Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Economics and Management
Department of Economics

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Fixrate - Determinants of the Interest Spread

Master's thesis in Financial Economics
Supervisor: Snorre Lindset
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Abstract

Interest rates are a key element in the economy, and is often considered as the price of money. Therefore, the mechanisms affecting the interest rate offered by banks is a topic of great interest. While one can observe the interest rate offered on consumer products online, the process is more complicated for interest rates on large deposits. Fixrate, a Norwegian fintech company, has created an online marketplace where one can observe the deposit rate offered to organizations from over 40 Norwegian banks. Organizations can deposit money to these banks directly on the marketplace, streamlining a previously cumbersome process. With a dataset of transactions, we study what affects the interest spread (deposit rate minus NIBOR) offered by the banks on Fixrate.

We investigate how bank size, maturity, transaction size and macroeconomic variables affect the interest spread. To analyse we use panel data econometrics and find that smaller banks offer higher interest spreads. We also find that a longer notice period gives higher spreads. The macroeconomic measures increase the explanatory power of our model substantially. An increase in NIBOR gives a lower interest spread, while an increase in volatility and bond spreads gives an increase in the spread. Further we examine if banks react differently to changes in macro measures, based on their size. Changes in the money market rate seems to affect banks similarly, while changes in the bond spread affects banks differently.

Abstrakt

Renter er et viktig element i økonomien, og er ofte betegnet som prisen på penger. Det er derfor av stor interesse å undersøke mekanismer som påvirker renten bankene tilbyr. På internett er det enkelt å finne rentenivået som tilbys til husholdninger, men prosessen er vanskeligere for større innskudd fra organisasjoner. Fixrate er et norsk fintech selskap som har laget en online markedsplass der organisasjoner med likviditetsoverskudd kan observere innskuddsbetingelser fra over 40 norske banker. Organisasjonene kan gjennom denne markedsplassen plassere pengene sine direkte i bankene, noe som effektiviserer en tidkrevende prosess. Med et datasett bestående av disse transaksjonene, vil vi undersøke hva som påvirker rentepåslaget (innskuddsrente minus NIBOR) tilbudt av bankene på Fixrate.

Vi undersøker hvordan bankstørrelse, oppsigelsestid, transaksjonsstørrelse og makroøkonomiske mål påvirker rentepåslaget. Ved hjelp av paneldataøkonometri finner vi at mindre banker setter et høyere rentepåslag enn større banker. Vi finner også at lengre oppsigelsestid på innskuddene øker påslaget satt av bankene. Videre ser vi at en økning i pengemarkedsrenten (NIBOR) fører til lavere rentepåslag, samtidig vil en økning i volatiliteten og påslaget i obligasjonsmarkedet gi økt rentepåslag. Videre undersøker vi om bankene reagerer annerledes på endringer i utvalgte makromål, basert på bankenes størrelse. Vi finner at endringer i pengemarkedsrenten ser ut til å påvirke bankene likt, mens endringer i obligasjonsmarkedet påvirker bankene ulikt.

Contents

1. Introduction

Bank deposits are one of the most popular ways of saving. One of the incentives of depositing is the return you earn through the interest rate. Understanding the mechanism behind the interest rate offered on deposits is therefore of great value, as it reveals information about a key element of the economy. In this thesis, we will examine the determinants of the interest spread offered on deposits.

The process of organizations investing their liquidity surplus in a bank is different from the process of consumer deposits. As the amount invested by an organization usually is larger, the process of the transaction is more complicated as well as time-consuming. Traditionally, the organization has to contact a bank that will respond with a specified offer. The process of collecting different offers to compare, as well as producing these offers, is an ineffective element in the economy. The Norwegian fintech company Fixrate has streamlined this process by creating an online market for such transactions.

Since its inception in October 2017, over 11 billion NOK has been brokered through Fixrate (Ellingsen, 2019a). These transactions are mostly to small and medium-sized local banks, from both private and public organizations. The data of these transactions gives information about the Norwegian deposit market. This thesis studies the interest spread of the transactions, which is defined as the deposit rate minus the three-month NIBOR[1]. We aim to answer the research question: *What determines the interest spread on deposits at Fixrate?*

The interest spread offered by banks has been investigated numerous times. Ho and Saunders (1981) are acknowledged for their study, where they developed a framework influencing later research of the topic. Later studies has used their framework, where both bank specific and macroeconomic measures are included, to explain the interest spread. We use transactional data as well as macroeconomic factors in a panel data

[1] NIBOR stands for Norwegian InterBank Offered Rate and serves as a reference interest rate in the money market. It is commonly used to price financial instruments.

regression to estimate determinants of the interest spread. Using transactional data instead of bank specific measures is reasoned by the dataset provided by Fixrate, as well as it allows for the dynamics of the marketplace to be captured.

Our contribution to the topic is to apply economic theory and previous findings to a modern, online marketplace for deposits. We are in a unique position, since the marketplace is a new supplement to the Norwegian deposit market. The results found in this thesis indicate that the determinants of the interest spread offered at Fixrate follows the predictions from economic theory and previous literature. Both transactional data and macroeconomic factors are significant determinants of the deposit spread.

1.1 The Institutional Details of Fixrate

Fixrate is a marketplace that is unknown to many, so we will examine its institutional details. The service offered by Fixrate is an online marketplace, where organizations easily can deposit money through the banks' offers. The banks get easier access to a larger share of the market, and can raise capital more efficiently. The organizations get an easier overview of the different conditions offered by various banks. The process of transferring the investment and signing contracts is streamlined through Fixrate, reducing time consumption. Thus, the service Fixrate provides is in favour of the banks and the organizations depositing money, improving the efficiency of both the supply and demand side of the market.

Figure 1.1 shows how the marketplace looks for an organization who wants to deposit money, with offers from six different banks. The depositor gets information about the interest rate offered, a size interval for the possible amount to invest, and the maturity of the investment.

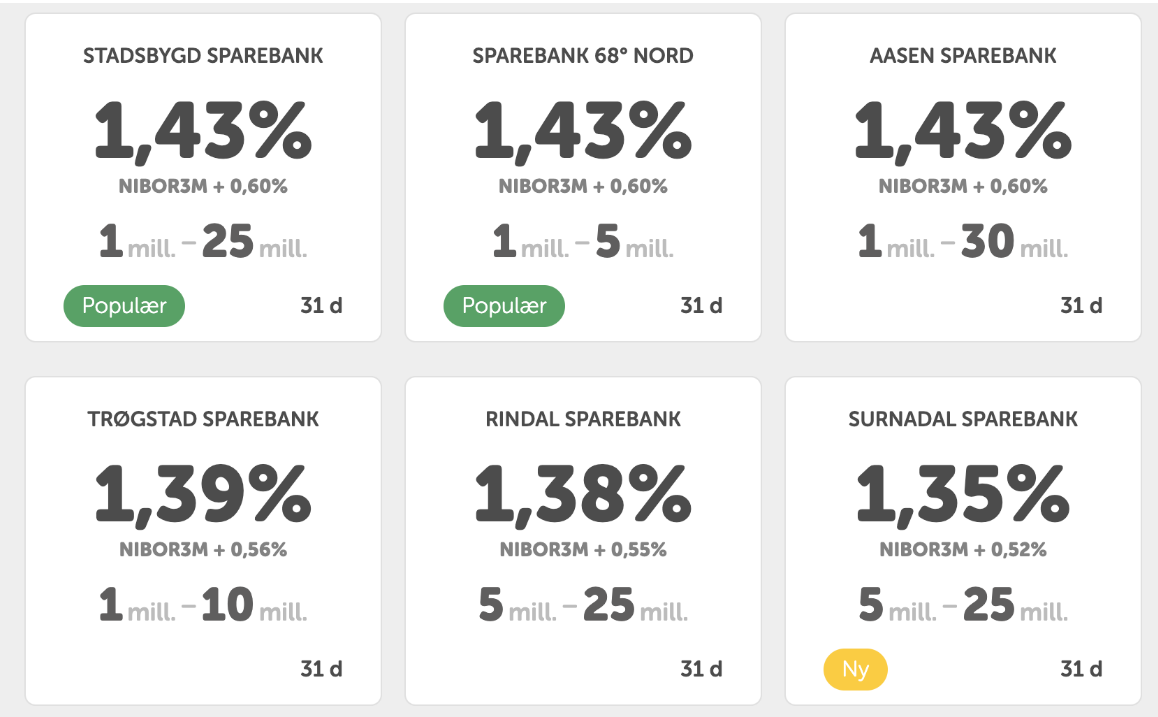

Figure 1.1: Illustration of the marketplace at Fixrate. Offers on the marketplace from six different banks, including information on interest rate, maturity, and minimum and maximum volume to deposit.

In January 2020, 42 banks had placed offers on Fixrate. In 2019 the number of unique depositors doubled, from 50 to approximately 100 (Ellingsen, 2019b). The banks in Fixrate‘s portfolio are mainly small to medium-sized local banks. The organizations using Fixrate are both from the private and public sector, ranging from municipalities, power companies, pension funds and fund managers (Fixrate, 2020b).

The banks may offer a fixed or an adjustable interest rate. The adjustable interest rate consists of a fixed spread as well as the money market rate, NIBOR, which is the adjustable component. These contracts have a notice period of either 31 or 90 days. When the organization want to withdraw their deposits, they notice the bank and wait either 31 or 90 days before the deposit can be withdrawn. In theory, the duration of these deposits can be stored as long as the organization wants. Fixrate has looked into the duration of deposits with 31 days' notice. They found that 65% of these deposits have a lifetime of 12 months or longer (Fixrate, 2019). Because fixed interest is not composed of the NIBOR rate and an additional spread, transactions with a fixed interest will not be analysed in this thesis.

