Wealth Redistribution through Balance Sheet Revaluations

Evidence from Norway

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Abstract

This thesis investigates the impact of fluctuations in inflation, monetary policy, and oil prices on the balance sheets of Norwegian households across the wealth distribution. Using a Bayesian Structural Vector Autoregression model, this study simulates the shocks and assesses their transmission through the unexpected inflation and portfolio composition channel throughout the wealth distribution. The result shows that post an inflation shock, wealthier households initially experienced a temporary surge in wealth. In contrast, the poorest households show a steadier return to the pre-shock state due to their balance sheet predominantly comprising of debt. Furthermore, the impact of an interest rate increase shock showed that most households experienced a wealth decrease, while the poorest households' significantly increased. The oil price shock yielded results similar to the monetary policy shock, but that is highly ambiguous. The analysis is repeated with an extended model with the additional variables of the output gap and exchange rate, further strengthening the results of the two first shocks while providing even more dubious results for the oil price shock. These findings showcase the vulnerability of the poorer segments of the population to monetary shocks.

Keywords: Inequality, Wealth, Monetary Policy, Inflation, Household Heterogeneity

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List of Abbreviations

ARM Adjustable-rate Mortgage

BEAR Bayesian Estimation, Analysis and Regression

BPS Basis points

BSVAR Bayesian Structural Vector Autoregression

DSGE Dynamic Stochastic General Equilibrium

ECB European Central Bank

FED Federal Reserve

FRED Federal Reserve Economic Data

HFCS Household Finance and Consumption Survey

I-44 Import-weighted krone exchange rate

IRF Impulse Response Function

NOK Norwegian Krone

QE Quantitative Easing

SCF Survey of Consumer Finances

SOE Small Open Economy

SVAR Structural Vector Autoregression

SZR Sign- and Zero-restrictions

URE Unhedged Interest Net Exposures

VAR Vector Autoregression

ZLB Zero Lower Bound

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1 Introduction

Scholars have recently highlighted increasing income and wealth inequality in several advanced countries since the 1980s (Chancel, Piketty, Saez & Zucman 2022). To explain this trend, an interest in how inflation and monetary policy affect inequality has sparked as a reaction. This has been manifested as central banks, in recent years, have increasingly addressed distributional effects and inequality in their communications, which is a shift from prior practices (Bonifacio, Brandao-Marques, Budina, Csonto, Fratto, Engler, Furceri, Igan, Mano, Narita, Omoev, Pasrischa & Poirson, 2022). In response, a vast amount of research is being dedicated to examining how different economic factors, such as monetary policy, affect income inequality with the help of statistics based on income tax records. However, as wealth taxes are implemented much less than income taxes, this has caused a lack of reliable data, creating a gap in the literature regarding empirical research examining how different economic developments affect wealth inequality.

Despite living in a world with an abundance of data, we thus still miss fundamental information regarding wealth inequality. For example, even though governments worldwide provide annual economic growth statistics, they still seldom tell us how it is divided across the population. However, an exception to this is Norway, which, unlike many of its neighbouring countries, implements a wealth tax which makes it able to provide unique, reliable statistics regarding its population's wealth distribution. Furthermore, as they are not a part of the EU, they are relatively forgotten, which has led to less research on inequality in Norway compared to similar advanced economies.

This thesis thus aims to address the following research question:

How have fluctuations in inflation, monetary policy, and oil prices impacted the balance sheets of Norwegian households in different ways across the wealth distribution in recent years?

The research question will be answered by first applying a Bayesian Structural Vector Autoregression (BSVAR) model to simulate how the different shocks have affected the values of balance sheet categories in recent years. Then, by using information regarding holdings of asset classes and liabilities by different wealth groups, the effects of the shocks throughout the wealth distribution are obtained by multiplying the share of each balance sheet category for all wealth groups by the corresponding change in value given by the BSVAR's Impulse Response Functions (IRFs). Furthermore, an extended BSVAR model will also be examined that includes the additional variables of the output gap and the exchange rate to assess the robustness of the model.

The results showed that post an inflation shock, households experienced a sudden surge in wealth, attributed to a revaluation of assets due to inflation, before seeing a mild dip after five quarters. With an exception, this was the first quintile, representing the poorest households. It showed a slower, steadier return to its pre-shock state, likely because its balance sheet predominantly comprises debt. After an interest rate increase shock, wealthier households experienced a decrease in wealth, while the poorest quintile showed a significant wealth increase. The oil price shock produced ambiguous results with less direct and immediate impacts, yielding weaker responses along all quintiles. The results of the extended model supported the main result and further questioned the results of the robustness of the oil price shock.

This thesis contributes to the literature in the following ways: First, it describes the theoretical frameworks and empirical limitations for analysing wealth redistribution due to monetary mechanisms. Secondly, it outlines and assesses the composition of the balance sheets across the wealth distribution in a country with statistics considered to have the most extensive coverage of its population and data of the highest quality in the world. Thirdly, it yields an example of using the methodology of a BSVAR model to assess the dynamics of wealth. Lastly, it improves the understanding of inflation's and monetary policy's influence on wealth during recent decades' unusual and novel economic circumstances and turbulence.

The rest of the thesis is outlined as the following: Section 2 sets out a theoretical framework by presenting which transmission channels inequality is affected through, accompanied by a selection of earlier literature that examines them. After that, Section 3 describes the categories of the balance sheets and the sources providing information regarding them. Next, Section 4 provide a descriptive analysis of the composition of the Balance Sheets in Norway. Section 5 then explains the empirical methodology of the BSVAR and presents its application of IRFs, which is accompanied by graphical interpretations. Section 6 conducts the final analysis where the descriptive analysis and the information of the IRFs of the BSVAR are combined to assess how different households along the wealth distribution are affected by the implemented shocks. Lastly, Section 7 concludes and summarises the thesis.

2 Framework

This section presents the different theoretical transmission channels of monetary mechanisms to inequality and a selection of earlier literature examining them.

2.1 Transmission Channels

Monetary policy affects households in three ways. One is the income effect, where monetary policy directly affects the interest rates induced on borrowers and compensated to savers. After that is the wealth effect which stems from how different types of asset values react to monetary policy. Lastly is the substitution effect, which can be interpreted through the Euler equation as changes in the real interest rate influence the relative price of current and future consumption.

Households exhibit heterogeneity in terms of their levels of income and wealth, as well as their sources of income and composition of their wealth. In turn, the different effects of monetary policy interact with these discrepancies through different distributional channels that influence inequality. Ampudia, Georgarakos, Slacalek, Tristani, Vermeulen, & Violante (2018) groups these channels into the two categories *direct* and *indirect* channels.

The Direct Effects are *the savings redistribution channel, the unexpected inflation channel, the interest rate exposure channel,* and the *portfolio composition channel.* These partial equilibrium responses occur due to changes in monetary policy, holding employment status, prices, and wages fixed, which affect households' incentives to save and their net financial income.

The Indirect Effects are *the earnings heterogeneity channel and the income composition channel.* These are general equilibrium consequences from monetary policy through prices and wages, which affects labour income and employment. Households and firms react to changes in monetary policy by altering their expenditure and investment, which in turn alter their output, employment and wages. This affects households differently and evidently also affects inequality in the economy.

The indirect effects mainly affect income inequality. They will therefore be fully delimited from the analysis in this paper as it will focus solely on how different monetary mechanisms affect the wealth distribution.

The Saving Redistribution Channel relates to the disparate impacts of monetary policy given the heterogeneity of households' net wealth. When central banks implement expansionary monetary policy, it reduces interest rates. This decrease hurts savers as they earn less on their savings or investments. In contrast, borrowers benefit because their interest payments are reduced. This channel has the potential to reshape wealth distribution by altering the rewards for saving and the costs of borrowing.

The Unexpected Inflation Channel concerns the redistribution of wealth between savers and borrowers that occurs following unexpected changes in the price level. This channel mainly concerns nominally fixed debts and deposits. As a result, unexpected inflation leads to a significant reevaluation of nominal balance sheets, bringing a host of repercussions for savers, borrowers, and lenders. Savers benefit somewhat counterintuitively. While their saving money's purchasing power decreases, they still benefit as their investments' value rises with inflation, which helps protect their wealth. However, savers can also be lenders. Unexpected inflation can thus negatively impact them as borrowers repay their loans with money that's worth less than anticipated. This devalues the amount that lenders receive back, as the purchasing power of the money repaid is less than the purchasing power of the money lent. The core of this phenomenon is the presence of nominal debt. In a scenario with unexpected inflation, the nominal value of the debt remains constant, but the real value - which considers inflation - decreases. This acts as a wealth transfer mechanism from lenders, who are typically wealthier, to borrowers, who are generally less wealthy. Other refers to this as the *Fisher channel*, which have been a part of the debate regarding monetary policy ever since Fisher (1933).

Interest Rate Exposure Channel relates to the Unhedged Interest Net Exposure (URE), which was defined by Auclert (2019). He defined it as the difference between all maturing assets and liabilities at a point in time as a measure of a household's balance sheet exposure to real interest rate changes. Those households with negative UREs, which often hold Adjustable-rate Mortgage (ARMs), thus gain from expansionary monetary policy through the losses from the households with positive UREs.

The Portfolio Composition Channel influences wealth inequality as the composition of households' balance sheets differs across the wealth distribution. As the expansionary policy is implemented, financial assets' price increase. However, this affects households differently, depending on their portfolio structure. As most financial assets are mainly held by those at the upper end of the wealth distribution, expansionary monetary policy can exacerbate wealth inequality. However, monetary policy also has a distinct effect on real estate values, including house prices. However, expansionary monetary policy can also increase house prices, which can have an equalizing effect on wealth inequality if homeownership is more evenly spread across the wealth distribution. Therefore, expansionary monetary policy can increase wealth inequality by enhancing financial asset values and decrease it by increasing house prices. Thus, the overall impact of wealth inequality depends on the balance of asset ownership within a society.

The empirical exercise that will be conducted in this paper consists of different types of unexpected shocks. E.g. when an unexpected inflation rate shock is introduced, the nominal rate will be held constant, causing the real interest rate to decrease by the same amount as the inflation rate does, as following the Fisher equation. Then we will use this to see how this affects households' balance sheets differently along the wealth distribution. Furthermore, this allows us to see how different shocks and sudden introductions of monetary policy affect wealth inequality and which groups along the wealth distribution gain and lose from this.

2.2 Related Literature

The following section presents empirical research examining the impact of monetary mechanisms on wealth inequality. Table 1 summarises all their samples, methodology and results.

A key challenge in the literature is the flaws and absence of data describing individuals' wealth positions which complicates reaching reliable estimates of wealth inequality. Therefore, much former literature has focused on improving methodologies suitable for imperfect data sources.[1]

Doepke & Schneider (2006) and Adam & Zhu (2016) found that unexpected inflation is advantageous to (young) middle-class households that are net borrowers and have mortgage debts. Conversely, it harms (old) wealthy households that are net lenders with large savings mostly invested in long-term bonds. As a result, lower classes benefit from reduced liabilities due to lower interest rates and increased inflation, while the wealthy's net wealth decline as their savings decrease.

Using Norwegian data, Fagereng, Holm, Moll, & Natvik (2019) looked at how saving behaviour varies across the wealth distribution. They found that the saving rate of capital gains remains constant across the wealth distribution. However, as households grow

[1]For some examples of these types of estimations used in Sweden, Denmark, and France, see Lundberg & Waldenström (2018), Jakobsen, Jakobsen, Kleven, & Zucman (2020) and Garbinti, Goupille-Lebret, & Piketty (2021)

wealthier, they tend to save more, leading to inequalities in the wealth distribution.

Using Italian and American household surveys, Auclert (2019) finds evidence for redistribution via the Interest Rate Exposure Channel. However, Tzamourani (2021) finds noticeable variations across the Eurozone. Households in Germany and Austria generally had positive UREs, whereas households in Cyprus, Ireland, Netherlands, Portugal, and Spain exhibited negative UREs.

Adam & Tzamourani (2016) find great heterogeneity in responses to wealth inequality after an asset price shock across the Eurozone. Finland, Netherlands, Portugal, and Spain have high homeownership rates among poor households, leading to increased house prices counteracting wealth inequality. While, e.g., in Germany, with low homeownership, the median household in the wealth distribution is unaffected by house price hikes.

Lenza & Slacalek (2018) impose a Quantitative Easing (QE) shock on France, Germany, Italy and Spain. They find that QE mildly decreases wealth inequality. This is since QE's influence on house price increases as homeownership is evenly distributed throughout the wealth distribution, which causes a uniform effect across the wealth distribution.

