ECONOMIC COMMENTARIES

The use of reference rates and their impact on the currency market

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The use of reference rates and their impact on the currency market

Millions of trades are executed in the currency market daily. Exchange rates move continuously during the day and can fluctuate considerably within a very short time span. In many contexts, there is a need for a daily reference rate that reflects prices at a specific time of day. This is often referred to as a currency fix. In this paper, we look more closely at what a currency fix is and present the most important fixes in the Norwegian krone (NOK) market. We also look at what currency fixes are used for, and how activity, prices and liquidity in various currency crosses are affected around the time the fix rates are set. The main focus of this paper is on NOK.

1. Key currency fixes in the Norwegian krone market

A currency fix is the setting of a daily reference rate. This rate is set at a specific time of day and is intended to express a representative exchange rate at the time of the fix. In this paper, we have chosen to focus on the two most important currency fixes in the market for NOK.

The most widely used benchmark in the global currency market is the *WM/Reuters fix*, which normally takes place daily at 5 p.m. Central European Time (CET)[1]. Produced jointly by The World Markets Company[2] and Thomson Reuters, the WM fix started in 1994 and sets spot rates for 160 currencies on the hour, and half past the hour for the 21 most traded. Of these, the 5 p.m. fix is the most important, because it is used to calculate a variety of financial indices (FSB, 2014). The rates are normally based on the median of all quotes and trades on the electronic trading platforms of Thomson Reuters and Electronic Broking Services (EBS) within a window of 30 seconds on either side of the fix.[3]

The *ECB fix* is another key reference rate in the market and is normally set daily at 2.15 p.m. CET. The ECB began publishing daily reference rates in 1999 and now publishes rates for 32 different currencies against the euro. The reference rate is set via a daily teleconference between the ECB and central banks both within and outside the euro area. The rate is based on an average of quoted bid and offer prices for the various currencies against the euro, which means that it does not necessarily reflect actual traded prices. Information from our market contacts and a number of studies indicates that commercial players rather trade around the ECB fix than around the WM fix (FSB, 2014).

2. What are currency fixes used for?

Currency fixes play a key role for a variety of transactions in financial markets. For example, the daily reference rate from WM/Reuters is used to calculate stock, bond and credit indices worldwide, and is therefore used by many asset managers to measure the value and performance of portfolios invested in multiple currencies.[4] A study by Melvin and Prins (2010) finds that activity in the currency market is particularly high around the time of the WM fix, especially at the month-end. This is because managers often rebalance their portfolios at the end of the month to ensure that their currency exposure is in line with their benchmark indices. This rebalancing generally means that the manager gives the bank an order to buy or sell a given amount of currency at the fix rate that day. The

[1] This is often referred to as the "London 4 p.m. fix".
[2] The World Markets Company is part of State Street Bank and Trust Company.
[3] Thomson Reuters and EBS are the two most important marketplaces for currency trading between banks. A more detailed presentation of the methods used to calculate the WM fix can be found on the WM/Reuters website: www.wmcompany.com.
[4] For example, the WM fix is used in the calculation of the MSCI stock index, bond indices from Barclays, Citi and JPMorgan, and Markit's credit index.

advantage of executing the order at the currency fix is that the manager knows that the trade will be made at an official benchmark rate. Because the same rate is also used for the benchmark index the manager is measured against, the manager's currency risk is eliminated.

Similarly, multinational companies may have an interest in valuing their currency holdings using a common reference rate – and rebalancing if necessary. Trading at the currency fix rate is often seen as transparent, because the transaction is executed at an official reference rate. It also saves companies from putting resources into monitoring the market and enables them to eliminate the currency risk relative to internal benchmarks that use the fix rate. Both commercial and financial players thus have an interest in linking orders to currency fixes. This generates large orders and extensive transactions for banks ahead of the times the reference rates are set.

3. Participants' approach to trading around the fix

The participants in transactions linked to a currency fix may have conflicting interests when it comes to the level at which the reference rate is set. In this context, it may be useful to look at a bank's risk management as regards fix orders. To illustrate this, we will look at two examples: a "standard order" and a "fix order".