The cost of using Fixrate is carried by the banks, and is proportional to the amount of money a bank has financed through Fixrate. If a bank has no funding through Fixrate, it is not charged any costs (Fixrate, 2020a). When a bank signs up with Fixrate, it must have at least one offer at the marketplace at all times. The service is free for the depositors. To use the service, the depositor needs a Norwegian organization number(Fixrate, 2020b).

2. Theory

2.1 Literature Review

The literature on marketplaces similar to Fixrate is limited. This is due to Fixrate being one of the first companies that have created an online marketplace for large scale deposits. In 2019 it was written a master thesis on the company, where Ahmed and Aune (2019) seeks to understand how the marketplace works.

In existing literature on interest spreads, authors seek to explain the factors that determines the spread. In most literature, the interest spread is defined as the difference between the interest rate on loans and deposits. The net interest margin from the income statement is also a measure used as a definition of the interest spread. Both of these definitions are from banks point of view. In this thesis, we use a definition of the interest spread which is more similar to the definition used in the bond market, where the spread is defined as the interest rate minus the money market rate. As a result of this, most of the existing literature is not directly transferable to our thesis. We differ as we study the interest rate spread on deposits, on a new digital marketplace. However, the methods used by others, as well as their results, are still relevant for our thesis.

Ho and Saunders (1981) is widely recognized for a seminal paper on interest spreads. They analyse how bank-specific factors from the financial statements affect the interest spread. They establish that there are four factors the interest spread depend on: the degree of managerial risk aversion; the size of the transactions undertaken by the bank; bank market structure; and the variance of interest rates. They also find that smaller banks had a higher spread than the larger banks, and that the difference comes from market structure factors. Saunders et al. (2000) applied the method to a multinational panel, and found that both bank-specific and macroeconomic factors affect the interest rate. The results indicate that less competition in the bank market increases the interest spread, as well as volatility in the real interest rate.

Demirguc-Kunt and Huizinga (1999) finds in their international study of interest margins that bank-specific measures from financial statements explain much of the interest margin. They also find that macroeconomic measures such as inflation and real interest rate leads to higher margins. The authors further study the impact of competition, and notice that higher competition leads to lower interest margins.

A common factor included in these analyses is the money market rate, which in Norway is defined as the NIBOR rate. Raknerud et al. (2011) studied the relationship between NIBOR and the interest rate offered by Norwegian banks, by looking at a panel of banks and banking groups. They found that a unit increase in NIBOR gives an increase of 0.8 in the deposit rates. Their panel included larger banks, such as DNB[1]. Our data consists of mainly small to medium-sized banks, and our panel is therefore different than what is used by Raknerud et al. This might affect the relationship between NIBOR and the interest spread, because bigger banks typically have more market power relative to smaller banks. This makes the smaller banks price takers in the market, which might result in a spread that is more influenced by the market rates, than spreads from bigger banks.

Fixrate is a new and modern marketplace, and the literature presented here cannot be directly applied for the analysis we will undertake. We differ both in the definition of spread as well as the marketplace. Even though we diverge from the existing literature in some ways, the literature has influenced our research, expectations and the methodology used in our thesis.

[1] DNB is one of the largest bank in Norway.

2.2 Financing of Banks

Understanding how a bank is financed is important when studying the interest spread, as it reveals information about the process and costs of raising capital. A bank's balance sheet consists of assets, liabilities and equity. Mortgages, consumer loans and corporate loans contribute to a bank's assets. Borrowed capital such as customer deposits, certificates and bonds are liabilities. For Norwegian banks most assets consist of loans to customers (Norges Bank, 2019b, p.54). The most important sources of financing are customer deposits and market funding (Hoff, 2011, p.23). Norwegian banks got on average over 33% of their funding from customer deposits, and 30% from long term market funding (Norges Bank, 2019a, p.53).

Depositing money to a smaller bank is usually considered to contain a higher level of risk compared to a bigger bank (Brynjar Ellingsen, interview, May 2020). This difference in risk is related to the fact that larger banks often are more diversified than smaller banks. A large bank is also more known to an investor, compared to a small bank. Thus, we expect smaller banks to offer a higher spread on their deposits, to compensate the investor for the additional risk.

One significant cost of financing for banks is the interest rate it has to pay. The higher maturity, the higher the interest rate to compensate the investor for undertaking such an investment. This compensation is called a risk premium and arises because market participants are faced with different types of risk when investing in interest-rate instruments. Valseth (2003) looks at three different types of risk that affects risk premium for the market interest rate: term risk, liquidity risk and credit risk. Term risk compensates the investor for the possibility that the level of the interest rate can develop unfavourably. The liquidity premium compensates for the risk of owning an insufficient liquid financial instrument, while the credit premium compensates for the risk that the counterpart fails to comply with the agreed deal.

Based on the three different premiums Valseth describes, term risk is likely the most present risk at Fixrate. Both liquidity and credit risk can be considered to be low in the Norwegian deposit market, while the possibility of unfavourable changes in the interest rate level can occur. For the deposits at Fixrate, the risk is likely to increase as the notice period and the transaction size increase. When the risk increase, the risk premium will increase to compensate for a higher level of risk, leading to a higher spread.

Banks typically rely on both short- and long-term funding. For long-term funding, banks often rely on the bond market (Syed, 2011). The interest rate on bonds can be separated into two parts, the market cost of financing, plus a spread or risk premium. The market cost of financing in Norway is the NIBOR rate. The spread will increase when the risk increase. For example, the spread will increase as time to maturity increases, because as time increase so do uncertainty. Liquidity and credit risk are also factors that contribute to an increase in the bond spread.

The use of long-term funding stabilizes bank funding, and reduces the bank's risk of having insufficient funds for meeting their obligations (Syed, 2011). Bonds often have a given time to maturity, while the funding through Fixrate can be deposited in the bank as long as the organization wishes. Bonds have a maturity of a year or more, while the deposits through Fixrate usually have a duration of over 12 months. Even though we have differences in these options of bank funding, they are alternatives to each other. Both the returns of bonds and deposits studied in this thesis is priced by the three-month NIBOR, and the risk premium in both markets depend on similar factors. As bonds and deposits also are alternatives ways for a bank to raise capital, we expect there to be a positive relationship between changes in the bond market and the deposit market.

The banks at Fixrate are generally small in size, and smaller local banks are more dependent on customer deposits (Norges Bank, 2019a, p.53). If for instance a local company needs capital quickly, the bank can meet this demand by gathering capital rapidly through Fixrate. Such a processes involve lower transaction cost for the bank, compared to entering the bond market, because of the high fixed costs related to the bond market.

2.3 Market Conditions

To set the environment of the analysis we will present the conditions in the Norwegian economy of the period we are studying. There has been a steady growth in the Norwegian economy since 2016 and until December 2019. This growth is related to rising activity internationally, higher oil price, low interest rates and better cost competitiveness (Norges Bank, 2019c, p.8). As a result, the Norwegian central bank has increased the policy rate several times during the period. The policy rate is the interest rate the banks receive if they deposit money in the central bank. Therefore, the policy rate and its expected level is a key variable when describing the level of interest rates.

At the inception of Fixrate in October 2017, the Norwegian policy rate was at 0.5%. Since then the policy rate has been raised four times and is by the beginning of 2020 at 1.50% (Norges Bank, 2020). This increase caused a higher NIBOR, and led to a higher interest rate offered by banks on loans and deposits.

Banks price their products with either a fixed or a floating interest rate. A floating interest rate is often priced such that it follows the changes in the money market instantaneously, like bonds. Products with fixed interest rates will react slower to changes in the market. Such products are typical consumer products like mortgages and deposits. This rate is set by the bank and is updated manually to react to changes in the money market. Most banks using Fixrate are heavily dependent on consumer products, and therefore use this type of pricing on most of their products (Brynjar Ellingsen, interview, April 2020). For deposits brokered through Fixrate, an increased NIBOR leads to higher costs on the existing deposits for a bank. Bank managers will then price new offers with a lower spread, to adjust for the increased NIBOR (Brynjar Ellingsen, interview, April 2020).

2.4 Economic Theory

To rely upon the assumption that a market has perfect competition is common in economic theory. Perfect competition is a theoretical market structure that needs several strict criteria to hold. We will not impose this assumption on the market at Fixrate, but we use the economic theory that follows these criteria to explain how the interest spread can be affected. Perfect competition relies on several assumptions according to Idsøe and Eckhoff (2014), but we will mainly focus on:

- There is no asymmetry in the information available to the market participants
- There are no transaction costs

Asymmetric information occurs when the participants in a transaction receives an unequal amount of available information (Law, 2015). The introduction of Fixrate reduces asymmetric information for the market participants in several ways. First, banks can now observe what the competitors offer in terms of deposit conditions. Second, the information gap between banks and customers are likely to be reduced with this digital marketplace. The reduction of asymmetric information is likely to improve the efficiency of the market.

Changes to the access of information in a market might change the competition in that specific market. Since banks at the marketplace observe the offers of their competitors, they might offer an even higher interest spread than what is already on the marketplace to gain new customers and a higher market share. Hence, a lower degree of asymmetric information might lead to a higher interest spread because of a higher degree of competition.

The reduction of asymmetry and higher competition could lead to a “race to the top” situation. Ahmed and Aune (2019) explains this as a situation where the banks at Fixrate offer a higher interest rate than their competitors to secure new deposits, customers and thus higher market share. This is not sustainable in the long run for the banks as they would most likely lose margins.

Transaction costs are the cost of implementing an economic exchange. It includes transaction fees as well as the time spent to make the transaction (Black et al., 2017). In Chapter 1.1 we explained how Fixrate streamlines the process of deposits, both for banks and for the organization with liquidity surplus. This reduces the transaction cost for both parties. In theory the reduction of transaction cost could result in a higher interest spread offered from the banks. If using Fixrate reduces the bank's cost of raising capital substantially, these reduced costs could make it possible for a bank to offer a higher spread. Both the customer and the bank benefit from using Fixrate if this holds. The customer will earn a higher rate of return than what is possible in other deposits markets, and the bank will attract new customers and deposits.