Using Japanese data, Inui, Sudo, & Yamada (2017) found that the mechanisms stemming from savings redistributing and portfolio compositions balance out the impact of expansionary monetary policy on the wealth distribution. As a result, wealthy households owning many financial assets benefit from increased asset values while, at the same time, their savings suffer from falling interest rates.

Fagereng, Gomez, Gouin-Bonenfant, Holm, Moll, & Natvik (2023) analyses the effect of rising asset prices on welfare distribution in Norway. They argue that increased wealth inequality is less harmful if it is due to "paper gains" as higher valuated assets provided no additional income and thus no welfare. Therefore, instead of assessing the effect on the wealth distribution, they measure welfare created from asset price changes. They found that the distribution of gained welfare differed from the distribution of wealth from asset reevaluations. The welfare gain was, on average, zero for the population. However, they still found redistribution from the poorest to the richest, as the wealthiest are often sellers of real estate and equity.

Apart from Norwegian wealth data being regarded as of the highest quality in the world (Zucman, 2016), Norway is unique as a sample when assessing its wealth distribution. Norway has a unique socio-economic landscape due to their management of its oil reserves, creating an equal distribution of the wealth gained from this. The Norwegian government has a pivotal role in managing the nation's wealth through the Government Pension Fund Global, often called the Norwegian Oil Fund, which returns used to finance an array of public services, ensuring a high standard of living for all citizens. This may mitigate monetary policy's impact on wealth distribution in Norway as the fund's assets are invested mainly abroad (Norges Bank Investment Management, 2023). Domestic monetary policy thus has a relatively muted impact on the fund's returns contributing to the stability of Norway's welfare distribution over time.

To sum it up, large parts of the literature suggest that the effect of inflation and monetary policy on wealth inequality depends on the magnitude and direction of balance sheet categories' responses to different shocks. In addition, it is highlighted the importance of different financial assets and liabilities in the portfolio composition of households. However, this often results in the total distributional effect being small or insignificant as various forces drive inequality in opposite directions.

Del Canto, Grigsby, Qian, & Walsh (2023) use a methodology resembling th one used by Fagereng et al. (2023) and assess the distributional effects of oil price shocks. They found that oil price shocks increase inequality along the welfare distribution by lowering equity prices while leaving housing unaffected, increasing unemployment, and reducing weekly earnings, especially amongst low-education households.

We will also assess how oil price shocks affect Norway's wealth distribution. The redistribution mechanism should insulate the broader population from the direct impacts of oil price volatility. However, understanding how oil price shocks influence this framework could yield valuable insights into the resilience of Norway's wealth distribution model.

However, this paper does not consider individual households' reactions to shocks in terms of altered interest expenditure or saving behaviour. Thus, all effects caused by the *saving redistribution and interest rate exposure channels* will not be considered further and will instead only focus on the *portfolio composition* and *unexpected inflation channels*. Therefore, the next section will further examine the different categories of Norwegian households' balance sheets.

Table 1: Summary of Empirical Studies: Distributional Effects of Monetary Policy

Study	Country Sample	Period	Method	Shock Type	Impact on Inequality	Distributional Channel
Doepke & Schneider (2006)	USA	1952–2003	Microsimulation	Expansionary (+ 10% price level)	Reduce	Unexpected Inflation
Adam & Zhu (2016)	Eurozone	2010 HFCS	Microsimulation	Restrictive (−10 price level)	Increase in Eurozone, Except Decrease in Austria, Germany, France, Italy & Malta	Unexpected Inflation
Tzamourani (2021)	Eurozone	2017 HFCS	Quantifying	Restrictive (+ Interest rate)	Varying depending on UAE	Interest Exposure
Inui, Sudo, & Yamada (2017)	Japan	1981–1998	Local Projections	Expansionary (−100 BPS)	Insignificant	Portfolio Composition & Saving Distribution
Adam & Tzamourani (2016)	Eurozone	2010 HFCS	Microsimulation	Expansionary (+ asset prices)	Negligible	Portfolio Composition
Lenza & Slacalek (2018)	France, Germany, Italy, Spain	1999–2016	BSVAR & Microsimulation	Expansionary (− term spread)	Negligible	Portfolio Composition
Fagereng et al. (2023)	Norway	1994–2019	Sufficient Statistics calculating welfare gains	Expansionary (+ asset prices)	Increase	Portfolio Composition
Sundén (2023)	Norway	2005–2021	BSVAR	Restrictive (+ Price level) Restrictive (+ Interest rate) Restrictive (+ Oil Price)	Ambiguous Decrease	Unexpected Inflation & Portfolio Composition

This paper contributes to this strand of literature by examining how monetary mechanisms affect the wealth distribution. Specifically, it illuminates how household heterogeneity and monetary mechanisms affect inequality through altered asset valuations with an application of an alternative methodology. Further, this is applied to one of the samples of advanced economies with the most extensive and reliable data covering a population that remains under-explored. Consequently, this augments the dataset's richness, providing new perspectives and better understanding and generating new questions on the complex connection between asset valuation, monetary mechanisms, and wealth distribution patterns.

3 The Balance Sheets of Households

Most other wealth inequality studies use surveys that have estimated wealth holdings in the population. In the Eurozone, the Household Finance and Consumption Survey (HFCS) is used, while in the US with the Survey of Consumer Finances (SCF) is used. In contrast, this study's empirical findings are based on Norwegian administrative data. This is mainly because Norway still applies a wealth tax compared to other Scandinavian countries. In contrast to income taxes that are levied individually, the wealth tax in Norway is levied on the whole household. Every year, it is mandatory for all citizens in Norway to provide a complete account of their income and balance sheet components, including every asset type, for these taxes to be collected. Third parties, such as employers and financial institutions, report this data instead of the taxpayers themselves, increasing its reliability. It is submitted to the tax authorities, which scrutinise them and use them for tax purposes which further minimises mismeasurement due to tax evasion. Assets that are traded are measured by the market value at the end of the year. The data has the advantage of using instead of summary measures of inequality as it is based on administrative data covering the entire population instead of survey data where the upper parts of the wealth distribution are top-coded.

Statistics Norway provide data describing the balance sheets of different groups of households along the wealth distribution. First, they classify the aggregated classes as, on the asset side as *total real capital, bank deposits, shares & securities* and *other financial capital securities*. Then, on the other side, the household's net worth and liabilities are represented by *debt*.

Total Real Capital is defined as "Includes real estate, real capital in business and personal property". Real estate is an asset that mainly affects the middle class. It differs from other assets, such as stocks, as households tend to hold on to them to a much higher degree as their prices rise. Households also tend to consume more when house prices increase as they feel wealthier even though they have no additional income (Case, Glaeser, & Parker, 2000). For the BSVAR analysis, a House Price Index covering all of Norway will be used. The index is estimated using data from the Norwegian Real Estate Broker's Association, the private consulting firm Econ Proyry and listings from the primary Norwegian platform for house transactions [www.finn.no].[2]

While there is no time series available to represent the subcategories of Real Capital, Statistics Norway presented the two subcategories **Assessed tax value of dwelling, primary residence** defined as "Assessed tax value of primary residence at the end of the year. The registered home of the owner" and **Assessed tax value of dwelling, secondary residence** defined as "Assessed tax value of secondary residence at the end of the year. Holiday homes do not count as secondary residence". This enables us to create a third subclass of **Other Real Capital** being the residual of *total real capital* after removing the two other subcategories. This asset class is essential for assessing the groups in the lower parts of the distribution. As the poorest household might not own any real estate, their most important asset might, for example, be other types of personal property, such as vehicles which are included here. Therefore, the House Price index is not the ideal variable to represent *other real capital* as a time series. However, as no other data regarding Real Capital is available quarterly, it will still be used. However, as shown in Figure 4a *other real capital* is only a major component in *total real capital* for the three poorest deciles where it is only a minor component of its total balance sheet as seen in Figure 1, this does not lead to any major complications for the analysis.

Bank Deposits are defined as "Deposits in domestic banks at the end of the year". Unfortunately, this leaves out data regarding bank deposits of Norwegian households placed in foreign banks. However, this is no major issue as bank deposits are mainly a crucial asset for households in the lowest parts of the wealth distribution that need their bank deposits easily accessible for daily use or as a buffer for unforeseen expenses and therefore places them in domestic banks. The reaction of bank deposits to shocks is highly unpredictable as it depends on various factors. For example, during the COVID-19 pandemic, deposits dramatically rose even if economic activity decreased as fiscal stimulus increased and citizens were prevented from spending (Statistics Denmark, 2022). For the BSVAR

[2]More information regarding its computation can be found at [www.norges-bank.no/en/topics/Statistics/Historical-monetary-statistics/House-price-indices/].

analysis, the average deposit value per Norwegian citizen will be used.

Shares & Securities are defined as the "Value of shares, securities, bonds and options at the end of the year." Their prices are susceptible to interest rate changes. If tightening monetary policy gets introduced, i.e., an increased interest rate and these assets get cheaper. This is because it makes borrowing more expensive, reduces the attractiveness of bonds, and lowers future cash flows' present value. Also, it may lead to investors demanding a higher rate of return to compensate for the increased risk, which can further decrease their prices. However, re-evaluations of financial asset prices mainly concern a narrow distribution share of the population as the wealthiest citizen mostly holds it. This is evidenced in Section 4. Most households do not have any financial wealth; many only live hand to mouth and are not concerned by these price changes. Adam & Tzamourani (2016) further find that capital gains from bond price increases leave net wealth inequality relatively unaffected by revaluations.

Fagereng et al. (2019) used a time series of the price changes of the Oslo Stock Market to represent price changes of equity. This study, however, will in the BSVAR instead use the average of the total value of the total current stock of debt securities, equity and financial derivatives per Norwegian citizen from Statistics Norway. This is because it better represents the diverse portfolio of financial capital households hold, which consists of much more than stocks listed on the domestic stock market. E.g., a large share of this is held in investment funds, for which it is difficult to determine what fraction of their assets they own in stocks or other types of financial securities.

Other Financial Capital is defined by Statistics Norway as "Cash, outstanding claims, private pension savings, etc.". Norway is moving towards a cashless society where most purchases and transfers are made through electrical payments. Therefore, there is no need to account for cash in the analysis. Furthermore, the government of Norway provide a generous public pension scheme for their citizen. On top of that, citizens can also extend it through private pension schemes in accounts held by their employers. While private pension savings represent a form of wealth, they may not accurately reflect an individual's current financial standing or ability to consume in the present, as these savings are intended for use during retirement and may not be relevant for measuring an individual's current economic situation. Also, defined benefit pensions are not accounted for as they have no market value and will not vary over time. Therefore these assets are assumed to be unaffected by monetary policy and are delimited from the BSVAR exercise.

Debt held by households overwhelmingly consists of loans in the form of mortgages, as mortgages mainly finance all households' housing. Therefore, the households that hold them are vulnerable to changes in interest rates as it impacts their mortgage payments depending on whether there is a fixed-interest mortgage or an ARM. In this sense, they are affected by monetary policy. For example, if a tightening monetary policy is introduced and they have a fixed-interest mortgage, their house and all other real estate prices will fall. Nonetheless, they will still have unaltered fixed-interest rate payments.

The number of loans in Norway with a fixed interest rate accounts for around 19% of all loans, according to the annual report of the Husbanken (2021). Furthermore, they state that the overall loan portfolio is more significant when expressed in Norwegian Kroner (NOK) value, with 35% of loans having fixed interest rates and 65% being ARMs. Furthermore, Lindquist, Solheim, & Vatne (2022) state that approximately 70% of Norwegian households are homeowners, and residential mortgages account for most household debt. These mortgages are overwhelmingly ARMs. Finally, Fagereng et al. (2023) explains that mortgage payments in Norway are most often in annuity loans with 25-year repayment schedules. Thereby every time the central bank changes its policy rate, its payment schedule alters, so the sum of monthly debt repayment and interest charged is maintained at a constant level throughout the rest of the contract period. Because of this, the interest change every year, which also changes the individuals' interest cost. Assuming all of the household's mortgages are ARMs, they can be interpreted as negative positions in one-year bonds.

Even though the effects of different monetary mechanisms on mortgage expenditures are not directly transmitted through the unexpected inflation or portfolio composition channel, it is still important to consider when interpreting the results. As Norway have a high degree of ARMs, households will be vulnerable to interest rate hikes. This will indirectly asymmetrically affect households along the wealth distribution disposable income to invest in other assets or save. This does not directly affect households' balance sheets through asset revaluation, but it will still greatly matter in the long run.