Standard order – buy/sell a given amount of currency at the current market price

When a client asks a bank to buy or sell a given amount of currency at the current market price, the bank will quote the client a price. In the currency market, prices are always quoted as a spread between a bid price (at which the bank will buy) and an offer price (at which the bank will sell). The spread is the market-making bank's compensation for accepting currency risk. If, for example, the EURNOK spread is 8.2580-8.2620, the bank can, in principle, buy EURNOK at 8.2580 and then turn around and sell the corresponding amount at 8.2620.[5] The bank will then have eliminated its own currency risk. In periods of great uncertainty, however, there is a risk of prices moving a long way before the bank manages to hedge its exposure. To allow for this, the bank may widen the spread quoted to the client. A wider spread increases the bank's potential profit, but also reflects more uncertain market conditions.

Fix order – buy/sell a given amount of currency at today's fix price

With a fix order, the client instructs the bank to buy or sell a given amount of currency at the reference rate the same day. Assume, for example, that a client wishes to buy NOK at the WM fix rate. The bank receiving the order guarantees the client that it will buy NOK at a yet unknown price and therefore takes on a currency risk. Because the fix price is a mid rate, the bank will not be compensated for this risk via the spread as in the example above. This means (in isolation) that the bank will need to hedge its risk and make its profit in other ways. To hedge its own currency exposure, the bank will often begin to buy NOK ahead of the actual fix. This is because it is not possible in practice to trade a large amount of currency at a single price at exactly the time of the fix. In isolation, the bank's purchases of NOK will serve to push up the value of the krone, which means that a fix order can affect pricing in the period to the fix.

It should be noted that the client and the bank are not necessarily interested in the currency moving in the same direction in the period to the fix.

[5] This is based on the assumption that there is sufficient interest in the market in both buying and selling the currency and that market prices do not change.

The client wants to buy NOK as cheap as possible and has an interest in the krone appreciating as little as possible. The bank, on the other hand, wants to make a profit on the order and has an interest in the krone strengthening, because this makes it more likely that the bank will be able to sell the NOK to the customer at a higher price than the bank paid for them.[6]

A report published recently by the Financial Stability Board (FSB, 2014) highlights several aspects of today's currency fixing system that can lead to a conflict of interests of this kind between client and bank. As mentioned above, the current system results in a structure where the bank has to hedge its risk and make its profit in other ways than earning the spread. According to the FSB, this could, in the worst case, create an incentive for the bank to manipulate the exchange rate in the period leading up to the fix, and so influence the fix rate itself. As a result, the client may end up paying more for the NOK than would be the case with a standard order. The FSB report makes a series of recommendations to help improve the current construction of currency fixes. These include extending the window used to set the benchmark rate so that it is harder to manipulate, and a change from the current practice of a bank giving the client a mid rate to a system where the bank is rewarded more directly for the currency risk it takes on.[7]

4. Market dynamics around currency fixes

As mentioned in Section 2 above, currency fixes play a key role for a variety of transactions in financial markets. There is therefore reason to believe that activity will increase around the times of the various fixes. This increase in activity can be expected to have consequences for both liquidity and volatility in the currency market. In this section, we analyse activity in the spot market around the ECB and WM fixes with a special focus on NOK. We use high-frequency intraday data from Thomson Reuters' electronic trading platform (Spot Matching 3000 Xtra). According to a study by the Bank for International Settlements (BIS, 2013), electronic platforms account for a growing share of turnover in the spot market. Figures from April 2013 indicate that 64 per cent of transactions in the global currency market were performed on this type of platform. For the currency pairs we examine, Thomson Reuters is the most widely used platform, and there is therefore good reason to believe that these data gives a representative picture of activity in these currencies. The intraday data are divided into 15-minute intervals, so that each 24-hour period contains 96 observations. The data set runs from 2002 to 2013, and all of the calculations in the analysis are expressed as an average of the intraday data during this period.

