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The Effects of Oil Price Shocks on Bank Profitability and Financial Stability in Norway

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Abstract

This thesis examines how oil price shocks affect bank profitability. We use this examination to assess the implications for financial stability in Norway. Our analysis employs a sample of commercial banks from 2012 to 2021. To control for persistence in profitability, we use dynamic panel data with a system generalized method of moments (GMM) estimator. This thesis differentiates between the direct and indirect effects of oil price shocks, where we explore the latter through non-linear relationships. The main findings are that oil price shocks have both a positive and negative impact on Norwegian banks through different channels. Credit exposure to the oil sector yields a positive, albeit small direct effect on profitability. Banks with a high level of non-interest income are also positively affected. Furthermore, we find a non-linear relationship between oil price shocks and inflation on bank profitability. Our results imply that the impact of the oil price shock is negative for high inflation levels. We present evidence that the negative effect is due to higher loan loss provisions. However, the overall assessment is that oil price shocks do not threaten financial stability. Even so, this thesis points out risk factors that should be considered.

Keywords – Oil price shocks, Bank profits, Financial stability, Dynamic panel data, Loan loss provisions

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1 Introduction

In 2021, the oil sector stood for 50% of Norwegian exports and 21% of the gross national product (Norwegian Ministry of Petroleum and Energy, 2022). Therefore, the Norwegian economy is heavily reliant on oil. 20% of loans issued by Norwegian banks consist of industries directly exposed to changes in the oil price, whereas they allocate 5% to oil and gas production (Haug et al. (2021); Norges Bank (2021b)). Followingly, the oil sector is also important for Norwegian banks.

The credit exposure entails that oil price shocks directly affect bank profitability. An increased oil price will also affect the economy, transmitting via government spending, the exchange rate, and inflation. Banks are exposed to the economy through loans to businesses, private consumers, and equity investments. Therefore, an oil price shock could also indirectly affect bank profitability.

How oil price shocks impact bank profitability could have implications for financial stability. The financial system must be robust to disturbances and ensure an environment for stable economic development to maintain stability (Norges Bank, 2021b). If bank profitability is highly affected by oil price developments, it may be a risk factor for the economy.

This thesis looks at the relationship between the banking sector and oil price shocks to see if the financial system is robust to such disturbances. Hence, we want to address the following questions:

1) Do oil price shocks affect bank profitability?

2) Are oil price shocks a source of financial instability in Norway?

Studying the effect of oil price shocks on oil-exporting economies is a known field of study. However, no research to date looks at the impact on banks in an oil-exporting, small and open economy with a similar fiscal policy to Norway. Our approach for analyzing this topic is to differentiate between the direct and indirect effects of oil price shocks on bank profitability. The direct effect will encompass the banks' credit exposure to the oil sector. The indirect effect explores if banks are affected through other channels, like equity investment, inflation, and gross domestic product (GDP).

To investigate the topic, we build upon research by Hesse and Poghosyan (2016); Killins and Mollick (2020) on bank profitability and oil price dependency. We use interaction terms to capture the difference between direct and indirect effects.

When using a similar approach in Canada, Killins and Mollick (2020) find that oil price shocks have a positive direct effect on bank profitability. Additionally, they find positive indirect effects through trading activities. Hesse and Poghosyan (2016) find that oil price shocks have a positive indirect effect on profitability through macroeconomic variables. However, their findings do not support a positive direct effect when they account for the indirect effect. Moreover, they find that oil price shocks positively correlate with profitability for investment banks but have a non-significant relationship for commercial banks.

Besides the effect of oil price shocks, the literature explores other factors that influence bank profitability (Demirgüç-Kunt and Huizinga (1999);Athanasoglou et al. (2006);Athanasoglou et al. (2008);Berger et al. (2010)). The general finding is that bank profitability is persistent and determined by bank-specific and macroeconomic variables (Killins and Mollick, 2020). Bank-specific factors for credit risk and capital adequacy have shown a negative and positive relationship with profitability, respectively (Athanasoglou et al., 2006). Furthermore, macroeconomic variables for inflation and GDP growth have both positive relationships with profitability (Hesse and Poghosyan, 2016). Our results align with the previous literature, which justifies using a similar approach when studying the effect of oil price shocks on banks in Norway.

Similar to Killins and Mollick (2020), we find both a direct and indirect effect of oil price shocks on bank profitability. We also find evidence for non-linear effects through non-interest income and the economy. In contrast to the literature, Norwegian banks have both a positive and a negative effect on oil price shocks through different channels.

By investigating the effect of oil price shocks on bank profitability, we shed light on its implications for financial stability. As Norway is actively trying to shield the economy from oil price volatility, adding it to the literature will provide essential insight into the effect of the country's fiscal policy.

Furthermore, this thesis adds to the literature by investigating the non-linear interaction between oil price shocks and macroeconomic measures. Our findings expand on previous linear research to provide a better understanding of how oil price shocks impact bank profitability and the economy. Additionally, by controlling for the year 2020, we ensure the robustness of these results considering the pandemic.

We will first introduce the relationship between the Norwegian economy, the oil price, and financial stability. Further, we present the data and how we calculated the variables. We then introduce the regression model before we give a detailed explanation of the methodology. Lastly, the regression results are discussed and analyzed according to the research questions before we make concluding remarks.

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2 Background

To provide a foundation for the results and analysis of this thesis, we will introduce the mechanisms of the Norwegian economy in relation to oil. Firstly, we explain how oil prices influence the economy and the fiscal policy concerning oil revenues. Secondly, to understand how the government controls economic uncertainties, like an oil price shock, we will briefly explain the Norwegian monetary policy. Lastly, we describe the banks' role in financial stability, which will give insight into how the economy can be vulnerable through the banking system.

2.1 The Oil Price Transition Mechanism

For an oil-exporting country such as Norway, oil prices will generally affect the overall economy through two channels (Alekhina and Yoshino, 2018). The first is the export channel which is influenced by the exchange rate. When the oil price increases, foreign investors will invest their capital in the Norwegian economy to expose themselves to oil. This effect will appreciate the Norwegian currency (NOK) compared to foreign currencies. Norwegian consumers will hence get more for every NOK spent. The relative price for imported goods will fall such that Norway imports lower inflation in the long term (Alekhina and Yoshino, 2018). In that sense, a floating currency will have natural stabilizing properties that dampen the effect of higher energy prices from an increased oil price (Bergo, 2006).

The second channel is the fiscal channel or government spending. For most oil-exporting countries, the government will increase their spending as the oil price increases. Higher spending is due to increased tax revenues from the oil and gas sector (Alekhina and Yoshino, 2018). An increase in government spending will increase economic activity and real GDP growth. However, the Norwegian economy differs from other oil-exporting nations as the petroleum sector is partly state-owned. Moreover, a mandate from the government dictates that oil revenues shall be placed in the Norwegian sovereign wealth fund and not be used directly in the mainland economy (Bergo, 2004).

2.2 Oil Fund Mechanisms

The Norwegian sovereign wealth fund, or the government pension fund of Norway, was established in 1990 to ensure future generations' right to oil wealth (Bergo, 2004). The fund's establishment contributed to the outline of the country's economic politics. Mainly, all government surplus from the petroleum sector is placed in the fund and invested in foreign assets (Lund and Stiansen, 2017). The policy ensures that Norwegian economic activity is less dependent on volatility in the oil price (Bergo, 2004). In 2001 the government established a budgetary rule for fiscal policy (Bergo, 2006). The rule states that transfers from the fund finance any deficit in the government budget. The transfer shall not exceed the fund's annual expected return, which is quantified as 3% (Norges Bank, 2020). This is to ensure the fund's existence in perpetuity.

2.3 Monetary Policy

Norway's monetary policy is used to create a stable economic environment and defend against economic setbacks (Norges Bank, 2017). The main goal is to ensure average inflation of 2% over time (Bergo, 2004). Low and stable inflation will benefit the economy by reducing uncertainty about inflation expectations (Norges Bank, 2021c). High inflation will weaken the role of cash as a store of value. However, some inflation is necessary for flexibility in the monetary policy (Norges Bank, 2021c). The main point is to anchor inflation expectations to ensure stable economic growth (Norges Bank, 2017).

To obtain this goal, the central bank adjusts the interest rate. This will affect inflation through three channels (Norges Bank, 2019). Firstly, a higher interest rate will attract foreign investors to hold NOK, which will appreciate the exchange rate and lower imported inflation. Secondly, it will change the inflation expectations, which will affect the real inflation rate. Thirdly, it will affect the relative relation between consumption and savings. A lower interest rate will encourage more consumption at the cost of savings. This will affect economic activity and hence the price level.

As the inflation target policy is an overall goal in the long term, the interest rate will also be used as a countercyclical measure in the short term (Bergo, 2004). This means that the central bank can use the interest rate to dampen economic fluctuation, as demonstrated during the financial crisis in 2008 (Norges Bank, 2017).

The central bank's job is to ensure financial stability in the economic environment (Norges Bank, 2021b). The inflation target contributes to financial stability as it ensures a stable monetary value, but there are also other factors to consider when assessing financial stability.

2.4 Financial Stability

The Norwegian central bank's definition of financial stability is that the "financial system is robust to disturbances and contributes to stable economic development. The financial system shall effectively supply financing and investment opportunities, ensure liquidity in payments, and diversify risk" (Norges Bank, 2021a). A robust banking sector is vital for a well-functioning economy (Norges Bank, 2021b).

The banks' primary role is to enable the saving and lending of money (Norges Bank, 2021a). Banks have exclusive rights to create and receive deposits from the general public (Norges Bank, 2021a). For that reason, banks are central to a well-functioning payment system. Further, the banks' loan risk assessment contributes to a well-functioning credit market (Norges Bank, 2021a). This leads to risk-adjusted prices on loans, which ensures that money is channeled to profitable projects.

A bank's robustness is its ability to ensure liquidity and financing opportunities in different market conditions. Because of the banking system's importance to the economy, any disturbance to the banks' ability to operate could create market turmoil (Norges Bank, 2021b).

The banks' profitable operations and solid capital adequacy contribute to market financing opportunities (Norges Bank, 2021b). Shocks that affect banks' profitability will therefore threaten financial stability. Profitability is the first line of defense against loan losses (Norges Bank, 2021b). Hence, a bank's profitability indicates its ability to effectively provide loans and reallocate deposits.

Banks need to have enough capital to withstand liquidity problems. The banks have a responsibility to control liquidity risk and not rely on government intervention in periods of market turmoil (Norges Bank, 2021b). Berger (1995) points out that banks' profits and equity are highly correlated through retained earnings. This indicates that profitability is linked with the level of capital. Further, the Norwegian central bank (2021b) states that the banks have increased their capital over the last several years to be robust against liquidity shortfalls.

The banks cooperate through the interbank market to ensure effective redistribution of liquidity (Norges Bank, 2021a). They are also interconnected because they own each other's debt. Norwegian banks hold 60% of Norwegian-covered bonds, representing 2/3 of their market funding (Norges Bank, 2021b). This interconnection causes a threat to financial stability as it is subject to ripple effects.

A high debt level among the general public is the main threat to the Norwegian financial system (Norges Bank, 2021b). The debt levels have increased over the last decade and are growing at a higher pace than wages. The debt holders are vulnerable to interest rate changes and disturbances that cause a loss of income (Norges Bank, 2021b). This may threaten financial stability through loan losses and tightening consumption. Deposits from customers are the most important source of funding for Norwegian banks (Norges Bank, 2021b). A threat to deposits may hurt the banks' access to financing.

Because of the banking system's importance in the overall economy, the government imposes regulations on the sector to ensure stability and efficiency (Norges Bank, 2021b). Capital adequacy rules are in place to ensure that banks have enough capital to cover substantial, unexpected losses (Norges Bank, 2021a). The most important is the countercyclical capital buffer, which the central bank regulates to ensure that the banks have enough capital to manage market risks (Norges Bank, 2021b). Liquidity rules impose banks to have a certain amount of liquidity to cover expenses in uncertain market conditions. Further, due to the financial crisis of 2008, the government has imposed a minimum requirement for own funds and eligible liabilities rule (MREL), which requires the banks to have sufficient capital and debt that can be converted to equity in case of default (Norges Bank, 2021b). The rule was introduced to reduce the moral hazard problem of the banks being too big to fail.

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3 Data

To answer the research questions, we have gathered yearly data from the financial statements of 33 Norwegian banks from 2012 to 2021. According to numbers from Finans Norge (2022), the number of Norwegian consumer banks is 94. Furthermore, the ten largest banks have a market cap of 61%[1]. The bank data is obtained from the Orbis database[2] of the Bureau of van Dijk. The dataset includes nine of the ten largest banks and 24 smaller commercial banks. Therefore, we assess that a sample of 33 banks is large enough to get valid results. The variables obtained are net profits before tax, net income, net interest income, non-interest income, loan loss provisions, total assets, total equity, and gross loans to customers. Some banks have limited data and do not have observations dating back to 2012. We have limited the dataset to only include banks with a minimum of four years of data. We also remove outliers by winzorising[3] the dataset at the 99th percentile.

Further, we have collected measures on Brent Crude spot and Brent Crude 12-month forward rate from Bloomberg[4]. Additionally, we collected quarterly data for Norway's real GDP and yearly consumer price index (CPI) data from Statistics Norway[5]. We obtained macroeconomic data in the same period, 2012 to 2021, as the bank measures.

Our dataset contains 276 observations with 12 variables. We have calculated measures from the dataset, which we later use as variables in the regression analysis.

3.1 Calculated Variables

To measure the profitability of each bank, we use return on assets (ROA). We have calculated ROA by dividing net profits before taxes by total assets[6]. Figure 3.1 displays that ROA has increased over the sample period. However, the increase is small, and the measure lies between 1-1.5% on average. This is in line with the relevant literature, which finds that bank profitability is persistent (Killins and Mollick, 2020).