4 Descriptive Statistics

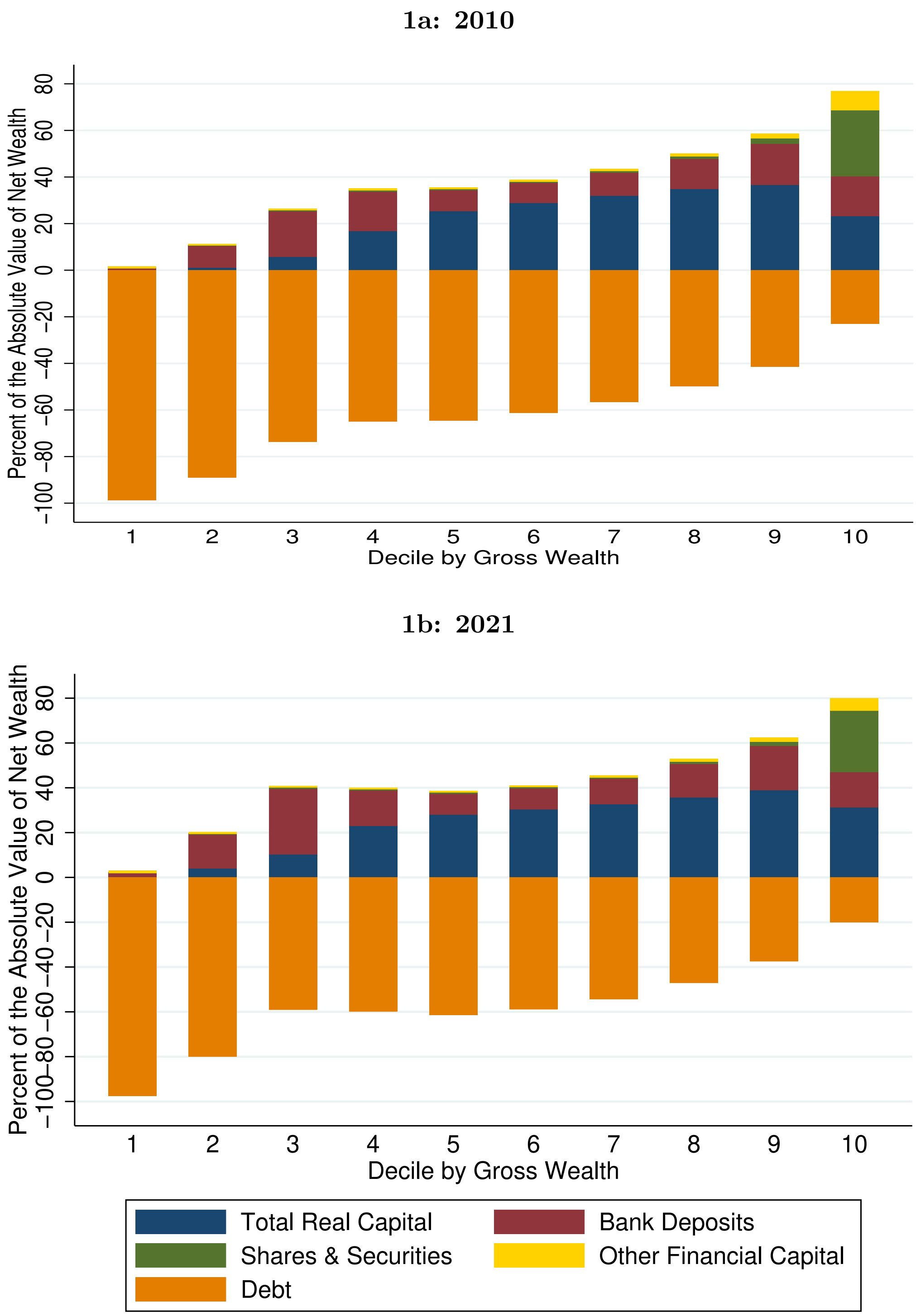


Figure 1: Composition of Balance Sheets

Source: Statistics Norway

Figure 1 shows the portfolio composition of the different deciles along the gross wealth distribution for the earliest and latest available data. They are calculated by summing all absolute values of all balance sheet categories and then taking each separate category's value as a share of this total sum. They show remarkable variation in the portfolio composition across the wealth distribution, which should cause the *unexpected inflation* and *portfolio composition channel* to impact significantly. Deciles' balance sheets 1 to 2 mainly consist of Debt and little Bank Deposits. The deciles 4 to 9 have quite similar balance sheets but with a slightly decreasing Debt level higher up the distribution we look at. Their main asset is real capital, with a modest share of Bank Deposits and a negligible little share of Shares & Securities. The tenth decile holds the majority of all Shares & Securities and Other Financial Capital.

Only minor shifts can be seen in the data over the period. All deciles have slightly decreased their share of Debt while slightly increasing their gross assets. This change is most greatly seen in deciles 2 and 3. This is mainly because their Bank Deposits have more than doubled in both deciles while minimally increasing their Debts. Further worries of compositional changes over the period are also of no concern as the top 1 per cent of the wealth distribution share only changed from 24.2 per cent to 22.7, the top 10 from 51.2 to 52.2 and the bottom 50 from 2.3 to 3.6 between 2010 and 2021 (World Inequality Database, 2023).

Moreover, using Norwegian data, Fagereng et al. (2019) found evidence for inertia in the rebalancing households' asset composition. With regard to this, it is assumed in the analysis that households never alter their shares in their portfolio, and only compositional values from 2021 will be used in the rest of the paper. Furthermore, by holding quantities constant (i.e. fixing the balance sheets), this concept of capital gains is unaffected by potentially endogenous portfolio adjustments, which also further isolates the *unexpected inflation* and *portfolio composition channel* amongst the observed reactions of households on the balance sheets.

In contrast, Figure 2 presents the nominal values worth of assets held by each group. Comparing it to Figure 1, it more clearly shows discrepancies in the multitude of asset holdings along the wealth distribution. It also further shows how the top decile holds a clear majority of all Shares & Securities and Other Financial Capital. Furthermore, it shows how insignificantly small share Other Financial Capital holds throughout the wealth distribution, which further argues that leaving them out cause no major complications for the rest of the analysis. However, what is most worth noting is that the Net Wealth remains negative from decile one to seven. Notably, the Debt value stayed relatively constant from the fifth decile to the ninth.

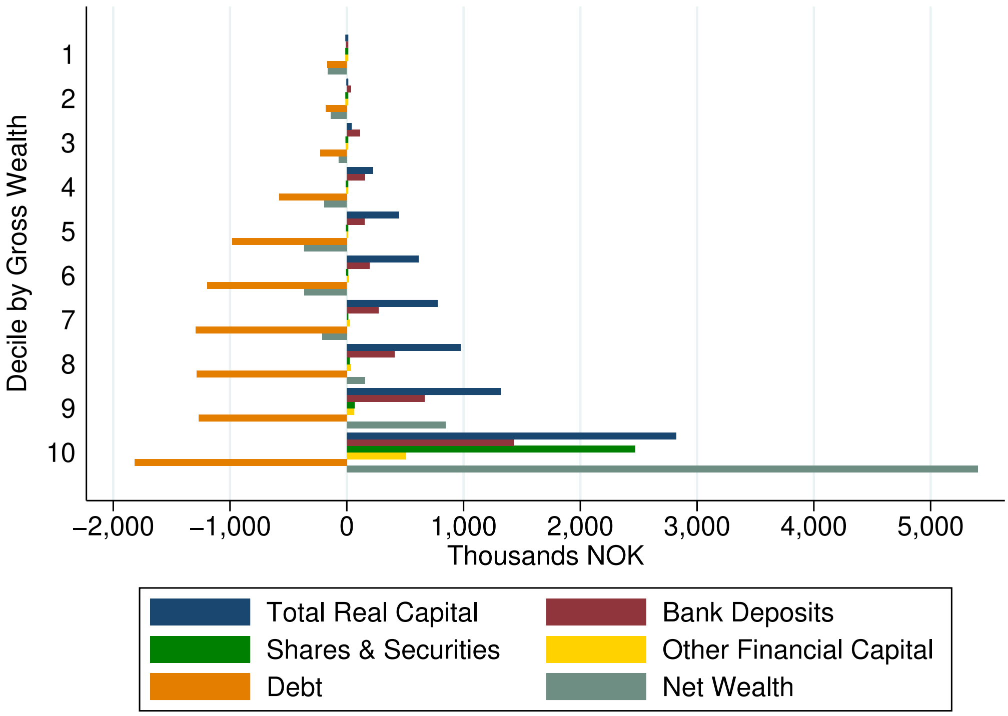


Figure 2: Composition of Balance Sheets in 2021, Nominal Values

Source: Statistics Norway

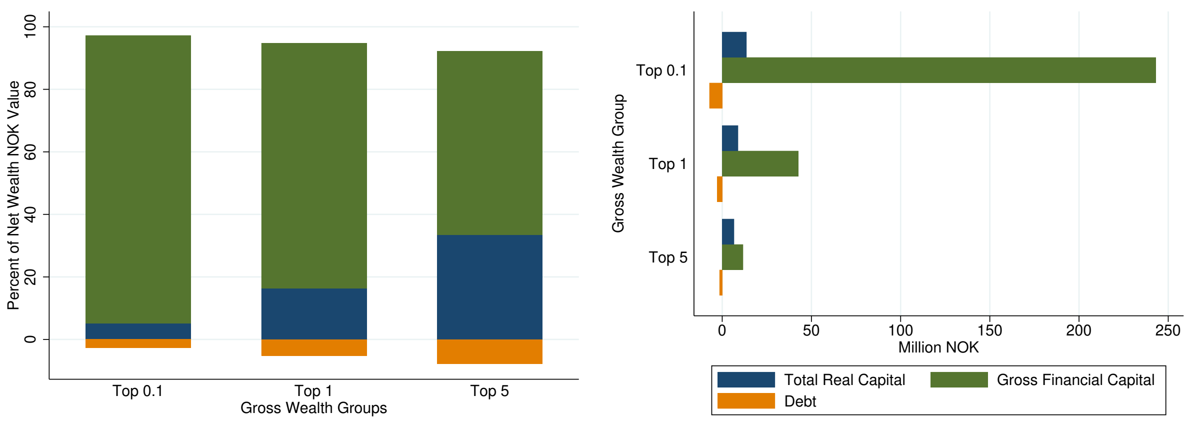


Figure 3: Top Composition of Balance Sheets in 2021

Source: Statistics Norway

Figure 3a and 3b show even more granular data describing the portfolio compositions of wealth groups higher in the wealth distribution. Note, however, that Statistics Norway provided a separate dataset for these wealth groups where Bank Deposits were excluded. Also, instead of including Shares & Securities and Other Financial Capital as categories, they only present the category Gross Financial Capital. However, this should make no more considerable difference as Other Financial Capital is most likely not increasing in share substantially or behaving significantly differently than Shares & Securities over time. Also, since Bank Deposits' ratio to Shares & Securities quickly decreases in the higher deciles in Figure 1. Furthermore, these figures show even more skewness towards the upper parts of the wealth distribution holding most Financial Capital as the share of Financial Capital only increases the higher up in the wealth distribution we zoom in.

Figures 4a and 4b present more granular descriptive statistics for Total Real Capital for the different wealth deciles. As discussed in Section 3, the three lowest deciles own nearly no real estate at all, and all their Total Real Capital consists of Other Real Capital in the form of other types of personal property and chattel. Furthermore, the shares in deciles four to seven are very similar, where the Primary Residence consists of approximately 80 per cent of Total Real Capital. In comparison, approximately 20 per cent consists of Other Real capital. After that, Secondary Residence starts to successively increase from decile eight to ten, where it in the tenth decile ends up being the major component consisting approximately of 40 per cent of Total Real Capital.

4a. Shares of Total Real Capital **4b. Nominal Values**

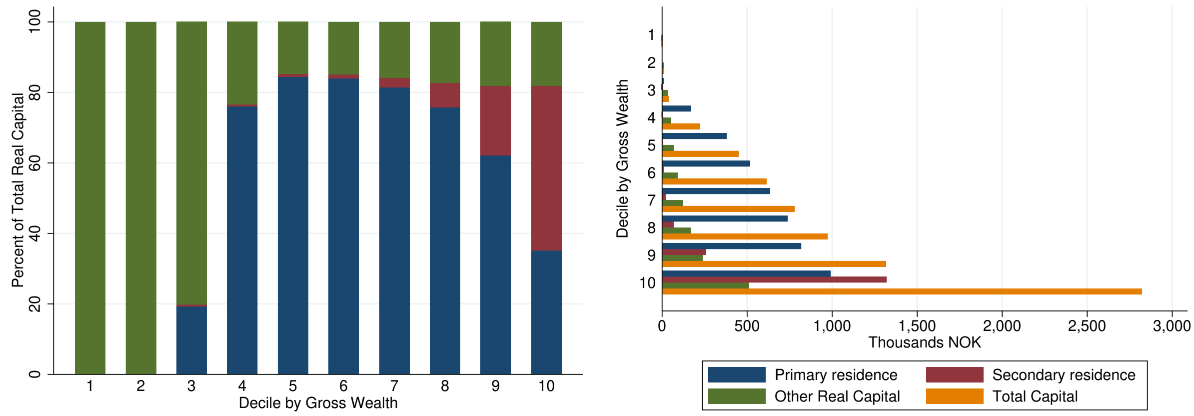


Figure 4: Total Real Capital Composition in 2021

Source: Statistics Norway

As these statistics are based on tax data, the data leaves out all assets that are not reported to the tax authorities. This causes the average for the reported values of asset holdings to differ from the average of the total population's asset holdings. However, this analysis uses the average of the total population. Further information regarding this can be found in Appendix B.

