOK. If there was uncertainty about the use of oil income, Norges Bank could relieve this uncertainty by shifting its demand curve of foreign currency to the right as well. This would relieve the pressure on the exchange rate.

The intention of this paper is not to focus on short term swings. One should notice, as can be seen in figure 9, that after the speculative attacks in 1997 and 1998 the exchange rate returned to a its long term trend within months.

3 A cointegration analysis

In the following estimation I will use data covering the period from May 1993 to December 2001. I have data on Norges Banks actual purchases from November 1992, however the speculative attack in December 1992 is such a special event that I choose to start my series at a somewhat later date.

If the purchases by Norges Bank reflect the process described in section 2.2 is stable over time, there should be a connection between the level of the exchange rate and the accumulated transactions made by Norges Bank. This would be a long term relationship, and should be reflected in a regression capturing such features.

One should note however note two things. First, NB is the amount of NOK purchased by Norges Bank. A more negative number indicates a larger holding of foreign currency. If we take section 2.2 seriously, we should expect a positive relationship between the accumulates change in Norges bank purchases, aNB, and the level of the exchange rate, i.e. the exchange rate should *appreciate* when Norges Bank sell NOK and buy foreign currency. This is a result of the fact that the effect on the exchange goes through the excess demand for NOK. In the estimation NB will be a proxy of excess demand for NOK.

The second problem is related. The relationship between NB and OF depends on β. However I do not expect β to be constant over time. Further, as described in a footnote above, the process in section 2.2 is only correct for the last part of the period. It would not be unreasonable to suspect a structural break when the revenue from SDFI was invested directly into the Petroleum Fund.

In the end I estimate a standard cointegration, assuming a linear relationship.

The first part of the section discusses the methodological background. The second part discusses the empirical results.

3.1 Methodology

We are interested in the long term relationship. The nominal exchange rate is a non-stationary variable. The accumulated series of NB is following a non-stationary process as well. The usual procedure to investigate long term relationships for a non-stationary variable like the exchange rate is cointegration.

I use data from week 16 1993 to week 52 2001. Week 16 is the beginning of May 1993. That leaves a few months for the exchange rate to "stabilise" after the speculative attack in December 1992. We end the sample in December 2002, as the policy regarding NB changed in January 2002.[18]

This leaves us a sample of 453 periods. However, it covers slightly less than 9 years of data. There is a theoretical discussion of how long a series need to be for cointegration to be valid. In theory a cointegration relationship is supposed to last *for ever*. This is just not the case in this study. In fact I assume that the effect I am looking at will disappear from January 2002. In other words, there are certainly conceptual problems of using cointegration analysis in this framework. Despite these concerns, I believe cointegration is the best way of working with non-stationary series.

The relationship between the exchange rate and Norges Bank purchases of currency do not exist in a vacuum. The exchange rate is influenced by a number of variables. Any analysis of a long-term relationship in the exchange rate need to address the standard hypothesis of exchange rate behaviour, i.e. the purchasing power parity and the uncovered interest rate parity.

The variable of interest will be the NOK/EUR rate. For observations before January 1, 1999 I use the DEM as a proxy for the EUR. The choice of EUR (and DEM) is rational given that 80-90 per cent of all trading in the Norwegian currency market is denominated in EUR.

In addition to the accumulated value of NB I include the log of the Norwegian and German price level. This assures that we can test for PPP. I also include the 10 year benchmark interest rate for both Norway and Germany. A stable interest differential will be a test of UIP in this setting. Because of the oil dependence of the Norwegian economy I include the log of

[18] See section 4.

the oil price in USD. This can be justified as a proxy of a trade variable.[19]

Tests of cointegration in a single equation framework will only be valid if the variables on the right hand side are weakly exogenous. It is difficult to justify a priori that variables like the long term interest rates or the price level should be weakly exogenous in a regression on the Norwegian exchange rate. Further, I can not assume a priori that capital flows are weakly exogenous in any system containing the above variables.

To take account of non-stationary endogenous variables I need to use a multivariate model. I will follow the procedures used by Johansen (1995) and Johansen and Juselius (1992).[20] The multivariate framework implies that I conduct joint modelling of all endogenous variables. I define the vector stochastic process as

$$X_t = (lNOK_t, aNB_t, pNOR, pDEM, iNOR, iDEM, lOIL).$$

$lNOK_t$ is the log of the NOK/EUR rate. aNB is the accumulated series of NB collected from Norges Bank. $pNOR$ is the log of Norwegian CPI, while $pDEM$ is the log of German CPI. $iNOR$ is the 10 years benchmark rate and $iDEM$ the similar German rate. $lOIL$ is the log of the oil price (Brent Blend) in USD. With the exception of NB all numbers are collected from Datastream.

