Block-Trading and Central Bank FX Transactions Announcements: Implications for Short-Term Volatility and Returns*

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Abstract

This paper investigates the implications of block-trading, also known as block-transactions, in the context of the central bank foreign exchange (FX) announcements on short-term volatility and returns in the Norwegian foreign exchange market. Block-transactions executed by large financial institutions or generated by announcements moving several individual investors can significantly impact asset prices. Our study focuses on the monthly announcements of the Norges Bank, the Central Bank of Norway, which informs the market about FX transactions of the Norwegian currency. We make three key contributions: Firstly, we introduce the concept of an information shock by isolating the impact of the announcement, providing insights into its immediate effects on currency dynamics. Secondly, we emphasize the unique nature of Norges Bank's announcements, which can induce block-trading behavior among market participants. Thirdly, we contribute to understanding the short-term costs and implications of central bank operations on exchange rates. Finally, the Norges Bank policy is not targeting the smoothness of the currency but only accomplishes a budget deficit mechanism, which is an obligation of the central bank. Our empirical analysis reveals a significant association between Norges Bank's announcements and short-term volatility and returns of the USD/NOK and EUR/NOK currency pairs. The results suggest that the announcements may increase short-term volatility, challenging the traditional view of central banks actions seeking to stabilize currencies. This study advances our understanding of block-trading in the context of central bank FX transactions and provides valuable insights for policymakers in formulating effective strategies for managing exchange rate dynamics.

Keywords: Block-Trading, Block-Transactions, Foreign-Exchange Transactions, Norges Bank, Currency Returns, Volatility, High-Frequency Data.

JEL Codes: F20, F31, F37, G14, G15, G18

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1 Introduction

Block-trade or block-transactions are transaction in the financial market that typically are executed by large financial institutions, investment funds, or other institutional investors. Block-transactions can significantly impact asset prices. The movements of large financial institutions also may have a second order effect by inducing the movement of individual investors. This study seeks to study the implications of these block-transactions in the context of the announcements of the Central Bank of Norway, the so called Norges Bank, that inform the market about FX transactions of the Norwegian currency on behalf of the government in a monthly basis, in the context of the petroleum revenues management and the Government Pension Fund Global. This fund demands strong currencies, like dollar and euro. Thus, the transactions announced by the Norges Bank can impact the financial market.

More specifically, our study examines return and realized volatility of the USD-NOK FX rate, identifying the short-term effects of the monthly foreign exchange operations conducted by Norges Bank. Our aim is to uncover the immediate implications of Norges Bank's monthly FX transactions announcements on the return and realized volatility of the USD-NOK (and also, for the EUR-NOK FX rate). To achieve this, we profit from a high-frequency intraday data on the USDNOK and EURNOK to simulate NOK 5/10/30-minute returns and realized volatility, using a data with 1-minute frequency.

Our primary contributions are threefold. First, we introduce the concept of an information shock by separating the announcements and transactions in FX operations. By isolating the impact of the announcement, we provide a more clean identification of the exogenous information shock, allowing us to study immediate effects on currency returns and volatility. Moreover, with the announcements, we may have an increase in the return volatility instead of the smoothness desired by this type of policy by promoting block-transactions of individual investors reacting to the central bank information shock.

Second, we emphasize the unique nature of Norges Bank's operations compared to other FX transactions, such as FX interventions, since in this case the policy in not related to smooth FX volatility, but just a budget deficit mechanism introduced by the government. Unlike interventions that occur simultaneously with the announcement, Norges Bank's mechanism are pure policy surprises as the announcements precede the transaction itself. Our hypothesis is that this characteristic makes them exogenous to the monetary policy and allows us to examine their impact on currency returns and realized volatility.

Third, our study also contributes to the understanding of the effects of central banks operations and FX rate. While the existing literature primarily focuses on the medium to long-term benefits of FX interventions, our research sheds light on the short-term costs and implications of central banks actions. By examining the immediate effects of Norges Bank's

transactions, we provide evidence that this short-term cost could exist and warn policymakers to formulate effective strategies for policies that affect exchange rates.

By analyzing the immediate results of Norges Bank's monthly FX transactions, this study advances our understanding of central bank operations and the impact of large institutional transactions as a central bank or a large market fund. It also provides valuable insights that assist policymakers in formulating effective strategies for mitigating risks of announcements that may impact the market.

Our empirical estimation reveals a significant association between Norges Bank's foreign exchange transactions announcements and the return and volatility of USD/NOK and EUR/NOK. The results suggest that the central bank's communication have a substantial impact on currency volatility in the 5-minute, 10-minute, and 30-minute intervals following the announcement. The most significant effect is observed in the 30-minute returns, particularly when there are large surprises relative to the market consensus. However, surprises in the bank's announcements also influence returns, albeit to a lesser extent, indicating that market participants quickly adjust to the new information shock even before the FX flow takes effect.

Regarding volatility, the evidence suggests a positive association with both announcements and surprises, indicating that these events increase market uncertainty. In conclusion, Norges Bank's foreign exchange operations appear to play a critical role in influencing short-term returns and volatility in the Norwegian foreign exchange market. Contrary to what commonly FX interventions seek when acting in the currency market, the announcements increase the short-term volatility instead of helping to stabilize the currency.