[1] Numbers gathered from Finans Norge's data on Norwegian banks: Finans Norge (2022)
[2] Orbis Database (2022): Access through Norwegian School of Economics
[3] A method used to minimize the influence of outliers in the data
[4] Accessed through Bloomberg Terminal at the Norwegian School of Economics
[5] GDP gathered from National accounts (2022c) and CPI from Consumer price index (2022b)
[6] All variable calculations are listed in A1

Figure 3.1: The Average Return on Assets (ROA) per Year (2012-2021)

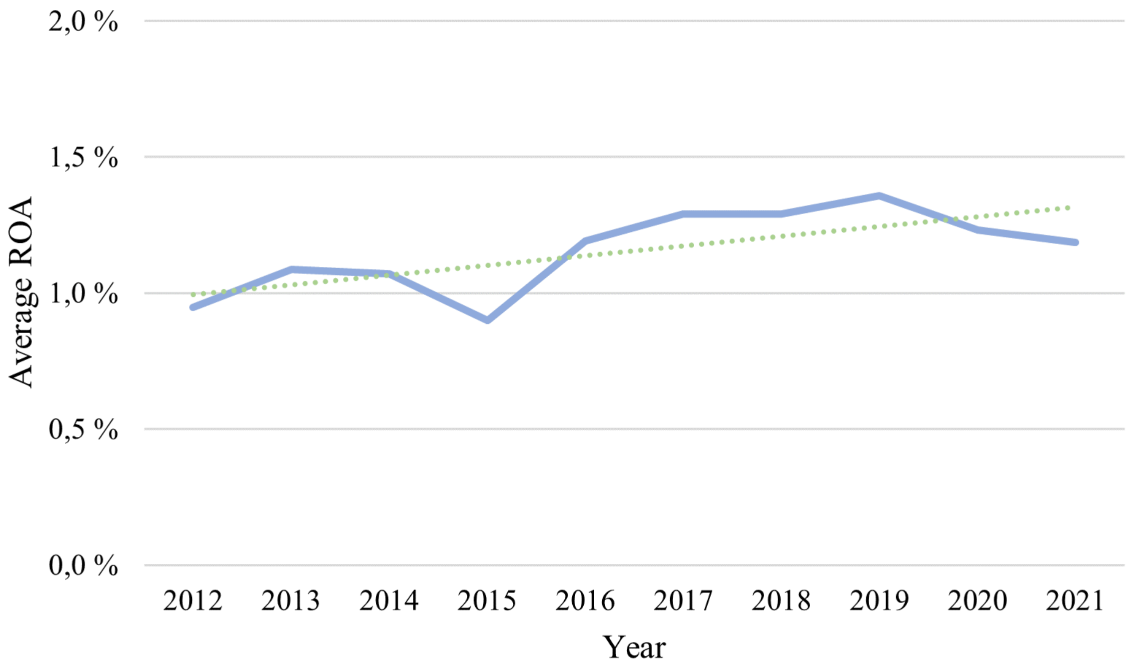

Figure 3.1 displays the average ROA per year for the 33 sample banks. The figure shows that ROA has increased over the sample period but with small margins.

We use equity over assets (EA) to proxy for capital adequacy. The measure portrays how much capital the bank has available, indicating financial strength (Norges Bank, 2021b). We calculate a variable for credit risk by dividing loan losses provisions on gross loans (LLP). This variable measures predicted losses. Other papers exploring similar topics (Athanasoglou et al. (2008); Killins & Mollick (2020); Hesse & Poghosyan (2016)) have also used loan loss provisions over gross loans. Provisions for loan losses will indicate how the management assesses the riskiness of their loan portfolio. Figure 3.2 shows that LLP has increased over time.

Figure 3.2: Average Loan Loss Provisions (LLP) per Year (2012-2021)

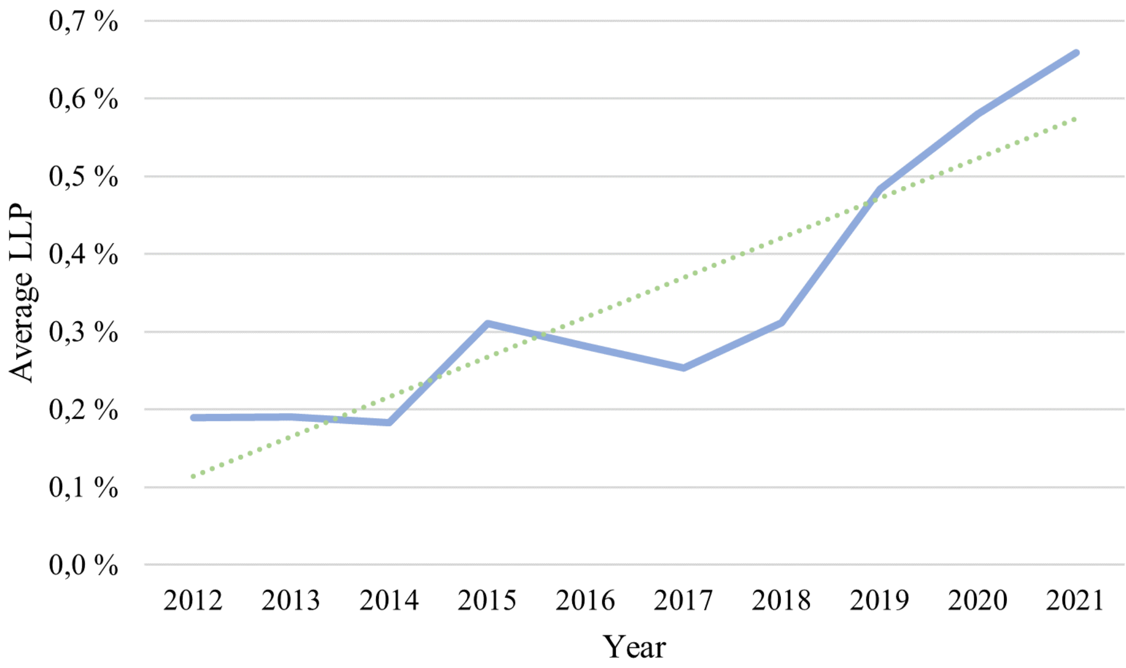

Figure 3.2 shows that average loan loss provisions for the 33 sample banks have increased over the sample period. This indicates that the banks in our sample have taken on more risky loans in later years.

Figure 3.3: Average Loan Loss Provisions per Bank (2012-2021)

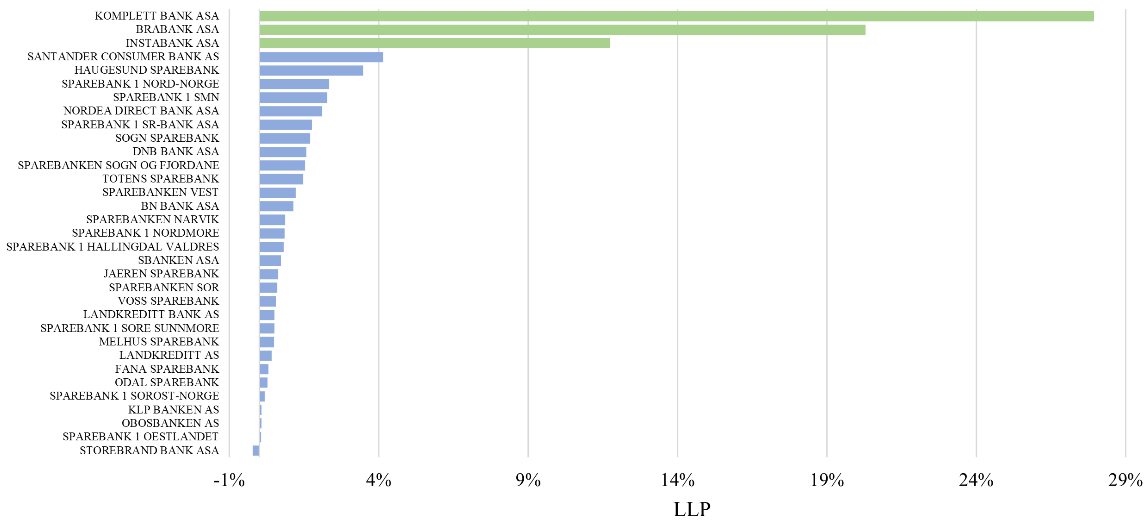

Figure 3.3 displays the average loan loss provision over the sample period for each bank in the data sample. The banks Komplett Bank ASA, BRABank ASA, and InstaBank ASA have considerably larger loan loss provisions than the rest of the sample. Green columns outline these three banks.

The increase in LLP can be related to a few banks in our sample. For instance, figure 3.3 shows that three banks have a significantly larger credit risk than other banks in our dataset. These banks started their business operation in 2014 or later, which may drive the increase in LLP from figure 3.2.

We use the share of net non-interest income (SNONII) to measure income diversification. Non-interest income includes equity investments, derivatives, and commissions. The variable is calculated by dividing net non-interest income by total net income. From figure 3.4 we observe that the share of non-interest income has decreased over the sample period.

Figure 3.4: The Average Share of Non-interest Income (SNONII) per Year (2012-2021)

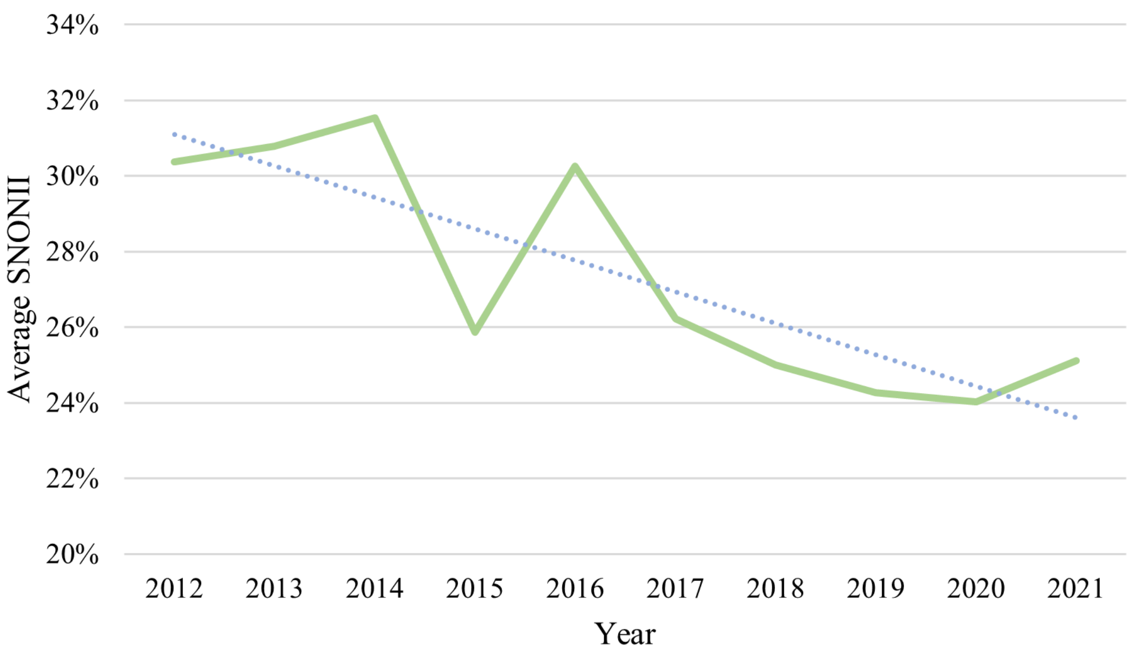

Figure 3.4 displays the average SNONII per year for the 33 sample banks. The average share of non-interest income lies between 0.32-0.24. The figure shows that the banks have decreased their share of non-interest income over the last ten years.

We calculate real GDP growth as a proxy for economic activity using quarterly data. By annualizing the data we find an estimate for yearly growth. The estimate represents the movement in economic activity throughout the year. Further, we calculated the inflation rate from yearly CPI as a proxy for economic uncertainty. Figure 3.5 displays real GDP growth and inflation in our sample data. We observe that all years in the sample have positive real GDP growth, except 2020, which had a negative growth due to COVID-19.