4.1 Activity

As an indicator of activity levels during the day, we look at the number of transactions executed.[8] Chart 1 shows how many trades were made on average during the different time intervals during the day, calculated as a percentage of total daily trades to allow comparison between currency pairs.[9]

[6] In this example, the bank has agreed to sell NOK to the client at the fix price and so makes money by buying NOK below this price. The larger the amount, the easier it will normally be for the bank to influence the price. If the amount is small, there is a risk of other banks having larger transactions in the other direction, with the result that the bank could lose money if prices move the wrong way and the bank has hedged its risk too early.
[7] In the report, the FSB presents 15 recommendations for improvements to the current construction of currency fixes.
[8] To obtain a more precise overview of actual activity levels during the day, one would ideally look at volumes traded, because the volume behind each trade may vary. We do not, however, have access to high-frequency data for volumes traded. Information from our market contacts indicates that the number of trades may nevertheless be a good indicator of overall turnover in the currency market.
[9] The total number of trades during the day will add up to 100 per cent for each currency cross.

Chart 1: Average activity levels intraday in the period 2002-2013. Calculated as a percentage of the total number of trades during the day. The shaded areas denote the periods around the ECB and WM fixes.

Chart 1A: EURNOK, EURSEK and EURGBP

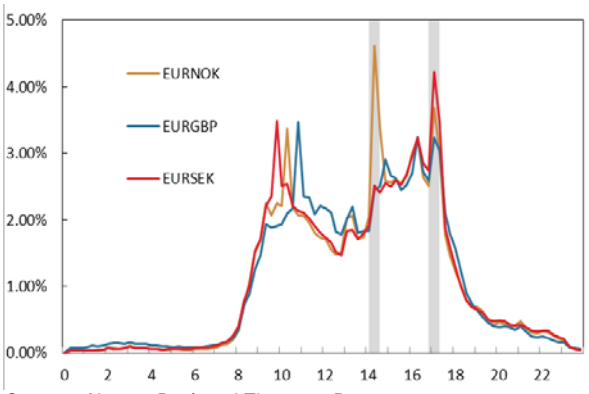
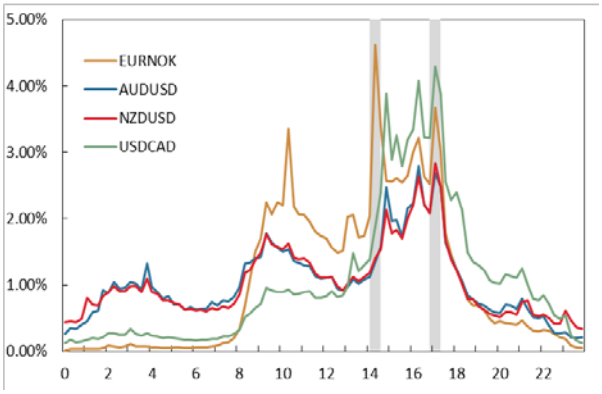


Chart 1B: EURNOK, USDCAD, AUDUSD and NZDUSD



Sources: Norges Bank and Thomson Reuters.

Chart 1A shows that activity in the EURGBP, EURSEK and EURNOK crosses increases between 9.30 and 10.30 a.m. CET, which ties in well with when economic indicators are published. There are differences between countries, however, presumably due to variations in the time at which economic indicators are released. EURNOK activity picks up at 10.00-10.15 a.m., as Norwegian data tend to be published at 10.00 a.m.. A similar pattern is seen with EURSEK and EURGBP following the publication of Swedish data at 9.30 a.m. and UK data at 10.30 a.m.. There is also a clear tendency for market activity in all of the currency pairs to increase ahead of the WM fix. As can be seen from Chart 1, however, EURNOK activity stands out by being markedly higher ahead of the ECB fix at 2.15 p.m. (see Table 1). EURNOK activity in the run-up to the ECB fix is also higher than for any other currency pairs examined at any time.

Table 1: Average activity levels intraday for four selected periods.[10] Calculated as a percentage of total daily trades. 2002-2013. Periods with the highest activity picked out in red.