To the best of our knowledge, we are the first to investigate the short-term effects of central banks' FX transactions using high-frequency intraday data, focusing on the impact of information shocks rather than flows. By examining the immediate implications of these operations, we aim to contribute to the understanding of how such shocks influence currency returns and volatility.

To validate our results and verify whether the are robust to different specifications and parameters, we conducted additional analyses by varying specifications of the volatility equation and the currency return. Allowing for a seasonal component in the volatility equation does not change the impact of announcements and surprises on the volatility of the currency. Results are also strongly significant when adding several lags of the realized volatility in the estimation equation. When changing the currency, results consistently demonstrate the significant impact of foreign exchange transactions by the Central Bank of Norway on the EUR/NOK exchange rate. Across different time intervals, including 5 minutes, 10 minutes, and 30 minutes, the estimated coefficients consistently indicate a positive relationship between transactions and currency volatility. For surprises, the results are also significant for returns. Moreover, our

robustness analyses also show that the effects on returns and volatility are driven from positive surprises relative to the expected by money market players, that is, our sample analysis show that the results are both economic and statistically significant when the central bank announces higher amounts of FX purchases rather than smaller amounts compared to the expected. Thus, results are all in line with the main findings, showing that the specification is not driving our results.

The subsequent sections are structured as follows: Section 1.1 provides an overview of the literature on block-trading and the specific case of central banks' transactions and highlights our contributions to these fields. Section 1.2 presents the Norges Bank mechanism, which generates an exogenous information shock. Section 2 describes the data and the empirical model employed to investigate our hypothesis. Sections 3 and 4 present our main results and additional robustness exercises. Finally, Section 5 concludes the paper.

1.1 Literature Background

Our paper is related to the literature of block-transactions. Block-transactions are buy and sell orders that usually are executed by big institutions, funds or other institutional investors and can have a big impact on asset prices. Specially, some funds may announce (previously) their movements to smooth the volatility, and as a consequence move the market in the announced direction. Once a big player announce adjustments in its position, the market may move in the same direction in an attempt to exploit an extraordinary profit. When studying market volatility, these broad and concentrated fluctuations can lead to price increases, and thus they are important to evaluate, and are related to movements of central banks, specially large operations, the case of Norges Bank monthly FX transactions.

Keim and Madhavan (1996) create a block-transactions market model where order sizes, beliefs, and prices are endogenously certain. Using data from 5,625 stock deals between 1985 and 1992 to test the model's prediction, it was discovered that pre-trade price movements are significantly positively correlated with trade size, which is consistent with knowledge leakage as the trade date gets closer. The word "marketed" describes block. Additionally, the block trading market's intermediation may have a brief price impact or liquidity effect that is a concave function of the order size.

The 1982 establishment of a mutual fund with the goal of capturing small-cap stock returns is examined by Keim (1999). The fund is based on the small size stock index CRSP 9-10 Index, but it also includes investment guidelines and a trading technique that are intended to reduce the potentially exorbitant transaction costs that could be incurred by investing in these non-liquid stocks. The investigation came to the conclusion that the fund's investment policies and trading technique significantly outperformed the 9-10 index between 1982 and 1995, with

a yearly return differential of 2.2%.

By analyzing how central bank policies have affected volatility and returns in the foreign currency market, particularly taking into account the impact of block transactions, our article offers a fresh perspective. We introduce the notion of "information shock" in relation to FX outages and investigate how surprises occurring prior to Norges Bank actions, which are distinct from covert policy, show how quickly market participants are adjusting to fresh information shocks. Building on current financial literature, we increase our understanding of the interaction between central bank operations and significant market moves by including block transaction literature.

Our study adds to the knowledge about the effectiveness of currency exchange transactions. We focus more on the 'information shock' factor brought on the central bank announcements than the actual transactions. We can evaluate the effects of these announcements on currency exchange rates using a mechanism that has not the goal of smooth FX volatility. Despite the existence of a strong theoretical framework that highlights the potential advantages of central bank actions on economies (Gabaix and Maggiori, 2015; Hassan et al., 2016; Fanelli and Straub, 2017; Chang, 2018; Cavallino, 2019), empirical progress in clarifying the potential short-term volatility brought by such actions has been comparatively small. In contrast to the announcements, which act as an "information shock," the majority of research focus on the interventions intended to stabilize foreign exchange volatility.

Gabaix and Maggiori (2015) rationalized the empirical discrepancy between exchange rates and traditional macroeconomic fundamentals by considering the imbalance in balance sheets due to capital flows, which impact the level and volatility of exchange rates. Hassan et al. (2016) highlighted how currency manipulation strategies by central banks can lower a country's risk premium on international markets, leading to decreased risk-free interest rates, increased domestic capital accumulation, and higher wages. They also demonstrated how currency manipulation by powerful nations affects global capital accumulation and interest rates. Chang (2018) emphasized the European Central Bank's (ECB) expanded participation in governing the Euro region, extending beyond traditional monetary policy-making and increasing its influence within the EU.

It is widely recognized that accurately identifying the impact of interventions within a macroenvironment where numerous other factors may interact presents a significant challenge. To address this, we leverage the availability of high-frequency data on exchange rate fluctuations and publicly available information on the announcements of the Norwegian central bank regarding forthcoming foreign exchange operations. This approach allows us to effectively isolate the influence of market transactions by eliminating extraneous factors beyond the flows themselves, as is typical in high-frequency studies (Dominguez, 2003; Pasquariello

and Vega, 2007; Melvin et al., 2009).