Figure 3.5: Real Gross Domestic Product (GDP) Growth and Inflation Rate (2012-2021)

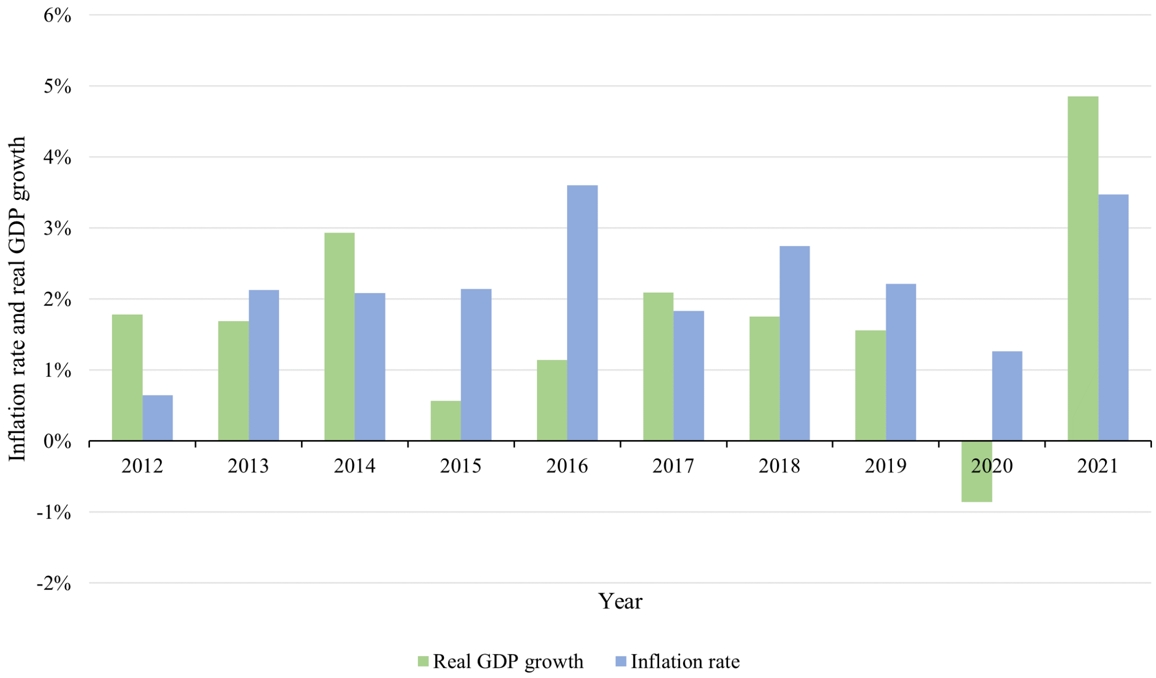

Figure 3.5 displays real GDP growth and inflation for each year in our sample. The figure shows that 2020 was the only year with negative real GDP growth. Further, 2016 and 2021 have considerably higher inflation levels.

To estimate the effect oil price movements have on bank profitability, we use several measures for oil price shocks. As there is no clear-cut definition of what constitutes an oil price shock, we calculate different proposed measures to give a nuanced picture of the effect.

We use the average annual growth rate as suggested by Hesse and Poghosyan (2016) in equation 3.1. We calculate this measure by taking the annual arithmetic mean of daily Brent spot prices. Hence we get an estimate of the oil price volatility and development during a 12-month period. We denote this measure as *deltaoil*.

$$\Delta oil_t = \frac{\sum_{i=1}^{365}[\log(brent_{t,i}) - \log(brent_{t-1,i})] \times 100}{365} \tag{3.1}$$

Deltaoil will therefore indicate the overall direction and magnitude of oil price movements. However, it does not constitute a deviation from fundamental values in the commodity price.

Equation 3.2 captures the effect of oil price changes that exceed the fundamental values. We use a Hodrick-Prescott filter to measure the underlying trend in the time series, where $\lambda = 100$ is the smoothing parameter for yearly data (Ravn and Uhlig, 2002). Followingly, we employ the same method as with *deltaoil*, but instead of calculating change, we calculate the deviation from the underlying trend.

$$HP_t = \frac{\sum_{i=1}^{365}[\log(brent_{t,i}) - \log(brent_{t-1,i}^{HP})] \times 100}{365} \tag{3.2}$$

HP will capture shocks in the oil price movements by measuring the deviation from the fundamental values that drive the trend. For this reason, we consider *HP* as a more accurate measure of oil price shocks.

We also want to consider market expectations about oil price developments. Hence, we use the 12-month forward rate as a proxy for future oil prices in equation 3.3. We use the same calculation method as for the previous oil measures. The only difference is that we use monthly instead of daily data when calculating the arithmetic average. Bloomberg does not offer a daily frequency of forward contracts for the desired period.

$$Forward_t = \frac{\sum_{i=1}^{12}[\log(brent_{t,i}) - \log(12m(F)_{t-1,i})] \times 100}{12} \tag{3.3}$$

As the forward rate consists of today's fundamental values and future expectations, it contains all information about the price. In theory, any deviation would be considered news and a good measure for oil price shocks. However, in reality, the forward price may contain premiums like the cost of carry (Douglas Foster et al., 2019). This could make the forward measure unreliable.

Figure 3.6 displays the calculated measures for oil price shocks from 2012 to 2021. All three measures seem to correlate and show the same oil price shocks with somewhat different magnitudes. The forward measure is significantly larger than the others. This could be because forward contracts contain a premium on the cost of carry, and because the variable uses monthly data.

Figure 3.6: Estimates of Oil Price Price Shocks *Deltaoil*, *HP100* and *Forward* over the Sample Period (2012-2021)

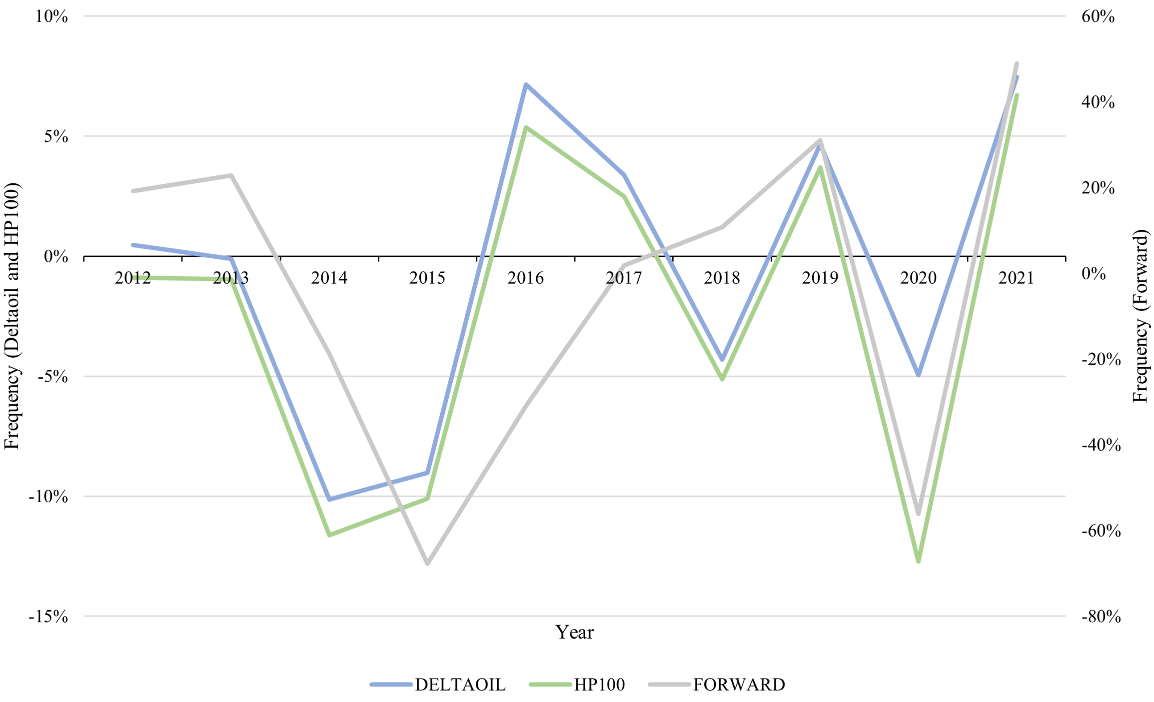

Figure 3.6 displays the three calculated oil measures. Deltaoil is the measure calculated in equation 3.1, while HP100 and Forward come from equation 3.2 and 3.3, respectively.

From figure 3.6 we observe that the period in question contains two substantial negative oil price shocks. These are the oil crisis of 2014 and the COVID-19 crisis in 2020. For that reason, we will try to account for the price drop associated with the COVID-19 crisis in our analysis, as this was a peculiar economic crisis. We observe that the period also contains positive oil price shocks. Although in smaller magnitude than the negative shocks.

3.2 Descriptive Statistics

Table 3.1 contains the summary statistics for the calculated variables. The mean value of ROA is 1.16%, with a standard deviation of 0.008. These measures are in line with what we observed in figure 3.1. EA has a mean value of 10.5%, which suggest that the banks are highly levered. The level of leverage supports our choice of performance measure. SNONII has an average value of 27.4%, which means that about 1/3 of the banks' earnings come from non-interest income. The standard deviation for SNONII is 16.4%, indicating individual differences between the banks in income diversification. The average LLP in our data is 0.335%. Therefore, a Norwegian bank will set aside 33.5 NOK for every 10 000 NOK they give out in loans to customers.

Table 3.1: Summary Statistics for All Calculated Variables

	MEAN	ST.DEV	MINIMUM	MAXIMUM
ROA	.0116175	.0080432	-.0261438	.0580512
EA	.1048147	.0326683	.0321537	.2203965
LLP	.0033505	.0088374	-.0028744	.0899259
SNONII	.2739239	.1638243	-.1063883	.8372905
DELTAOIL	-.0067382	.0615177	-.1012768	.07471
HP100	-.0242357	.0686143	-.1271757	.0671313
FORWARD	-.0678522	.359426	-.6774917	.4897572
INFLATION	.0225934	.0081021	.0064309	.036
GDP	.0167838	.0134328	-.0086108	.0485635
N	276			

Table 3.1 contains summary statistics for the variables in our dataset. The table displays the mean, standard deviation, minimum and maximum value for all variables.

All our oil measures have a negative mean value. This indicates that negative oil price shocks have the most prominent presence in our sample. Further, the oil measures have a considerable standard deviation, indicating a volatile oil price period.

Table 3.2 displays a correlation matrix for the variables. The main takeaway from this table is that all our oil measures have a positive but small correlation with the profitability measure. This may indicate that oil price shocks do not significantly impact ROA. The variables with the most significant correlation with ROA are EA and SNONII.

Table 3.2: Correlation Matrix Between Calculated Variables

	roa	ea	llp	snonii	gdp	inflation	deltaoil	hp100	forward
roa	1.00								
ea	0.36***	1.00							
llp	0.15*	0.45***	1.00						
snonii	0.21***	0.05	-0.37***	1.00					
gdp	0.02	-0.02	-0.00	0.05	1.00				
inflation	0.05	0.14*	0.03	0.00	0.39***	1.00			
deltaoil	0.09	0.14*	0.05	-0.01	0.31***	0.43***	1.00		
hp100	0.08	0.10	0.02	0.01	0.46***	0.49***	0.96***	1.00	
forward	0.07	-0.00	0.02	0.00	0.68***	0.14*	0.56***	0.65***	1.00

* $p<0.10$, ** $p<0.05$, *** $p<0.010$

Table 3.2 shows the correlations between the variables.

The oil measures are highly correlated with GDP, which is not surprising for an oil-exporting country. A high correlation between oil price shocks and GDP indicates that the oil price is important for Norwegian economic activity. In relatively small oil-exporting nations, the causality goes from oil price shocks to macroeconomic measures, not the other way around (Hesse and Poghosyan, 2016). This is because the country's output level is not big enough to impact the oil price, which is determined by the international market.

There is a small correlation between GDP and ROA. According to financial theory, this correlation should be more considerable, as banks are procyclical (Athanasoglou et al., 2014). However, figure 3.1 shows that ROA is persistent. Therefore, the correlation could be misleading, as the persistence has not yet been accounted for. It is necessary to run a regression that accounts for this to find the right relationship.

4 Methodology

4.1 Model Specification

This thesis will study the effect of oil price shocks on bank profitability. Our approach builds upon estimating an equation for bank profitability, Π, with added controls, oil shocks and interaction terms. Equation 4.1 explores the direct and indirect effects of oil price shocks:

$$\Pi_{it} = \beta_0 + \beta_1 \Pi_{it-1} + \beta_2 bank_{it} + \beta_3 macro_t + \beta_4 oil_t + \beta_5 (oil \times x_i)_t + \varepsilon_{it} \tag{4.1}$$

The model follows from the works of Hesse and Poghosyan (2016) and Killins and Mollick (2020), where i signifies each Norwegian bank at time t. The dependent variable, Π_{it}, is the return on assets (ROA). ROA is the standard measure for bank performance in the literature as it reflects returns from using all allocated resources (Killins and Mollick, 2020). The models are dynamic, with the first right-hand side variable being the lagged value of profitability, Π_{it-1}. $bank_{it}$ signifies the bank-specific control variables; equity to assets (EA), loan loss provisions (LLP), and share of non-interest income (SNONII). $macro_t$, signifies real GDP growth and inflation, followed by oil_t as a measure for oil price shocks. Lastly, the model includes an interaction term between a variable x_{it} and the oil measures oil_t. x_{it} represents the variable we want to interact with the oil measures.

Including interactive terms in our model has the benefit of uncovering joint effects between the variables. Killins and Mollick (2020) argue for the use of an interactive term between SNONII and the oil measures for economic reasons. If there is an increase in the oil price, they assume that trading activity will increase because the banks need to position themselves accordingly. We want to explore this effect in Norway, which is why SNONII will represent x_{it} in one of our models.

Further, we argue for the use of interactive terms between the oil measures and the macroeconomic variables. Rodríguez and Sánchez (2005) found that when the oil price goes up, the GDP in oil-exporting economies increases while it falls in oil-importing countries. Additionally, a change in the oil price will affect inflation in an oil-exporting country (Alekhina and Yoshino, 2018). Therefore, we want to check for indirect effects on bank profitability through interactive terms with the macroeconomy. In this case, x_{it} will hence be represented by $macro_t$.

To justify our choice of model, we will explain a step-by-step approach to its components and function. The base model we want to investigate is as follows in equation 4.2:

$$\Pi_{it} = \beta_0 + beta_4 oil_t + \varepsilon_{it} \tag{4.2}$$

We want to find the direct relationship between oil price shocks and bank profitability. However, because this is a simple linear regression and bank profitability does not solely depend on the oil price, we include bank-specific effects to control for some of the volatility in profitability. We add capital adequacy because Berger (1995) shows in his study that bank returns and capital have a positive relationship. Firstly, more capital leads to higher earnings through a reduced interest rate. This is because the company is viewed as less risky. Secondly, retained profits will inversely increase capital, leading to more income-generating projects. Thirdly, a capital increase is often associated with reduced portfolio risk, which is rewarded with higher earnings. Therefore, we predict a positive relationship between capital adequacy and return on assets.