The cointegration analysis presumes that X can be parameterised as a vector equilibrium correction model, on the form

$$\Delta X_t = \alpha_1 \beta' X_{t-1} + \sum_{i=1}^{p-1} \Gamma_{1,i} \Delta X_{t-i} + \delta_1 + \varepsilon_{1,t}, \tag{12}$$

where δ_1 is a vector of deterministic variables, including a constant and dummy variables. ε is assumed to be white noise.

α and β are $7 \cdot r$ matrices, where r is the rank, or number of cointegration relationships in the system. α contains the loading parameters of the system, and will tell us something about how the variable adjust back to the long term equilibrium rate. A test of weak exogeneity in the cointegration relationship would be to test whether the parameter of α is zero. $\beta' X_t$ will comprise the cointegration relationships in the system.

In the estimation I add two deterministic variables. First, I add a trend, t. I constrain this variable to the cointegration space. This implies that I

[19]There exists an empirical literature on the relationship between the oil price and the Norwegian exchange rate. Akram (2000b) argues that the effect is non-linear, and most important when the oil price is below USD 14. This is however only an empirical observation, and have no theoretical foundation.

[20]A good introduction to the topic is found in Harris (1995).

Table 4: Test of rank

Ho:rank=p	**eigenvalue**		**adj.**		**95 %**	**trace**		**adj.**		**95 %**
p == 0	56.4	**	52.0	*	49.4	179.8	**	166.0	**	146.8
p ≤ 1	44.0	*	40.6		44.0	123.5	*	113.9		114.9
p ≤ 2	30.5		28.2		37.5	79.5		73.3		87.3
p ≤ 3	23.3		21.5		31.5	48.9		45.2		63.0
p ≤ 4	13.7		12.6		25.5	25.7		23.7		42.4
p ≤ 5	9.6		8.9		19.0	12.0		11.1		25.3
p ≤ 6	2.4		2.2		12.3	2.4		2.2		12.3

must redefine the stochastic vector process as $X^* = (X, t)$. Second, I add one dummy variable. This takes the value one in week 29 2001, and zero on all other dates. The dummy reflects a shock to the Norwegian price series in this period.

Given X I can test for specific hypotheses. E.g. a test of pure PPP would imply a stable cointegration relationship given by the vector β constrained as $(1, 0, -1, 1, 0, 0, 0, 0)$, where the positions refer to the vector X^*, which is defined as[21]

$$X^* = (lNOK, aNB, pNOR, pDEM, iNOR, iDEM, lOIL, t).$$

A test of UIP would imply a test of a stable interest rate differential, or a β-vector constrained as $(0, 0, 0, 0, 1, -1, 0, 0)$.

3.2 Results

I do a cointegration analysis with seven endogenous variables, using a multivariate system. The primary interest of this study is to see whether the accumulated purchases by Norges Bank, aNB, is an integrated part of fully specified system of the Norwegian exchange rate. A restricted multivariate system of the kind estimated in this paper is the closest the current literature on macro econometrics come to taking account of the interaction between variables.

In my opinion the results obtained in this analysis are reasonable, and therefore give credibility to the interpretation of the data presented in the

[21]This follows as pure PPP implies that the exchange rate, ϵ, when defined as the price of foreign currency in local currency, is given as

$$\epsilon = \frac{P}{P^*}, \tag{13}$$

where P is the local price level, and P^* is the foreign price level.

Table 5: Stability tests

Test	**lNOK**		**aNB**		**pNOR**		**pDEM**		**iNOR**		**iDEM**		**lOIL**	
AR 1- 7 F(7,408)	1.30		1.40		4.35	**	4.52	**	2.17	*	0.48		1.65	
Normality $\chi^2(2)$	291.90	**	614.53	**	94.06	**	89.10	**	78.20	**	25.06	**	7.53	*
ARCH 7 F(7,401)	9.72	**	19.92	**	9.29	**	9.59	**	9.97	**	3.05	**	0.74	
X_i^2 **F(72,342)**	2.46	**	2.73	**	0.76		0.63		2.41	**	1.62	**	0.94	
	System													
AR 1-7 F(343,2510)	1.09													
Normality $\chi^2(14)$	1146.70	**												