2.5 Research Question

The service offered by Fixrate has resulted in a unique overview of transactions between Norwegian banks and organizations. Using this data, we seek to answer this research question:

What determines the interest spread on deposits at Fixrate?

The interest spread is an important factor that determines a large part of the interest rate on the adjustable contracts. To understand how it has developed, and what determines it, is of great interest because it affects many participants in the market. As discussed in the previous section, this has been done in similar studies in other markets. Inspired by the previous work on the topic, we aim to answer these questions:

1. Does bank size, time to maturity and the transaction size play a role in determining the spread?

2. Are the spreads affected by macroeconomic measures such as NIBOR, bond spreads and market volatility?

To answer these two questions we will study the effects of these factors on the spread offered at Fixrate, using panel data regression. We will analyse whether the measures behave accordingly to the predictions of the economic theory discussed in this chapter.

3. Data

3.1 Data From Fixrate

Fixrate is a new contribution to the deposit market, so we will describe the dataset that has been given to us in a thorough and detailed manner.

The dataset we use was provided by Fixrate, and consists of two components of the marketplace: the offers from the banks and the transactions that the depositors have placed. The dataset begins at 18.10.2017 and ends at 13.01.2020, a time period of two years and three months. Over this time horizon there have been a total of 421 offers from the banks and 623 transactions.

We are using the dataset containing information about transactions, and not the offers. Each bank must have an offer at the marketplace at all times. Some banks avoid this by placing an offer with such a low interest rate that no organization would want to place their money there. This might introduce some bias to our analysis, and consequently we have chosen to focus on the transaction data from Fixrate.

Banks who offer deposits at Fixrate can do so through either a fixed or an adjustable interest rate. We will study the transactions with adjustable interest, as this is where we can analyse the spread. For each transaction we have data on its maturity, an anonymized bank id, bank size, transaction size as well as the interest spread. For the adjustable products the maturity is given by a notice period of either 31 or 90 days.

Each bank is given an anonymized ID, which makes it possible to follow a bank over time. The bank is also placed in a group based on their asset size. In total there are four different asset groups, ranging from 0-2 billion NOK to 10 billion + NOK. The volume variable displays the amount money being transferred. We are also given information about the amount of money an organization can deposit at a given bank, which place an upper and lower limit on the offer. These limits are set by the banks, and are used to reduce the risk a bank undertakes when accepting deposits from customers.

The dataset contains daily observations from the transactions at Fixrate, but with gaps. The gaps occur since there are days without transactions. As there are some periods without transactions from the separate banks, we have an unbalanced panel. Figure 3.1 gives a representation of the problem with an unbalanced dataset. Here we have plotted each transaction for three different banks at Fixrate.

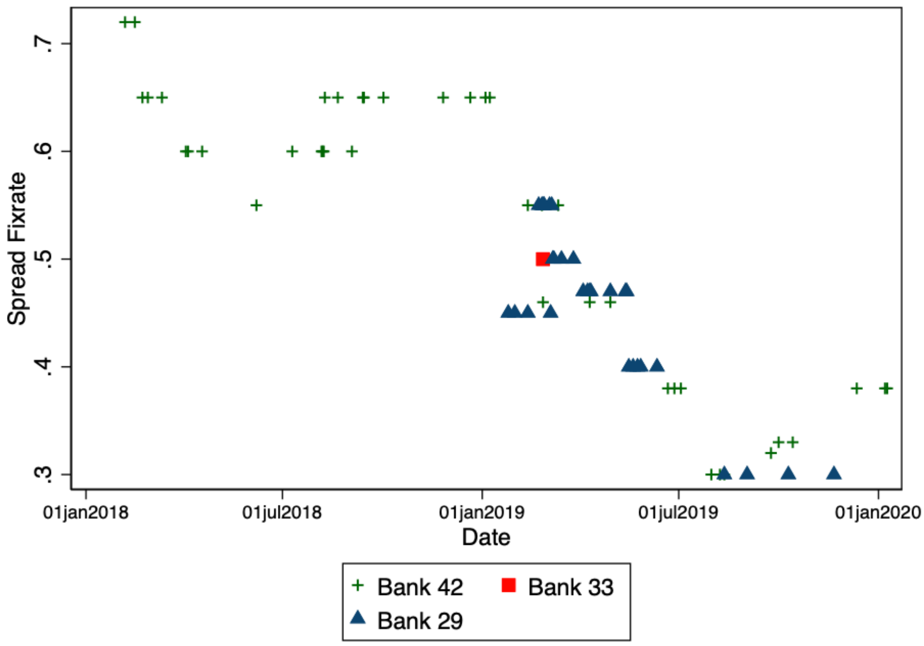

Figure 3.1: Illustration of unbalanced data. The dots represents spreads from transactions on Fixrate over time, for three different banks.

Bank 42 is one of the banks with the most transactions over the time period, with 41 deposits. Bank 29 has received 30 deposits, while bank 33 only one deposit. From the figure we can see gaps in the plot, which indicates a period of time where there have not been any deposits to the bank.

3.2 Data From Other Sources

We have added three other variables to the dataset from Fixrate. The money market rate (the three-month NIBOR), a volatility measure called VSTOXX and bond spread from the Norwegian banking market.

The NIBOR rate was published by Oslo Stock Exchange until 31.12.2019, and after that *Norske Finansielle Referanser AS* (NoRe) took over the responsibility. NoRe is owned and established by Finance Norway and serves to administer financial benchmarks (Norske Finansielle Referanser, 2017). We collected the NIBOR rate from both publishers. The dataset with the NIBOR rate up to 2020 was available from Oslo Stock Exchange until mid-January. Observations of NIBOR from 2020, was collected manually from NoRe. The NIBOR rate we use is the daily rate from weekdays with a maturity of three months. It covers the same time period as the data from Fixrate. Figure 3.2 shows the development of NIBOR over the time period.

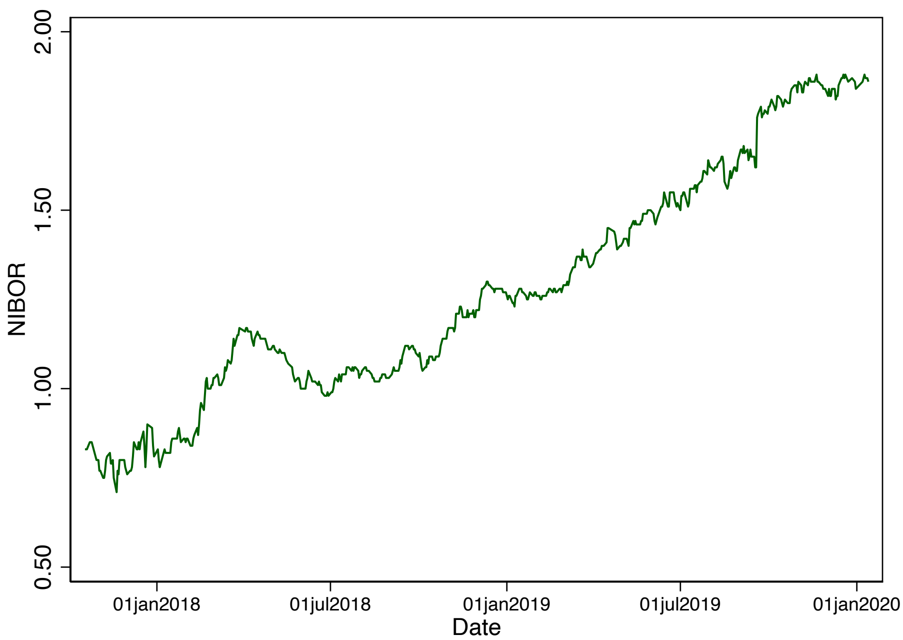

Figure 3.2: Development of NIBOR. NIBOR is the money market interest rate, and this figure is based on daily observations of the three-month NIBOR.

Another variable included to explain the interest rate spread, is bond spreads from the banking market. We received the spreads from Nordic Bond Pricing (NBP). NBP was founded in 2013 and is a company that offers daily independent pricing of bonds (Nordic Bond Pricing, 2020). The spread from the bond market is calculated in the same manner as the spread at Fixrate, by taking the difference between the offered interest rate and the three-month NIBOR. The data is given as a weekly average. It contains interest spreads for eight different banking groups. These groups are based on the size and the credit rating of the banks. Banks in group one is the biggest and best rated banks, while banks in group eight are the smallest and have a lower rating.

For each banking group we have weekly bond spreads with durations from three months to ten years. We have decided to use the one year maturity in our thesis because this duration is similar to how long a deposit stands on Fixrate. Figure 3.3 illustrates the development of bond spreads with a maturity of one year, across the different banking groups.