5 Bayesian Structural Vector Autoregression

5.1 Empirical Methodology

One may analyse the simple mechanical transmission of asset price increases directly to the households to see how they react differently along the wealth distribution. However, this is not something we observe in reality. Instead, using a BSVAR has the advantage that we now can use a more realistic shock, e.g., shocks of interest rate, inflation, oil prices and asset purchases and see how these, in turn, affect the assets and in turn the wealth distribution based on historical data and these variables' co-movements.

Compared to other fields of economics, which are firmly determined to ascertain the relationship between variables with an exogenous part, macroeconomics focus on factors from different aspects of society and the economy that are indisputably interdependent. Because of this, this study will analyse the interrelationship of the variables of interest using vector autoregression (VAR) models as it can distinguish between effects going both ways and acknowledges the endogeneity of the included variables (Sims, 1980). Dynamic Stochastic General Equilibrium (DSGE) models are more commonly used in macroeconomics as they are grounded in economic theory and can be used to explain the underlying economic mechanisms (e.g. Kaplan, Moll, & Violante (2018)). However, the VAR model still has advantages as it is data-driven, is not bounded by earlier economic theories, and is more applicable in situations that are not as well understood. Therefore, a structural VAR (SVAR) is used here as it enables us to estimate to what degree monetary mechanisms have affected different asset classes and household groups along the wealth distribution based on historical data.

The standard VAR model that will be used can be written as follows:

$$y_t = c + B_1 y_{t-1} + B_2 y_{t-2} + ... + B_p y_{t-p} + \epsilon_t \quad \epsilon_t \sim \mathcal{N}(0, \Sigma_n) \quad t = 1, ..., T \qquad (1)$$

Here y_t has the dimension of $(n \times 1)$, B has $(n \times n)$ and ϵ has $(n \times 1)$. The model thus contains n endogenous variables and p lags. The error term ϵ_t contains all error terms with Σ_n, which is the covariance matrix of errors.

However, the VAR model has cross-related error terms, which prevents us from identifying the individual shocks. To be able to identify the contemporaneous relationship between the variables of interest, we apply an SVAR written as the following:

$$A_0 y_t = c + A_1 y_{t-1} + A_2 y_{t-2} + ... + A_p y_{t-p} + v_t \quad v_t \sim \mathcal{N}(0, I_n) \quad t = 1, ..., T \tag{2}$$

Equation 2 thus gives us v_t, which is a vector of structural disturbances of the dimension $(n \times 1)$ with mean zero $(E[u_t] = 0)$ with a diagonal variance-covariance matrix $(E[u_t u_t'] = I_n)$. I_n thereby implies that v_n gives structural shocks in the model that are uncorrelated and independent from each other. Furthermore, we can achieve the reduced form of the SVAR by multiplying both sides of equation 2 with A_0^{-1}. With $B_j = A_0^{-1} A_j$, $C = A_0^{-1} c$ and $\epsilon_t = A_0^{-1} v_t$ giving us:

$$y_t = C + B_1 y_{t-1} + B_2 y_{t-2} + ... + B_p y_{t-p} + \epsilon_t \quad \epsilon_t \sim \mathcal{N}(0, \Sigma_n) \quad t = 1, ..., T \tag{3}$$

As the majority of the analysis will be conducted with quarterly data, the lag length of p =4 is chosen as recommended by Blanchard & Perotti (2002) and Caldara & Kamps (2008). Furthermore, a bayesian estimation technique is chosen to estimate the parameters in our VAR model. This is beneficial as the probability distribution (the posterior) of the model parameters will then be given by earlier historical data and thereby better follow the historical behaviour of the variables in Norway. Finally, given the likelihood function provided by the data, the probability distribution is completed by retrieving the prior distribution with Minnesota priors developed by Litterman (1979).

5.2 Monetary Policy & the Norwegian Economy

Increase shocks of inflation, the interest rate and oil price will be implemented to analyse they differently affect households along the wealth distribution through the *unexpected inflation* and *portfolio composition effect*. Our mainline BSVAR regression will include the variables Inflation, Monetary Policy, Oil Price, Total Real Capital, Shares & Securities, Bank Deposits and Debt. The extended model also includes the variables Output Gap and Exchange Rate.

As Norway is assumed to be a Small Open Economy (SOE) (Bjørnland, 1998) that largely depends on trade, the floating exchange rate acts as a stabilisation tool in depreciating the currency in economic downturns. Exchange rate changes can affect inflation via import prices, influence monetary policy, and alter the relative value of financial assets. Particularly for an oil-exporting country like Norway, exchange rate dynamics can be crucially linked to oil price movements. In addition, an output gap may affect inflation and monetary policy decisions. For example, a positive output gap, i.e. where actual output exceeds potential output, can lead to inflationary pressures, potentially prompting tighter monetary policies. Ignoring these relationships could lead to an incomplete or misleading understanding of the inflation and monetary policy dynamics.

Therefore, the extended model works as a robustness test to further enhance the model's credibility by ensuring the findings are not sensitive to excluding critical economic factors. This can help confirm the validity of the initial findings, leading to more accurate and nuanced responses to imposed shocks. For example, an oil price increase might affect an economy differently depending on the state of the output gap and exchange rate. If the economy operates below potential (negative output gap), an oil price increase might stimulate economic activity and reduce the output gap. On the other hand, if the exchange rate is appreciating, the same oil price increase might impact inflation less than expected.

Other studies, such as Lenza & Slacalek (2018), also choose to include some form of measure of how unconventional monetary policy affected wealth inequality. However, it is excluded from this analysis.[3] This is because, unlike many other advanced economies, Norway has yet to implement negative interest rates, and neither heavily relied on QE to stimulate its economy (Holter, 2020). Avoiding the effect of QE also simplifies our analysis, as the distributional effect of unconventional policy faces an identification problem. Given that the period of QE overlaps with the period of the Zero Lower Bound (ZLB), it is difficult to distinguish whether the impact on inequality is due to near-zero interest rates policy, QE, or the interaction of both.

Instead of QE, the Norwegian government has emphasised using fiscal stimulus measures. As a result, Norway's monetary policy has diverged from other economies with which it is highly integrated, and spillover effects have been seen in it (Bache, 2023). This independence in monetary policy further shows the need to include the exchange rate in a robustness test.

Oil price shocks are relevant to investigate to asses how different sources of inflation may have different distributional consequences. This is especially relevant in the case of Norway, where this effect might be even more evident due to the country's great dependency of income of oil. For example, the total export value of crude oil, natural gas, and natural gas liquids accrued to 73% of all their exports of goods (Norwegian Petroleum, 2023),

[3] Debortoli, Galí, & Gambetti (2020) estimate that conventional monetary policy and QE are perfect substitutes in the US.

and its oil revenues contributed to 4.3% of their total GDP in 2022 (Isachsen & Gylfason, 2022). However, this reliance on oil also brings vulnerability. An example of this was the global oil price crash in 2014 which led to a significant contraction in Norway's oil sector, resulting in lower investment, job losses, and reduced economic growth (Bjørnland & Thorsrud, 2014; Hvinden & Nordbø, 2016).

The main difference between oil price shocks and monetary policy shocks is their different effect on asset prices. Del Canto et al. (2023) found that oil supply shocks greatly decrease financial security prices while leaving real capital relatively unaffected. Therefore, oil price shocks should be more redistributive than monetary policy and an inflation shock.

The inflation shock should mildly increase wealth inequality. However, the primary determinant of this outcome depends on the magnitude of the increase in the prices of Financial Capital versus Total Real Capital. Suppose the effect of Financial Capital dominates, and wealth inequality increase, with the wealthiest in the population mainly benefiting. This is because the wealthiest individuals primarily hold the most Financial Capital. Conversely, wealth inequality may decrease if the upswing in Total Real Capital is greater than financial securities. This is because housing is the median household's most significant asset. Thus, when Total Real Capital dominate, it benefits a broader range of households, potentially reducing wealth inequality. Conversely, the opposite should happen for interest rate and oil price increases.

5.3 Sign- & Zero-Restriction

The reduced form of the model contains fewer parameters than the structural form. To avoid overparameterisation, one must impose some restrictions between the variables. Throughout the analysis, Sign- & Zero-Restrictions (SZR) developed by Arias, Rubio-Ramirez, & Waggoner (2014) will solve this and correctly identify the SVAR. By implementing these restrictions on the variables, we can identify the structural component of each shock in their IRF. All restrictions are implemented to be enforced on impact. Furthermore, Table 2 provides an overview of all chosen restrictions and is followed by motivations of the choices.

Table 2: Identification Restrictions

shock/variable	*CPI*	*MP*	*OIL*	*RC*	*SS*	*L*	*BD*	$\hat{Y}$	*I-44*
Inflation	+	+	0	+	+				
Monetary Policy	−	+	0	−	−	−		−	−
Oil Price	+		+					−	

Notes: (+) = positive sign, (−) = negative sign, (0) = zero contemporaneous effect, blank indicates unrestricted, (CPI) = Inflation, (MP) = Monetary Policy, (OIL) Oil Price, (RC) = Total Real Capital, (SS) = Shares & Securities, (BD) = Bank Deposits, (L) = Debt, ($\hat{Y}$) = Output Gap, (I-44) = Exchange Rate

- All shocks are assumed to affect themselves positively, and hence they all have a (+).

- Bank Deposits are left fully unrestricted. This allows response to be flexible, given the unpredictable reactions that may occur. In addition, this allows for a more adaptable examination of the underlying economic correlations and interactions.

- Although Norway is a major oil producer, it is still an SOE. It has no significant influence on the global oil price as it only produces approximately two per cent of the world's oil consumption (Norwegian Petroleum, 2023). Therefore, domestic economic developments do not affect the global oil price. Because of this, the oil price variable is assumed to be an exogenous variable with zero restrictions on the other shocks.

- It is assumed that Norges Bank follows the Taylor rule and therefore raises its policy rate following increases in inflation, hence (+).

- House prices are assumed to only positively react to inflation shocks as inflation typically leads to higher nominal prices, including real estate. As a result, investors often seek tangible assets like housing as a hedge against inflation, thus (+).

- Financial asset prices are assumed to only react positively to inflation shocks because investors often seek assets that can preserve their purchasing power during inflationary periods. As inflation rises, assets like stocks and bonds may experience increased demand as they offer potential returns that outpace inflation, driving up their prices, thus (+).

- Loans are unrestricted to inflation shocks because various factors influence loan values during inflationary periods. For instance, changes in interest rates, borrowers' income, credit conditions, and lenders' risk appetite can all impact loan values.

- While some Central Banks are mandated to enhance economic performance and fight unemployment, this is not the case for Norges Bank, which only focuses on maintaining monetary stability. Hence the output gap is unrestricted to inflation shocks.

- Inflation decreases as monetary policy shocks are assumed to encourage saving and reduce economic activity, which would negatively affect inflation, hence (–).

- It is assumed that house prices only negatively react to monetary policy shocks because raising interest rates generally increases borrowing costs. This higher cost of borrowing discourages potential homebuyers, leading to reduced demand and downward pressure on house prices, thus (–).

- It is assumed that financial asset prices only negatively react to tightening monetary policy shocks because they can lead to higher discount rates and reduced liquidity. This may lower asset valuations and increase the attractiveness of alternative investments and downward pressure on financial asset prices, thus (–).

- Loans are assumed to only negatively react to tightening monetary policy shocks as it increases borrowing costs. Higher borrowing costs discourage consumers and businesses from taking loans, leading to declining loans, thus (–).

- Following Bjørnland & Halvorsen (2014), we impose the restrictions that increased policy rates imply an appreciation in the exchange rate. Note that an appreciation corresponds to a decrease in the exchange rate whilst a depreciation corresponds to an increase, hence (–)

- Oil price shocks are assumed to cause inflation as they raise production costs and reduce household demand, hence (+).