Table 6: Testing restrictions on α and β

beta	**assuming**	**Beta restrictions**	**LR prob.**
I	No trend	(1,*,*,*,*,*,*,0)	0.08 [0.77]
II	No aNB, no trend	(1,0,*,*,*,*,*,0)	7.28 [0.03] *
IIIa	Pure PPP	(1,0,-1,1,0,0,0,0)	39.8 [0.00] **
IIIb	Augmented PPP, no trend	(1,*,-1,1,*,*,*,0)	3.95 [0.27]
IVa	Pure UIP	(0,0,0,0,1,-1,0,0)	44.3 [0.00] **
IVb	Augmented UIP, no trend	(1,*,*,*,a,-a,*,0)	2.04 [0.36]
V	No oil, no trend	(1,*,*,*,*,*,0,0)	2.44 [0.30]
VI	PPP, UIP, no aNB/oil/trend	(1,0,-1,1,a,-a,0,0)	36.2 [0.00] **
VII	Augmented PPP+UIP, no trend	(1,*,-1,1,a,-a,*,0)	4.07 [0.40]

alpha	**weak exogeneity of**	**Alpha restrictions**	
A	lNOK	(0,*,*,*,*,*,*)	2.77 [0.10]
B	aNB	(*,0,*,*,*,*,*)	0.45 [0.50]
C	pNOR	(*,*,0,*,*,*,*)	4.64 [0.03] *
D	pDEM	(*,*,*,0,*,*,*)	1.49 [0.22]
E	iNOR	(*,*,*,*,0,*,*)	0.11 [0.74]
F	iDEM	(*,*,*,*,*,0,*)	7.20 [0.01] **
G	lOIL	(*,*,*,*,*,*,0)	0.96 [0.33]
H	pDEM, iDEM, oil	(*,*,*,0,*,0,0)	9.66 [0.02] *
I	NB, pDEM, iNOK, oil	(*,0,*,0,0,*,0)	5.39 [0.25]

Joint	**VII+I**		
beta	Augmented PPP+UIP, no trend	(1,*,-1,1,a,-a,*,0)	
alpha	aNB, pDEM, iNOK, oil	(*,0,*,0,0,*,0)	10.29 [0.25]

Table 7: α and β-vectors

unrestricted	**lNOK**	**aNB**	**pNOR**	**pDEM**	**iNOR**	**iDEM**	**lOIL**	**Trend**
alpha	-0.06	6.07	0.01	0.00	0.21	-1.23	-0.26	—
beta	1	-0.0004	-0.19	0.49	-0.05	0.05	0.04	-0.07

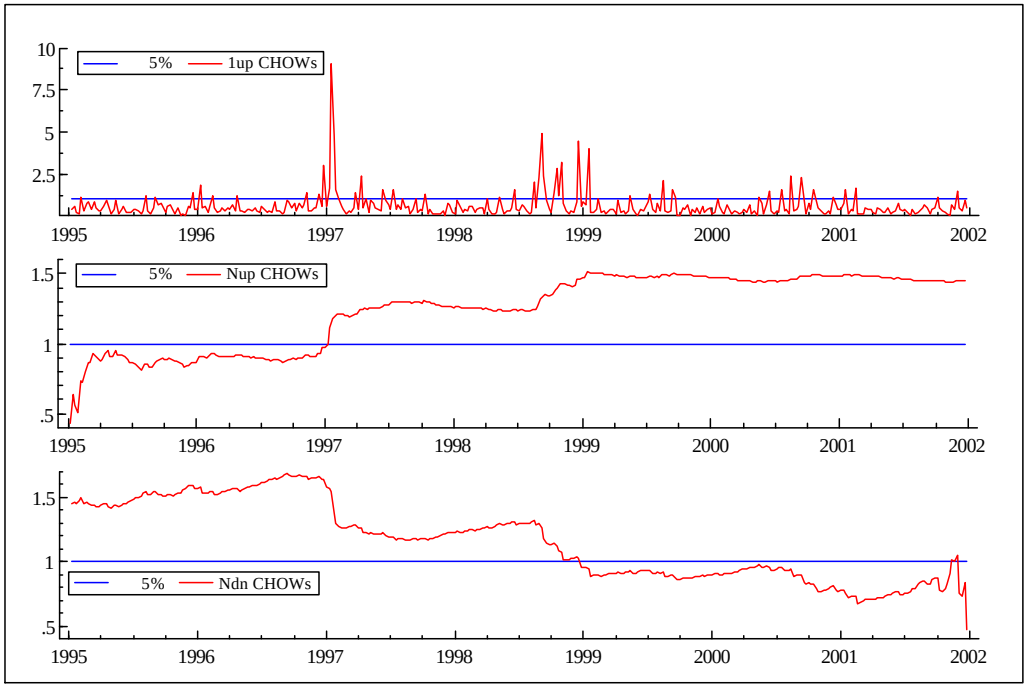
VII+I	**lNOK**	**aNB**	**pNOR**	**pDEM**	**iNOR**	**iDEM**	**lOIL**	**Trend**
alpha	-0.08	0	0.01	0	0	-1.01	0	—
st.errors	*0.02*	—	*0.003*	—	—	*0.26*	—	—
beta	1	-0.0005	-1	1	-0.03	0.03	0.07	0
st.errors	—	*2.94E-05*	—	—	—	*0.005*	*0.009*	—