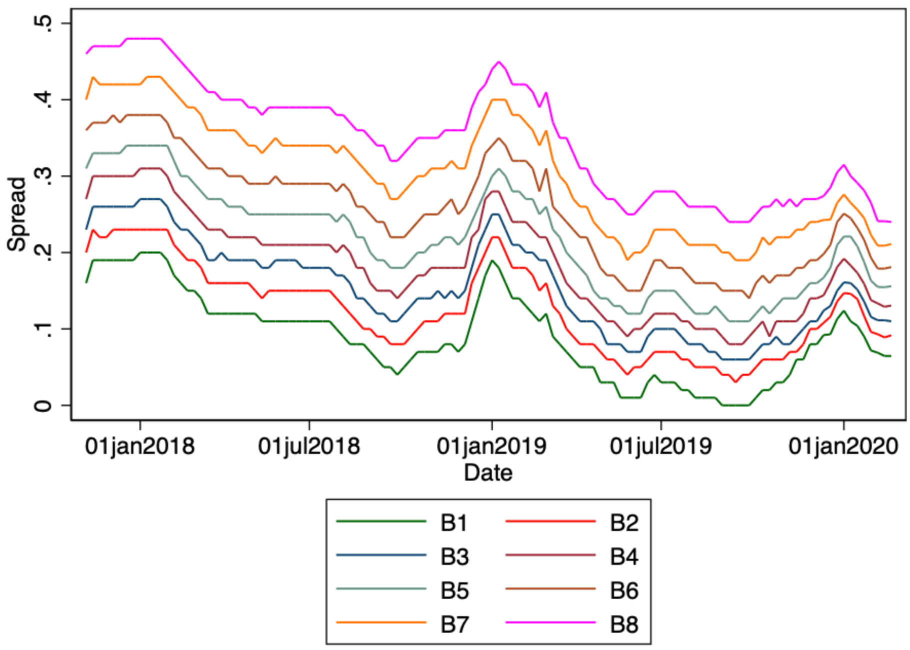

Figure 3.3: Development of bond spreads. The figure shows the development of bond spreads to different banking group. Group B1 contains some of the largest banks, while B8 contains the smallest banks.

To include a measure of volatility in the economy we have chosen the Euro Stoxx 50 Volatility (VSTOXX). This is a daily measure of the implied variance, based on an index consisting of the 50 most traded and liquid stocks in the euro-zone (Eurex, 2020). A high VSTOXX value indicates high volatility in the economy, while a more stable economy gives a lower VSTOXX. Figure 3.4 shows how volatility has developed over time.

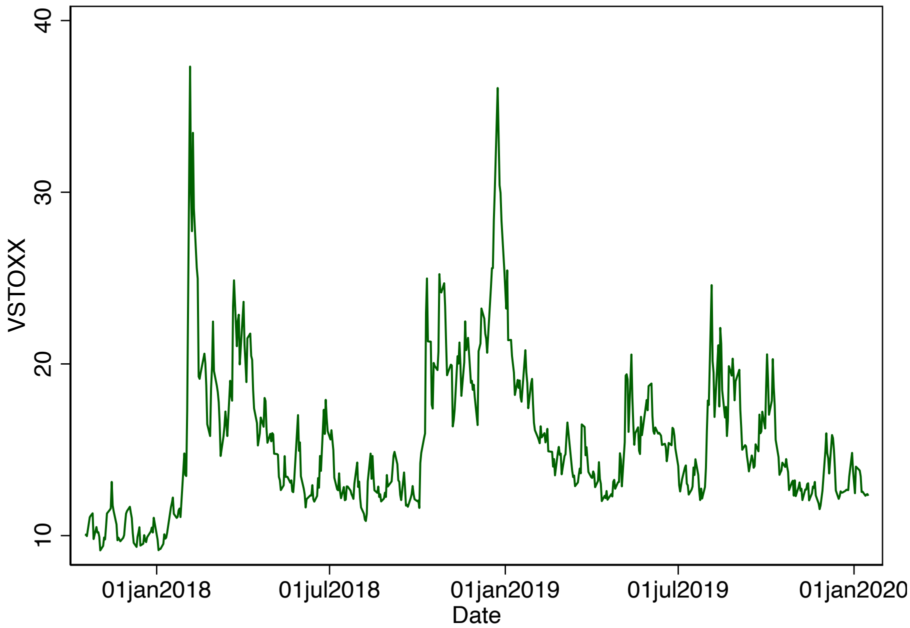

Figure 3.4: Development of volatility. The figure illustrates how the volatility measure, VSTOXX, has developed over time.

3.3 Descriptive Statistics

The following statistics are based on the transactions with an adjustable interest rate. There has been a total of 448 transactions by 38 different banks over the period.

Table 3.1 shows how many deposits each bank in our dataset has received over the period. Some bank IDs have zero transactions, because some banks have made offers on the marketplace, but the offer has been left unused. Some banks have only made offers with fixed interest rate, and have thus been excluded.

Table 3.1: Number of unique deposits to different banks on Fixrate. The table gives an overview of the number of transactions to each bank.

Bank ID	Count	Percent	Bank ID	Count	Percent
1	24	5.35	22	15	3.34
2	16	3.57	23	14	3.12
3	4	0.89	24	7	1.56
4	4	0.89	25	22	4.91
5	6	1.33	26	7	1.56
6	10	2.23	27	14	3.12
7	44	9.82	28	10	2.23
8	1	0.22	29	30	6.69
9	0	0.00	30	3	0.66
10	13	2.90	31	9	2.00
11	0	0.00	32	7	1.56
12	1	0.22	33	1	0.22
13	0	0.00	34	4	0.89
14	5	1.11	35	9	2.00
15	0	0.00	36	4	0.89
16	17	3.79	37	15	3.34
17	16	3.57	38	18	4.01
18	7	1.56	39	16	3.57
19	7	1.56	40	8	1.78
20	4	0.89	41	13	2.90
21	2	0.44	42	41	9.15

From Table 3.2 we see that most banks have an asset size of 2-5 billion NOK, while the smallest asset group has the lowest number of banks in it. The asset group is a measure of the size of the bank, defined by the value of assets it holds.

Table 3.2: Number of banks grouped on bank size. Overall there has been 38 banks that received deposits with an adjustable interest rate.

	Count	Percent
0-2 bill.	4	10.52
2-5 bill.	17	44.73
5-10 bill.	10	26.31
10 bill. +	7	18.42
Total	38	100

Table 3.3 shows that most of the transactions is to banks in the range of 2 to 5 billion NOK in assets, followed by banks in asset group 5 to 10 billion.

Table 3.3: Summary of bank size based on transactions. The table shows how many deposits each banking group have received over the period.

	Count	Percent	Cumulative
0-2 bill.	40	8.98	8.98
2-5 bill.	175	39.06	48.04
5-10 bill.	137	30.58	78.62
10 bill. +	96	21.42	100.00
Total	448	100	

In Table 3.4 we see summary statistics of the variable volume, sorted by bank size. There is a clear difference in the averaged deposited money between the different bank sizes. The smallest banks at Fixrate had deposits with an average of 8.72 million NOK, while the largest banks had an average of 35.64 million NOK.

Table 3.4: Summary of the volume of the transactions by bank size. The table shows the average deposited volume for each banking group, and the standard deviation.

	0-2 bill.		2-5 bill.		5-10 bill.		10 bill. +	
	Mean	sd	Mean	sd	Mean	sd	Mean	sd
Volume	8.72	5.35	11.40	6.53	16.94	12.58	35.64	45.93
N	40		175		137		96	

Table 3.5 shows the average deposit spread across the different bank sizes. Smaller banks have a higher average spread on their deposits, relative to larger banks.

Table 3.5: Summary of spreads by bank size. The table shows the average spread based on the different bank sizes.

	0-2 bill.		2-5 bill.		5-10 bill		10 + bill.	
	Mean	sd	Mean	sd	Mean	sd	Mean	sd
Deposit spread	.64	.15	0.52	.12	.50	.13	.40	0.10
N	40		175		137		96	

Table 3.6 provides a summary statistics of some of the variables in the dataset. The average deposited volume of a transaction with the adjustable interest rate is 18 million NOK, with 5 million as the lowest and 350 million as the largest transaction. The bond spreads in the banking market has an average of 0.23%, while the spreads at Fixrate has an average of 0.5%.

Table 3.6: Summary statistics. The table shows the mean, standard deviation and min/max for the deposit spread, macroeconomic variables and the volume.

	Count	Mean	sd	Min	Max
Deposit spread	448	.50	.14	.1	.95
Bond spread	448	.23	.06	.14	.37
NIBOR	448	1.34	.28	.77	1.88
VSTOXX	448	15.58	2.73	10.67	30.17
Volume	448	18.05	24.65	5	350

In Table 3.7 we observe that the largest share of the transactions is with a maturity of 31 days. Of the 448 deposits with an adjustable interest rate almost 93% is with a notice period of 31 days.

Table 3.7: Summary of maturity. The table gives an overview of what notice period the deposits on Fixrate consists of.

	Count	Percent
31 d	415	92.63
90 d	33	7.36
Total	448	100

Since the inception of Fixrate in 2017 there has been a steady increase in numbers of transactions. This is shown in Table 3.8. In 2017 and 2020 the low numbers of transactions are due to the fact that the dataset starts in late 2017, and ends at the beginning of 2020. Comparing numbers of transaction each day, we see a steady increase throughout the time period.

Table 3.8: Transactions per year. Summary of transactions on Fixrate each year. The measure *Count/Days* shows how many transactions there has been per day in each year, and is included as the inception of Fixrate was in late 2017.

Year	Count	Days	Count/Days
2017	15	75	0.20
2018	166	365	0.45
2019	253	365	0.69
2020	14	13	1.07

The dataset is ranging from 18.10.2017 to 13.01.2020.

Table 3.9 shows the correlation between the variables. We observe that the spread at Fixrate has a high correlation with the spread in the bond market and a high negative correlation with the NIBOR rate. There is a strong negative correlation between the bond market spread and the NIBOR rate. This is most likely due to the fact that there exists an inverse relationship between interest rates and bond prices. For the rest of our variables the correlations are lower.

Table 3.9: Correlation matrix. The table shows the correlation between variables in the dataset.