- Monetary policy, house prices, financial assets, loan values and the exchange rate are all unrestricted to oil price shocks because oil price fluctuations can significantly impact various aspects of the economy, including inflation, production costs, consumer spending, and overall economic growth.

- Increased oil prices are assumed to increase the cost of production. Therefore, they are positively related to firms' marginal costs and negatively related to economic activity and the output gap, hence (–).

5.4 Data

The time series featured in the BSVAR are in quarterly frequency and span from the first quarter of 2006 to the last quarter of 2021. Furthermore, inflation, oil price, house price indices and the exchange rate have been transformed by using the natural logarithm and then taking the first difference, giving us the annual percentage change. Also, an HP filter has been used on the inflation, monetary policy, oil price house price indices and the exchange rate to remove underlying trends and turn them into deviations from their steady state. This ensures the variables are stationary, a necessary condition for our VAR model. To represent the exchange rate, we use the Import-weighted krone exchange rate (I-44), which is a nominal effective exchange rate index based on NOK exchange rates as measured as a geometric weighted average in terms of import value against the currencies of Norway's 44 most important trading partners. The Output Gap is measured as the difference between actual and potential GDP. GDP is seasonally adjusted, and potential output is measured using an HP filter. To ensure stationarity, a Dickey-Fuller test for a unit root is performed using four lags. The null hypothesis of a unit root could be rejected for all of the variables using four lags. Appendix A presents plots of the developments of all the variables used in the BSVAR.

5.5 Impulse Response Functions

Following Dieppe, Legrand, & Van Roye (2016), we use IRFs to cause a one-time shock to a given variable in period t. The IRF then estimates how the variable j reacts to it and changes over time if it were to start from its steady state. The extent of the shock is estimated by its structural shock in the SVAR. Using this and the structural parameters of the variables, we can estimate their movements after the shocks and back to their steady state given their lags. IRFs enable us to analyse the dynamics and relationship of different variables after a shock in an individual variable ceteris paribus. Figure 5 to 7 visually represents the dynamic responses of the variables in our model to shocks of one standard deviation of sudden increases in the inflation and the policy rate and an exogenous oil price shock.

The Bayesian Estimation, Analysis and Regression (BEAR) toolbox from the European Central Bank is used along with its guide to estimate the IRFs of the BSVAR (Dieppe, Legrand, & Van Roye, 2016).[4]

[4]The BEAR toolbox URL: [`https://github.com/european-central-bank/BEAR-toolbox`]

Total Real Capital and Shares & Securities react almost identically in Figures 5 to 7. However, Shares & Securities respond slightly stronger and return more evenly to their steady-state prices after inflation and monetary policy shocks. Bank Deposits react to all shocks with an ambiguous and volatile response. This behaviour can be attributed to the heterogeneity of households' financial circumstances, preferences, and expectations, which lead to diverse reactions to economic shocks. This is a liability of this analysis as its lack of use of microdata makes us unable to determine how the development of the value of deposit holdings changed differently across the wealth distribution, especially concerning the lower deciles as it is their dominant asset type.

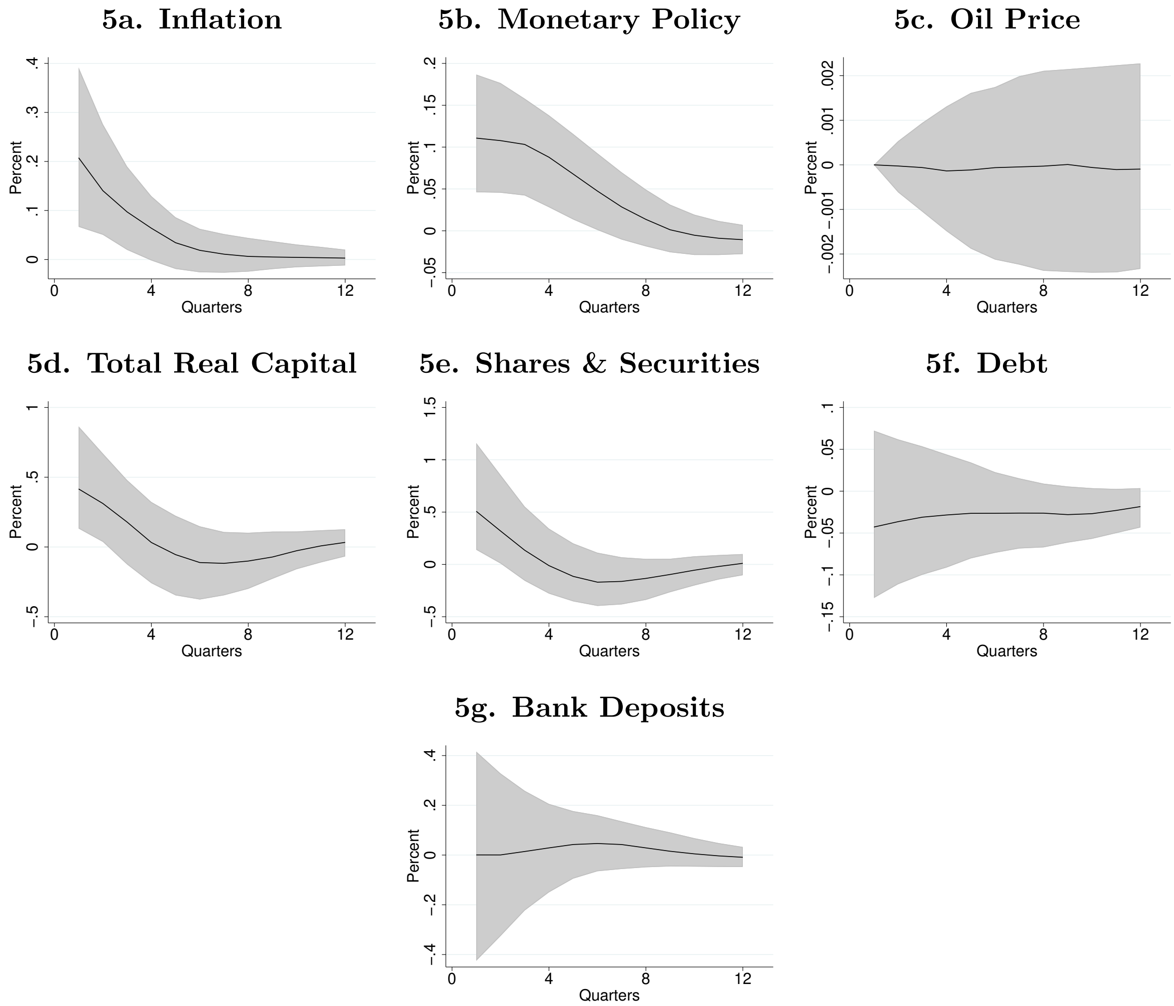


Figure 5: IRF for the Main Model After an Inflation Shock

Note: The shaded area around the median response represents one standard deviation

Monetary Policy reacts almost uniformly to an Inflation shock in Figure 5b as expected, which shows that Norges Bank continuously follows the Taylor Rule throughout the period. Total Real Capital and Shares & Securities in Figure 5d and Figure 5e respond by initially increasing and then decreasing in value in the fourth quarter. This can be explained by the fact that in the short term, inflation expectations lead to increased spending, fueling demand for housing and financial assets. However, in the fourth quarter, sustained inflationary pressures contributed to rising interest rates and heightened borrowing costs, which subsequently suppressed demand for housing and financial assets. In Figure 5f, Debt has an ambiguous and volatile response with a negative median response to inflation shocks. This pattern should arise due to the uncertainty surrounding the broader economic implications of inflation shocks, which can impact borrowers' ability to repay loans and lenders' willingness to provide credit. As inflation rises, the real value of money erodes, making it more difficult for borrowers to repay their loans. Additionally, increased inflation lead to higher interest rates, increasing borrowing costs and thus reducing credit demand.

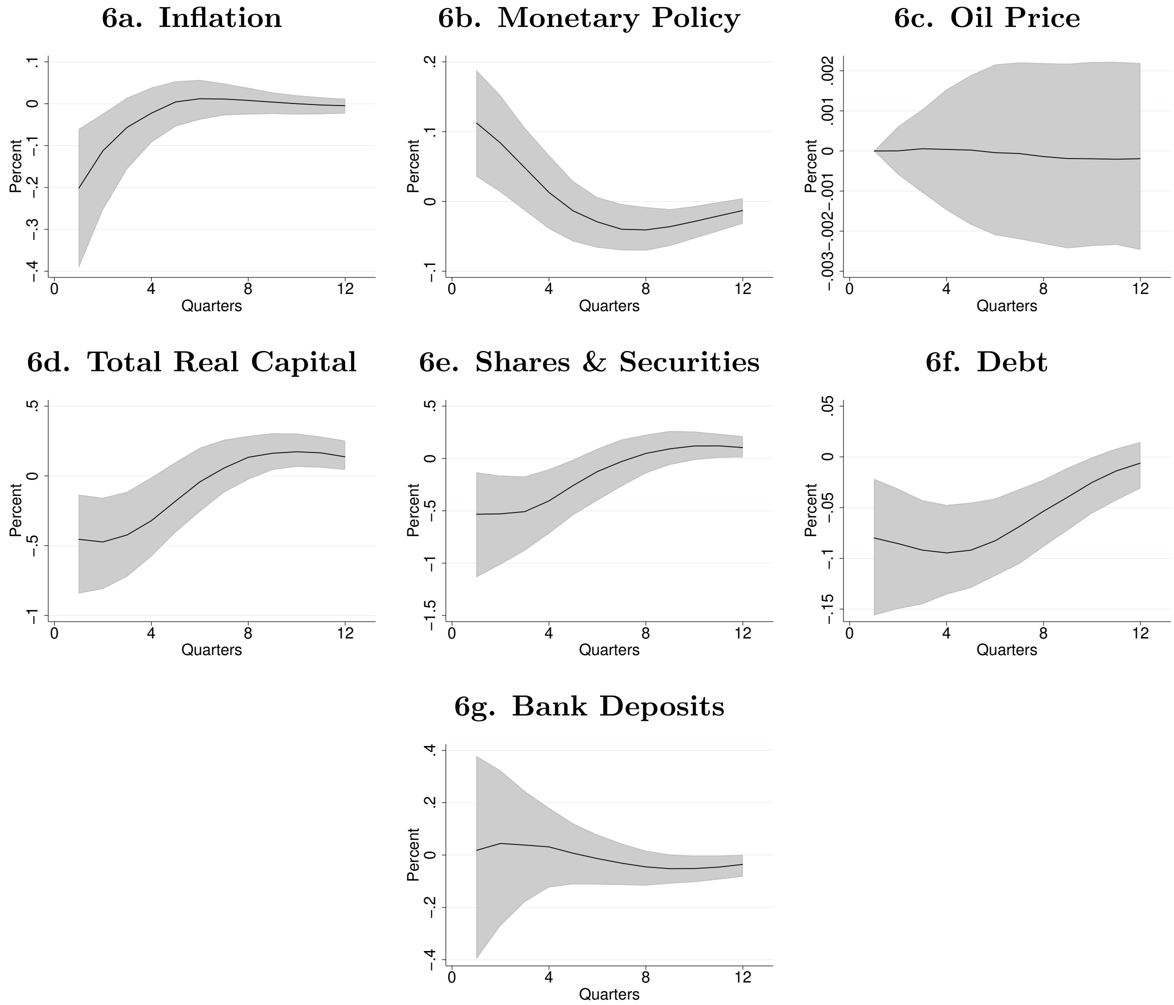


Figure 6: IRF for the Main Model After a Monetary Policy Shock

Note: The shaded area around the median response represents one standard deviation

In Figure 6a, we find an immediate response of the Inflation rate to an increase in the policy rate, as it tends to decrease accordingly. This is a reasonable response as a higher policy rate increases borrowing costs and consequently dampens aggregate demand. With reduced spending in the economy, the overall pressure on prices subsides, which leads to a decline in the inflation rate. Total Real Capital and Shares & Securities in Figure 6d and Figure 6e react to an increased policy rate by a decrease lasting three quarters before returning to a steady state. This can be attributed to the fact that tightening monetary policy leads to higher borrowing costs which dampens investment and consumption. As a result, the demand for housing and financial assets weakens, causing prices to decline. However, after three quarters, market participants adjust to the new interest rate environment, and economic activity gradually resumes, allowing asset prices to return to their steady state. The Debt in Figure 6f reacts to a monetary policy shock with a four-quarters decrease before returning to a steady state. This can be attributed to the impact of higher policy rates on borrowing costs, dampening the demand for credit. In addition, as interest rates rise, consumers and businesses may reduce their borrowing activities, leading to a decline in average loan holdings. After four quarters, market participants adjust to the new interest rate environment, and borrowing resumes, allowing loan holdings to return to their steady state.