Table 8: Parameter stability

beta	**lNOK**	**aNB**	**pNOR**	**pDEM**	**iNOR**	**iDEM**	**lOIL**	**Trend**
Week 16:93-52:95	1	-0.0003	-11.12	11.12	-0.11	0.11	0.50	-7.92E-05
Week 26:97-52:01	1	-0.0002	-0.05	0.05	-0.05	0.05	0.03	1.02E-04
Week 16:93-52:02	1	-0.0004	-0.49	0.49	-0.04	0.04	0.06	-2.21E-05

Estimated with the following restriction on the β-vector: $(1, *, b, -b, a, -a, *, *)$. The restriction holds for all sub samples.

Figure 10: Chow tests of the system stability



above sections. However, one needs to interpret a system like this with care. The fact that I obtain a significant coefficient with a reasonable parameter for the NB does not prove that NB had a purposes as a "signalling variable", only that these purchases evidently must have reflected some aspect of the exchange rate series. This paper has given one interpretation of this relationship.

Table 4 report the test of rank. All four tests report at least one cointegration vector. A problematic part of the analysis is found in table 5. Here I report different test-statistics. These are reported both for the seven different equations, and for the system as a whole.

As we can see there are several econometric problems in this analysis. However, according to Eitrheim (1996) the most problematic feature in a cointegration analysis is autocorrelation *in the system*. As we can see, there is no autocorrelation in the system as a whole. Neither is there autocorrelation in the two equations I care most about, the exchange rate and NB. That we find autocorrelation in the price-series should perhaps not be surprising, given that we have spliced these series from a monthly series. More worrying is the results in figure 10. As we can see, the forecast stability of the estimation is not as good as we would want.

A reason the results in figure 10 should be taken seriously is that they

might indicate parameter instability. In the bottom of table 8 I have estimated a restricted cointegration vector over three sub-samples. The vectors are estimated under the assumptions of a stable spread for the price level and the long term interest rate. These restrictions hold for all sub-samples. As we can see the coefficient for aNB is relatively stable over the sub-samples. This might indicate that the problems reflected in figure 10 are not that important. However, for sub-samples that begin or end in the period week 20 1996 - week 20 1997 there are evidence of parameter instability.

Table 6 reports tests on the α and β matrix. First, we see that we can take out the trend. In fact, re-estimating the equation with no trend would not change the results in tables 4 and 5. I find that neither pure PPP nor pure UIP hold in this system. Neither result will attract much surprise, given prior tests of these hypotheses. However, in line with the findings in Akram (2002) and Bjørnland and Hungnes (2002), PPP does hold in an augmented setting. Both papers test for the PPP in Norwegian data using systems similar to the one presented in this paper. Further, the interest rates can be substituted with an interest rate spread. The last result does not indicated that UIP holds, however.

We see that it is not a valid restriction to set NB equal to zero. In the tests for weak exogneity we find support for the interpretation that NB is weakly exogenous. The variable is not decided inside the system. Assuming that NB implicitly reflect long term governments calculations this interpretation is not unreasonable. We find that foreign prices and the oil price are also long term weakly exogenous in this system.