In this context, our study aims to enhance economists' understanding of the short-term effects of foreign exchange transactions and the large trade generated by previous announcements of those transactions, which can shad light on the hidden adverse short-term effects of block-trade and central bank interventions. Specifically, we focus on a scenario where policymakers demonstrate a heightened receptiveness to the use of FX operations as a viable policy instrument (Blanchard et al., 2015; Ghosh et al., 2017; Obstfeld et al., 2019). There is existing documentation that central banks globally recognize FX interventions as an integral component of their toolkit (Mohanty and Berger, 2013; Frankel, 2016).

Our study also engages in dialogue with previous research that explores alternative approaches to identification. Recognizing the limitations of employing high-frequency frameworks to draw conclusive statements about longer-term outcomes, a segment of the literature employs lower-frequency settings to address this issue, such as event studies (Fatum and M. Hutchison, 2003; Fratzscher et al., 2019), policy-change exploitation (Kearns and Rigobon, 2005), or counterfactual comparisons(Fischer and Zurlinden, 1999; Rossi and Pagano, 2013). While there may be a potential risk of encountering endogeneity due to confounding factors, these approaches generally yield findings that indicate the high effectiveness of central bank actuation (Dominguez et al., 2012).

In the context of our study, it is worth noting the relevant work by Lerbak et al. (2016), LUND and TAFJORD (2017), and Løberg (2018) who investigate the consequences of FX operations by the Central Bank of Norway in the foreign exchange market. Løberg (2018) found both short- and long-term effects on the NOK-EUR exchange rate from the bank's currency operations related to the non-oil government budget deficit, contrary to theoretical predictions. LUND and TAFJORD (2017) studied the Petroleum Buffer Portfolio (PBP) used by the central bank to manage foreign exchange transactions related to petroleum fund mechanisms and how changes in the government's net cash flow from petroleum activities impact PBP movements. Lerbak et al. (2016) provided further clarification on the function of the petroleum fund mechanism, demonstrating how it directs government income from petroleum-related activities toward expenditure and savings, while highlighting the changes in government spending on petroleum earnings over time and the necessity of currency exchange.

Our study contributes to the theoretical and empirical evidence on the effects of FX policy on economic outcomes. Building on the theoretical frameworks established by Gabaix and Maggiori (2015), Hassan et al. (2016), Chang (2018), and others, we use high-frequency data to distinguish between the interventions themselves and their announcements, shedding light on the short-term effects of such interventions. Our particular focus is on volatility, and we estimate the impact of these transactions on both returns and volatility using a simple

empirical model. This approach complements alternative methodologies examined in the literature, such as lower-frequency settings and event studies. By incorporating specific findings related to the Norwegian context as studied by Lerbak et al. (2016), LUND and TAFJORD (2017), and Løberg (2018), our research offers a robust empirical analysis that expands the understanding of these market operations, contributing to the broader conversation around economic policy and foreign exchange interventions.

1.2 Norway and the Petroleum Mechanism

Given Norway's significant oil income, the Norwegian Central Bank, known as Norges Bank, plays a crucial role in managing foreign exchange operations. As part of its FX policy, Norges Bank regularly publishes updates on its foreign exchange transactions to control the government's non-oil budget deficit and maintain the value of the Norwegian Krone (NOK).

To align the NOK-FX exchange rate with economic fundamentals and policy goals, the central bank engages in trading on the foreign exchange market through its petroleum mechanism. These transactions impact both the government's net cash flow from petroleum activities and the non-oil budget deficit (Løberg, 2018; Lund & Tafjord, 2017). The amount of the non-oil budget deficit largely determines the government's net purchases of NOK, with Norges Bank executing the foreign exchange operations on behalf of the government. It is important to note that the government's net purchases of NOK are not influenced by revenues from petroleum activities or the breakdown of these revenues by currency (Lerbak et al., 2016).

Figure 1 provides a diagram summarizing the Norges Bank transactions set-up. The diagram illustrates that government revenues derived from oil activities are used to finance budget deficits. A portion of these revenues is collected in foreign exchange, which is directed to the national pension fund, the Norwegian Government Pension Fund Global (GPFG). The other part of the government's resources is in NOK, obtained from taxes paid by petroleum companies exploring the Norwegian continental shelf and dividends from the state oil company (Equinor). The mechanism of Norges Bank's FX transactions operates as follows: When there is a surplus between oil revenues represented in NOK and the amount required to cover the government's non-oil budget deficit, this revenue is converted to EUR or USD for utilization in the GPFG, which is denominated in foreign currency. Conversely, if the government's revenues are insufficient to cover the domestic deficit, the government taps into the GPFG, converting foreign currency resources into NOK. In both cases, Norges Bank acts as an intermediary for these transactions on behalf of the government. Although these operations directly impact the value of USD/NOK and EUR/NOK exchange rates, their primary goal is to fulfill the government's revenue mechanism.