Further, we use loan loss provisions as a proxy for credit risk. The increase in credit risk is related to decreased profitability (Athanasoglou et al., 2008). A higher loan loss ratio indicates more risky assets and an increased default ratio, leading to lower earnings. We would therefore expect LLP to have a negative relationship with ROA. Moreover, we hypothesize this relationship to be significant as it has played an important role in determining the banks' overall profitability (Killins and Mollick, 2020).

Lastly, we use the share of non-interest income to measure how reliant a bank is on investment activities. This variable is important for profitability and the risk level in Canadian banks (Killins and Mollick, 2020). Over the years, it has been more common to have different income diversification to get the highest possible risk-adjusted returns. Another important note is that SNONII tends to shrink over periods of low growth and be more volatile and sensitive to macro shocks than interest income (Calmès and Théoret, 2014).

These are the variables we see as most relevant because of their significance in the related literature. This results in the following equation 4.3:

$$\Pi_{it} = \beta_0 + \beta_2 bank_{it} + \beta_4 oil_t + \varepsilon_{it} \tag{4.3}$$

The model explains much of the variation in profitability stemming from internal factors, but external forces could also influence our dependent variable. To proxy for the state of the economy, we use real GDP growth. Banks can generally expand lending in periods of high activity due to reduced risk (Athanasoglou et al., 2008). Therefore, banks can enjoy higher non-interest income due to increased stock market activity (Hesse and Poghosyan, 2016). Further, when businesses are doing well, and unemployment rates are low, the banks can have lower loan loss provisions as the quality of the loans are higher (Athanasoglou et al., 2008). Demand for credit can also lead to higher interest margins during the later stages of the business cycle. The opposite is true in periods of slow activity. Hence, we assess that ROA will have a positive relationship with economic activity in the country.

Further, we include inflation as a macroeconomic variable. Inflation causes a more risky environment which leads to higher returns (Hesse and Poghosyan, 2016). Both Athanasoglou et al. (2006) and Hesse and Poghosyan (2016) find that inflation positively impacts profitability. Banks can better predict inflation and adjust interest rates accordingly (Hesse and Poghosyan, 2016), thus avoiding extra costs associated with higher inflation. Athanasoglou et al. (2006) also consider that bank customers do not have the same predicting power as the bank management and that this is a case of excess profits due to asymmetric information. The inflation rate will also dictate interest rates through monetary policy. We chose not to include a variable for the interest rate because it is interconnected with inflation. Athanasoglou et al. (2008) found similar results when using the interest rate and inflation, which supports this decision.

Because oil price shocks and shocks to the economy tend to be correlated, it could lead to multicollinearity in our linear model 4.3. Furthermore, the model remains inconsistent because bank profitability has been shown to be highly persistent over time. Berger (2000) found it to be the result of imperfect competition, information opacity, and serial correlation in macroeconomic shocks. The implication of this persistence is a correlation between the independent variables and the error term in the model. This will lead to the Nickell (1981) bias and would be a problem for methods such as fixed effects OLS (Baltagi et al., 2009). We use a dynamic panel data model to handle the persistence, where we include the lagged dependent variable as a regressor. This gives us the following dynamic model in equation 4.4:

$$\Pi_{it} = \beta_0 + \beta_1\Pi_{it-1} + \beta_2 bank_{it} + \beta_3 macro_{it} + \beta_4 oil_t + \varepsilon_{it} \tag{4.4}$$

To estimate a consistent model with a persistent dependent variable and multicollinearity, we use a system generalized method of moments (GMM) estimator (Arellano and Bover, 1995; Blundell and Bond, 1998). This estimator will eliminate the correlation caused by the time-invariant effects and the regressors by differencing the model and instrumenting for the idiosyncratic error (Baltagi et al., 2009). Equations 4.5 and 4.6 are provided to show the error term the system GMM estimator aims to eliminate (Roodman, 2009b). i and t indicate units and time. x in equation 4.5, is the vector for the control variables, whereas ε_{it} contains the fixed effects υ_i and the idiosyncratic error ν_{it}, in equation 4.6.

1) The estimated model

$$y_{it} = \alpha y_{it-1} + \beta x_{it1} + \varepsilon_{it} \tag{4.5}$$

2) The error terms

$$\varepsilon_{it} = \upsilon_i + \nu_{it} \tag{4.6}$$

The GMM estimator takes the first difference of model 4.5, to eliminate the time-invariant fixed effects υ_i from equation 4.6. This does not, however, remove the endogeneity problem that arises from y_{it-1} being correlated with ν_{it-1}. This is dealt with in the estimator by adding the previous lags of y_{it-1} as instruments. These are exogenous and relevant because of sequential exogeneity, where past values of y_{it-1} are not correlated with future error terms, and autoregressive paths, where each point in time is predicted by the preceding period (Roodman, 2009b).

The system GMM estimator gets its name from using several differences between y_{it-1} and earlier lags as instruments in a stacked system. E.g the difference between y_{it-1} and y_{it-2}, and y_{it-2} and y_{it-3} are both used as instruments. This is more accurate than simply using y_{it-2} and y_{it-3} as individual level instruments, which is called difference GMM. We use the system GMM instead of difference GMM because the latter performs poorly with a persistent dependent variable and creates weak instruments (Blundell and Bond, 1998). This is because previous lags of a persistent variable can be correlated to the present error term, whereas the differenced lags are not (Roodman, 2009b).

A challenge with our model from equation 4.3, is using capital adequacy as a control variable for profitability. This variable is endogenous to the dependent variable because of the assumption that more profits will attract more capital, increasing the EA ratio (Athanasoglou et al., 2008). EA is therefore correlated with the model's error term, which will provide inconsistent results (Ullah et al., 2018). However, the estimator removes this correlation by using systems of differenced lags as instruments. This is because the difference between two previous lags of an endogenous variable is not correlated with the idiosyncratic error term ν_{it} (Roodman, 2009b). Lastly, a system GMM approach solves the problem of omitted variable bias, which is useful as there are potentially other explanatory variables we have not included in the model (Hesse and Poghosyan, 2016).

By including interaction terms in the specified model from equation 4.4, we get the final model from equation 4.1. The model lets us investigate both direct and indirect effects of oil price shocks which are used to answer the research questions.

4.2 Implementation

The model in equation 4.1, treats EA as endogenous by creating lagged instruments from lag two until nine. LLP is also treated as endogenous by instrumenting from the fourth lag. We discard the previous lags because they significantly reduced the model's fit, which implies that they correlate with current error terms. This decision coincides with Athanasoglou et al. (2008), who found the variable to be predetermined and potentially endogenous because of changes in banking standards for provisions.

Furthermore, we treat the lagged dependent variable and the oil measures as predetermined and not strictly exogenous. This implies that they can be influenced by previous errors, but not by current disturbances (Roodman, 2009a). Treating a persistent dependent variable as predetermined is standard according to Roodman (2009a) because it is potentially endogenous and correlated to its previous error terms. However, by including several longer lags as instruments that are orthogonal to the error terms, we can ensure reliable instruments. The oil measures were treated as predetermined and not exogenous because of improved model fit. Some correlation to the error term $\upsilon_{i,t-1}$ may therefore be present. The remaining variables are treated as exogenous because they instrument themselves.

The Arellano and Bover (1995) approach for system GMM is made for wide panels with a large number of units, N, and a short time period, T. When using this estimator, there is a tradeoff between the efficiency gains of including more instruments and reducing the bias from overidentifying the model (Baltagi et al., 2009). A balance is found where the number of instruments is high but lower than the number of banks N. Achieving this in system GMM is potentially problematic because the number of instruments generated for every variable is quadratic with time, T, such that the instrument count tends to explode (Roodman, 2009b). Every variable thus creates a column in the instrument matrix for every time period and unit. However, the instrument count is drastically reduced by collapsing the matrix, where we add the columns together for each unit N (Roodman, 2009b). This deals with a potential overidentification problem of the regressors, which is tested with a Hansen-Sargan test. Lastly, we use robust standard errors to control for heteroskedasticity and autocorrelation within individuals (Roodman, 2009a).

While the Hansen-Sargan test checks the joint validity of our instruments, the Arellano and Bond test looks for second-order autocorrelation in the idiosyncratic disturbance term ν_{it} from equation 4.6. The test does not consider the full error term ε_{it} as it contains fixed effects that are assumed to be autocorrelated. If the idiosyncratic error term ν_{it}, is serially correlated, it will make previous lags endogenous and weak instruments (Roodman, 2009b). Therefore, the AB(2) test should not reject the null hypothesis of no serial autocorrelation for the model to be accepted (Baltagi et al., 2009).

We hypothesize that oil price shocks will have a positive effect on bank profitability, either by themselves or through the interaction with the controls, as shown by Killins and Mollick (2020). They conjecture that when oil prices go up, banks increase their trading activities, raising the share of non-interest income. We hypothesize a similar effect in Norway, as the economy heavily relies on oil. Further, we expect that there will be an indirect effect with the macroeconomic variables as found by Hesse and Poghosyan (2016).

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5 Results

To separate between direct and indirect effects, we present five separate models. The first model includes control variables and one of our oil measures, *HP100*. The following two models have different interaction terms to draw out potential correlations between the regressors. By doing this, we aim to determine where the indirect effect originates and give a clearer picture of the direct effect Further, we include a fourth regression to understand our results better. Lastly, we present a regression that excludes the year 2020 in the sample to see if COVID-19 changes our results.

5.1 What Do the Control Variables Tell Us?

First, we want to investigate the impact of the control variables on bank profitability using equation 4.4. We also want to find the direct effect of oil price shocks and whether they are correlated with the macroeconomic measures. This is done by running four different regressions with various combinations of the macroeconomic variables in table 5.1. To simplify the output, we have chosen to use only one of our oil measures, *HP100*. As stated in the Data section, we believe *HP100* gives the best representation of an oil price shock.

Table 5.1: Regressions of Oil Measures on Bank Profitability

	(1) ROA	(2) ROA	(3) ROA	(4) ROA
L.ROA	0.423***	0.428***	0.420***	0.426***
	(0.0919)	(0.0874)	(0.0914)	(0.0868)
EA	0.210***	0.217***	0.212***	0.217***
	(0.0648)	(0.0652)	(0.0643)	(0.0652)
LLP	-0.429**	-0.444**	-0.438**	-0.448**
	(0.180)	(0.178)	(0.177)	(0.176)
SNONII	-0.000735	-0.00183	-0.00108	-0.00197
	(0.00999)	(0.00987)	(0.0103)	(0.0100)
HP100	-0.0000351	-0.00916*	-0.00165	-0.00912*
	(0.00600)	(0.00524)	(0.00581)	(0.00521)
INFLATION		0.119*		0.106
		(0.0610)		(0.0736)
GDP			0.0182	0.0122
			(0.0298)	(0.0320)
CONSTANT	-0.0132**	-0.0168**	-0.0136**	-0.0166**
	(0.00589)	(0.00675)	(0.00582)	(0.00692)
Observations	241	241	241	241
No. of instruments	28	29	29	30
AR2 (p-value)	0.0242	0.361	0.0388	0.389
Hansen-J (p-value)	0.284	0.276	0.314	0.257

Standard errors in parentheses
* $p<0.10$, ** $p<0.05$, *** $p<0.010$

Table 5.1 models four system GMM regressions for oil price shocks on bank profitability. Each regression contains different combinations of macroeconomic variables. Regression (1) includes only the controls and the oil measure. (2) adds inflation as a macroeconomic variable. (3) adds real GDP as a macroeconomic variable, and (4) includes real GDP and inflation. The robust standard errors are enclosed in parentheses. The data is winsorized at the 99% level to remove outliers that could affect the regression.

Table 5.1 shows that the lagged profitability variable is highly significant, with a coefficient of 0.42 for all the models. This finding confirms that a dynamic panel data specification with a lagged dependent variable is correct. The results of ROA from table 5.1 are in alignment with results from Canada of 0.4 (Killins and Mollick, 2020), MENA countries of

0.3 (Hesse and Poghosyan, 2016), and Goddard et al. (2011) which finds that the average persistence of profitability is 0.47 for banks in 19 developed economies.

The bank-specific control variables in table 5.1 behave as expected. The variable for capital adequacy, EA, has a significant positive relationship with ROA and a coefficient of 0.21. This result is in line with the findings of Berger (1995) that there is a positive relationship between capital availability and bank profitability. A positive relationship confirms that more capital will increase the return on assets. Furthermore, the regressions verify that modeling EA as endogenous was correct as the results are robust and in line with results from Athanasoglou et al. (2008). However, this result is not economically sound according to finance theory, as an endogenous relationship breaks with perfect capital markets. If the theory were to hold, a higher EA ratio would reduce equity risk, further reducing expected return. This effect would be amplified by a reduction in the debt ratio, which signals a lower credit rating and an increased cost of capital (Berger, 1995). Our results suggest that banks with higher equity ratios will increase profits despite the theory. According to Berger (1995), this could be the result of reduced costs related to a lower risk of financial distress. Furthermore, it will enable borrowing from uninsured funds to invest in riskier and more profitable projects.

Loan loss provisions in table 5.1 have a strong negative, and significant relationship with ROA as the coefficient lies between -0.43 and -0.45. When banks increase their exposure to unsecured assets, which generate little to no revenue, their return on assets is negatively affected. This is because the banks need to set aside more money for provisions in case of losses, which could be used in profit-generating activities (Ekinci and Poyraz, 2019). The sign of the findings corresponds with those of Athanasoglou et al. (2008). However, the magnitude is over four times more negative for Norwegian banks than in Greece. This indicates that the Norwegian banking system is more risk-averse and has a better screening of non-performing assets.