	Deposit spread	Small	Medium	Large	Big	Volume	Bond spread	NIBOR	VSTOXX
Deposit spread	1								
Small	0.21	1							
Medium	0.43	-0.31	1						
Large	-0.26	-0.21	-0.54	1					
Big	-0.42	-0.16	-0.43	-0.28	1				
Volume	-0.46	-0.24	-0.37	0.01	0.68	1			
Bond spread	0.68	0.01	0.19	-0.28	0.06	-0.11	1		
NIBOR	-0.79	0.06	-0.41	0.40	0.03	0.15	-0.80	1	
VSTOXX	0.18	0.27	-0.09	0.02	-0.12	-0.07	-0.01	-0.11	1

Figure 3.5 shows how many banks have entered Fixrate over the time period. We observe a steady increase of new banks over time. Figure 3.6 shows how the the interest rate spread at Fixrate, bond spread[1] and NIBOR have developed over time.

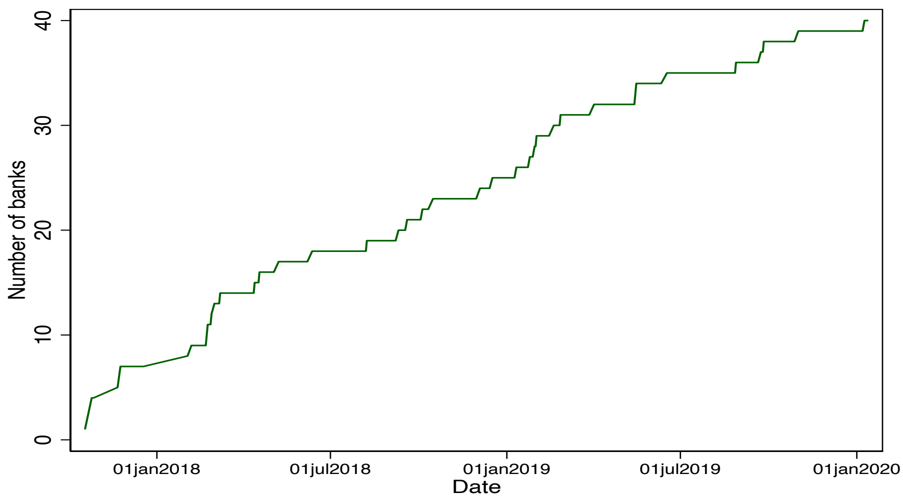

Figure 3.5: Number of banks on Fixrate. Illustration of the development in number of banks on Fixrate.

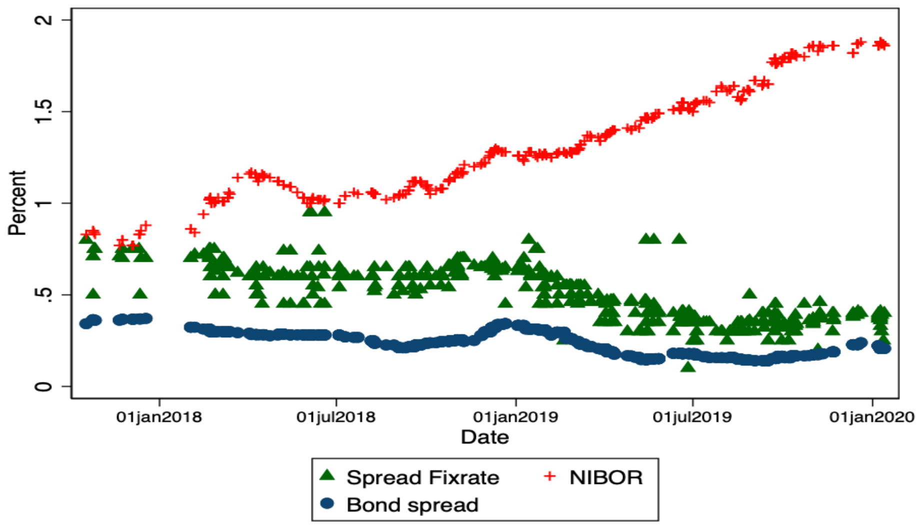

Figure 3.6: Development of spreads and NIBOR. The figure shows how three-month NIBOR and the spreads on Fixrate and in the bond market has developed over time.

[1]This bond spread is based on a weighted averaged calculation we have done. See Chapter 4.2 for further details.

4. Method

4.1 Econometric Method

The dataset has observations for each bank from October 2017 to January 2020. Since we follow each bank over time, we are dealing with a panel dataset. The data of the adjustable contracts consists of 448 transactions. As shown in Figure 3.1 our dataset is unbalanced.

There are several estimation models to choose from when dealing with a panel dataset. The three most common estimation models for panel data are pooled ordinary least squares (POLS), random effects (RE) and fixed effects (FE). These three models rely on multiple assumptions, which are listed in the appendix. The preferred model can be determined through tests, and expectations about how unobserved heterogeneity affects the explanatory variables. The unobserved heterogeneity, a_i, where subscript i denotes the bank ID (i= 1,...,38), captures all unobserved, time-constant factors that effects the dependent variable (Wooldridge, 2016). In our dataset, an example of unobserved heterogeneity could be the working culture in a bank. A good working culture could make the workers more productive and contribute to making the bank more successful. This is not directly observable, but could affect the dependent variable, the interest spread.

The key assumption to discuss is how unobserved heterogeneity relates to the explanatory variables, denoted x_{it}, where subscript t denotes time (t= 1,...,T). Both the POLS and the RE models are based on the assumption that the covariance between these variables and the unobserved heterogeneity is zero, $cov(x_{it}, a_i) = 0$. In our case, this would mean that we assume the banks working culture to be uncorrelated to the bank's size. If this assumption is violated, results from the POLS and RE estimations will be inconsistent.

The FE model does not impose any assumption about the covariance between the explanatory variables and a_i. This estimation method solves the potential problem with unobserved heterogeneity by eliminating it. The weakness of the FE model is that time-constant variables will not be estimated. Hence the variables for bank size in our data will not be estimated in this model, which is a drawback of using the FE model.

If $cov(x_{it}, a_i) = 0$ the preferred models are POLS or RE. The latter generally produces more efficient results than POLS and is therefore preferred (Wooldridge, 2016). If $cov(x_{it}, a_i) \neq 0$ then FE is the best model of choice. The most common practice is to estimate both RE and FE models and then test for statistically significant differences in the coefficients with time-varying variables. The results of this test are reported in appendix A.2.

4.2 Data Transformation

Before analysing the transactions from Fixrate, we implemented some adjustments. When we received the data, all banks were anonymized with IDs like this "1ea66b4d750cf3d6590e833bd3c649fa9699c543bf581c50af03a75ff5ec95d8". To simplify, we changed it to a number between 1 and 42. The number is random, the bank with ID 1 was not the first to use Fixrate, and the bank with ID 42 is not the newest bank on Fixrate.

The second step was to include the macroeconomic measures; NIBOR, bond spread and the VSTOXX index. The three-month NIBOR and the VSTOXX index was added directly. To include the bond spreads from NBP we computed a weighted average of the observed spread for a given duration. We did this to compare the two ways of financing for the same banks. The data contained spreads from eight different bank groups, based on size and rating. We observed which banks that were included in each group and identified which of these banks that uses Fixrate. *Frequency* is the number of banks using Fixrate in each of the banking groups from the NBP data.

Table 4.1: Frequency of banks using Fixrate appearing in NBP's bank groups. The table shows how many banks from Fixrate that are represented in the different bank groups from NBP.

Bank Group	Frequency	Percent
B1	0	0
B2	2	5.3
B3	3	7.9
B4	4	10.5
B5	8	21.1
B6	7	18.4
B7	10	26.3
B8	4	10.4
Sum	38	100

Using the frequency of bank groups in percent, we calculated a weighted average of the weekly bond spreads with a maturity of one year.

After this we matched all transactions with the macro measure observed on that day, by using Excel. If there where no observations of a macro measure on the day of the transaction, the most recent observation was used. For example, if a transaction went through on a Saturday, we used NIBOR from the previous Friday. For the average bond spread, the observations are weekly, with an observation every Thursday. When a transaction on Fixrate is done on a Monday, the bond spread from the previous Thursday is matched.

To use the data in a panel data analysis some further adjustments were necessary. On certain dates there existed more than one observation. These duplicates are problematic when the observations also have the same bank ID. Our solution was to make an average of volume and the interest rate spread for the duplicates. For certain observations where the date and ID are the same, the type of product differs. One product could for example have a notice period of 31 days, while the other got a 90 days' notice period. In these cases, we have not taken the average, since making averages for product types is not straight-forward. When importing the dataset to Stata, we dropped the remaining duplicates. So when there are two transactions on the same day with the same bank, but different notice period, the second observation is deleted. This procedure reduced the number of transactions from 623 to 524. Of these 524 transactions, 448 of them had an adjustable interest rate.

To include maturities and bank size as variables in our analysis we transformed the data, from text to numbers. For maturities we created a factor variable where the number of days seen below represents the notice period, and the number on the right of the equal sign is the new factor variable:

- 31 days = 1
- 90 days = 2

Bank size is captured by creating a dummy variable for the different sizes. A dummy variable is a binary variable that is either equal to one or zero. In this case if a bank is categorized as small the variable *Small* will equal one, and the other will be zero. The bank sizes are represented by:

- Small = 0-2 billions NOK
- Medium = 2-5 billions NOK
- Large = 5-10 billions NOK
- Big = 10 + billions NOK

We have also included year dummies in the regression. The year dummies are represented in the following way:

- Year 2017 = 1 if a transaction was done in 2017, zero otherwise
- Year 2018 = 1 if a transaction was done in 2018, zero otherwise
- Year 2019 = 1 if a transaction was done in 2019, zero otherwise
- Year 2020 = 1 if a transaction was done in 2020, zero otherwise

5. Analysis

5.1 Development of Spread

The interest spread observed at Fixrate is the key variable we want to explain in our thesis. Our explanatory variables include the three-month NIBOR and the bond spread. The development of these variables over time is illustrated in Figure 3.6, and in Figure 5.1 we have included the Norwegian policy rate. The large gap in the data in early 2018 is caused by a period with no activity on Fixrate.