Figure 1: Norway Petroleum Revenue Mechanism

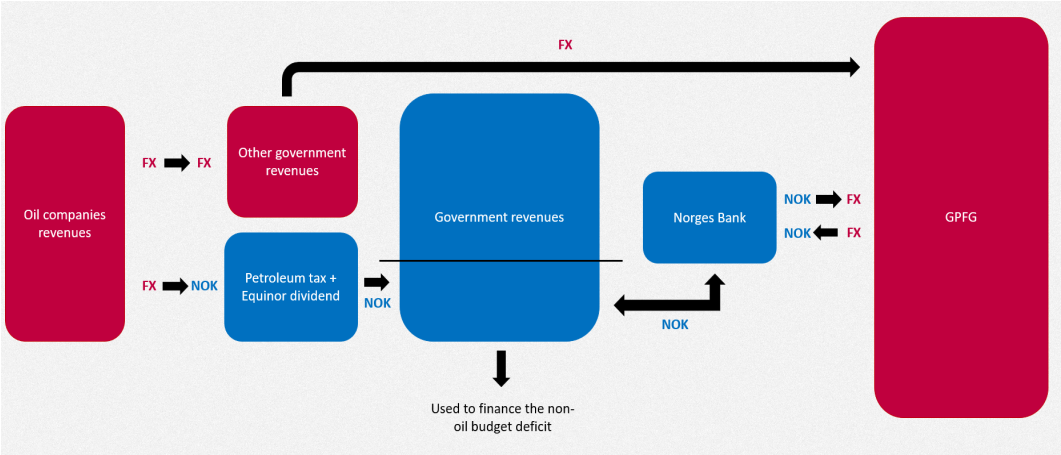
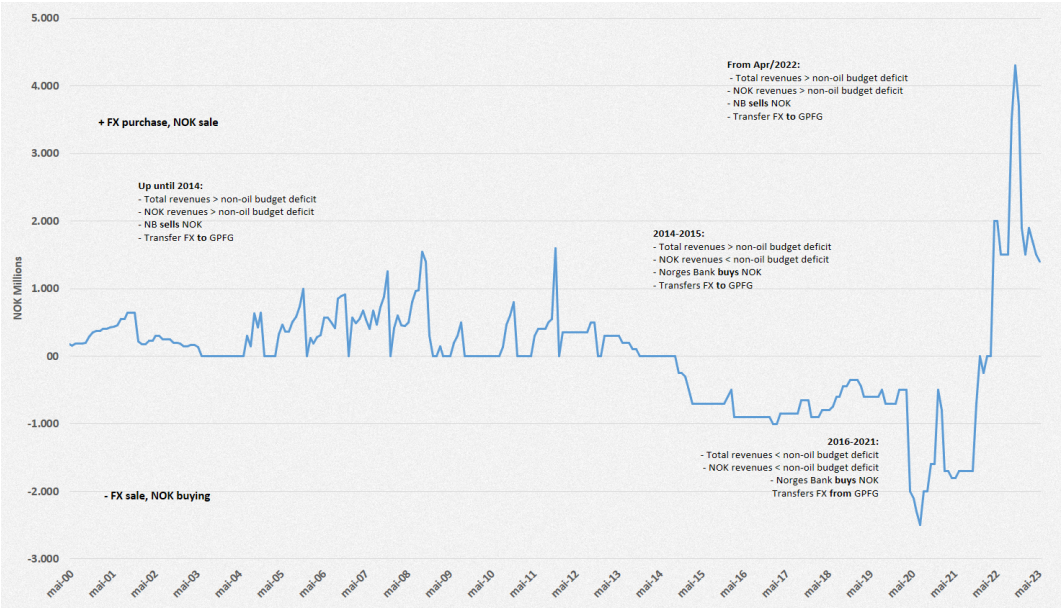


Figure 2 displays the amount of foreign currency (USD and EUR) purchased by Norges Bank to convert and allocate oil revenues to the Norwegian GPFG. Depending on global variables affecting the government's petroleum revenues, the central bank can either be a net buyer or seller of foreign currency[1], or it may not participate in the FX market at all. The announcements of FX transactions occur monthly, on the last working day of each month, when money needs to be transferred to or from the GPFG.

Figure 2: Norges Bank Daily FX Transactions on Behalf of the Government



Hence, when the amount of FX transactions is negative, Norges Bank buys NOK (or

[1]At the time of writing (May 2023), Norges Bank is purchasing foreign currency as government revenues from petroleum activities exceed the domestic deficit.

sells foreign currency), indicating that the non-oil budget deficit surpasses the government's collected resources. Conversely, when the amount is positive, the central bank conducts foreign exchange purchases (or sells NOK) to transfer the net cash flow from petroleum activities to the GPFG.

The announcement and implementation of these transactions can affect the NOK exchange rate in the short and long term. These FX purchases aim to control volatility in flexible exchange rate regimes (Sarno et al., 2001) and stabilize the exchange rate over the long term, providing a smoother trajectory in nations with narrow-band regimes (Fratzscher et al., 2019).

However, in the short term, the Norges Bank mechanism can lead to information shocks that impact the exchange rate when the central bank announces them at the end of each month. These shocks occur when the market updates its expectations based on the new information provided by the central bank, potentially resulting in changes in the level and realized volatility of the NOK immediately following the announcement.

Therefore, while the central bank's foreign exchange transactions are designed with medium- to long-term objectives, it is crucial to consider the immediate consequences of these information shocks on exchange rate volatility and levels. Understanding these impacts is essential for formulating effective monetary policy and managing potential risks associated with foreign exchange interventions.