	AUDUSD	EURGBP	EURNOK	EURSEK	NZDUSD	USDCAD
2.00-2.15 p.m.	1.4	2.5	4.6	2.5	1.4	1.9
2.15-2.30 p.m.	1.6	2.5	3.4	2.4	1.5	2.4
4.45- 5.00 p.m.	2.7	3.2	3.7	4.2	2.8	4.3
5.00-5.15 p.m.	2.5	3.0	3.0	3.5	2.5	3.9

Sources: Norges Bank and Thomson Reuters.

4.2 Liquidity

There is reason to believe that high levels of activity in the currency market go hand-in-hand with ample liquidity. Liquidity in a currency cross is often referred to as a measure of whether an order can be executed quickly with little price impact and limited transaction costs. It is difficult, however, to find a precise measure of liquidity. In this analysis, we have used the spread between bid and offer prices as a percentage of the mid price. A lower spread indicates better liquidity.[11] Chart 2 shows this liquidity measure at different times of the day. Liquidity is reasonably stable for all of the currency crosses during European opening hours. There is, however, a slight tendency for EURNOK liquidity to be somewhat worse than for other currency pairs and to fluctuate more during the day. There are signs that EURNOK liquidity is best in the run-up to the ECB fix. There therefore seems to be a

[10] It is important to note that Australian, New Zealand and Canadian dollars are not fixed against the dollar at the ECB fix, which may explain why activity levels for these currencies are slightly lower at this time.

[11] The spread between bid and offer prices reflects the bank's view of the currency risk associated with market-making in the currency market. If liquidity is poor, there is a high risk of the price moving a long way before the bank is able to hedge its own currency risk. This will tend to be reflected in a wider spread.

connection between high levels of activity and improved liquidity (cf. the results in Section 4.1 above).

Chart 2: Average spread intraday in the period 2002-2013. Calculated as the difference between bid and offer prices as a percentage of the mid price. The shaded areas denote the periods around the ECB and WM fixes.

Chart 2A: EURNOK, EURSEK and EURGBP

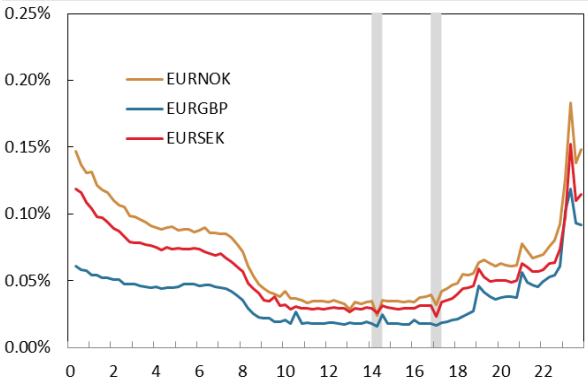
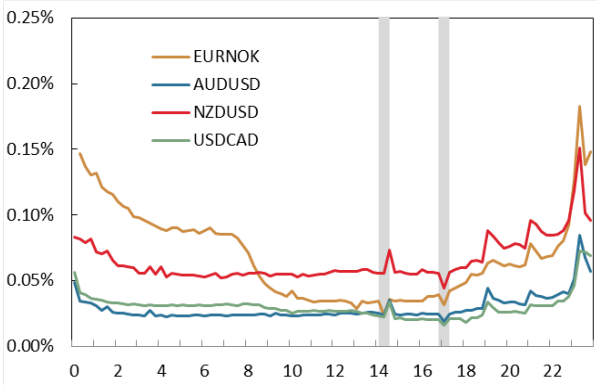


Chart 2B: EURNOK, USDCAD, AUDUSD and NZDUSD



Sources: Norges Bank and Thomson Reuters.

4.3 Volatility

As a measure of volatility during the day, we have looked at the percentage change in exchange rates, measured as the absolute price change between 15-minute intervals. Chart 3 illustrates that periods of high volatility tend to coincide with periods of high activity, as mentioned earlier. There is a tendency for volatility in all currency pairs to be greatest in the period ahead of the WM fix. As with activity levels, however, we see that the market for NOK stands out in the run-up to the ECB fix. The chart shows that there is a marked increase in volatility in this period for NOK.[12]

Chart 3: Average volatility intraday in the period 2002-2013. Measured as the absolute price change as a percentage of the mid price. The shaded areas denote the periods around the ECB and WM fixes.