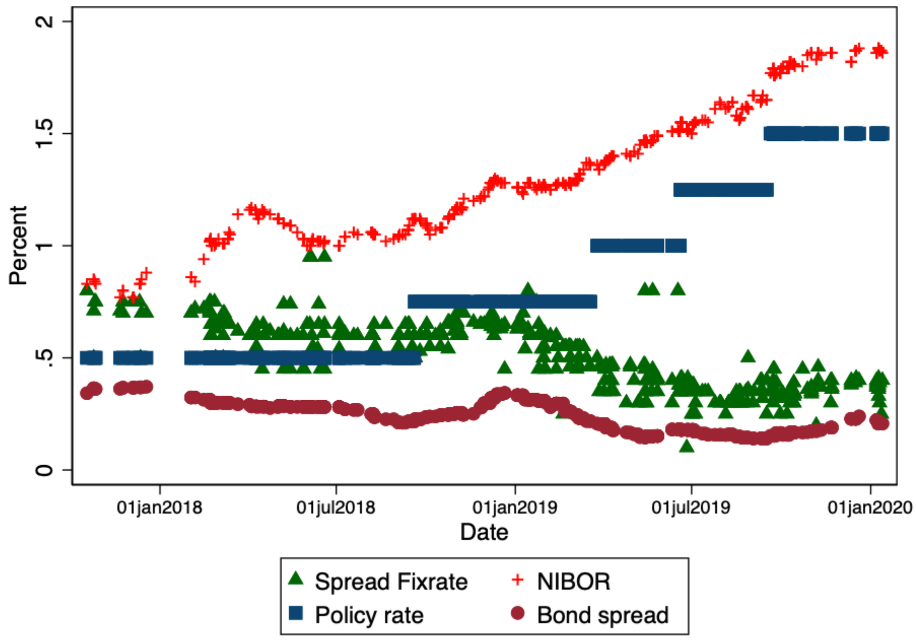

Figure 5.1: Development in spreads over time. The figure shows development in NIBOR, the policy rate and spreads over time.

From Figure 5.1 one can observe that the development of Fixrate's spread follows the development of the bond spread. Since the bond market is an alternative market for funding, and both spreads are determined by three-month NIBOR, this is expected. NIBOR has increased since the beginning of 2019, which is caused by the increased policy rate. We observe that the spreads on the deposits offered at Fixrate develop in opposite directions of the NIBOR rate.

The mirroring of the interest spread and NIBOR after the increase in the policy rate, can be explained by the structure of the deposits at Fixrate. Deposits with adjustable interest rate consist of the three-month NIBOR and the spread. The three-month NIBOR is given, while the interest spread is a variable each bank determines on their own. One possible explanation of the decrease in the spread is that when the three-month NIBOR increases all existing deposits will be more expensive for the banks. Therefore, when issuing new offers on the marketplace they offer a lower spread, because the NIBOR is higher.

This inverse relationship between NIBOR and the spread could also be seen in light of the expectations of bank managers. If a bank manager believes that the policy rate is likely to increase in the next month, he knows that the three-month NIBOR will increase. Hence the manager might be leaning towards offering a lower spread on new deposits, as this would reduce the bank's cost of funding.

5.2 Interest Spread

To analyse what affects the interest spread, we run the following regressions:

$$spread_{it} = \beta_0 + a_i + \boldsymbol{\beta}\vec{Banksize}_i + \beta_4 Volume_{it} + \beta_5 90days_{it} + \boldsymbol{\delta}\vec{Years}_t + u_{it} \quad (5.1)$$

$$\begin{aligned} spread_{it} =& \beta_0 + a_i + \boldsymbol{\beta}\vec{Banksize}_i + \beta_4 Volume_{it} + \beta_5 90days_{it} \\ &+ \beta_6 NIBOR_t + \beta_7 Bondspread_t + \beta_8 VSTOXX_t + \boldsymbol{\delta}\vec{Years}_t + u_{it} \end{aligned} \quad (5.2)$$

Equation (5.1) consists only of the transaction data from Fixrate, while equation (5.2) consists of data from Fixrate and macroeconomic measures.

The bank size variable in the equations is a vector of dummy variables where the reference group is the big bank size (10+ billion NOK). We have also included a vector of year dummies in our regression. The year dummies are included to control for year-specific shocks over the period. Such shocks or events could for instance be a financial crisis, which would likely affect both the deposit spread on Fixrate, and some of our explanatory variables, such as three-month NIBOR. Thus, failing to control for year-specific shocks could lead to biased estimators.

In the following regression tables, column (1) contains results from POLS, column (2) results of the RE model, and column (3) represents the FE model. There is no estimated coefficient on bank size in column (3), caused by the method used to estimate this model.

We focus on the RE model in our analysis. Running the Breush-Pagan test and the Hausmann test, the results indicate that the RE is the best fitted model [1]. There are weaknesses to the RE model if the underlying assumptions do not hold. Because of this, we have included the FE and the POLS model. These models might prove to be better fitted for our data, as there is a possibility for a type one error in the conducted hypothesis tests.

[1] These tests are found in appendix A.2

Table 5.1 shows the result of three models estimating equation (5.1):

Table 5.1: Relationship between deposit spread, bank size, maturity and volume

	(1) POLS	(2) RE	(3) FE
Small	0.1652***	0.1821***	
	(0.0212)	(0.0325)	
Medium	0.0730***	0.0992***	
	(0.0133)	(0.0231)	
Large	0.0507***	0.0490*	
	(0.0131)	(0.0260)	
Volume	-0.0002*	0.0003	0.0004*
	(0.0001)	(0.0002)	(0.0002)
90 days	0.0920***	0.0790***	0.0765***
	(0.0202)	(0.0170)	(0.0182)
Year effects	Yes	Yes	Yes
N	448	448	448
R^2	0.64	0.62	0.51

Standard errors in parentheses
The dependent variable is the deposit spread offered for the adjustable contracts at Fixrate
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The variable *Big* is left out of the regression on purpose. These results should therefore be analysed in relative terms with respect to the banks categorized as *Big*.

In column (2) we observe that smaller banks have higher spreads on their deposits, relative to big banks. A small bank will on average have 0.18% higher spreads relative to a big bank, all else equal. This effect is statistically significant at any conventional level. The positive effect is also present for a medium bank, but for a large bank relative to a big bank the effects are only statistically significant at a 10%. The greater the difference between the banks are, the greater is also the increase in interest spread. However, the statistical significance seems shrink as we compare banks in the groups *Large* and *Big*. Based on our dataset, one possible explanation is that we do not know the exact value of the bank's total assets. It could be that banks in group *Big* are just above the limit of ten billion in asset value. If so, banks with the largest asset values could be similar to banks in the second-largest asset group. This could serve as a possible explanation for why banks in the category *Large* is statistically significant at a 10% level, while banks in the category *Small* and *Medium* are statistically significant at 1%.

The coefficient *Volume* represents how the spread changes when one more million NOK is deposited. For one more million deposited the interest spread will on average increase by 0.0003%, ceteris paribus. The effect is positive, but close to zero. The coefficient is not statistically significant, indicating that transaction size does not affect the interest rate spread on Fixrate. One possible explanation is that the effect from transaction volume is already controlled by the bank size variables. Table 3.4 shows that as bank size increases, so does the average volume of a transaction. Hence, the effect of higher transaction size could be captured by the bank size.

The last coefficient, *90 days*, is a factor variable that tells the relative difference in spreads between contracts with 90 days' and 31 days' notice period. Contracts with 90 days will on average have a 0.079% higher spread than contracts with 31 days, all else equal. The estimated parameter is statistically significant, and the positive coefficient makes economic sense. Longer maturities on deposits leads to more uncertainty for the depositors, and a higher spread is compensating them for that.

From Table 5.1 we also observe the R^2, which shows how much of the variation in our dependent variable that is explained by our explanatory variables. In column (2), 62% of the variation of the spread is explained by bank size, maturity, volume and year effects, and 53% in column (3). This difference is however not surprising since R^2 increase when we add more variables, and column (3) has fewer explanatory variables compared to column (2).

In Table 5.2 we have included the macroeconomic measures and estimate equation (5.2):

$$
\begin{aligned}
spread_{it} =& \beta_0 + a_i + \boldsymbol{\beta}\vec{Banksize_i} + \beta_4 Volume_{it} + \beta_5 90days_{it} \\
&+\beta_6 NIBOR_t + \beta_7 Bondspread_t + \beta_8 VSTOXX_t + \boldsymbol{\delta}\vec{Years_t} + u_{it}
\end{aligned}
$$

We have used the same models as in Table 5.1.

Table 5.2: Relationship between deposit spread, bank size, volume, maturity, NIBOR, bond spread and volatility.

	(1) POLS	(2) RE	(3) FE
Small	0.1420***	0.1553***	
	(0.0177)	(0.0285)	
Medium	0.0775***	0.0864***	
	(0.0097)	(0.0204)	
Large	0.0620***	0.0741***	
	(0.0093)	(0.0228)	
Volume	-0.0002	0.0001	0.0001
	(0.0002)	(0.0001)	(0.0001)
90 days	0.0983***	0.0743***	0.0724***
	(0.0162)	(0.0101)	(0.0103)
NIBOR	-0.2330***	-0.2219***	-0.2229***
	(0.0192)	(0.0172)	(0.0173)
Bond spread	0.6895***	0.7797***	0.7851***
	(0.0836)	(0.0568)	(0.0567)
VSTOXX	0.0024**	0.0028***	0.0029***
	(0.0011)	(0.0009)	(0.0009)
Year effects	Yes	Yes	Yes
N	448	448	448
R^2	0.83	0.82	0.74

Standard errors in parentheses

The dependent variable is the deposit spread offered for the adjustable contracts at Fixrate

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

From column (2) we observe that an increase of one percent in the NIBOR rate gives a decrease of 0.22% in the spread, ceteris paribus. If the spread of bonds with a maturity of one year increase by one percent, the spread at Fixrate is expected to increase by 0.78%. If the volatility index VSTOXX, increase by one unit, our dependent variable is expected to increase by 0.003%. All of these macro measures are statistically significant at a 1% significance level. The coefficients are similar in column (1) and (3).