The share of non-interest income is negative in table 5.1, implying reduced profits for increased investment activities. However, it is insignificant for all regressions which matches the findings of Killins Mollick (2020).

5.2 What Is the Direct Effect?

Regression (1) in table 5.1 shows an insignificant effect of oil price shocks. This could be because underlying effects in the variable are pulling in different directions. The model fit is weak with a significant AR(2) test statistic.

To find the direct effect of oil price shocks, we add inflation (2) and GDP (3) separately before we include both in regression (4). In the second regression, we find that both inflation and the oil shock become significant at the 10% level. Furthermore, the model fit is good with insignificant AR(2) and Hansen statistics. Both variables have different signs, with inflation pulling in the opposite direction from the oil measure. The coefficient for the oil shock is more negative in regression (2) than in (1), which implies that inflation captures some of the underlying positive effects in the oil measure. A negative direct effect of a positive oil shock is contrary to previous findings in oil-exporting countries (Hesse and Poghosyan, 2016; Killins and Mollick, 2020). However, it is in line with a paper on Turkey, a net oil importer, where a negative direct effect was found (Katircioglu et al., 2020).

Regression (3) aims to show the direct effect of including GDP as a macroeconomic variable. We find no significance in the oil measure, which indicates either too much noise or that GDP does not explain enough of the underlying macroeconomic effect. The AR(2) test is also significant, signaling a poor model fit. However, the direct effect is still negative, which substantiates the sign of the oil shock for all the models. When including both variables in regression (4), the direct effect reclaims the 10% significance from regression (2) with an equal negative magnitude. Furthermore, both tests indicate a good model fit.

5.3 What Is the Indirect Effect?

The indirect effect on profitability captures the underlying macroeconomic variations in the oil measure. We expect that bank profitability should respond positively to improved economic conditions and price growth (Hesse and Poghosyan, 2016). From regressions (2-4) in table 5.1, we observe that both inflation and GDP are positive. However, only inflation is significant and positive in regression (2). The findings coincide with Hesse and

Poghosyan (2016), who found a significant and positive effect for inflation but not for GDP. Moreover, they found inflation to be the source of the explanatory power in the oil measures. By including inflation, they removed the direct effect of oil shocks, proving a link with the indirect macroeconomic channel.

There is only evidence of a significant direct effect in our regressions after adding inflation in regressions (2) and (4) in table 5.1. We add both inflation and GDP in the latter, where neither is significant. This could be because they correlate with each other.

These findings entail that both a direct and an indirect effect are present in our model and that inflation is a better representation of the indirect effect than real GDP growth. As these results are contrary to results from the literature, we want to explore what causes the negative effect between oil shocks and bank profitability. First, we want to differentiate between earnings from trading activity and loans.

5.4 What Is the Effect of Non-interest Income?

In the following models, we want to investigate the indirect effect between the oil measures and the share of non-interest income through their interaction terms. As the Norwegian stock exchange is heavily weighted by oil stocks we hypothesize that banks with a high share of non-interest income should respond positively to an increased oil price. The regressions are similar to those of Killins and Mollick (2020) because it is of interest to analyze and compare the same effect in another oil-exporting economy.

The results are presented in table 5.2 and show our three regressions for oil price shocks. Regression (1) includes oil price change (*Deltaoil*), (2) shows the deviation from the Hewlett-Prescott filter (*HP100*), and (3) displays the deviation between the 12-month forward rate and the oil price (*Forward*). The first variables are bank-specific controls, inflation, and the interaction terms between oil price shocks and SNONII. As argued in the previous regression, inflation captured most of the underlying indirect effect in the oil measure. Including both GDP and inflation removed the explanatory power of the latter, which is why inflation is the only macroeconomic variable in the following regressions.[7]

[7] Regressions on ROA using the interaction between GDP and oil price shocks are provided in table A3.6 in the Appendix

Table 5.2: Regressions on ROA Using an Interaction Term Between SNONII and Oil Measures

	(1) ROA	(2) ROA	(3) ROA
L.ROA	0.452***	0.441***	0.455***
	(0.0844)	(0.0869)	(0.101)
EA	0.215***	0.213***	0.197***
	(0.0608)	(0.0607)	(0.0650)
LLP	-0.410**	-0.413**	-0.387**
	(0.166)	(0.161)	(0.169)
SNONII	-0.000751	0.00114	0.000162
	(0.00927)	(0.00944)	(0.00938)
INFLATION	0.109*	0.105*	0.0600
	(0.0604)	(0.0526)	(0.0533)
DELTAOIL	-0.0546***		
	(0.0193)		
SNONIIxDELTAOIL	0.155**		
	(0.0667)		
HP100		-0.0388**	
		(0.0163)	
SNONIIxHP100		0.116**	
		(0.0548)	
FORWARD			-0.00236
			(0.00259)
SNONIIxFORWARD			0.00904
			(0.00935)
Constant	-0.0169**	-0.0170***	-0.0141**
	(0.00625)	(0.00609)	(0.00613)
Observations	241	241	241
No. of instruments	30	30	30
AR2 (p-value)	0.725	0.701	0.170
Hansen-J (p-value)	0.227	0.202	0.261

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.010

Table 5.2 models three system GMM regressions on bank profitability with controls (capitalization, loan loss provisions, share of non-interest income), inflation, oil measures, and interaction terms. The regressions use different oil measures. Regression (1) uses the change in the oil price (Deltaoil) along with its interaction with the share of non-interest income (SNONII). (2) uses the deviation from a smoothed trend (HP100), along with its interaction with SNONII. (3) uses the deviation from the forward price (FORWARD), along with its interaction with SNONII. Robust standard errors are enclosed in parentheses. The data is winsorized at the 99% level to remove outliers that could affect the regression.

In both the first and the second regression in table 5.2 we find a significant and negative direct effect of an oil price shock, alongside a significant and positive interaction with SNONII. Regression (3), using the forward deviation, has no significance but the signs are the same. This signals robustness in regressions (1) and (2). We do not give much importance to the insignificance in regression (3), as the forward rate may be a less reliable measure[8]. Lastly, all three regressions demonstrate good Hansen and AR(2) statistics.

The direct effect is more negative than in table 5.1, indicating that the interaction term has extracted some of the increased trading effects of the oil price shock. This would explain why the interaction term is positive. These findings correspond to those by Killins and Mollick (2020). However, their direct effect was positive when including an interaction term between oil shocks and SNONII.

To interpret the interaction term, we will investigate the marginal effects of oil shocks on ROA for different levels of SNONII. As in the previous regression, we use *HP100* as the measure for oil price shocks. Figure 5.1 displays the marginal effects.

Figure 5.1: Effect of Oil Price Shocks on Bank Profitability for Different Shares of Non-interest Income

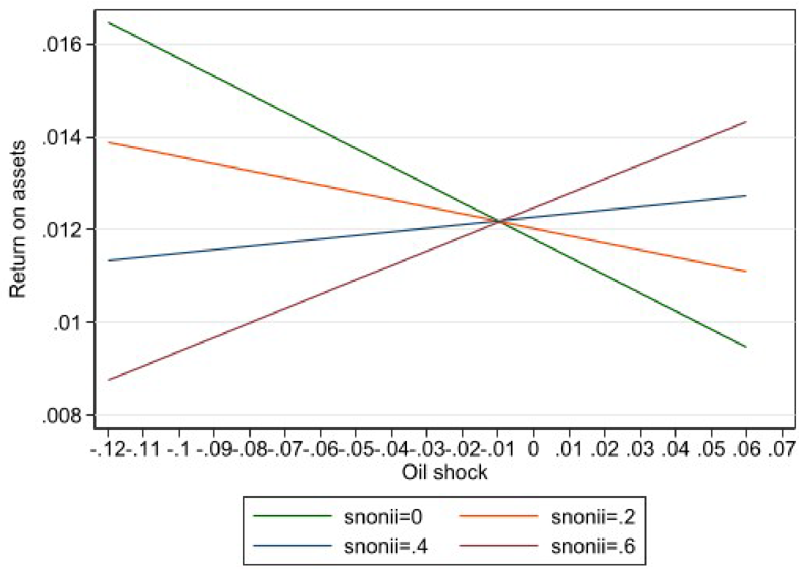

Figure 5.1 displays a marginal plot of the interaction between the share of non-interest income (SNONII) and oil shocks on bank profitability. Oil shocks are shown along the x-axis. Return on assets lay along the y-axis. The graphs are different levels of SNONII. The plot is made using marginal effects from equation 4.1

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[8]We argued in the data section that the forward rate might contain premiums which could affect its reliability

Figure 5.1 shows four different lines for different shares of non-interest income in the banks' revenue stream. If the share is 0, their only income is interest related and the bank is represented by the green line. If the share is 0.6, the bank is represented by the purple line. For higher levels for SNONII, the line increases towards the right, and positive oil price shocks will have a more positive effect on ROA. We observe a cutoff at a SNONII of 34%. Banks below this percentage have decreasing profitability for positive oil price shocks, and banks above show increasing profitability. The opposite is true on the negative side of the plot, where high SNONII banks suffer from negative shocks to the oil price. These results are in line with the findings of Hesse and Poghosyan (2016), who found that positive oil price shocks have a positive relationship with investment banks.

The findings indicate that banks that get most of their revenue from interest income are negatively affected by an increased oil price. We want to explore if there is an indirect effect through macroeconomic variables that causes this relationship.

5.5 What Is the Effect of Inflation?

In table 5.2 we found a positive, indirect effect of oil price shocks on profitability through the share of non-interest income. However, oil-price shocks were also negative and significant through the direct channel. This link is contrary to what was shown by Killins and Mollick (2020), which is why we investigate further. Based on the finding of Hesse and Phoghosyan (2016), oil price shocks should only have an indirect effect through macroeconomic variables. Therefore, we want to test this using equation 4.1 with an interaction term between inflation and oil price shocks. We aim to draw out the correlation between the two variables. Table 5.3 displays the results with the appropriate tests and instrument count.

Table 5.3: Regression on ROA Using an Interaction Term Between Inflation and Oil Measures

	(1) ROA	(2) ROA	(3) ROA
L.ROA	0.422*** (0.0902)	0.425*** (0.0913)	0.457*** (0.0967)
EA	0.205*** (0.0741)	0.213*** (0.0726)	0.206*** (0.0654)
LLP	-0.395** (0.189)	-0.400** (0.192)	-0.407** (0.166)
SNONII	-0.00118 (0.0104)	-0.00137 (0.0102)	-0.00203 (0.00979)
INFLATION	0.114* (0.0663)	0.0689 (0.0694)	-0.0327 (0.0829)
DELTAOIL	0.0522*** (0.0158)		
INFLATIONxDELTAOIL	-2.200*** (0.543)		
HP100		0.0454*** (0.0115)	
INFLATIONxHP100		-2.051*** (0.656)	
FORWARD			0.0119*** (0.00389)
INFLATIONXFORWARD			-0.491** (0.188)
CONSTANT	-0.0150** (0.00726)	-0.0146* (0.00719)	-0.0117** (0.00572)
Observations	241	241	241
No. of instruments	30	30	30
AR2 (p-value)	0.259	0.264	0.122
Hansen-J (p-value)	0.120	0.151	0.213

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.010

Table 5.3 models three system GMM regressions on bank profitability with controls (capitalization, loan loss provisions, share of non-interest income), inflation, oil measures, and interaction terms. The regressions use different oil measures. Regression (1) uses the change in the oil price (Deltaoil) along with its interaction with inflation. (2) uses the deviation from a smoothed trend (HP100), along with its interaction with inflation. (3) uses the deviation from the forward price (Forward), along with its interaction with inflation. Robust standard errors are enclosed in parentheses. The data is winsorized at the 99% level to remove outliers that could affect the regression.

In contrast to table 5.1 and table 5.2, we now have a positive direct effect on ROA. As the interaction terms with inflation are highly negative, we conjecture that the oil measures' indirect macroeconomic effect has been extracted. The direct effect remaining in the oil measures could be the positive effect of more lending to the oil sector, business activity, and increased liquidity (Sodeyfi and Katircioglu, 2016). The model fit is strong with Hansen statistics in the optimal range and insignificant AR(2) tests.

The negative coefficient for the interaction term indicates that a positive oil price shock would have a significant negative effect on bank profitability for higher levels of inflation. We illustrate this through marginal effects for different levels of inflation in figure 5.2.