2 Data and Empirical Model

2.1 Data

The paper analyzes the returns and realized volatility of the Norwegian Krone (NOK) at 5-minute, 10-minute, and 30-minute intervals. The data used consists of 1-minute bid price quotes for the USD/NOK and EUR/NOK currency pairs. The data covers the period from January 1, 2014, 00:00 GMT, to January 27, 2023, 23:59 GMT, resulting in 4,773,600 data points, with 1,440 observations per day over a span of 3,315 days. The USD/NOK and EUR/NOK exchange rates are traded 24 hours a day from Sunday 22:00 GMT to Friday 22:00 GMT and are obtained from Dukascopy Swiss Banking Group's Historical data feed.

The focus of the analysis is on the effects of Norges Bank's monthly announcements of foreign exchange transactions. The time stamps for the announcements are obtained from Bloomberg's Economic Calendar for Norway. These announcements occur on the last working day of each month when Norges Bank announces the amount of foreign exchange to be operated in the following month. The difference between the actual announcement and market expectations, as reflected in surveys, allows the identification of surprises. As explained in Section 1.2, these transactions are unrelated to FX control but rather pertain to the management

of the government's petroleum revenue mechanism.

2.2 Empirical Models

Our empirical specification is based on two simple equations. Equation (1) and Equation (2) present the simplest version of our model. We address other possible features of interest on Section 3, when presenting the main results. Equation (1) models currency returns as a function of the indicator variable $I_{NBI,t-1}$ which assumes the value 1 if Norges Bank announces an FX transaction at time t -1 and a lagged return ret_{t-1}. We account for time-varying volatility by including σ_t which is proxied by the realized volatility of the asset. β_{NBI} connects Norges Bank's transactions and currency returns being the main coefficient of interest for Equation (1). Equation (2) captures persistent volatility via an AR(1) while allowing for Norges Bank's FX purchases to affect the volatility level as captured by the coefficient V_{NBI}.

$$ret_t = \alpha + \beta_{NBI} I_{NBI,t-1} + \beta_r ret_{t-1} + \sigma_t \varepsilon_t \text{ with } \varepsilon_t \sim N(0,1) \tag{1}$$

$$\log \sigma_t = \alpha_V + V_{NBI} I_{NBI,t-1} + \phi log\sigma_{t-1} + \nu\eta_t \text{ with } \eta_t \sim N(0,1) \tag{2}$$

Similarly, we estimate an equation to capture the effect of surprises on return and volatility of the target asset, as specified in equations (3) and (5). In both equations, $S_{NBI,t-1}$ represents the difference between what is announced by the central bank and market expectations proxied by the Bloomberg survey.

$$ret_t = \alpha + \beta_{NBI} S_{NBI,t-1} + \beta_r ret_{t-1} + \sigma_t \varepsilon_t \text{ with } \varepsilon_t \sim N(0,1) \tag{3}$$

$$\log \sigma_t = \alpha_V + V_{NBI} S_{NBI,t-1} + \phi log\sigma_{t-1} + \nu\eta_t \text{ with } \eta_t \sim N(0,1) \tag{4}$$

We must recover the $\{\alpha, \alpha_V, \beta_{NBI}, \beta_r, \alpha_V, V_{NBI}, \phi, \nu\}$ conditional on the observed returns and realized volatilities. We estimate simply by Ordinary Least Squares to obtain all desired parameters.

To assess the latent variable σ_t we use the realized volatility, as in Andersen et al. (2003), as a proxy.

$$RVar_{t,t+\tau} = \sum_{t}^{t+\tau} r_t^2 \text{ and } RVol_{t,t+\tau} = \sqrt{RVar_{t,t+\tau}} \tag{5}$$

We aggregate $r_{i,t}^2$ to produce 5, 10 and 30 minutes realized volatilities.

Table 1 presents the descriptive stats for the variables in equations (1) to (5).

Table 1: Descriptive Statistics

	5min	10min	30min
$E(ret_t)$	-3.573×10^{-07}	-1.324×10^{-06}	-5.520×10^{-06}
$sd(ret_t)$	4.508×10^{-04}	6.571×10^{-04}	1.14×10^{-03}
$E(logRV_t)$	-7.63	-6.86	-5.72
$sd(logRV_t)$	0.89	0.84	0.80

Next section, we present the estimation results for the equations.

3 Results

This section presents the main results regarding the effect of Norges Bank's FX transactions announcement on different interest variables. Tables 2, 3 and 4 display the estimation results for the empirical model, accounting for three types of operations: announcements only, surprises relative to market expectations, and surprises larger than NOK 200 million, respectively.

The coefficient β_{NBI}, which represents the relationship between Norges Bank's transactions and currency returns, consistently demonstrates an impact on currency returns across all three scenarios and for all return intervals of 5, 10, and 30 minutes. In Table 2, we observe that in the presence of an announcement, the model predicts no significant impact on returns for the 5- and 15-minute intervals. The estimated impact is slightly larger for the 30-minute interval estimation, but with a low t-value, indicating that there is no significant impact of announcements alone on the coin return.