Chart 3A: EURNOK, EURSEK and EURGBP

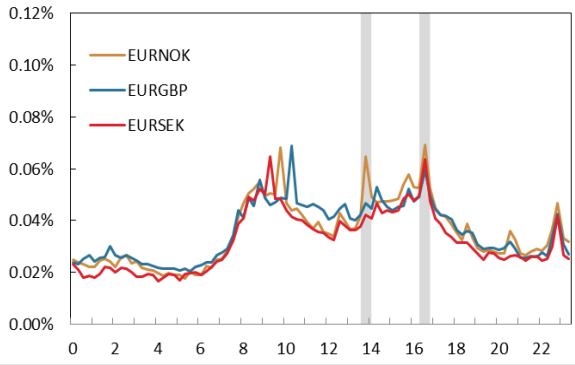
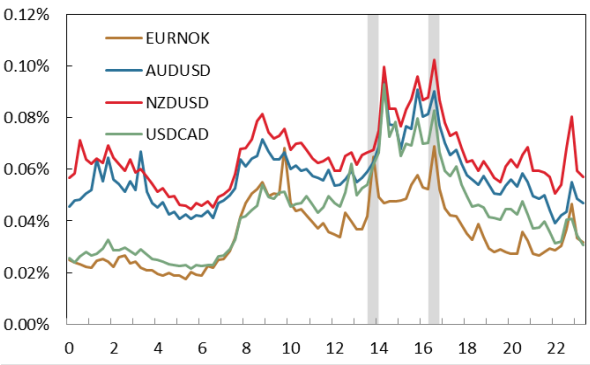


Chart 3B: EURNOK, USDCAD, AUDUSD and NZDUSD



Sources: Norges Bank and Thomson Reuters.

4.4 Price movements

The volatility around the WM fix and the uniquely Norwegian volatility around the ECB fix indicate that there are larger price movements at these times of the day than at other times of the day. It may therefore be interesting to examine whether movements around the fixes have had a consistent pattern over time – for example, whether they have been in a particular direction. One way of doing this is to

[12] USDCAD, AUDUSD and NZDUSD have historically been more volatile currency crosses than EURNOK, which is also reflected in intraday volatility in these crosses generally being higher than for EURNOK.

look at the percentage changes around the fixing windows. Unlike in Section 4.3, we are not now looking at absolute changes.

Chart 4 shows that the average change in EURNOK both before and after the WM fix has been close to zero. This indicates that over time (the period 2002-2013) there has been no consistent pattern where prices have moved in any specific direction in the period around the WM fix. Price movements for the krone are also in line with other currencies at this time of day. The results therefore indicate that the relatively volatile price movements seen around the WM fix in Chart 3 are two-sided. In other words, the krone has, on average, appreciated as much as it has depreciated.

The chart does, however, indicate that the krone has historically strengthened ahead of the ECB fix. On average, the krone has gained 0.02 per cent[13] against the euro in the period from 2.00 p.m. to 2.15 p.m. These movements in the krone market differ markedly from what we have found for other currency pairs around the ECB fix, and indicate that the movements in the krone exchange rate are more unidirectional around the ECB fix than around the WM fix, and far larger than for other comparable currencies. The appreciation of the krone ahead of the ECB fix is offset to some extent by the depreciation of the krone after the fix.

Chart 4: Average price movements intraday in the period 2002-2013. Measured as the price change as a percentage of the mid price. The shaded areas denote the periods around the ECB and WM fixes.