Figure 5.2: Effect of Oil Price Shocks on Bank Profitability for Different Levels of Inflation

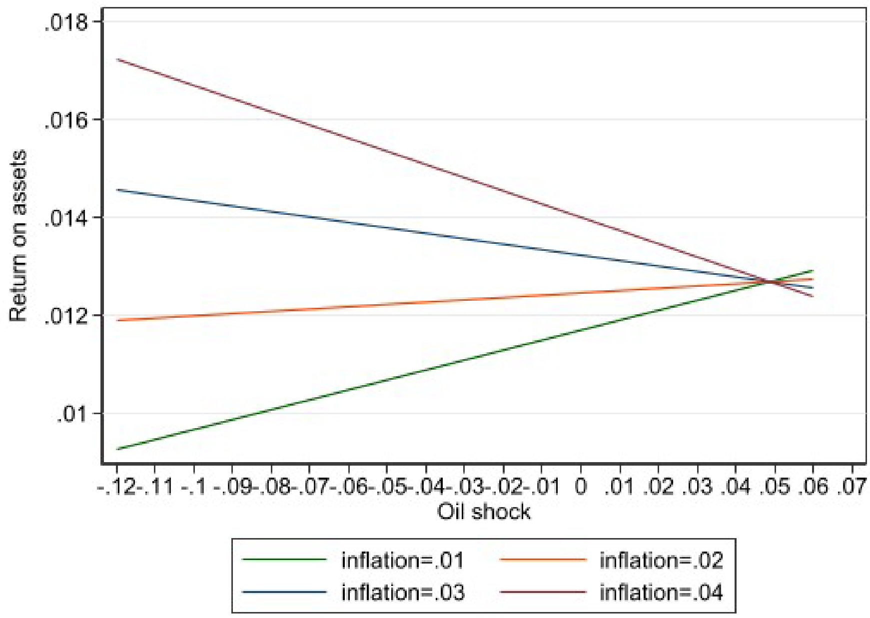

Figure 5.2 displays a marginal plot of the interaction between inflation and oil price shocks on bank profitability. Oil price shocks are shown along the x-axis. Return on assets lay along the y-axis. The graphs show different levels of inflation. The plot is made using marginal effects from equation 4.1

The plot shows the effect on ROA (y-axis) from an oil price shock (x-axis) for different levels of yearly inflation. When inflation increases, the slope of the curve becomes more downward sloping, indicating a more negative effect on ROA for positive oil price shocks. If inflation is above 2.3%, oil price shocks will negatively affect ROA. What causes this effect is unclear from this regression and needs to be investigated further.

5.6 What Causes the Negative Indirect Effect?

We hypothesize that the negative indirect effect of oil shocks is related to the banks' loan portfolio. Further, the only other negative variable is loan loss provisions, which means that profits decrease when banks have to offset more funds for losses. Our results in table 5.3 showed that a positive oil price shock would be negative for ROA when inflation is high. Hence, we wanted to test the same interaction between inflation and oil shocks on loan loss provisions.

5.6.1 Loan Loss Provisions Model

The model we want to run uses loan loss provisions (LLP) as the dependent variable instead of the return of assets (ROA). To investigate this, we use the model from equation 5.1.

$$LLP_{it} = \beta_0 + \beta_1 LLP_{it-1} + \beta_2 bank_{it} + \beta_3 macro_{it} + \beta_4 oil_t + \beta_5 (oil \times macro_i)_t + \varepsilon_{it} \quad (5.1)$$

As in equation 4.1, the model implements a lagged dependent variable because of expected persistence in provisions (Athanasoglou et al., 2008). The control variables are the same, along with the oil measures and the interaction term between oil and the macroeconomic variable. We no longer treat capital adequacy as endogenous, meaning that we treat all variables except for the lagged dependent variable as exogenous. This means they have one instrument each, together with all available lags for the lagged dependent variable.

5.6.2 Results of the Loan Loss Provisions Model

When running the regression from equation 5.1 we get a poorly specified and insignificant model in table A3.1. However, looking at figure 3.2 we discovered that three banks in our sample (Komplett bank, Instabank, and BraBank) were causing a disturbance through abnormally large loan loss provisions. Their business model is heavily reliant on risky loans, which makes them diverge from the sample when studying loan loss provisions. By removing the problematic banks, we get an accurately specified model in table 5.4. [9]

[9] The signs and magnitude of the coefficients remain the same if we include the three banks, albeit with insignificant results. The regression outputs of the LLP model, including the problematic banks and the outputs of table 5.2 and 5.3 excluding the banks, are found in table A3.1, A3.2 and A3.3, respectively.

Table 5.4: Regressions on LLP Using an Interaction Term Between Inflation and Oil Measures

	(1) LLP	(2) LLP	(3) LLP
L.LLP	0.127	0.147	0.273*
	(0.118)	(0.122)	(0.136)
EA	-0.00529	-0.00606	-0.00491
	(0.00529)	(0.00527)	(0.00400)
SNONII	0.000137	0.000235	0.000335
	(0.00134)	(0.00131)	(0.00108)
INFLATION	-0.0556***	-0.0231	-0.0325**
	(0.0185)	(0.0167)	(0.0146)
DELTAOIL	-0.0278***		
	(0.00919)		
INFLATIONxDELTAOIL	1.103***		
	(0.355)		
HP100		-0.0164**	
		(0.00595)	
INFLATIONxHP100		0.629**	
		(0.246)	
FORWARD			0.00157
			(0.00114)
INFLATIONxFORWARD			-0.116**
			(0.0487)
CONSTANT	0.00257***	0.00186**	0.00198***
	(0.000769)	(0.000695)	(0.000494)
Observations	223	223	223
No. of instruments	15	15	15
AR2 (p-value)	0.377	0.361	0.664
Hansen-J (p-value)	0.147	0.141	0.240

Standard errors in parentheses

* p<0.10, ** p<0.05, *** p<0.010

Table 5.4 models three system GMM regressions on loan loss provisions with controls (capitalization, loan loss provisions, share of non-interest income), inflation, oil measures, and interaction terms. The regressions use different oil measures. Regression (1) uses the change in the oil price (Deltaoil) along with its interaction with inflation. (2) uses the deviation from a smoothed trend (HP100), along with its interaction with inflation. (3) uses the deviation from the forward price (Forward), along with its interaction with inflation. Robust standard errors are enclosed in parentheses. The data is winsorized at the 99% level to remove outliers that could affect the regression.

Contrary to the literature, LLP does not seem to be persistent in table 5.4, as the lagged dependent variable is insignificant. Neither EA nor SNONII appears to affect loan loss provisions as both coefficients are insignificant. Inflation is significant and negative in regression (1) and (3), albeit with a small magnitude. The direct effect of oil shocks on LLP is also negative and significant, implying that an increased oil price will decrease loan loss provisions and increase bank profitability. These results correspond to our findings from table 5.3, where the direct effect of a positive oil price shock increased ROA.

The indirect effect through inflation in table 5.4 is significant and highly positive for regression (1) and (2). Regression (3) provides a negative coefficient for the interaction term. As the oil measure using forward deviations is not significant and has proved unreliable in table 5.1 and 5.2, we do not give it any importance. A positive indirect effect on LLP through inflation in table 5.4 matches the negative indirect effect on ROA in table 5.3. We can interpret this relationship through the marginal plot in figure 5.3.

Figure 5.3: Effect of Oil Price Shocks on Loan Loss Provisions for Different Levels of Inflation

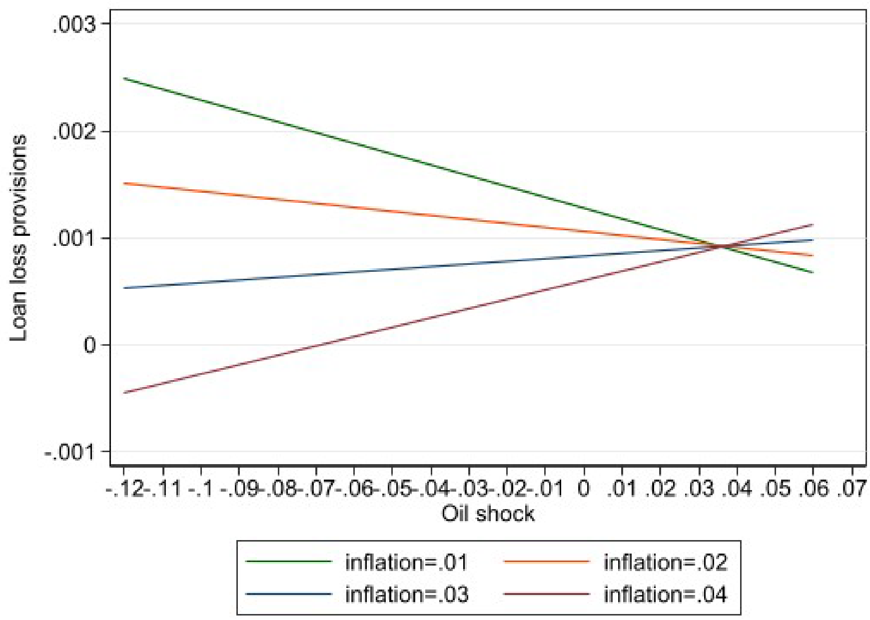

Figure 5.3 displays a marginal plot of the interaction between inflation and oil price shocks, on loan loss provisions. Oil price shocks are shown along the x-axis. Loan loss provisions lay along the y-axis. The graphs show different levels of inflation. The plot is made using marginal effects from equation 5.1

A positive oil price shock will increase loan loss provisions for higher inflation levels. This effect is reflected in table 5.3 as reduced profitability. These findings corroborate the story that the impact on LLP reduces ROA in table 5.3.

The banks are exposed to both non-financial businesses in Norway and consumers. We ran a separate regression on ROA for different sectors on the mainland and found that a positive oil price shock increases their profitability[10]. The results indicate that businesses on the mainland are positively affected by an oil price shock. This finding leads us to believe that the increased loan loss provisions following high inflation and an oil price shock are related to consumer debt.

5.7 Has COVID-19 Had an Impact?

The previous results have assumed that the relationship between the control variables, oil shocks, inflation, and bank profitability was not affected by the pandemic in 2020. This assumption is potentially false because COVID-19 was a black swan event that caused a dramatic drop in oil demand and widespread disruption in financial markets (Gharib et al., 2021). Therefore, we ran the models from table 5.2, 5.3 and 5.4 again, using the *HP100* oil measure and excluding observations for 2020. We present the results in table 5.5.

[10]see table A3.5 in the Appendix

Table 5.5: Regressions on ROA and LLP Excluding the Year 2020 in the Dataset

	(1) LLP	(2) ROA	(3) ROA
L.ROA		0.488***	0.470***
		(0.118)	(0.0864)
L.LLP	0.210*		
	(0.123)		
LLP		-0.0881	-0.223
		(0.191)	(0.201)
EA	-0.00513	0.105	0.181**
	(0.00477)	(0.0784)	(0.0827)
SNONII	-0.000337	0.00479	0.00575
	(0.00122)	(0.00722)	(0.00995)
INFLATION	-0.0392**	0.120	0.0989*
	(0.0151)	(0.0805)	(0.0577)
HP100	-0.0339***	0.0489**	-0.0459**
	(0.00913)	(0.0186)	(0.0203)
INFLATIONxHP100	1.397***	-2.060*	
	(0.366)	(1.021)	
SNONIIxHP100			0.138**
			(0.0658)
CONSTANT	0.00213***	-0.00800	-0.0157*
	(0.000633)	(0.00799)	(0.00782)
Observations	201	216	216
No. of instruments	15	27	30
AR2 (p-value)	0.586	0.166	0.824
Hansen-J (p-value)	0.256	0.0953	0.193

Standard errors in parentheses

* p<0.10, ** p<0.05, *** p<0.010

Table 5.5 models three system GMM regressions on bank profitability. The model excludes the year 2020 to remove the effect of the Covid 19 pandemic. Regression (1) shows a regression on loan loss provisions excluding banks with high loan loss provisions. It includes the control variables capitalization and share of non-interest income, inflation, the oil shock (HP100), and its interaction with inflation. Regression (2) displays a regression on profitability with the controls (capitalization, loan loss provisions, share of non-interest income), inflation, the oil shock (HP100), and its interaction with inflation. (2) displays a regression on profitability with the controls (capitalization, loan loss provisions, share of non-interest income), inflation, the oil shock (HP100), and its interaction with SNONII. (2) Robust standard errors are enclosed in parentheses. The data is winsorized at the 99% level to remove outliers that could affect the regression.

The regressions in table 5.5 are similar to our preliminary results. Regression (1) corresponds to regression (2) in table 5.4, regression (2) corresponds to regression (2) in table 5.3 and regression (3) corresponds to regression (2) in table 5.2. The lagged dependent variable in (1) is now significant, indicating that LLP is persistent. This implies that COVID-19 influenced the lagged dependent variable in table 5.4. The other variables in (1) maintain their sign and significance, which means that the effect in table 5.4 remains the same.

The results of the oil measures and their interactions in regressions (2) and (3) have the same interpretation as in table 5.1 and 5.2. However, loan loss provisions in both regressions and capital adequacy in regression (2) are now insignificant. Getting the same results from the oil shocks when we exclude 2020 indicates that our findings are robust and not affected by the pandemic.

We used orthogonal deviations instead of differencing to maintain the model's validity after removing one year from the data. This implies using the difference between the present value and the average of future values of the variable as differences. The method is used when there are gaps in the data, leading to missing instruments with a difference approach (Roodman, 2009).

6 Discussion

6.1 Analysis

This thesis has studied the direct and indirect effects of oil price shocks on bank profitability in Norway. Our main findings come from the interactions between the share of non-interest income and inflation. We used these interactions to determine which revenue stream is affected, what causes the relationship, and the magnitude of the impact.

Firstly, we find that the structure of the bank influence how it is affected by oil price shocks. If much of the profit comes from financial and trading-related activities, the bank will be positively affected by a higher oil price. These findings are in line with research by Calmès and Théoret (2010) and Houston and Stiroh (2006), who found that non-interest income reacts to shocks in macroeconomic aggregates. A bank with considerable exposure to the oil sector in terms of ownership will increase its financial revenue following an increase in the oil price. Further, the use of marginal effects lends insight into how large the share of non-interest income must be before the bank benefits. Figure 5.1 shows that the cutoff for a positive impact on ROA is at 34% share of non-interest income. This is above the average of 27% for Norwegian banks. The findings indicate that most of the Norwegian banking sector will be negatively affected by an increased oil price, implying a reduction in interest income.

These implications are important for financial regulators and executives in the banking industry. This is because regulators need to account for non-interest income instead of only looking at credit exposure in their risk assessment. The central bank should consider regulations on banks' trading activities when assessing financial stability. Especially in periods with both low interest rates and required rate of return. This could increase risk-seeking behavior and the prices of financial assets (Norges Bank, 2021b).