Table 2: Annoucements only

5 minutes:					
α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
-2.61×10^{-7}	3.27×10^{-5}	-2.80×10^{-2}	-2.78	0.63	0.63
(-0.67)	(0.89)	(-27.45)	(-385.67)	(9.43)	(677.33)
10 minutes					
α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
-9.53×10^{-7}	-1.38×10^{-5}	-2.49×10^{-2}	-2.29	0.56	0.66
(-1.19)	(-0.26)	(-17.17)	(-259.18)	(9.21)	(519.20)
30 minutes					
α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
-3.96×10^{-6}	-8.88×10^{-5}	-2.82×10^{-2}	-1.93	0.29	0.66
(-1.65)	(-0.96)	(-11.29)	(-150.40)	(4.96)	(297.96)

In Table 3, we focus on the effects of unexpected announcements, which deviate from specialists' predictions and are captured by the variable surprises. The estimated coefficients remain statistically significant when considering the 30-minute interval, but relatively smaller than those in the "Announcements only" scenario. Over a 5-minute interval, we find a β_{NBI} of 1.74×10^{-4}, marginally significant with a t-value of 1.60. For the 30-minute interval, the effect is larger, reaching 6.35×10^{-4}, and more significant with a t-value of 2.29. This result suggests that market participants might adjust more quickly in response to surprise FX transactions.

Table 3: Surprises

5 minutes:					
α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
-2.59×10^{-7}	1.74×10^{-4}	-2.80×10^{-2}	-2.78	1.31	0.64
(-0.67)	(1.60)	(-27.45)	(-385.61)	(6.51)	(677.39)
10 minutes					
α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
-9.62×10^{-7}	2.36×10^{-4}	-2.48×10^{-2}	-2.29	1.15	0.66
(-1.21)	(1.48)	(-17.16)	(-259.10)	(6.31)	(519.25)
30 minutes					
α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
-4.07×10^{-6}	6.35×10^{-4}	-2.83×10^{-2}	-1.93	0.83	0.66
(-1.69)	(2.29)	(-11.29)	(-150.36)	(4.84)	(298.08)

Moving on to the third set of estimation results presented in Table 4, we consider only large surprises, specifically those with a deviation larger than NOK 200 million. For this scenario, the model predicts a positive and statistically significant impact on returns. The estimated impact is larger for the 30-minute interval estimation, with a coefficient reaching $1.18 \times 10^{-}3$ and a t-value of 3.49, indicating significance.

Table 4: Surprises larger than 200MM

5 minutes:					
α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
-2.62×10^{-7}	5.79×10^{-4}	-2.80×10^{-2}	-2.78	1.46	0.64
(-0.68)	(4.34)	(-27.45)	(-385.60)	(5.92)	(677.39)
10 minutes					
α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
-9.67×10^{-7}	6.13×10^{-4}	-2.48×10^{-2}	-2.29	1.30	0.66
(-1.21)	(3.14)	(-17.16)	(-259.10)	(5.83)	(519.25)
30 minutes					
α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
-4.08×10^{-6}	1.18×10^{-3}	-2.83×10^{-2}	-1.93	1.18	0.66
(-1.69)	(3.49)	(-11.28)	(-150.37)	(5.56)	(298.09)

The effect of Norges Bank's FX operations and surprises on realized volatility is also relevant. The estimated parameter V_{NBI}, which captures this effect, is always positive and significant. This result aligns with our hypothesis that announcements can bring short-term volatility to the currency return. We observe that, in the case of regular transactions and surprises larger than 200 million, the effect peaks at the 5-minute interval (1.46 with a t-value of 5.92, as shown in 2 and 4 and gradually decreases as the time interval widens. For surprises, the effect on volatility is lower, peaking at 1.31 (t-value 6.51) for the 5-minute interval and decreasing to 0.83 (t-value 4.84) for the 30-minute interval.

The coefficients β_r (effect of lagged return) and ϕ (autoregressive parameter for log volatility) also show a robust, significant, and negative relationship with returns and a positive relationship with volatility across all models.

In summary, the presented results suggest that Norges Bank's announcements have a significant impact on the currency, as measured by their effects on returns and realized volatility. These impacts become more pronounced with larger surprises.

4 Robustness Exercises

4.1 Robustness in the volatility equation

4.1.A Adding lags in the volatility equation

The following exercise presents the estimation of the volatility equation with a different specification. Here, we focus on 5 minutes return and we show that the results for the impact of the FX transaction on the volatility are in line with the previous results, with positive and strongly significant results. The impact coefficients are .57 for the announcements only, 1.20 for surprises, and 1.37 for big surprises, with t-values of 9.01, 6.32, and 5.88, respectively. All 6 lags were significant in the volatility specification, but they do not change the direction of the impact coefficient. Hence, our results are robust to the specification of the equation.

Table 5: Volatility equation with the addition of lags

5 min: Annoucement								
	constant	V_{NBI}	lag1	lag2	lag3	lag4	lag5	lag6
Estimate	-1.261	0.574	0.418	0.078	0.098	0.075	0.071	0.096
t value	-146.219	9.006	345.162	59.436	75.112	56.994	53.872	79.384
5 min: Surprises								
	constant	V_{NBI}	lag1	lag2	lag3	lag4	lag5	lag6
Estimate	-1.260	1.203	0.418	0.078	0.098	0.075	0.071	0.096
t value	-146.155	6.322	345.192	59.426	75.100	56.995	53.882	79.404
5 min: Big Surprises								
	constant	V_{NBI}	lag1	lag2	lag3	lag4	lag5	lag6
Estimate	-1.260	1.371	0.418	0.078	0.098	0.075	0.071	0.096
t value	-146.149	5.881	345.190	59.425	75.098	56.995	53.890	79.402

Next, we present estimations allowing for the presence of seasonality in the volatility.