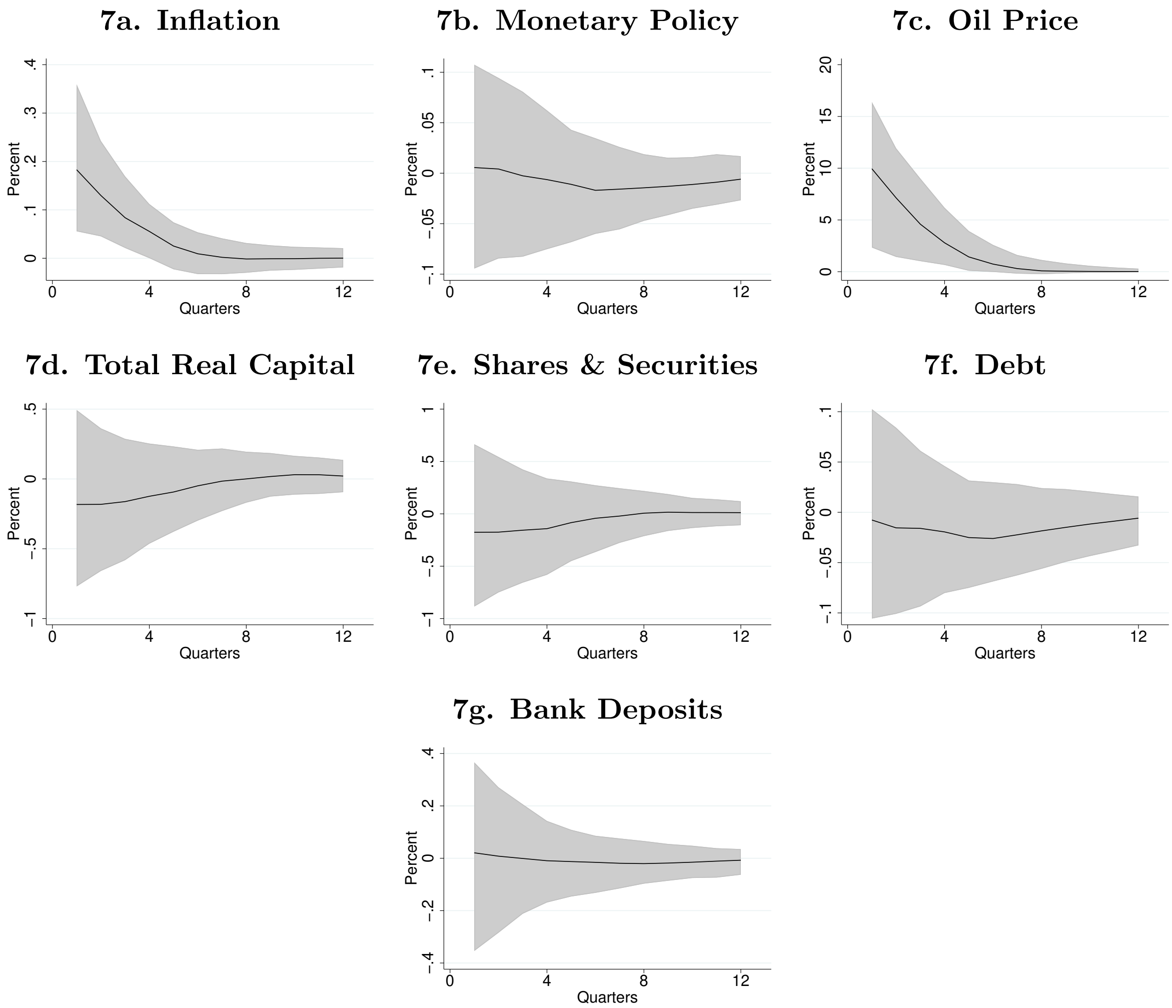


Figure 7: IRF for the Main Model After an Oil Price Shock

Note: The shaded area around the median response represents one standard deviation

Inflation in Figure 7a reacts to the oil prices shock with a temporary increase. Despite being an oil-rich nation, this transient spike shows that Norway is not immune to the pass-through effect of higher oil prices on production costs across various sectors. Although the country should benefit from increased revenues due to its oil exports, the domestic economy still experiences heightened costs for businesses that rely on oil as an input. These increased costs are subsequently passed on to consumers through higher prices for goods and services. However, the inflationary impact is short-lived as market participants adjust to the new price levels.

Monetary policy reacts highly volatile in Figure 7b to increased oil prices as it must adapt to various other economic conditions and shocks. The median response, however, is a non-immediate policy rate decrease, peaking six quarters before returning to its highly volatile steady state. It could be because Norges Bank did not choose initially to respond to oil price shocks due to their transitory nature. This cautious approach allows policymakers to assess the persistence and magnitude of the oil price increase and its potential spillover effects on the economy and the aggregated price level. After observing a sustained oil price increase, they may adjust monetary policy by decreasing interest rates to counteract the inflationary pressures.

Total Real Capital and Shares & Securities in Figure 7d and Figure 7e respond highly volatile to oil price increases, with median responses being negative and financial asset prices exhibiting even greater volatility. The uncertainty surrounding the broader economic implications of rising oil prices leads to fluctuations in both housing and financial asset markets. Investors and homebuyers may perceive the potential for adverse effects on economic growth, corporate earnings, and consumer spending, which in turn affects asset prices. Furthermore, financial assets are more sensitive to these changes due to their direct links to global financial markets and the rapid dissemination of information.

Debt reacts to oil price shocks in Figure 7f with initially volatile response can be attributed to the time it takes for the broader economic implications of rising oil prices to materialise, affecting both borrowers and lenders. As the cost of production and transportation increases, economic growth may be adversely affected, leading to tighter credit conditions and reduced loan demand. After six quarters, market participants adjust to the new oil price environment, and borrowing activities gradually resume, allowing loan holdings to return to their steady state.

6 Empirical Results

6.1 Main Model

To capture the effect of the inflation, monetary policy and oil price shocks on wealth, i.e. capture *unexpected inflation* and *portfolio composition channel*, the composition of the balance sheets in different groups of households along the wealth distribution from 2021 will be used. The effects of the shocks of the BSVAR IRFs of house prices, stocks, bonds, deposits and loans over time will be multiplied with the holding of each balance sheet category. This enables us to see which type of households that winners and losers from this shock and how it, in turn, affects wealth inequality. A summary of how values and variables will be calculated is presented in Table 3.

Table 3: Modeling of Responses of Wealth Components at Household Level

Wealth Component	Multiplied with Response of
Total Real Assets	House Price Index
Shares & Securities	Average Debt Securities, Equity & Financial Derivatives
Bank Deposits	Average Deposits
Debt	Average Loans

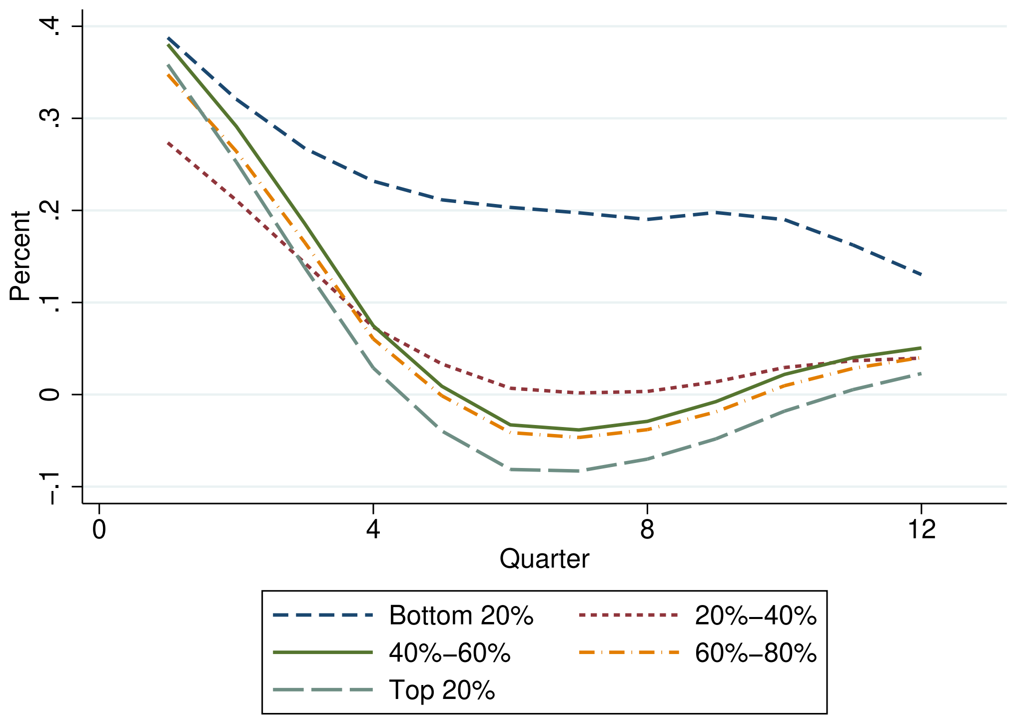


Figure 8: Impulse Response of Median Net Wealth Relative to Gross Wealth after an Inflation Increase Shock by Gross Wealth Quintile, Main Model

We have chosen only to use the median response of the IRFs in the graphs. If the standard deviations also would be displayed, the graphs would turn messy and difficult to interpret, thus risking concealing the key trends and patterns due to the broader variation. Furthermore, adding standard deviations might introduce insignificance across our findings. Thus, using the mean of the IRFs prioritises a clear, meaningful interpretation of our results over statistical dispersion.

The graphical representation of the wealth response of different quintiles to an inflation shock in Figure 8 reveals a strikingly uniform pattern across the wealth spectrum. Except for the first quintile, all other quintiles exhibit a marked increase in wealth immediately following the inflation shock, which subsequently dips marginally into negative territory in the fifth quarter before reverting to its steady state. Otherwise, quintiles two to five differ somewhat as the lines representing their responses become more convex the higher up the distribution as their responses become more severe to the shock.

This pronounced and synchronous surge in wealth across the second to fifth quintiles could be attributed to the portfolio composition effect, where inflation induces a revaluation of assets. This resembles the lines like the reaction of Real Capital and Shares & Securities to inflation in Figure 5. Thus the stronger response higher up in the distribution is explained by the shares of Real Capital and Shares & Securities simultaneously increasing in Figure 1.

However, the first quintile, representing the poorest segment, demonstrates a different pattern. Post the inflation shock, this group exhibits a much slower and constant return to its steady state, with an absence of the disturbance seen in the fifth quarter that the other quintiles experience. This behaviour is attributed to this wealth cohort holding fewer assets subject to inflation-induced revaluation. Instead, their balance sheet is highly dominated by their large debt post, which makes the unexpected inflation channel much more pronounced since they can repay their loans with money worth less than they expected due to the unexpected inflation.

This result aligns somewhat with Doepke & Schneider (2006) and Adam & Zhu (2016) results as the poorer households benefited from unexpected inflation. However, the wealthier parts of the distribution were less negatively affected than in their results. This is since their savings in different assets were only hurt mildly after five quarters which came after an initial value surge that coincided with the poorer quintile.