Banks with high levels of trading activity could therefore be a source of financial instability as their earnings are less regulated and more sensitive to shocks (Norges Bank, 2021b). However, the share of non-interest income (SNONII) for Norwegian banks is not large. Figure 3.4 displays that SNONII has decreased over the last ten years. Additionally, from table 5.2 we observe that the indirect effect of oil price shocks through SNONII does not have a big impact on bank profitability. When SNONII is 27%, a big negative oil price shock of 10% will account for a 0.08 percentage point decrease in ROA. The magnitude of this effect needs to be studied further to determine whether regulatory measures are required.

Secondly, this thesis adds to the literature by finding a positive direct effect and a negative indirect effect of oil price shocks on bank profitability. The direct effect is positive when we account for inflation. A higher oil price would increase activity for oil and gas-related businesses, which implies more business opportunities for banks. We assume that this is the cause of the positive direct effect of oil price shocks. The coefficient for the direct effect from table 5.3 lies between 0.045-0.052[11]. The direct effect is marginal, as a 10% positive oil price shock will amount to a 0.005 percentage point increase in ROA. Because the magnitude of the direct effect is small, it has little significance for policymakers other than to confirm that Norwegian banks have limited credit exposure to the oil sector. Our results align with the central bank's assessment that the banks are robust to loan losses in this industry (Hjelseth et al., 2016).

Thirdly, the results in table 5.3 and 5.4 show evidence of oil price shocks impacting banks indirectly through inflation. The joint effect of high inflation and a subsequent oil price shock will result in a net reduction in profitability. These findings diverge from those of Hesse and Poghosyan (2016), who found a strictly positive indirect effect through inflation. However, they did not account for the non-linearity of the effect by interacting the variables.

We explore this by looking at oil shocks for different levels of inflation. This thesis finds that a positive oil price shock will reduce profitability when inflation is high. Whereas for low inflation, banks will benefit from a positive oil price shock. Using equation 4.1, we find that a positive oil shock of 6 percent, when inflation is at 4 percent, will decrease bank profitability by 0.22 percentage points. The purple line could exemplify this in figure 5.2. If ROA is 1.4%, a decrease of 0.22 percentage points will equal a reduction in ROA of 15.7%. A positive oil price shock will substantially reduce bank profitability in a high inflation environment.

Our results imply that the negative indirect effect on profitability may be related to

[11]Not accounting for the regression using *Forward* as the oil measure

consumer debt. The consumer debt level in Norway is high compared to other countries, and consumers constitute 38% of bank loans[12]. We hypothesize that consumers' real income is affected when oil price shocks coincide with high inflation, which may drive the negative effects.

An explanation for a reduction in real income could be that an oil price shock would not significantly impact real GDP growth while it increases inflation. Unaffected real GDP growth would be a consequence of Norway's fiscal policy of investing oil revenues in a sovereign wealth fund instead of into the domestic economy. Changes in the oil price will thus be absorbed by the fund, limiting the economic exposure to shocks (Gjedrem, 2002). This policy is contrary to a country such as Canada, where the revenues are used to fund the government (Canada's Oil and Natural Gas Producers, 2022). Increased government spending will strengthen GDP, which will increase bank profitability through more loans, fewer defaults, and higher trading activity (Hesse and Poghosyan, 2016). In contrast, Norwegian fiscal policy is designed to limit the influence of oil price shocks on GDP (Norges Bank, 2016).

Higher short-term inflation would follow from increased energy prices (Eika, 2014). This will be balanced by an appreciated exchange rate and cheaper imported goods in the long run (Alekhina and Yoshino, 2018). However, we hypothesize that the short-term effect is most prevalent in our model from table 5.3. Increased energy prices will raise costs for businesses and consumers through higher prices for heating and fuel. Higher short-term inflation will to a greater extent affect consumers than businesses, as wages are slow to respond when there is a price shock (Kessel and Alchian, 1960). Furthermore, companies can pass their increased expenses on to consumers by raising their prices. Our findings of a positive effect of an oil price shock on mainland businesses support this reasoning (see table A3.5 in the Appendix).

The joint effect of the shock not increasing GDP but raising the cost of living could reduce disposable income. This would influence consumers' ability to service their loans, necessitating larger loan loss provisions and a reduction in profitability.

The negative effects of increased inflation are especially strong in countries that have

[12]Consumer debt level is calculated based on bank data from Statistics Norway using the latest updated numbers from March 2022: Statistics Norway (2022a)

experienced low price growth (Andrés and Hernando, 1999). As Norway has experienced 2.2% inflation over the last decade, it would follow that the country is vulnerable to increased energy prices (Statistics Norway, 2022b). Higher inflation would affect capital accumulation and total factor productivity, limiting growth (Andrés and Hernando, 1999).

High inflation coupled with an oil shock would further induce a more risky economic environment because the central bank has to increase the interest rate. Higher rates would hurt consumers and businesses through reduced activity and lending. This effect is amplified because high energy prices limit future growth predictions, as energy prices are a factor in GDP growth (Rühl and Erker, 2021). These factors could make loans riskier, which impacts bank profitability.

By running a regression on loan loss provisions in table 5.4, we found evidence for the negative effects of high inflation followed by an oil shock. The interaction between these effects was highly positive. This implies that the banks consider their loan portfolio riskier and set aside more funds for potential losses. These findings support the arguments mentioned above that increased prices and a weaker economic outlook will increase credit risk, which will reduce bank profitability.

From figure 5.2 we observe that when inflation is at 2%, oil price shocks will have a weak positive impact on bank profitability. This indicates that if the central bank achieves its inflation target, oil shocks will not be a real threat to financial stability in the long run.

If oil price shocks reduce disposable income, there may be problems in the short run. As stated earlier, deposits are the most important funding source for banks. A threat to deposits through reduced disposable income may cause disturbances in the banks' ability to lend money (Norges Bank, 2021b). However, the banks have built up capital to withstand short-term shocks (Hjelseth et al., 2016). Further, the central bank ensures that banks have enough liquidity through capital requirement regulations.

Since inflation targeting was introduced in 2001, the central bank has managed to hold inflation levels low and stable around the target of 2% (Norges Bank, 2017). From figure 3.5 we observe that our dataset includes three years where inflation is substantially higher than the inflation target. This may have contributed to the negative effect of oil price shocks from table 5.1. The overall impact of oil price shocks on bank profitability could be different if the dataset had a longer time frame.

We assess that oil price shocks will not significantly impact bank profitability in normal market conditions. However, in extraordinary market conditions with high inflation, a shock could substantially impact the banks' profits. This may be a risk factor for the financial system. Even so, regulations from the central bank will ensure the solidity of financial institutions. A relatively substantial reduction in profitability in a given year will not affect financial stability to a large degree. However, future studies should investigate these effects further.

6.2 Limitations

6.2.1 Data

The bank-specific data obtained from the Orbis database was limited to the time frame between 2012 and 2021. This period contains some unique events concerning the oil price. In particular, the 2014 oil price crash and COVID-19. The lack of a longer time series may be skewing the data towards these events. Furthermore, we could only obtain an unbalanced dataset as some banks did not operate from 2012, and some banks stopped reporting or went out of business during the period. In that sense, there is a bias in the Orbis database towards specific years. A bigger sample would therefore be preferable.

Moreover, our sample consists of mostly Norwegian banks, which do not represent the entire market[13]. Foreign branches constitute 24% of the Norwegian market for loans, which could have been valuable in this analysis (Michael H. Cook, 2020). However, we could not find sufficient data limited to their Norwegian branches.

The calculated oil measures are subjected to limitations as there is no clear definition of how to measure oil price shocks. We followed the approach suggested by Hesse and Poghosyan (2016), but there could be other more accurate methods. Furthermore, our forward deviation measure is uncertain as we only have access to monthly data compared to daily when calculating the other two.

[13]Our dataset includes Nordea Direct Bank ASA which is the Norwegian branch of the Danish Nordea Group

6.2.2 Methodology

We implemented system GMM using the methodology Roodman (2009b) developed for Stata.[14]. He emphasizes that using system GMM in Stata can be a black box because the method is complicated and can produce invalid estimates. This could be a limitation in our results. However, we followed his paper on how to implement the method correctly (Roodman, 2009a).

Furthermore, we based our specifications for the variables on previous research and proven methods. We found no literature on how to model oil shocks in system GMM correctly. Therefore, we chose the specifications that resulted in the best Hansan-Sargan statistics. This approach was based on Athanasoglou et al. (2008) who also specified certain variables according to model fit. Even so, there could be room for improvement in the implementation.

The number of instruments was limited to the available lags and the recommendation of not having more instruments than units. The choice of how many lags to use for the endogenous variables was based on what resulted in the better model fit. This could vary based on trends in the data, which is a limitation if our approach were to be reproduced on another dataset.

6.3 Path Forward

This thesis uses a system GMM estimator to remove error terms and endogeneity problems. However, other methods could provide further insight. Kilian (2009) introduced using a Vector Autoregressive (VAR) approach to study oil shocks. As the data in this thesis contains multiple time-series variables, a VAR approach may expand upon how the variables affect one another over time. Further research could use this method to improve the understanding of our results.

The data employed was limited to 10 years. It could be useful for future research to look at a more extended time series with a broader section of banks. For instance, our results may be somewhat driven by policy implications. We encourage future research to do an event study on the policy effect of introducing the sovereign wealth fund in Norway. It

[14]Stata is statistical software for data science. The software is found here

would also be interesting to see if there was a similar indirect effect between inflation and oil price shocks before inflation targeting was introduced. Lastly, doing an event study exploring the Norwegian bank crisis in the early 90s would be of interest. The crisis laid the groundwork for many of the regulations and the government's involvement in the banking sector (Rolf Marius Torsvik, 1999). Studying policy changes go beyond the scope of this thesis.

Furthermore, future studies should investigate the direct effect more closely, for instance, by differentiating between banks by their business model and area of business. Hesse and Poghosyan (2016) found evidence that oil shocks impact banks differently based on their business model. It would be interesting to go beyond the share of non-interest income and differentiate between investment and commercial banks in Norway. A geographical distribution based on where the oil sector is most active could also be of interest. Studying this would require a broader selection of financial institutions and their geographical location. This thesis is limited to commercial banks and does not account for different branches within each bank.

We argue that oil shocks are making loans riskier and thus reducing profitability. This link needs to be backed up by further research. For instance, one could look at the risk profile of consumer debt and see how oil shocks directly affect their default rate. Furthermore, we argue that consumers' real income has been reduced due to the joint effect of increased inflation and an oil price shock. This claim needs to be researched further. Studying the impact of oil price shocks on real income goes beyond the research questions in this thesis.

Finally, events during the first and second quarters of 2022 have seen inflation of over 5%[15] and an oil price shock of over 50% (The World Bank, 2022). Further work should study this period in light of our findings.

[15]Number calculated using CPI gathered from Statistics Norway (2022b)
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7 Conclusion

This thesis uses interaction variables in a dynamic panel model to understand if oil price shocks affect bank profitability. The method controls for persistence and endogeneity by using a system GMM estimator. We employ data from 33 commercial banks in Norway from 2012 to 2021. Our results have provided insight into the non-linear relationship between oil shocks, the economy, and banking. The implementation of this approach expands upon previous work.

This thesis finds supporting evidence for a positive effect of oil price shocks on bank profitability through trading activities. After accounting for inflation, we also find evidence for a positive direct effect from oil shocks on bank profitability. The direct effect is small but demonstrates that Norwegian banks are exposed to the oil sector through credit. Moreover, we find that an oil price shock negatively affects Norwegian bank profitability when inflation is high. The effect emerges from higher loan loss provisions due to riskier loans. This may be related to a reduction in real income, which increases the credit risk.

The findings show that oil price shocks affect bank profitability but to a limited extent. The financial system is highly regulated and structured to mitigate moderate shocks to the oil price. Even so, a more considerable shock in a high inflation environment could be a cause for concern due to high household debt. Furthermore, policymakers should pay attention to the share of non-interest income. If banks were to shift their business model to more nontraditional banking, our results indicate that the banks would be more dependent on the oil price. The findings in this thesis demonstrate that oil price shocks affect bank profitability directly and indirectly. However, it is not a major concern for financial stability in Norway.