The estimated coefficient on the volatility measure is close to zero. This small effect might be related to the time period we are studying. As mentioned in Chapter 2.3 there has been stable growth in the Norwegian economy, which contribute to a tranquil behaviour of the overall volatility in Norway. This period of tranquillity could be an explanation for the small effect from the volatility measure, as a the volatility in Norway might differ from the VSTOXX index. Another possible explanation is that the Norwegian deposit market is less affected from the Euro volatility, than other financial instruments. The reason being that bank deposits are considered to be safer than many other financial instruments.

The estimated coefficients behave according to the theory discussed in Chapter 2. The spread in the bond market and the NIBOR rate have a great impact on the spread level at Fixrate. From Table 3.6 we see that the standard deviation of the deposit spread on Fixrate is 0.14%. Thus, the coefficients from NIBOR and bond spread are large in terms of the effect it has on the deposit spread. The effect from the bond spread is over five standard deviations away from the average deposit spread. However, this is related to the initial increase of one percent. A one percent increase in these variables is a very large increase, and thus the estimated coefficients are large as well. Another explanation for the high coefficient of the spread in the bond market is that bonds are the other major funding option for banks. A high coefficient here shows the strong relationship between these two alternatives of financing.

A high coefficient on the three-month NIBOR substantiates the relationship between the spread at Fixrate and NIBOR. We expected a strong relationship between these two variables, as the interest rate offered at Fixrate is composed of both the spread and the NIBOR rate. As observed in Figure 5.1, the NIBOR rate increased during the period we study, caused by an increasing policy rate. The spread at Fixrate has decreased over the same period. The interest rate offered to customers (spread + NIBOR) has also increased, indicating that the increase in NIBOR is higher than the decrease in the spread at Fixrate. This relationship is shown by the coefficient for NIBOR. Being negative, but less than one, indicates that the spread decreases less than the NIBOR increase. As NIBOR increase the interest rate at Fixrate increase, but slower than NIBOR because of the decreasing spread.

One reason for the spread to decrease is that an increasing NIBOR and policy rate, could indicate higher activity in the economy. This might make banks decrease their offered spreads, as the increased activity could decrease their valuation of risk in the market.

The negative relationship between NIBOR and the interest spread is expected, and is linked to the interest rate conditions a bank has offered on its already existing deposits. In talks with the CEO of Fixrate, we discussed his viewpoint on how the mechanism of NIBOR and interest rate spread is working. When the three-month NIBOR increases the current deposits at a bank will be more expensive due to the fact that the contracts are adjustable, and therefore the customer will earn a higher interest rate. After the increase in NIBOR, the bank managers will then reduce the interest spread on new deposits (Brynjar Ellingsen, interview, April 2020).

The regression from Table 5.1 indicates that bank size and time to maturity are factors that affect the interest rate spread. Smaller banks tend to offer higher spreads relative to larger banks. This effect might be related to the level of riskiness of depositing money to a small bank, compared to a larger and well-known bank. The transaction size however is not statistically significant, and therefore does not seem to determine the level of spread. These findings are also apparent when we add macroeconomic measures. By including these measures we find that a higher level of volatility and bond spread increases the deposit spread. An increase in the money market rate (NIBOR) leads to a lower interest spread. These results are consistent with predictions from previous literature and economic theory. Including the macroeconomic measures to the model increases the R^2 from 62% to 82%. This indicates that more of the variation in the interest spread is explained as we introduce macroeconomic measures to the model.

5.3 Heterogeneous Response by Bank Size

In this section we study if changes in NIBOR and bond spreads have different effects across different bank sizes. To analyse this, we create interaction terms between bank size, three-month NIBOR and spreads in the bond market. The two models in Table 5.3 are estimated with a random effect approach, and the models are presented as:

$$\begin{aligned} spread_{it} = {} & \beta_0 + a_i + \boldsymbol{\beta} \vec{Banksize}_i + \beta_4 Volume_{it} + \beta_5 90days_{it} \\ & + \beta_6 NIBOR_t + \beta_7 Bondspread_t + \beta_8 VSTOXX_t \\ & + \beta_9 Small_i * NIBOR_t + \beta_{10} Medium_i * NIBOR_t \\ & + \beta_{11} Large_i * NIBOR_t + \boldsymbol{\delta} \vec{Years}_t + u_{it} \end{aligned} \tag{5.3}$$

$$\begin{aligned} spread_{it} = {} & \beta_0 + a_i + \boldsymbol{\beta} \vec{Banksize}_i + \beta_4 Volume_{it} + \beta_5 90days_{it} \\ & + \beta_6 NIBOR_t + \beta_7 Bondspread_t + \beta_8 VSTOXX_t \\ & + \beta_9 Small_i * Bondspread_t + \beta_{10} Medium_i * Bondspread_t \\ & + \beta_{11} Large_i * Bondspread_t + \boldsymbol{\delta} \vec{Years}_t + u_{it} \end{aligned} \tag{5.4}$$

From the estimation of equation (5.3) we can test empirically if an increase in NIBOR affects the deposit spread differently depending on the size of the bank. We know from our analysis in Section 5.2 that an increase in NIBOR leads to a lower interest spread. The motivation of estimating equation (5.3) and (5.4) is that it will show whether banks react differently to changes in NIBOR or bond spreads, depending on their size.

Table 5.3: Relationship between deposit spread and interaction terms

	(1) RE	(2) RE
Small	0.2308***	0.1927***
	(0.0688)	(0.0482)
Medium	0.1034**	-0.0077
	(0.0444)	(0.0310)
Large	0.1120**	-0.0062
	(0.0473)	(0.0325)
Volume	0.0001	0.0001
	(0.0001)	(0.0001)
90 days	0.0752***	0.0684***
	(0.0101)	(0.0099)
NIBOR	-0.2051***	-0.2161***
	(0.0284)	(0.0168)
Bond spread	0.7824***	0.5056***
	(0.0568)	(0.0963)
VSTOXX	0.0028***	0.0025***
	(0.0009)	(0.0009)
Small * NIBOR	-0.0544	
	(0.0447)	
Medium * NIBOR	-0.0114	
	(0.0278)	
Large * NIBOR	-0.0258	
	(0.0281)	
Small * Bond spread		-0.0998
		(0.1649)
Medium * Bond spread		0.4322***
		(0.1076)
Large * Bond spread		0.3867***
		(0.1110)
Year effects	Yes	Yes
N	448	448
R^2	0.82	0.83

Standard errors in parentheses

The dependent variable is the deposit spread offered for the adjustable contracts at Fixrate

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

From column (1) in Table 5.3, we see that a 1% increase in NIBOR causes the spread for the biggest banks to reduce by 0.2051%, all else equal. For the smallest bank the effect is $\hat{\beta}_6 + \hat{\beta}_9 = -0.26\%$. The coefficients on the interaction terms are negative, and none of them are statistically significant.

To empirically test if changes in the NIBOR rate affects the deposit spread differently based on bank size, we conduct a joint hypothesis test on the coefficients from the interaction terms in column (1). The null hypothesis is that all estimated coefficients are zero, where the alternative hypothesis is that at least one of them is different from zero. Failing to reject the null hypothesis indicates that there is no extra effect based on the size of a bank. While if we reject the null hypothesis, we know that at least one of the interaction terms has a statistically significant effect different from zero. This indicates that changes in NIBOR do effect the deposit spread differently, depending on the size of a bank. The result from the joint hypothesis test leads to a failure of rejection of the null hypothesis. We conclude that changes in NIBOR do not seem to affect the interest spread differently, depending on the bank size.

In column (2), a 1% increase in bond spreads are expected to increase deposit spread for the biggest bank by 0.5%, all else equal. From the interaction terms we see that banks in the category *Large* have an extra effect of 0.38%, and banks in the category *Medium* experiences an additional effect of 0.43%. The coefficients are significant at a 1% level. The negative estimated coefficient on the interaction term between small and spreads from the bond market is however not in line with what theory predicts. One would expect this to be positive, and higher than the coefficients on the interaction terms between *Large* and *Medium* banks. From Table 3.3 in "Descriptive Statistics" we see that banks in the category *Small* only represent approximately 9% of the total amount of transactions through Fixrate over the time period. This is a relatively small sample and could serve as a possible explanation for the unexpected results.

Looking further into the data, we observe that bank 41 is accountable for eight transactions with a spread that is two times higher than the standard deviations from the mean. Bank 41 is categorized as a *Small* bank based on its assets, thus eight of the 40 transactions to small banks are the outliers from bank 41. This could serve as an explanation to why the interaction term between bond spreads and *Small* is negative, and not statistically significant. Dropping the transactions from bank 41 makes the coefficient positive, and statistically significant at a 5% level.

By conducting a joint hypothesis test similar to the one we did in column (1), we check if changes in the bond spread affects the interest spread differently, depending on bank size. The results from this test leads to a rejection of the null hypothesis, and we conclude that changes in bond spreads seem to affect banks differently based on their size.