Chart 4A: EURNOK, EURSEK and EURGBP

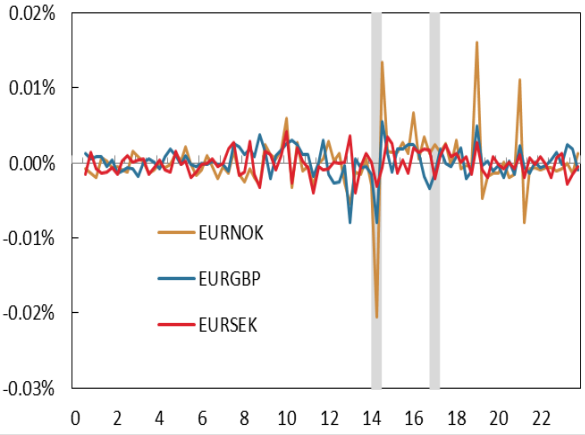
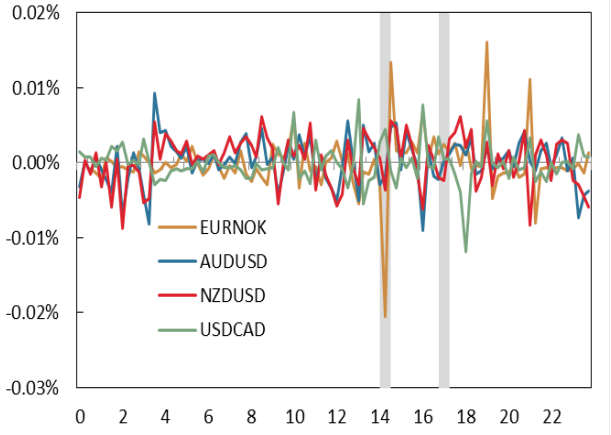


Chart 4B: EURNOK, USDCAD, AUDUSD and NZDUSD



Sources: Norges Bank and Thomson Reuters.

We can attempt to quantify this relationship using a standard regression analysis. The regression equation is given by:

$$\Delta \ln(S_T) = \beta_0 + \beta_1 * D_{200-215\,pm} + \beta_2 * D_{215-230\,pm} + \beta_3 * D_{445-500\,pm} + \beta_4 * D_{500-515\,pm}$$

where $\Delta \ln(S_T)$, the difference between the logarithms, expresses the percentage change in the currency rate from T-1 to T. $D_{200-215\,pm}$ is a dummy variable which has the value of 1 from 2.00 to 2.15 p.m. and otherwise 0. The other dummy variables are defined similarly for the time periods 2.15-2.30, 4.45-5.00 and 5.00-5.15 p.m.. The constant β_0 therefore reflects the average percentage price change for all other times (which have not been assigned a dummy variable). The average price

[13] The 0.020 per cent appreciation against the euro from 2.00 to 2.15p.m. is given by quoted market prices from Thomson Reuters, not by the actual fix price set by the ECB. If the same exercise is performed using the actual fix price, the appreciation is marginally less (0.019 per cent).

change between 2.00 and 2.15 p.m. is therefore given by $\beta_0+\beta_1$. The other dummy variables can be interpreted similarly.

Table 2 presents the regression results for selected currency crosses estimated on data from 2002 to 2013. The results confirm the movements seen in Chart 4. The Norwegian krone stands out when it comes to the ECB fix. The coefficient β_1 is negative,[14] which indicates that, on average, the krone has appreciated between 2.00 and 2.15 p.m.. More precisely, the Norwegian krone has gained an average of 0.02 per cent ahead of the ECB fix. The Pound sterling and the Swedish krona have also strengthened in the run-up to the ECB fix, but to a much lesser extent than the krone. On the other hand, we have not found any significant price changes around the WM fix for either the krone or the other currencies.

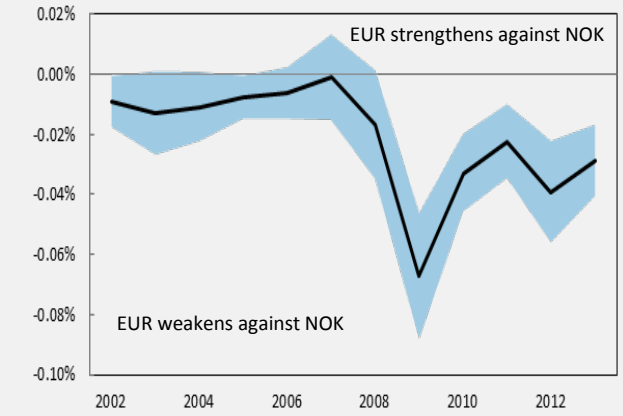
Table 2: Regression results for the coefficient, with standard errors in parentheses, based on data for 2002-2013[15]