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Appendix

A1 Appendix 1. Abbreviations

Table A1.1: Definitions of Abbreviations

Variable	Description
GMM	Generalized method of moments
GDP	Gross domestic product
NOK	Norwegian krone
CPI	Consumer price index
AR(2)	Arellano Bond test for second degree

Table A1.2: Variable Definitions

Variable		Calculation
ROA	=	$\text{ROA}_{it} = \frac{Profits\ \ before\ \ taxes}{Total\ \ assets}$
EA	=	$\text{EA}_{it} = \frac{Equity}{Total}$
LLP	=	$\text{LLP}_{it} = \frac{Loan\ \ loss\ \ provisions}{Gross\ \ loans}$
SNONII	=	$\text{SNONII}_{it} = \frac{Non-interest\ \ income}{Net\ \ income}$
DELTAOIL	=	$\Delta oil_t = \frac{\sum_{i=1}^{365}[\log(brent_{t,i})-\log(brent_{t-1,i})]\times 100}{365}$
HP100	=	$\text{HP}_t = \frac{\sum_{i=1}^{365}[\log(brent_{t,i})-\log(brent_{t-1,i}^{HP})]\times 100}{365}$
FORWARD	=	$\text{Forward}_t = \frac{\sum_{i=1}^{12}[\log(brent_{t,i})-\log(12m(F)_{t-1,i})]\times 100}{12}$
GDP	=	$\text{GDP}_t = \frac{GDP_t - GDP_{t-1}}{GDP_{t-1}}$
		$\text{GDP}_{annualized} = (1 + \frac{\sum_{t=1}^{4} GDP_t}{4})^4 - 1$
INFLATION	=	$\text{Inflation}_t = \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}}$

A2 Appendix 2. Banks

Table A2.1: List of Banks

Banks	
BN BANK ASA	SANTANDER CONSUMER BANK AS
BRABANK ASA	SBANKEN ASA
DNB BANK ASA	SOGN SPAREBANK
FANA SPAREBANK	SPAREBANK 1 HALLINGDAL VALDRES
HAUGESUND SPAREBANK	SPAREBANK 1 NORD-NORGE
INSTABANK ASA	SPAREBANK 1 NORDMORE
JAEREN SPAREBANK	SPAREBANK 1 OESTLANDET
KLP BANKEN AS	SPAREBANK 1 SMN
KOMPLETT BANK ASA	SPAREBANK 1 SORE SUNNMORE
LANDKREDITT AS	SPAREBANK 1 SOROST-NORGE
LANDKREDITT BANK AS	SPAREBANK 1 SR-BANK ASA
MELHUS SPAREBANK	SPAREBANKEN NARVIK
TOTENS SPAREBANK	SPAREBANKEN SOGN OG FJORDANE
NORDEA DIRECT BANK ASA	SPAREBANKEN SOR
OBOSBANKEN AS	SPAREBANKEN VEST
ODAL SPAREBANK	STOREBRAND BANK ASA
VOSS SPAREBANK	

A3 Appendix 3. Regressions

Table A3.1: Regressions on LLP Using an Interaction Term Between Inflation and the Oil Measures

	(1) LLP	(2) LLP	(3) LLP
L.LLP	0.751*** (0.140)	0.746*** (0.140)	0.784*** (0.109)
EA	0.0418 (0.0292)	0.0421 (0.0285)	0.0378 (0.0275)
SNONII	-0.00954* (0.00480)	-0.00957* (0.00472)	-0.00918* (0.00503)
INFLATION	-0.00498 (0.0649)	0.0107 (0.0593)	0.0227 (0.0932)
DELTAOIL	-0.0142 (0.0252)		
INFLATIONXDELTAOIL	0.679 (1.057)		
HP100		-0.0122 (0.0159)	
INFLATIONXHP100		0.603 (0.702)	
FORWARD			-0.000171 (0.00411)
INFALTIONXFORWARD			0.00513 (0.203)
CONSTANT	-0.000900 (0.00226)	-0.00126 (0.00246)	-0.00119 (0.00308)
Observations	241	241	241
No. of instruments	15	15	15
AR2 (p-value)	0.394	0.417	0.322
Hansen-J (p-value)	0.366	0.365	0.331

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.010

This table models three system GMM regressions on loan loss provisions with controls (capitalization, loan loss provisions, share of non-interest income), inflation, oil measures, and interaction terms. The regressions use different oil measures. Regression (1) uses the change in the oil price (DELTAOIL) along with its interaction with inflation. (2) uses the deviation from a smoothed trend (HP100), along with its interaction with inflation. (3) uses the deviation from the forward price (FORWARD), along with its interaction with inflation. Robust standard errors are enclosed in parentheses. The data is winsorized at the 99% level to remove outliers that could affect the regression. It uses all 33 banks collected from the Orbis database.

Table A3.2: Regressions on ROA Using an Interaction Term Between SNONII and the Oil Measures

	(1) ROA	(2) ROA	(3) ROA
L.ROA	0.0124	0.00919	-0.0206
	(0.104)	(0.110)	(0.131)
EA	0.0692**	0.0686**	0.0739**
	(0.0320)	(0.0303)	(0.0293)
LLP	-0.429**	-0.402*	-0.346*
	(0.189)	(0.209)	(0.173)
SNONII	0.0167**	0.0177***	0.0164***
	(0.00610)	(0.00631)	(0.00589)
INFLATION	0.0355*	0.0250	0.0263*
	(0.0209)	(0.0193)	(0.0139)
DELTAOIL	-0.0265**		
	(0.0119)		
SNONIIxDELTAOIL	0.0940**		
	(0.0440)		
HP100		-0.0168**	
		(0.00751)	
SNONIIxHP100		0.0681**	
		(0.0294)	
FORWARD			0.000413
			(0.00199)
SNONIIxFORWARD			0.00161
			(0.00727)
Constant	-0.000813	-0.000711	-0.000574
	(0.00339)	(0.00326)	(0.00257)
Observations	223	223	223
No. of instruments	30	30	30
AR2 (p-value)	0.324	0.364	0.470
Hansen-J (p-value)	0.285	0.267	0.212

Standard errors in parentheses
* $p<0.10$, ** $p<0.05$, *** $p<0.010$

This table models three system GMM regressions on bank profitability with controls (capitalization, loan loss provisions, share of non-interest income), inflation, oil measures, and interaction terms. The regressions use different oil measures. Regression (1) uses the change in the oil price (DELTAOIL) and the interaction with the share of non-interest income (SNONII). (2) uses the deviation from a smoothed trend (HP100), and the interaction to SNONII. (3) uses the deviation from the forward price (FORWARD), and the interaction to SNONII. Robust standard errors are enclosed in parentheses. The data is winsorized at the 99% level. The model excludes Komplett Bank, Instabank, and Bra Bank because of abnormal data.

Table A3.3: Regressions on ROA Using an Interaction Term Between Inflation and the Oil Measures

	(1) ROA	(2) ROA	(3) ROA
L.ROA	-0.0456 (0.0965)	-0.0547 (0.0940)	-0.0422 (0.107)
EA	0.0715** (0.0302)	0.0864*** (0.0299)	0.0864*** (0.0285)
LLP	-0.230 (0.200)	-0.227 (0.194)	-0.475** (0.181)
SNONII	0.0164*** (0.00596)	0.0155** (0.00586)	0.0151** (0.00625)
INFLATION	0.0680*** (0.0240)	0.0224 (0.0210)	-0.0177 (0.0159)
DELTAOIL	0.0449*** (0.0138)		
INFLATIONxDELTAOIL	-1.687*** (0.543)		
HP100		0.0296*** (0.00867)	
INFLATIONxHP100		-1.123*** (0.397)	
FORWARD			0.00647*** (0.00137)
INFLATIONxFORWARD			-0.247*** (0.0678)
CONSTANT	-0.000841 (0.00325)	-0.000913 (0.00341)	0.000122 (0.00286)
Observations	223	223	223
No. of instruments	30	30	30
AR2 (p-value)	0.422	0.432	0.431
Hansen-J (p-value)	0.307	0.329	0.237

Standard errors in parentheses
* $p<0.10$, ** $p<0.05$, *** $p<0.010$

This table models three system GMM regressions on bank profitability with controls (capitalization, loan loss provisions, share of non-interest income), inflation, oil measures, and interaction terms. The regressions use different oil measures. Regression (1) uses the change in the oil price (DELTAOIL) along with its interaction with inflation. (2) uses the deviation from a smoothed trend (HP100), along with its interaction with inflation. (3) uses the deviation from the forward price (FORWARD), along with its interaction with inflation. Robust standard errors are enclosed in parentheses. The data is winsorized at the 99% level to remove outliers that could affect the regression. The model excludes Komplett Bank, Instabank, and Bra Bank because of abnormal data.

Table A3.4: Regressions on ROA Excluding Banks With Abnormal Loan Loss Provisions, as Well as the Year 2020

	(1) ROA	(2) ROA
L.ROA	-0.0224 (0.0903)	0.0135 (0.0916)
EA	0.0614** (0.0275)	0.0611** (0.0282)
LLP	-0.379 (0.288)	-0.379 (0.247)
SNONII	0.0147** (0.00554)	0.0179*** (0.00644)
INFLATION	0.0784*** (0.0283)	0.0319 (0.0193)
DELTAOIL	0.0379*** (0.0134)	-0.0252* (0.0128)
INFLATIONxDELTAOIL	-1.431** (0.566)	
SNONIIxDELTAOIL		0.0919* (0.0487)
Constant	0.000226 (0.00280)	-0.000277 (0.00329)
Observations	201	201
No. of instruments	27	30
AR2 (p-value)	0.457	0.303
Hansen-J (p-value)	0.343	0.277

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.010

Table A3.4 models two system GMM regressions on bank profitability. The model excludes the year 2020 to remove the effect of the Covid 19 pandemic. The model also excludes Komplett Bank, Instabank, and Bra Bank because of abnormal data. Regression (1) displays the controls (capitalization, loan loss provisions, share of non-interest income), inflation, and the oil shock (HP100) along with its interaction with SNONII. (2) displays the controls (capitalization, loan loss provisions, share of non-interest income), inflation, and the oil shock (HP100) along with its interaction with inflation. Robust standard errors are enclosed in parentheses. The data is winsorized at the 99% level to remove outliers that could affect the regression.

Table A3.5: Regressions on ROA for Mainland Businesses

	ROA
L.ROA	0.780***
	(0.260)
LEVERAGE	-0.0835**
	(0.0348)
NIBOR	-0.0132
	(0.00827)
SIZE	-0.00208
	(0.00179)
TANGIBILITY	-0.00730
	(0.0206)
HP100	0.112**
	(0.0524)
CONSTANT	0.0677
	(0.0455)
Observations	136
No. of instruments	15
AR2 (p-value)	0.983
Hansen-J (p-value)	0.758

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.010

This table regresses control variables for leverage, interest rate, size, tangibility, and oil shocks on profitability for Norwegian mainland businesses. The control variables originate from a paper on the Norwegian mainland economy by Qureshi et al. (2020). The data consists of 17 non-financial business sectors in Norway from 2012-to 2020, including our oil measure and the NIBOR-rate. The non-financial business data was collected from SSB (2022), and the NIBOR data is from Bloomberg.

Table A3.6: Regression on ROA Using an Interaction Term Between GDP and Oil Measures

	(1) ROA	(2) ROA	(3) ROA
L.ROA	0.442***	0.439***	0.448***
	(0.103)	(0.101)	(0.104)
EA	0.228***	0.230***	0.223***
	(0.0662)	(0.0654)	(0.0653)
LLP	-0.443**	-0.446**	-0.443***
	(0.180)	(0.185)	(0.152)
SNONII	-0.00336	-0.00272	-0.00248
	(0.0104)	(0.0103)	(0.00986)
DELTAOIL	0.0262***		
	(0.00780)		
GDP	0.0133	-0.0137	0.00431
	(0.0294)	(0.0321)	(0.0540)
GDPxDELTAOIL	-1.520***		
	(0.449)		
HP100		0.0159**	
		(0.00636)	
GDPxHP100		-1.107***	
		(0.372)	
FORWARD			0.00397**
			(0.00152)
GDPxFORWARD			-0.241***
			(0.0761)
CONSTANT	-0.0144**	-0.0143**	-0.0136**
	(0.00591)	(0.00571)	(0.00601)
Observations	241	241	241
No. of instruments	30	30	30
AR2 (p-value)	0.0685	0.0698	0.0693
Hansen-J (p-value)	0.305	0.418	0.293

Standard errors in parentheses
* $p<0.10$, ** $p<0.05$, *** $p<0.010$

Table A3.6 models three system GMM regressions on bank profitability with controls (capitalization, loan loss provisions, share of non-interest income), GDP, oil measures, and interaction terms. The regressions use different oil measures. Regression (1) uses the change in the oil price (DELTAOIL) along with its interaction with GDP. (2) uses the deviation from a smoothed trend (HP100), along with its interaction with GDP. (3) uses the deviation from the forward price (FORWARD), along with its interaction with GDP. Robust standard errors are enclosed in parentheses. The data is winsorized at the 99% level to remove outliers that could affect the regression.

Figure A3.1: Effect of Oil Price Shocks on Bank Profitability for Different Levels of GDP

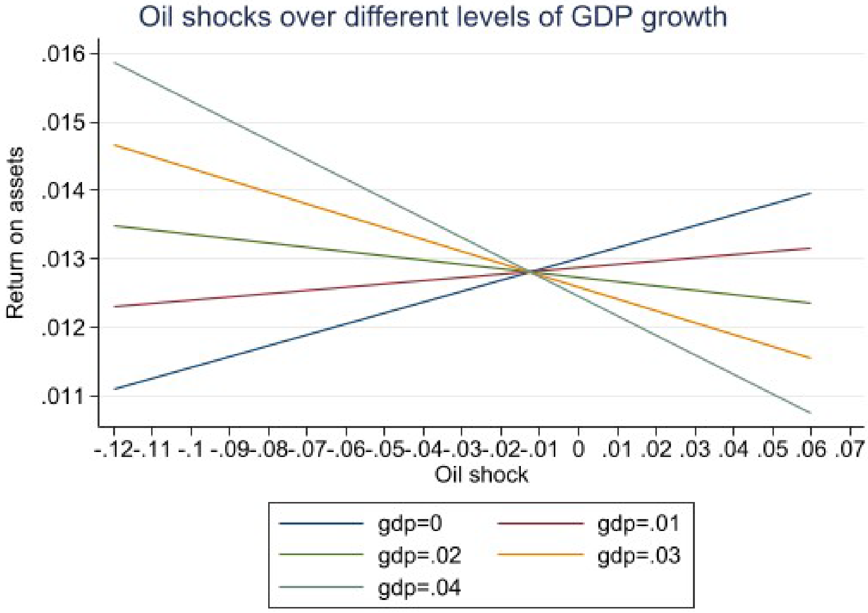

Figure A3.1 displays a marginal plot of the interaction between GDP and oil shocks, on bank profitability. Oil shocks are shown along the x-axis. Return on assets lay along the y-axis. The graphs are different growth rates of GDP. The plot is made using marginal effects from equation 4.1