4.1.B Seasonal effects on volatility

Table 6 shows the results for the estimation of the volatility by adding a seasonal component to the equation. The addition of seasonality do not change the significance and direction of the impact of announcements, surprises, and big surprises in the volatility of the currency.

Table 6: Volatility equation with seasonality

5 min: Annoucement			
	Seasonal Component	V_{NBI}	Lagged volatility
Estimate	0.482	0.382	0.518
t value	466.150	5.891	504.169
5 min: Surprises			
	Seasonal Component	V_{NBI}	lag1
Estimate	0.482	1.103	0.518
t value	466.153	5.692	504.158
5 min: Big Surprises			
	Seasonal Component	V_{NBI}	lag1
Estimate	0.482	1.268	0.518
t value	466.153	5.342	504.155

Overall, results are robust to the specification of the equation. However, there is similar data regarding the EUR-NOK exchange rate that allow us to test whether results are robust to the choice of the currency. Next section we provide the estimation of the main results for the EUR-NOK exchange rate

4.2 Results for EURNOK FX rate

In this subsection, we present the robustness results for EUR-NOK exchange rate, following the exact estimations presented in the previous section. The estimation results, presented in Tables 7, 8, and 9, provide similar results on the impacts of Norges Bank transactions in the context of EUR/NOK exchange rates. The results are similar, showing the robustness of the previous results

Table 1 reports the estimation results for announcements only. Although the coefficient β_{NBI} consistently demonstrates a positive relationship with currency returns across all three intervals (5 minutes, 10 minutes, and 30 minutes), these coefficients are not statistically significant. However, when looking to the volatility equation, we observe a strong and positive association between the announcements and the currency returns, showing the increase in the short-term volatility generated by this policy transaction.

Table 7: Annoucements only (EURNOK)

5 min						
	α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
Estimate	-3.39E-07	6.49E-05	-4.05E-02	-2.71	0.82	0.67
t value	-7.29E-01	1.76E+00	-3.28E+01	-358.39	9.33	722.90
10 min						
	α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
Estimate	-1.71E-06	1.62E-05	-4.27E-02	-2.23	0.71	0.69
t value	-1.83E+00	3.07E-01	-2.46E+01	-241.25	9.16	554.17
30 min						
	α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
Estimate	-3.89E-06	-1.11E-04	-4.24E-02	-1.87	0.41	0.69
t value	-1.41E+00	-1.23E+00	-1.41E+01	-139.91	6.05	320.36

Similarly, Table 2 presents the estimation results for the scenario of surprises. The coefficient β_{NBI} continues to exhibit a positive relationship with returns, but now with stronger significance in the return equation. For the 5-minute interval, the estimated coefficient is 2.85×10^{-4} (t-value: 1.84). For the volatility equation, we see a strong positive relationship between volatility and the surprises again.

Table 8: Surprises (EURNOK)

5 min						
	α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
Estimate	0.00	0.00	-0.04	-2.71	1.32	0.67
t value	-0.71	0.98	-32.77	-358.32	5.09	722.96
10 min						
	α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
Estimate	-1.72E-06	2.85E-04	-4.27E-02	-2.23	1.22	0.69
t value	-1.84E+00	1.84E+00	-2.45E+01	-241.16	5.37	554.21
30 min						
	α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
Estimate	-4.03E-06	3.41E-04	-4.24E-02	-1.87	1.01	0.69
t value	-1.47E+00	1.29E+00	-1.41E+01	-139.83	5.08	320.52

Table 9 restricts the results in table 8 by using only surprises larger than 200MM. The presented results for the impact on return and volatility are both positive and statistically significant.

Table 9: Big Surprises (EURNOK)

5 min						
	α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
Estimate	0.00	0.00	-0.04	-2.71	1.33	0.67
t value	-0.72	4.30	-32.77	-358.31	4.21	722.96
10 min						
	α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
Estimate	0.00	0.00	-0.04	-2.23	1.22	0.69
t value	-1.84	1.84	-24.54	-241.16	5.37	554.21
30 min						
	α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
Estimate	0.00	0.00	-0.04	-2.23	1.29	0.69
t value	-1.48	3.24	-14.10	-241.15	4.64	554.21

4.3 Anticipation Effects

In this subsection, we run our model computing the impact of the announcement on the previous return. To do this, we lag the dummy variable to investigate whether there is a significant impact by changing the variable to a period before, where there is no transaction.

As a result, we find no effect in both the mean and the volatility of the USDNOK return.