	AUDUSD	EURGBP	EURNOK	EURSEK	NZDUSD	USDCAD
β_0	0.0002 (0.0002)	0.0002* (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)	0.0003 (0.0002)	-0.0001 (0.0001)
β_1		-0.0082*** (0.0012)	-0.0207*** (0.0020)	-0.0032*** (0.0012)		
β_2		0.0053*** (0.0012)	0.0132*** (0.0013)	-0.0007 (0.0012)		
β_3	0.0001 (0.0024)	-0.0015 (0.0016)	0.0023 (0.0019)	-0.0021 (0.0017)	-0.0027 (0.0026)	0.0005 (0.0021)
β_4	0.0011 (0.0020)	0.0016 (0.0013)	0.0013 (0.0014)	0.0008 (0.0013)	0.0029 (0.0022)	0.0006 (0.0017)

*, ** and *** denote statistical significance at the 10, 5 and 1 per cent levels, respectively.

To investigate whether this relationship has persisted over time, we have estimated the model for each individual year in the period 2002-2013. Chart 5 presents the coefficient for the dummy variable for the ECB fix (β_1) with a 95 per cent confidence interval and shows that the krone has generally strengthened against the euro ahead of the fix ($\beta_1<0$).[16] The relationship has, however, varied somewhat over time. The results indicate that the krone has appreciated more ahead of the fix in recent years than in the first half of the period, and that the krone strengthened particularly in the period 2008-2010. Possible reasons for this are discussed in Section 5 below.

Chart 5: Coefficient for the dummy variable 1400-1415 shown with a 95 per cent confidence interval. Based on estimates for 2002-2013.



Sources: Norges Bank and Thomson Reuters.

In summary, we find that the WM fix is more important than the ECB fix for all of the crosses we have examined other than the Norwegian krone, which stands out with both activity and volatility at

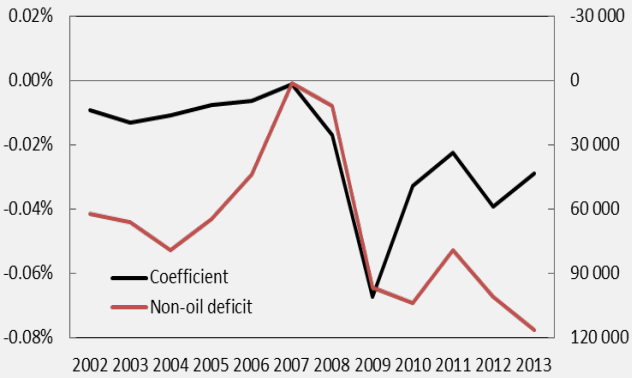
[14] The coefficient is negative with high significance.
[15] In the regression, we have included the dummy variable for the ECB fix (2.00-2.15 p.m.) only for the currency crosses that are quoted against the euro, and so we have not included this variable for AUDUSD, NZDUSD and USDCAD. The coefficients are multiplied by 100 and can therefore be interpreted as a percentage change.
[16] When we performed an equivalent exercise on EURGBP and EURSEK, the results were less significant than for EURNOK.

their highest around the ECB fix. Price movements for the EURNOK cross have also tended to move in one direction (stronger krone) in the run-up to the ECB fix, but the same pattern has not been observed for the WM fix. These results indicate that, over time, the ECB reference rate for the krone has been set stronger than the market price at 2.00 p.m.. In the following section, we discuss the mechanisms that may have contributed to these patterns.

5. The petroleum fund mechanism and movements in the Norwegian krone around the ECB fix

Over time, the Norwegian krone has tended to strengthen ahead of the ECB fix. The peculiarity of this pattern to Norway indicates that it may be due to factors of a more structural nature. One particular feature of the Norwegian economy is the large amount of foreign currency revenue received by the government from petroleum activities. In this section, we look more closely at the relationship between the petroleum fund mechanism and movements in Norwegian krone around the ECB fix.