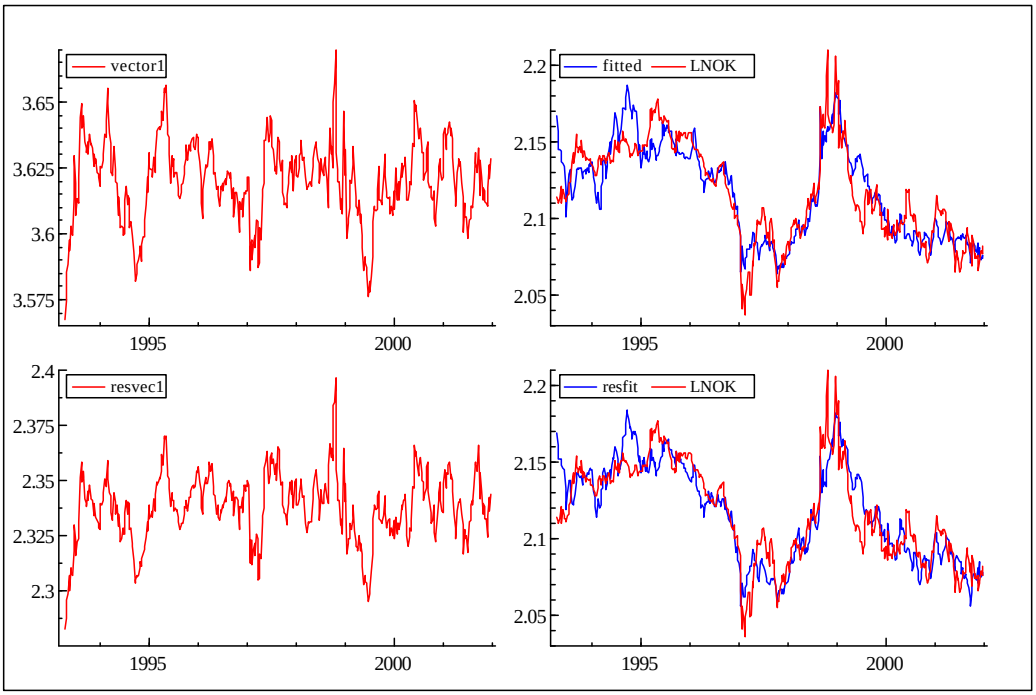
The restricted and unrestricted cointegration vectors are reported in table 7. We can use the restricted cointegration vector to interpret estimated effects on the exchange rate. These are discussed in table 9. The size effect of a central bank purchase might seem small—however when these purchases accumulate the effect becomes substantial. Also note that the size of these affects are comparable to the effect reported in Evans and Lyons (2002a). Trades in the setup of Evans and Lyons are not announced publicly. Further, they have no effect on macroeconomic variables like interest rates. This compares to a secret, sterilised intervention by a central bank. Evans and Lyons estimate the long term effect of a central bank intervention to 80 per cent of 0.44, or approximately 0.35 per cent per 1 billion USD. The comparable effect of one billion USD change in NB found here is 0.36. However, the sign is *wrong*, seen with the eyes of Evans and Lyons. In my estimation a Norges Bank purchase of NOK leads to an appreciation of NOK, not a depreciation of NOK.

Table 9 makes some attempts to look at size effects of the different variables in the cointegration analysis. In the lower part of the table I have

Table 9: Size effects

	Effect per billion NOK, NB	0.05 %
	Effect per billion USD, NB	0.36 %
	NB (in USD), million	41 823
i	**Effect from NB on NOK/EUR**	-15.25 %
	NOK/USD	7.49
	"PPP"	
	Change in $P - P*$ (93-01)	4.54 %
	Parameter	1
ii	**Effect**	4.54 %
	"UIP"	
	Change in $i - i*$ (93-01)	0.61 %
	Parameter	3.35
iii	**Effect**	2.03 %
iv	**Total effect, i+ii+iii**	-8.68 %
	Change in exch. rate w.16-93	-3.18 %
	Change from mean 93-94	-4.78 %
	Change from top (93-94)	-7.22 %

Figure 11: Restricted and unrestricted cointegration vectors



calculated the effects on the exchange rate of changes in the relative price level and the the long term interest rate. The long term interest rate can be interpreted as an indication of long term inflation expectations, and it is therefore reasonable to find that an increase in the spread lead to depreciation of the exchange rate. Using the estimated coefficient for NB and the change in NB we find that although the coefficient is small the accumulated effect is substantial.

4 Lessons for the future

Beginning January 2001 Norges Bank and the Ministry of Finance made a change in the system described in section 2. They decided that instead of transferring *net* income from SDFI to the Petroleum Fund they would now transfer *gross* income. The justification was that this would reduce the number of transactions in the FX-market.[22] Let gross income be GSD, and let the costs of SDFI be CSD.