We found that banks tend to react in a similar way when NIBOR changes, while smaller banks experience an increased spread relative to larger banks, when the bond spread increases. Larger banks typically raise a higher volume when they seek funding, relative to smaller banks. This can be seen from Table 3.4, the smallest bank group at Fixrate had an average transaction size of 8.72 bill. NOK, while the largest bank group averaged 35.64 bill. NOK. One possible explanation for the effects found here is that the transaction costs are lower at Fixrate relative to the bond market. Smaller banks that needs a lower volume of funding might face substantial higher transaction costs per million in the bonds market, relative to a larger bank. This might lead smaller banks to use Fixrate to a greater extent, and could explain why they increase the deposit spread to a higher degree compared to larger banks.

Changes in NIBOR do not seem to have any different effect on banks deposit spread, depending on their size. This could for instance been seen in the light that changes in NIBOR are universal for participants in the market, and seems to affect the banks in a similar matter. This indicates that the banks are price takers in the market, where they follow the changes in the money market.

5.4 Stationarity

To test the robustness of our estimation we look further into the stationarity of our data. If the interest spread at Fixrate follows a unit root process, the statistical inference in our previous estimations will be wrong. A unit root can also cause a falsely high R^2. To test for stationarity, we conducted multiple unit root tests on our data. We tested both with an Augmented Dickey-Fuller (ADF) test and a Phillips-Perron test. The tests have a null hypothesis of the interest spread following a unit root process. Both tests indicated a presence of unit roots. The conclusion remained the same with the inclusion of trends, lags and drift. The exact test statistics and results can be found in the appendix.

The usual solution to non-stationary data is to differentiate the data until you can reject the null hypothesis of the existence of a unit root. However, since our dataset is highly unbalanced and for some banks we only have one observation, differentiating the data is not possible. The gaps in observations also make it hard to differentiate, as for most banks we do not have observations from day to day. Often there are weeks, and sometimes even months, between transactions for a certain bank.

The unbalanced nature of the data might be a reason for the tests indicating a unit root. When testing for unit roots with dates as our time variable, it tests if there is a unit root between a date and the previous day. As we usually have gaps between dates of transactions for each bank, that leaves few observations for testing. The tests are then based on a very small sample of the observations. To look into this issue, we created a new time variable. The first transaction in each bank is now set as time 1, the second transaction as time 2 and so on. These numbers replace the date used in the previous analysis. Doing this, we remove the gaps in the data that were caused by the time gaps between transactions. By running the same unit root test, we can reject the presence of unit roots at all significance levels.

When replacing the date variable with this new time dimension in our previous regressions, both coefficients and standard deviations stay at the same levels. By doing this we conclude that the interest spread at Fixrate is stationary, and the conclusion in the first test is reasoned by a highly unbalanced dataset.

These results are in line with conclusions from similar research from Norges Bank and SSB on the behaviour of interest rates. Raknerud et al. (2011) studied the NIBOR rate and found it to follow a stationary process. Anundsen and Jansen (2013) studied the real interest rate in Norway and concluded that the rate is stationary. Combining these results from previous studies with the results of our test, we believe that the spread offered at Fixrate is stationary and does not follow a unit root process. However, to make a strong conclusion on this topic, further studies should be done when a larger dataset of transactions is available.

5.5 Limitations and Extensions

Throughout our thesis we have detected some limitations and possible extension for further work. Our findings regarding these topics will be discussed in the following section.

Using the results from the Hausmann test[2], we found that our best estimation method was the RE model. However, these coefficients were not very different from the estimated coefficients in the FE model. For our analysis, this indicates that it does not seem to be much unobserved heterogeneity in the way we have modelled the relationship between interest spread and the explanatory variables. However, this is not the same as saying that there is no unobserved heterogeneity, it might be that the relationship could be modelled differently. For instance the relationship between the interest spread and the explanatory variables are modelled as a static relationship. One could investigate further into a dynamic relationship between the interest spread and NIBOR. However, this was not possible for us due to the nature of the unbalanced dataset. For future work one could gather a larger dataset, over a longer period of time, to extend the model.

The dataset handed to us is anonymized, hence, we do not know specifically what bank we follow over time. It could be of interest to add bank-specific variables in our model, such as banks financing costs. This could serve as a further extension of our model, and could potentially control for omitted variable bias. Unfortunately, based on the anonymized dataset we could not control for such measures.

There is also a limitation to the data used in our analysis, which is that the three-month NIBOR is no longer available publicly after January 2020. From this date, *Norske Finansielle Referanser AS* publishes the NIBOR rate on behalf of Finance Norway. You have to pay for an annual subscription to access the daily NIBOR rate, making this study harder to replicate.

[2]See Appendix A.2

6. Conclusion

In this thesis we explored what affects the interest rate spread on the marketplace Fixrate. We have used an unbalanced panel dataset from October 2017 to January 2020 to answer the research question.

We find that bank size and maturity are statistically significant determinants of the interest spread. Smaller banks tend to have a higher interest spread compared to the biggest banks. This effect seems to shrink when we compare the second largest banks to the biggest banks. Deposits with longer maturities seems to offer a higher spread. Higher volume in transactions does not seem to have any effect on the spread offered at Fixrate. These effects follows the predictions of economic theory and what has been found in previous papers.

Factors from the transactional data from Fixrate do play a role in determining the interest rate spread. We find that bank size and maturity affect the spread. These effects are still present when we include macroeconomic measures.

We find that the three-month NIBOR, bond spreads and volatility in the Euro area all affect the interest spread at Fixrate. A higher NIBOR will reduce the interest spread, while both higher bond spreads and volatility will increase it. Macroeconomic measures play a significant role in determining the interest spread. Both bond spreads and the three-month NIBOR has a high impact on the level of the interest spread. The volatility from the Euro area is statistically significant, but the effect is not as strong as the other macroeconomic measures.

Including interaction terms allows us to see if the three-month NIBOR and bond spread affect the interest spread differently depending on the size of the banks. We found that changes in the three-month NIBOR affect banks interest spread similarly. The results were reversed for changes in bond spreads. Smaller banks relative to bigger banks experiences an additional increase when bond spreads changed.

Our estimated model is represented in a static way. This means that changes in NIBOR today will lead to changes in the interest rate spread today. It would have been interesting to model the relationship in a more dynamic matter, however limitation in the data prohibited us from doing this. In our thesis the results does not indicate a large discrepancy between RE estimation and FE estimation, which means that there seems to be little unobserved heterogeneity in our model. For future work one could obtain a larger dataset and model the relationship differently, for example more dynamically.

Our results from the analysis suggests that both bank size, time to maturity and macroeconomic measures affect the interest spread at Fixrate.

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A. Appendix Title

A.1 OLS Assumptions

In our analysis we have used POLS, RE and FE models. All these models are based on the assumptions of the OLS model. Wooldrige (2016) lists the following assumptions:

1. The model has to be linear in its parameters
2. Random sampling from the cross sectional data
3. No perfect collinearity: There can not be a perfect linear relationship between the independent variables
4. Zero conditional mean: The expected value of the error term has to be zero given all independent variables. The error term can not have any correlation with the independent variables
5. Homoscedasticity: The variance in the error term has to be constant given all explanatory variables
6. No serial correlation in the error term
7. Normality: The error term is independent from the explanatory variables and follows a normal distribution $u \sim N(0, \sigma^2)$

A.2 Testing

Breush-Pagan test

To test for heteroskedasticity we used the Breush-Pagan test, which is a Lagrange multiplier test, with the following test statistic and distribution:

$$LM = n * R^2_{\hat{u}^2} \quad \sim \chi^2_k$$

Under the null hypothesis our data is homoskedastic, while a rejection of the null hypothesis indicates heteroskedasicity. We get the following result for equation (5.1), the equation with only bank specific measures:

$$LM = 127.72 \quad \text{P-value} = 0.000$$

At any conventional significance level we reject the null hypothesis, indicating that the POLS will not be the ideal estimation method. For equation (5.2), the equation including both bank specific and macro economic measures, we get these results

$$LM = 512.95 \quad \text{P-value} = 0.000$$

For equation (5.2) we reject the null hypothesis at all used levels of significance. Based on these results from the Breush-Pagan test we conclude that the POLS is not the best fit for our data, and will continue with the RE and FE model.

Hausman test

To decide whether the RE or FE model is the best fit for our data, we run a Hausman test. Under the null hypothesis there is no systematic difference in the coefficients of the two models, and the RE effects model is preferred. If the null hypothesis is rejected the FE model is preferred. It follows the following test statistic:

$$H = (b - B)'[Var(b) - Var(B)]^{-1}(b - B) \quad \sim \chi^2_{Var(B)-Var(b)}$$

Here, b is a matrix of coefficients from the FE model, and B is a matrix of coefficients from the RE model.

We get the following results for equation (5.1):

$$H = 6.79 \quad \text{P-value} = 0.1473$$

For equation (5.2) we get these results:

$$H = 8.09 \quad \text{P-value} = 0.3248$$

Observe that we fail to reject the null hypothesis at all relevant significance levels, and prefer the RE estimation for both equations.

Augmented DF

The augmented Dickey-Fuller test is performed to test for the appearance of unit roots. Under the null hypothesis the panel data include a unit root, while the alternative hypothesis is that there is not an appearance of unit roots. We have used a Fisher-type unit root test based in the augmented Dickey-Fuller test. From Section 5.4 we have performed two tests. The first result is from when we used the original date as time dimension, and the second result is from when we created a new time dimension. The justification of this can be found in Section 5.4

$$P = -2\sum_{i=1}^{N} log\,\dot{p}_i$$

$$P = 3.7423 \quad \text{P-value} = 1.0000$$

We fail to reject the null hypothesis and conclude that the data with the original date as time dimension contain a unit root.

Below is the results from the test with a new time dimension, without gaps.

$$P = -2\sum_{i=1}^{N} log\, \dot{p}_i$$

$$P = 374.0289 \quad \text{P-value} = 0.0000$$

We reject the null hypothesis at all conventional levels and conclude that the date with the new time dimension does not have a unit root.

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