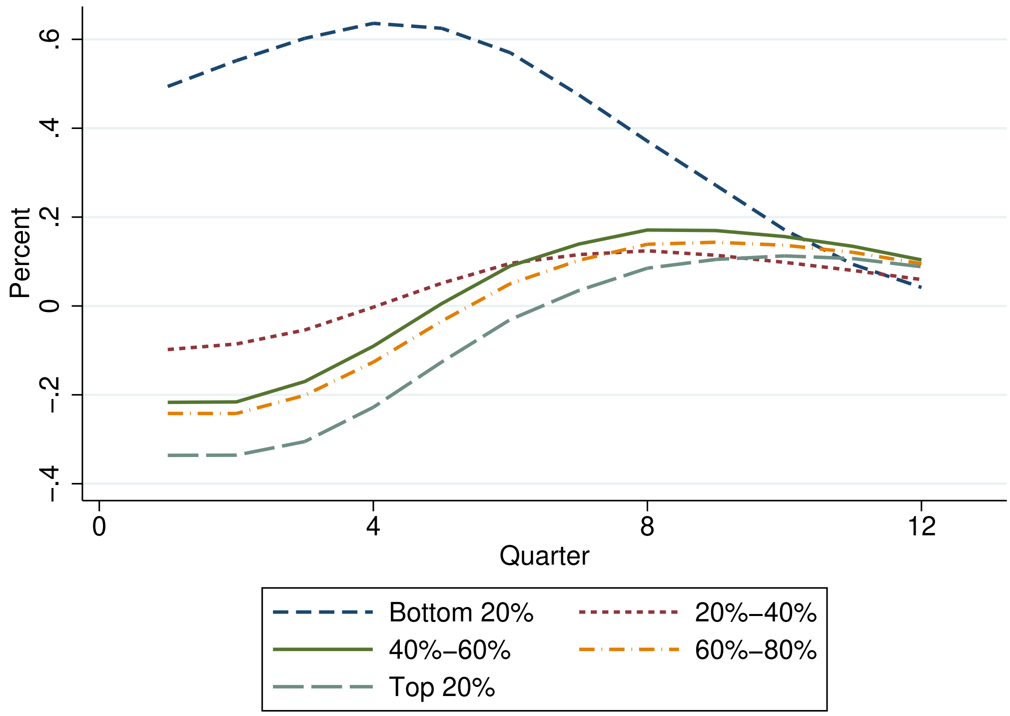


Figure 9: Impulse Response of Median Net Wealth Relative to Gross Wealth after an Interest Rate Increase Shock by Gross Wealth Quintile, Main Model

Figure 9 depicts the wealth responses to an interest rate increase shock. Broadly, the second to the fifth quintile all experience a decrease in wealth following the shock before reverting to their respective steady states. However, the magnitude of the decrease intensifies with each incrementally wealthier quintile. In stark contrast, the first quintile exhibits an inverse response characterised by a significant increase in wealth.

The decrease in wealth among the wealthier quintiles could once again be attributed to the portfolio composition effect by the impact on their substantial financial asset holdings as their lines broadly align to the responses of Real Capital and Shares & Securities in Figure 6. However, the wealth responses are not as stark as in those IRFs, partly due to the effect being counteracted by the unexpected inflation effect as their loans decrease simultaneously almost with the same response. Therefore it is reasonable that the negative effect increases higher up the wealth distribution as the debt-to-asset ratio decreases.

Contrarily, the first quintile reacts markedly differently, with wealth increasing in response to the interest rate increase. This divergence is again due to them holding much fewer assets, thus being much less directly impacted by the decrease in their value. At the same time, the unexpected inflation effect significantly decreases their debt burden as their balance sheets are dominated by their loans.

These results are pretty in line with the earlier results from Adam & Tzamourani (2016) and Lenza & Slacalek (2018) as the middle quintiles respond uniformly to the monetary policy shocks as their share of real capital is approximately in equal size. However, it is worth highlighting the exceptions of the first quintile, which holds a minimal share of real capital and is, therefore, significantly differently affected. Also, it is notable how the wealthiest quintiles' response is noticeably more substantial as they are additionally affected by their financial asset holding and minimal debt position.

Figure 10 shows the wealth responses to an oil price increase shock. Overall the reaction is very similar to the one in Figure 9 but with weaker responses along all quintiles. However, the results from the oil price shocks are more uncertain as the IRFs in Figure 7 are much more volatile than the ones in Figure 6. In addition, the first quintile's response is also more delayed for the oil price shock as its peak is not reached until the sixth quarter.

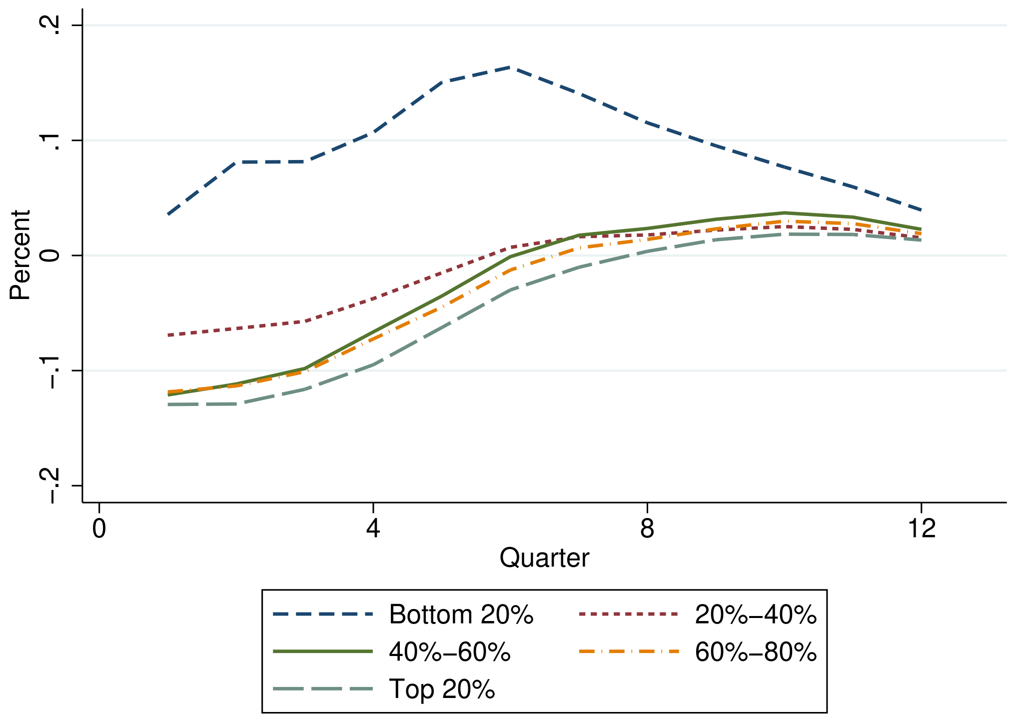


Figure 10: Impulse Response of Median Net Wealth Relative to Gross Wealth after an Oil Price Increase Shock by Gross Wealth Quintile, Main Model

The increased volatility can be due to oil price changes being unpredictable as several geopolitical and market factors influence them. Also, the pass-through of oil price shocks to the wealth distribution may be less direct and immediate than interest rate changes, which directly impact asset prices and investment returns. For example, the delayed response of the first quintile resembles in Figure 7 response of loans which is similarly affected. This could stem from the effects initially being absorbed by intermediaries along the supply chain. It could also reflect the time it takes for the benefits of higher oil prices, such as increased employment opportunities in oil and related sectors, to materialise.

This result partly connects to the findings of Del Canto et al. (2023) as the Shares & Securities are negatively affected. However, in comparison to Del Canto et al. (2023), Real Capital is also negatively affected (although highly volatile). This causes a more uniform reaction along the wealth distribution which does not increase wealth inequality but instead indicates the opposite. However, it should be noted that they employ a different methodology that attempts to measure the welfare impact instead of pure wealth. In summary, the result of the oil price shock is highly uncertain, which makes it worth bearing in mind the results from the extended model in Section 6.2 in mind when interpreting these effects.

Figure 11 shows the responses to the shocks of the top wealth groups with more granular data. Again, it shows a near-identical response across all these groups. The difference that can be noted is the increase in the magnitude of initial median responses of all shocks between the top 20 and the rest of the wealthier groups. This can mainly be explained by the difference in the share of financial assets seen in Figure 3 between the top decile and the rest of the population. This, in turn, causes the wealth groups situated in the top decile with heavier financial capital exposure to have stronger initial median responses almost identical to the responses of Shares & Securities in Figures 5e, 6e and 7e.

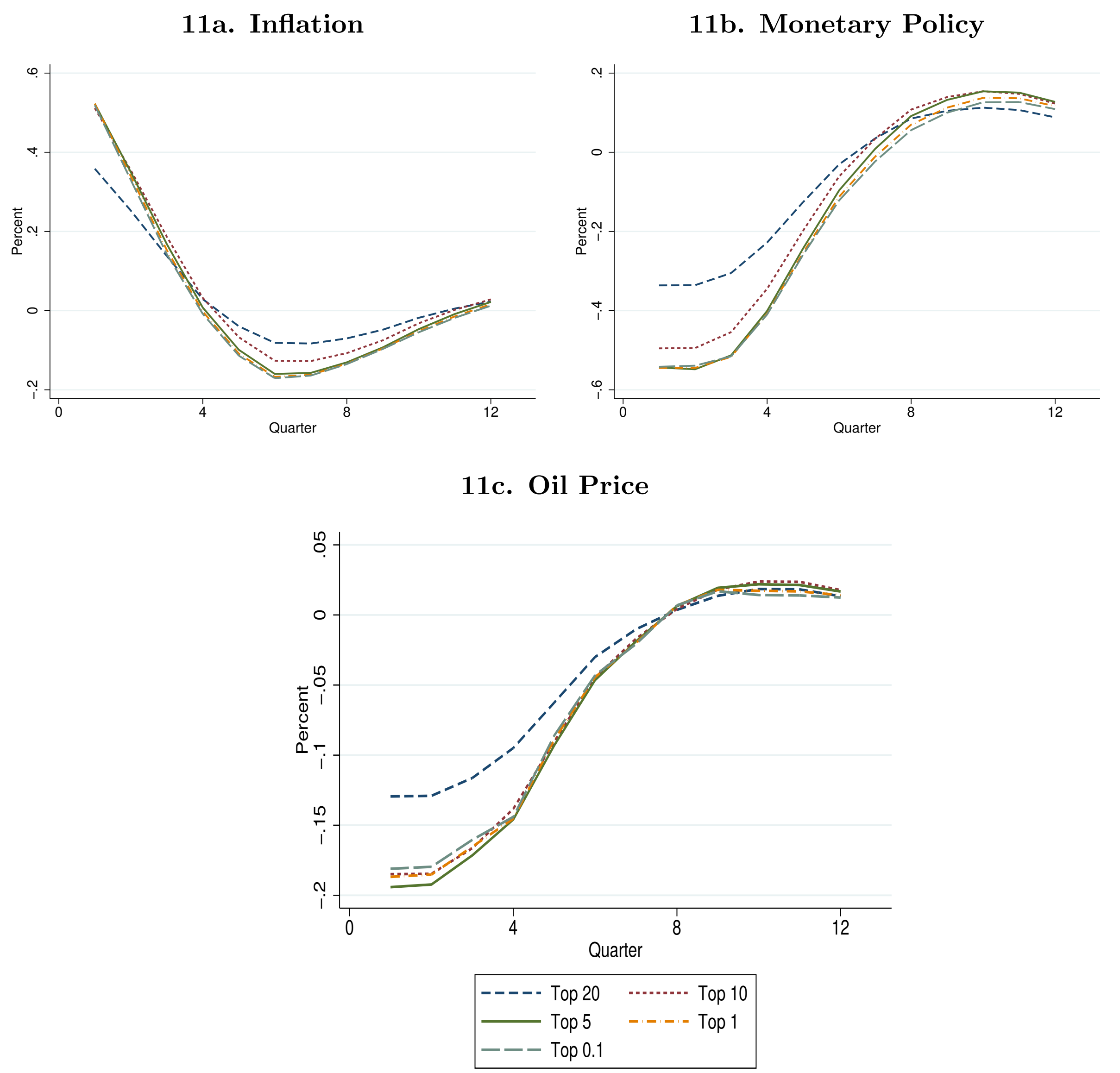


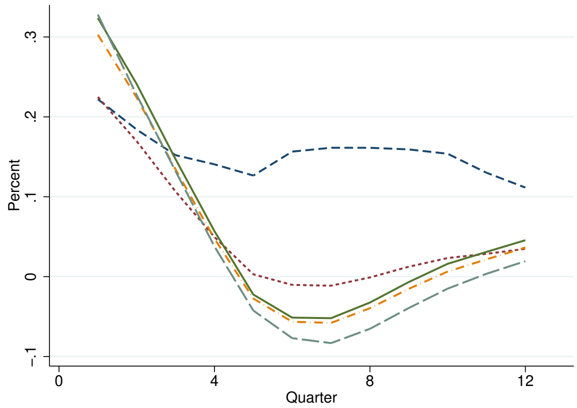
Figure 11: Impulse Response of Median Net Wealth Relative to Gross Wealth after Different Shocks by Top Gross Wealth Groups, Main Model

6.2 Extended Model

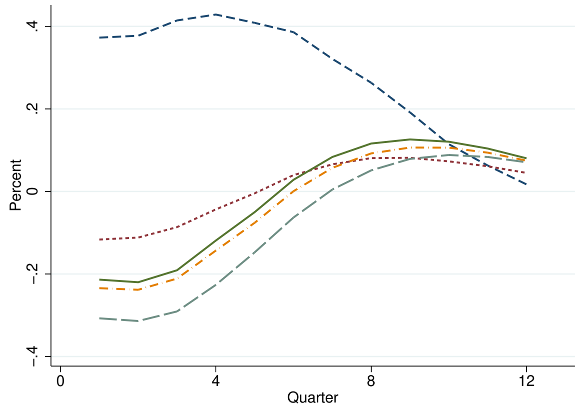
Appendix C presents the result from the IRFs from the extended model where the additional variables of the exchange rate and the output gap are included. Other than this inclusion, the responses in Figures 22 and 23 are almost identical to the ones in Figures 5 and 6, thus strengthening the validity and robustness of the main model. The primary distinctions between the two are subtle differences in volatility and the intensity of the responses' main model.