Table 10: Anticipation placebo test for 5 minutes return

Announcements Only						
	α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
Estimate	0.0000	0.0000	-0.0281	-2.78399	0.118273	0.635651
t value	-0.658	-0.874	-27.452	-385.573	1.750303	677.3863
Surprises						
	α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
Estimate	0.0000	-0.0001	-0.0281	-2.78389	-0.04057	0.635661
t value	-0.665	-0.499	-27.453	-385.566	-0.20106	677.4033
Big Surprises						
	α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
Estimate	0.0000	0.0001	-0.0281	-2.78389	-0.07993	0.635662
t value	-0.668	0.459	-27.455	-385.566	-0.32345	677.4042

4.4 Negative and Positive Surprises

Next, we present the effect for positive and negative surprises. Table 11 and 12 present the results for surprises when the announcement/ is different from the predicted, showing distinct results when the transaction is more extensive than the predicted in the survey from when the operation is lower than the predicted.

Results indicate that positive surprises are driven the previous results for the mean return. However, the impact of the FX transaction is strongly significant for both negative and positive surprises.

The results for volatility are significant in all intervals and type of surprises. For the mean return, results are significant for Big Surprises in all intervals, and are strongly significant for all surprises in the 30-min return.

Table 11: Effect for positive surprises

Positive Surprises						
5-min return						
	α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
Estimate	0.000	0.000	-0.028	-2.784	1.313	0.636
t value	-0.673	1.603	-27.449	-385.609	6.507	677.394
10-min return						
Estimate	0.000	0.000	-0.025	-2.296	1.149	0.665
t value	-1.206	1.483	-17.163	-259.101	6.305	519.255
30-min return						
Estimate	0.000	0.001	-0.025	-1.930	0.840	0.663
t value	-1.211	3.144	-17.161	-150.368	4.842	298.081
Positive Big Surprises						
5-min return						
Estimate	0.000	0.001	-0.028	-2.784	1.463	0.636
t value	-0.680	4.341	-27.450	-385.603	5.920	677.395
10-min return						
Estimate	0.000	0.001	-0.028	-2.784	1.463	0.636
t value	-1.692	2.295	-11.288	-385.603	5.920	677.395
30-min return						
Estimate	0.000	0.001	-0.028	-1.930	1.181	0.663
t value	-1.696	3.489	-11.284	-150.373	5.560	298.098

Table 12: Effect for negative surprises

Negative Surprises						
5-min return						
	α	β_{NBI}	β_r	α_v	V_{NBI}	ϕ
Estimate	0.000	0.000	-0.028	-2.78	0.40	0.64
t value	-0.674	1.082	-27.4558	-385.58	2.95	677.40
10-min return						
Estimate	-9.67E-07	0.000	-0.025	-2.296	0.391	0.665478
t	-1.211	1.435	-17.172	-259.067	3.21668	519.2633
30-min return						
Estimate	0.000	0.000	-0.028	-1.930	0.306	0.663
t	-1.680	0.539	-11.288	-150.327	2.647	298.105
Big Negative Surprises						
5-min return						
Estimate	0.000	0.000	-0.028	-2.784	0.358	0.635653
t value	-0.673	0.894	-27.455	-385.580	2.757748	677.3992
10-min return						
Estimate	0.000	0.000	-0.025	-2.296	0.394	0.665
t	-1.210	1.382	-17.171	-259.067	3.361	519.265
30-min return						
Estimate	0.000	0.000	-0.028	-1.930	0.290	0.663
t	-1.680	0.545	-11.288	-150.326	2.601	298.106

5 Conclusion

In conclusion, this study provides empirical insights into the short-term effects of FX block-transactions generated by the Central Bank announcements, focusing on the impact of Norges Bank's actions on the USD/NOK and EUR/NOK currency exchange rates. Through analysis of high-frequency data and distinguishing between interventions and their announcements, we uncover the implications of these operations on currency returns and volatility.

Our findings contribute to the existing literature in several ways. Firstly, by introducing the concept of an information shock and isolating the impact of the announcement, we gain a clearer understanding of the exogenous information shock's immediate effects on currency dynamics. This enhances our understanding of the transmission mechanism of FX operations and their influence on exchange rate dynamics, providing robust empirical evidence within the Norwegian context.

Secondly, our framework is based on the unique nature of Norges Bank's announcements compared to typical block-transactions. The characteristic that these announcements precede the actual actions makes them arguably exogenous to other market activities, allowing us to examine their isolated effects on asset returns and volatility. Our study sheds light on how market participants quickly adjust to new information shocks, even before the actions take effect.

Thirdly, our research expands the scope of understanding the effects of FX operations on policy decisions. By examining the near-term costs and implications of Norges Bank's actions, we offer valuable insights that assist policymakers in formulating effective strategies for regulating exchange rates and mitigating risks.

The results of our analysis demonstrate that Norges Bank's actions have a significant impact on currency returns, with the estimated coefficients consistently indicating a positive relationship between announcements with surprises and currency returns, supporting theoretical expectations and highlighting the importance of operations in shaping short-term returns.

Furthermore, our study reveals a positive impact of central bank actions on currency volatility, a crucial aspect explored in this research. The estimated coefficients establish a statistically significant impact of announcements and surprises on realized volatility in all specifications.

In conclusion, this study enhances the understanding of the effects of central bank announcements and actions, analogous to block-transactions in the usual stock market, shedding light on their impact on currency returns and volatility. The findings have implications for policymakers, market participants, and researchers seeking to comprehend the dynamics of foreign exchange markets and the consequences of central bank operations. By considering the unique characteristics of Norges Bank's surprises and the short-term implications of actions,

our research provides valuable insights for formulating effective strategies and policies in the foreign exchange market.

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