Above we could define

$$NB = (1 - \beta)OT. \tag{14}$$

From equation 2 we remember that

$$PF = OT + NSD - BB. \tag{15}$$

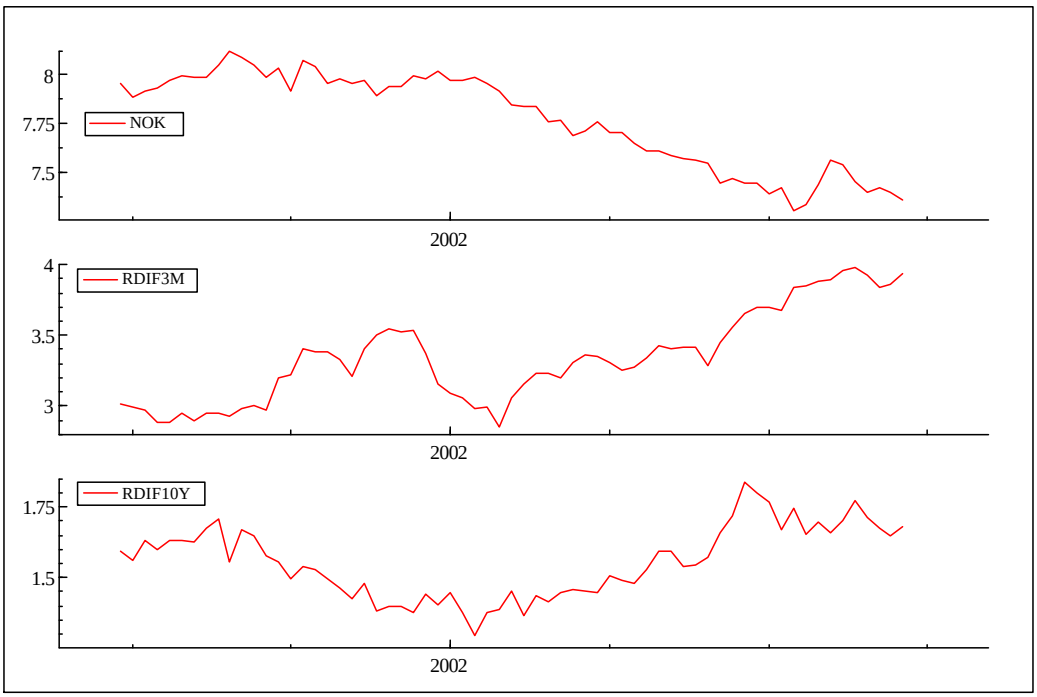
After the change of January 1, 2002, we have that

$$NB = PF - BSD = OT + NSD - BB - NSD - CSD = (1 - \beta)OT - CSD. \tag{16}$$

The implication is that there is no longer an obvious relationship between OF and NB. Of course, the order flow as such has not changed, but the relationship between order flow and Norges Bank transactions has vanished. NB is no longer an indicator of excess demand for NOK. To put it bluntly: the guide has gone. The markets are left in the middle of nowhere. The old lady is out of sight.

[22]This is true only under some assumptions. Assume that all costs in the SDFI are denominated in foreign currency. Then transferring gross foreign currency income to the Petroleum Fund, and exchanging NOK to foreign currency to pay expenses would imply the same number of actual transactions as the old system when only net revenue was transferred to the Petroleum Fund. However, I have been told that only about 1/3 of the transactions on the cost side of SDFI are denominated in foreign currency. So the new policy did probably imply a reduction in the number of currency transaction. The change is however fairly marginal.