Chart 6: Coefficient for the dummy variable 200-215 pm based on estimates for the years 2002-2013 (LH axis). Non-oil budget deficit in millions of NOK (RH axis, inverted).



Sources: Norges Bank, Thomson Reuters and Ministry of Finance.

The Norwegian government derives considerable revenue from the petroleum sector through taxes and duties paid by the oil and gas companies, the State's Direct Financial Interest (SDFI) and dividends from Statoil. The bulk of this revenue is invested abroad through the Government Pension Fund Global (GPFG) and so has no impact on the krone exchange rate.[17] The amount that is phased into the Norwegian economy is dictated by the so-called "fiscal rule", which requires that the structural non-oil budget deficit corresponds over time to the average real return on the GPFG, which is estimated at 4 per cent. As the GPFG grows, therefore, the fiscal rule allows more petroleum revenue to be channelled into the government budget. Because the fiscal rule is based on the structural deficit, it also allows spending of petroleum revenue to increase when the economy is weak and decrease when it is strong. Petroleum revenue is generated mainly in foreign currency, and the portion that is transferred to the GPFG will remain in foreign currency. It is only the portion that is phased into the Norwegian economy that ends up in NOK. The government's need for NOK is therefore given by the size of the non-oil budget deficit.[18]

As mentioned in Section 2 above, multinational companies have an interest in trading at official reference rates, because this reduces the currency risk relative to internal benchmark indices. There may therefore be reason to believe that the conversion of foreign currency into NOK in connection with petroleum tax payments etc. may be linked to fix rates. If this is the case, it could explain some of the peculiar dynamics of the krone exchange rate around the ECB fix. Because net purchases of NOK

[17] The SDFI receives virtually all of its revenue in foreign currency. As the SDFI does not pay tax, this revenue is transferred directly to the government in foreign currency and does not therefore need to be converted. Norges Bank, on the other hand, purchases currency corresponding to the difference between transfers to the GPFG and revenue from the SDFI. For a more detailed discussion of the petroleum fund mechanism, see *Economic Commentaries* 14/2012: "The petroleum fund mechanism and Norges Bank's purchases of foreign exchange for the GPFG".

[18] The structural non-oil deficit eliminates cyclical variations, such as fluctuations in taxes, duties and unemployment benefits. It is therefore the non-oil deficit that expresses the government's real need for NOK, and so we have chosen to focus on the latter in this analysis.

are given by the non-oil deficit, we have looked more closely at the relationship between the non-oil deficit and the appreciation of the krone ahead of the ECB fix. Chart 6 shows the non-oil deficit and the regression coefficient from Chart 5. As explained above, this coefficient shows how much the krone strengthened ahead of the fix in each of the years in the period 2002-2013. The chart shows a good correlation between the two variables.[19] The larger the non-oil deficit, the more the krone has strengthened in the run-up to the ECB fix. This may be an indication that the conversion of foreign currency into NOK connected to petroleum activities has been linked to the ECB fix.

6. Closing remarks

Our analyses indicate that reference rates play a key role for activity in the currency market. The ECB fix is particularly important for the Norwegian krone. For example, there are clear signs that this is the most active time of the day, and that the krone has tended to strengthen ahead of the ECB fix over time. This appears to be connected to structural factors in the Norwegian economy. The petroleum fund mechanism allows the government to channel part of its petroleum revenue into the government budget. Over time, there appears to be a relatively good correlation between the spending of oil revenue by the government and how much the krone appreciates ahead of the ECB fix. This may indicate that large parts of these transactions are linked to the ECB fix.

Linking an order to a currency fix can have a number of benefits for a client in the currency market. In isolation, good liquidity can mean lower transaction costs for the client. It also eliminates the client's currency risk relative to benchmark indices and spares the client from having to monitor the market during the day. It is, however, questionable whether this will always give the client the best price, and the design of today's currency fixes can create a conflict of interests between client and bank (see Section 3 above). A number of these issues have been addressed in a recent report from the FSB, in which the working group presents concrete recommendations for changes to the current construction of currency fixes.

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[19] The correlation between the series is -0.64.