Figure 12: Period 07.2001-08.2002



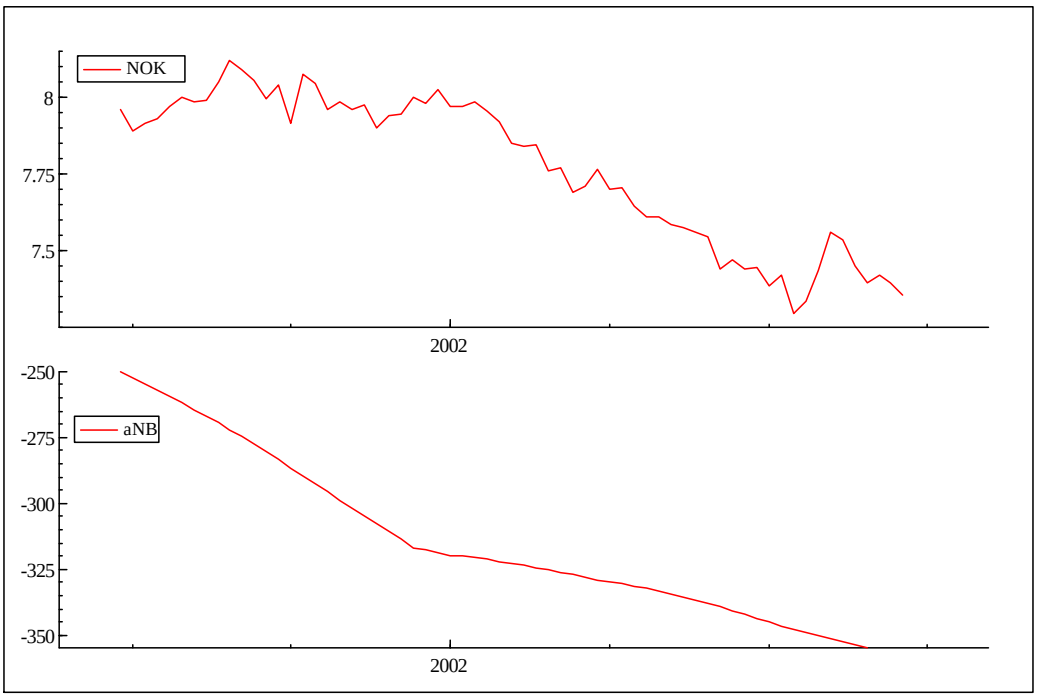
From January 1 to the end of June, NOK appreciated with 7.7 per cent against the EUR. And this was a period when the EUR was appreciating against most other currencies. NOK appreciated with 18.7 per cent against the USD in the same period. During the summer appreciation stopped. However, the exchange rate remains volatile. During the fall of 2002 it fluctuated between 7.25 and 7.50.

Can the change in Norges Bank's purchasing strategy explain this change? Alone, no. However, 2001 was a year with a number of important changes in Norwegian economic policy. As explained above, a new budget rule was introduced and an explicit inflation target was introduced.

In the regime prior to 2001 it was uncertainty about both long term use of petroleum revenue and long term inflation. With the announced changes there would still be some uncertainty about how much money was taken into the Norwegian economy each year, but the uncertainty would be much less. More important was that the budget rule assured that it would be a substantial amount each year, independent of short term fluctuations in i.e. the oil price or the business cycle. Alone this feature should strengthen the belief in a future real appreciation of NOK. Combined with a credible inflation target this became a belief in a nominal appreciation as well.

At the same time the effect of an independent monetary policy was felt,

Figure 13: Period 07.2001-08.2002

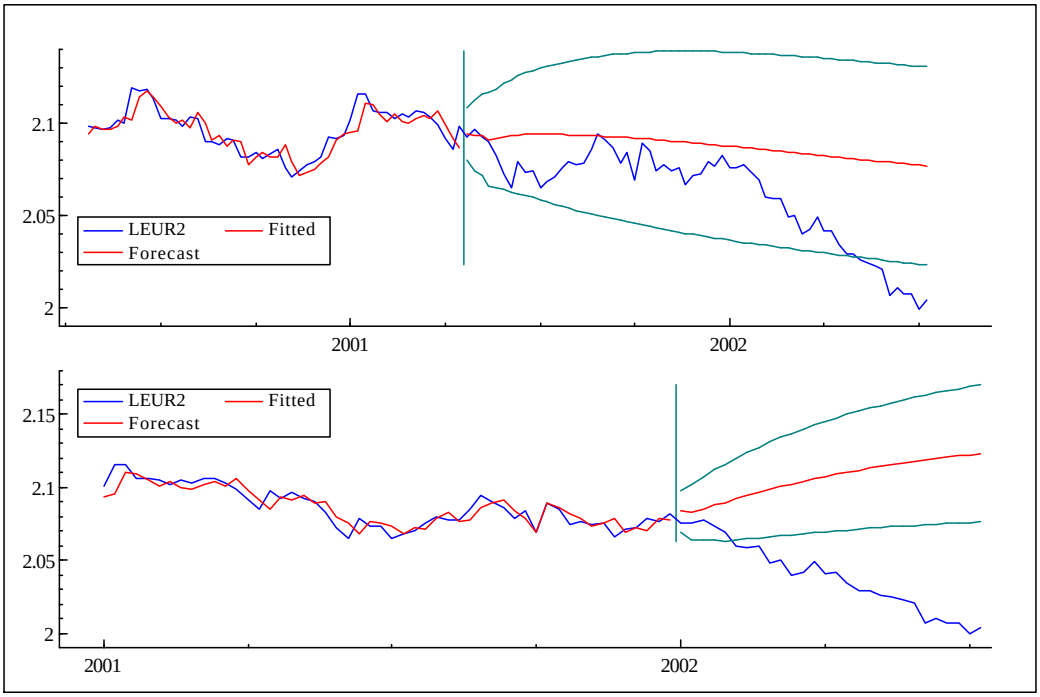


as lack of coordination between the business cycle in Norway and her main trading partners lead to an increase in interest rate differentials. This came at the same time as income from the Petroleum sector grew due to higher oil prices. Figure 12 shows the exchange rate and the 3 month and 10 years interest rate differential to Germany. We see that the spread is increasing during the first six months of 2002. There is however no clear one-to one relationship between the change in the spread and the change in the exchange rate.

Figure 13 show the exchange rate and the accumulated purchases of Norges Bank. We see that the shift in strategy by Norges Bank comes at almost exactly the same time as the break in the exchange rate—both occur at at the turn between 2001 and 2002.

An important factor here is the timing. If the announcement of new rules for fiscal and monetary policy was the factors determining the exchange rate appreciation, one should have expected a shift in the exchange rate to occur at the time of this announcement. This would imply a break in the exchange in April 2001. Figure 14 gives a simple indication of when the structural break actually occurred. The model described above, including the price level, long term interest rates, the oil price and NB is estimated. In the upper panel I estimate the model up till March 2001, and calculate a dynamic forecast.

Figure 14: Forecasted values and actual outcome



Estimated model is a VAR that includes (lNOK,aNB,pNOR,pDEM,iNOR,iDEM,lOIL,t) and 5 lags. Upper panel is estimated up until week 14 2002. The lower panel is estimated up until week 52 2002. Estimated forecasts are dynamic.

In the lower model I estimate the model up till the end of December 2001, and calculate the dynamic forecast. In fact the forecasting abilities for the period from March to December are reasonably good. From January 2002 the model clearly breaks down.

Does this prove that the change in Norges Bank's currency transactions influenced the exchange rate? A scientific proof would demand more, and is probably under no circumstances possible to obtain. Despite this precautionary note, I still find it reasonable to question if the change in "transaction policy" was wise. Why was it made? Primarily because the Ministry of Finance and Norges Bank wanted to reduce the amount being exchanged in Norges Bank. "Efficiency" could be increased by transferring gross income directly from SDFI to the Petroleum Fund. However, doing so they forgot that a change in the trading behaviour of Norges Bank could have consequences for the market, not because the amount of trading in the market was changed, but because the information flow from the government to the markets was changed. They lost one channel of giving markets information.

What is the cost? One can not know. I only observe that the exchange rate broke through its former "fluctuation margins" at the same time as Norges Bank changed its policy. Most probably a sharp appreciation of the NOK would have occurred anyway. After all, the new rules for fiscal and monetary policy had changed much of the underlying structure in the Norwegian market, and it was probably a question of time before this would be reflected in the exchange rate as well. However, combining this with the change in procedures for currency transactions for the Petroleum Fund might have amplified the effect on the exchange rate, possibly leading to an overshooting of the exchange rate. This might have been more of an experiment than the government was actually aware.

5 Conclusion

In this study I have looked at a very special case concerning Norges Banks' purchases of currency for the Norwegian Petroleum Fund. This is an example of a central bank being active in the FX-market. As such it can be related to the literature on foreign exchange interventions. However, these purchases were not interventions in the standard use of the words. Rather they were made in attempt to affect the market as little as possible.

This paper has argued that the these flows might have conveyed information to the markets about important parameters, like government policy and government expectations. To change these flows can therefore have affected the behaviour of the market. In the last section I proposed that the change

in policy might have been a factor contributing to the increased volatility in the NOK/EUR exchange rate during the spring of 2002.

The asset pricing literature is filled with rival theories. Most theories fit well in-the-sample, but few fit well out-of-the-sample. This paper provides no theory to be tested on future observations. What I have tried to do is to take the microstructure argument on the foreign exchange market seriously. One important lesson from this theory is that markets are more than just the net volume being traded. Markets are about who trades, and how they trade. These patterns relay information. When patterns change, information changes. In the long run this should have no effect—patterns of trading should not change the "equilibrium exchange rate". However, the lesson from the microstructure literature is that patterns of trading might affect both dynamics and volatility in the FX-market. Any radical change in trading patterns should therefore be evaluated carefully.

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