However, when comparing the IRFs of the extended model in Figure 24 with those of the main model in Figure 7, the IRFs of the extended model exhibit less volatility. However, most median responses remain relatively unaffected and close to the steady state. This is accrued to oil price changes being considerably unpredictable and partly correlating with the business cycle. This leads to the Output Gap accounting for some of the fluctuations in the oil price as the oil price have significant impact on the world's business cycles. These variations would have otherwise been attributed to household balance sheet categories, which are no longer considered in the explanation.

12a. Inflation



12b. Monetary Policy



12c. Oil Price

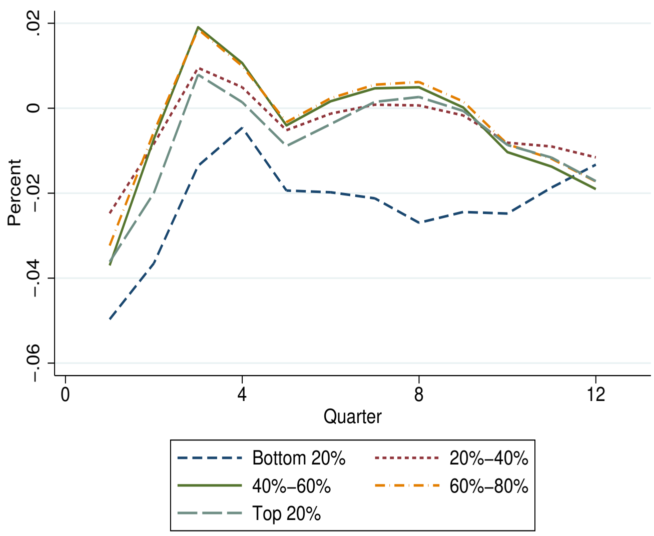


Figure 12: Impulse Response of Median Net Wealth Relative to Gross Wealth after Different Shocks by Top Gross Wealth Quintile, Extended Model

Non-surprisingly, the responses of the extended model in Figure 12 are still very similar to Figures 8 and 9. However, the response after an oil price shock in Figure 12 distinctly differs from that in Figure 10. While this further amplifies the effects of the shock of inflation and interest rates, on the other hand, the oil price shock provides a highly irregular response with an unclear interpretation, further diffusing the actual effect of the oil price on wealth inequality.

6.3 Policy Implications

The results can partly be assumed to provide inversely symmetric results if deflation, monetary expansion and oil price drop shocks were induced instead. Still, considerations should be taken regarding factors that add asymmetrical implications to the response of monetary policy mechanisms. For example, the ZLB was reached during the analysed period, thus limiting the Norges Bank's capacity to conduct expansionary monetary policy. On the other hand, as discussed in Section 3, fixed-interest mortgages only react to rate cuts when borrowers can renegotiate their terms while choosing to do nothing during rate hikes.

However, regardless of any asymmetrical dynamics, one of the most important insights from the analysis is that households in the lowest wealth quintile, which holds few assets but larger debts, are highly vulnerable to unexpected inflation and monetary policy.

However, adding distributional goals for central banks can diminish their effectiveness, intrude on their independence, make them less accountable and complicate communication with the public. Moreover, these additional goals may conflict with their overall objective of maintaining price stability and thus reduce overall welfare in the long run. As argued by Blanchard & Galí (2007), the problem of the non-existence of the "Divine Coincidence" that efforts to stabilise inflation not leading to output being stabilised can thus reasonably be further applied to the complication of reaching distributional goals. Having a single goal as price stability is easier to monitor and be used to assess the central bank's performance. Nevertheless, central banks should still consider economic agent heterogeneity and wealth distributions when conducting policy as they affect the transmission of monetary policy.

Clear communication from central banks is critical to addressing the perception of increased inequality or certain unfavourable monetary policy stances that are perceived to harm exposed groups in society. They need to clearly state their objectives and explain their policy's role in achieving them, acknowledging and discussing any distributional effects of their policies. By addressing public concerns about these effects, they can highlight the counterfactuals and underline structural factors behind the long-run increase in inequality. Furthermore, governments and financial regulators must support the central banks' efforts and ease vulnerable groups' situations with fiscal stimulus and policies fostering financial inclusion.

7 Conclusion

This thesis aims to analyse how fluctuations in inflation, monetary policy and oil prices affect households differently across the wealth distribution. We found that inflation shocks highly benefit the poorer segments of the population through the unexpected inflation channel as the main constituent of their balance sheet, debt, is starkly decreasing. A more temporary benefit was seen for the rest of the population through the portfolio composition channel as real capital and financial assets increased in value. Furthermore, an contractionary policy shock benefited the lower part of the wealth distribution through devaluated loan holdings once again. On the other hand, the other groups were disadvantaged as their asset now instead decreased. The effect of the Oil prices shock was highly ambiguous but otherwise strikingly resembling the monetary policy shock. Moreover, the response to all shocks intensifies the higher one looks at the wealth distribution. This is attributed to the proportional increased share of financial assets as one progresses up the wealth distribution, which is explained by financial assets overall having stronger responses than real capital.

The results indicate how vulnerable the poorest parts of the wealth distributions are to monetary shocks and how their responses may highly diverge from the rest of the population. Furthermore, real capital had a somewhat smoothing effect on the wealth distribution as it is relatively evenly distributed throughout the population. However, the predominant holding of most financial capital by the top layer of the wealth distribution may lead to the wealth distribution's skewness if monetary conditions remain in the wealthier parts favour more extended periods. As the effects on Oil prices were highly ambiguous, more research is needed to determine these effects conclusively. Policymakers must therefore continue to monitor these dynamics and adjust their strategies accordingly.

It is not optimal for central banks to add a distributional goal into their objective as it could highly conflict with their primary objective of price stability. However, they must keep the distributional effects of their policies in mind to understand how their policies are transmitted to assess their effectiveness. Nonetheless, to ensure policy transparency and facilitate public understanding, they must maintain awareness of the distributional impacts these policies could engender to preserve trust and confidence in monetary institutions, thereby ensuring a more efficient transmission mechanism for monetary policy and the overall stability of the economic system.

What ultimately could improve this paper would be to use microdata. However, since there was no microdata accessible, we instead used aggregate data for analysing the dynamics over time. This might leave out relevant information that could have impacted the results if the balance sheet categories had significantly heterogeneous behaviour across the wealth distribution. A further vulnerability of our results is the choices SZRs, as they dictate the direction of relationships and whether specific effects exist. Even though no radical choices were taken that conflicted with conventional economic theory, the results should be considered with these limitations in mind.

More statistics regarding individuals' wealth in other countries must be documented to understand how monetary mechanisms affect wealth inequality comprehensively. However, progress is being made, e.g., the Swedish Riksbank and Financial Supervisory Authority is starting to document household balance sheets better to counteract inflation and financial instability. However, trade and industry in Sweden oppose this as they fear it may benefit political actors that want to implement a wealth tax (Öhrn, 2023). Thus, a balanced approach is necessary to address these contrasting perspectives. While a more comprehensive wealth database is essential for researchers, the reservations of various economic stakeholders should not be disregarded. The challenge lies in promoting transparency and gathering essential data without infringing upon the rights and interests of different economic actors. Achieving this balance would require ongoing dialogues, regulatory finesse, and a commitment to evidence-based policy formulation that respects and accommodates a broad range of socioeconomic considerations.

Further research with access to more detailed data needs to remember that the implications of asset revaluations are primarily relevant to households currently planning on selling or purchasing assets. This makes it only relevant to asses those households who would have changed their balance sheets if the shocks were absent (Fagereng et al., 2023) and not faced by a borrowing constraint (Del Canto et al., 2023) as this is what makes price changes of assets to have a noticeable effect on welfare to individuals and influence broader economic behaviour.

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Appendix A - Overview of Variables

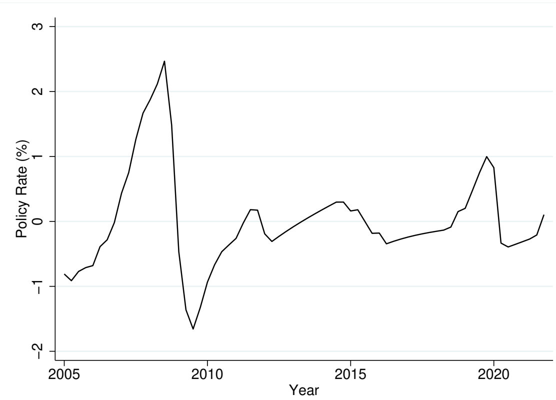

Figure 13: Domestic Monetary Policy, Detrended

Source: Norges Bank, author's calculations

Figure 14: Inflation Rate Annual Change, Detrended

Source: Statistics Norway, author's calculations

Figure 15: Real Capital, Annual Change, Detrended

Source: Statistics Norway, author's calculations

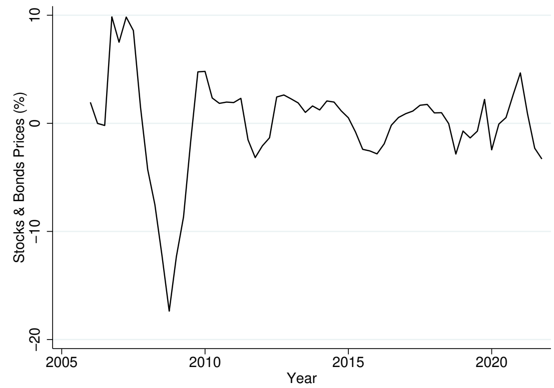

Figure 16: Stocks & Bonds, Annual Change, Detrended

Source: Statistics Norway, author's calculations

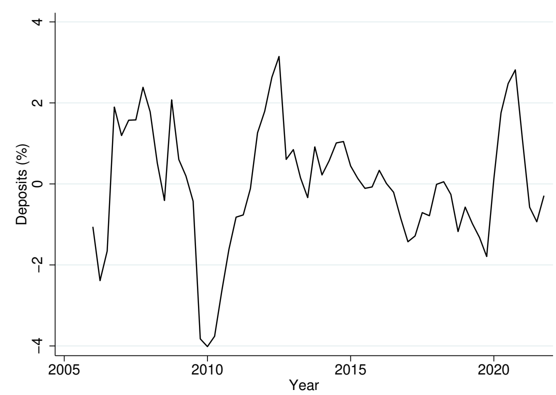

Figure 17: Deposits, Annual Change, Detrended

Source: Statistics Norway, author's calculations

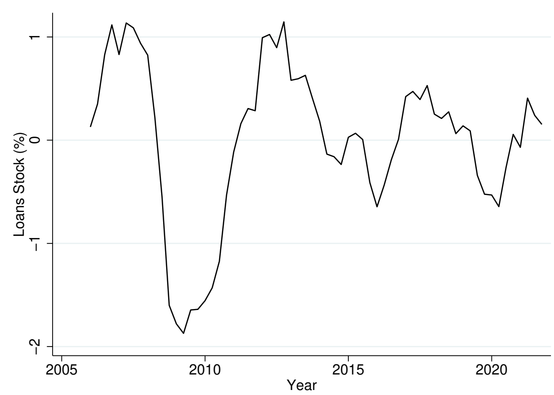

Figure 18: Loans, Annual Change, Detrended

Source: Statistics Norway, author's calculations

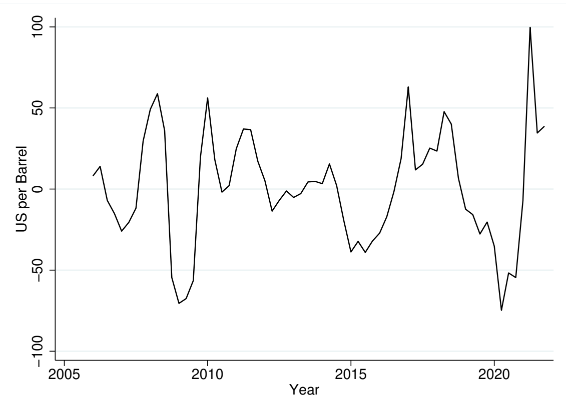

Figure 19: Oil price, Annual Change, Detrended

Source: Statistics Norway, author's calculations

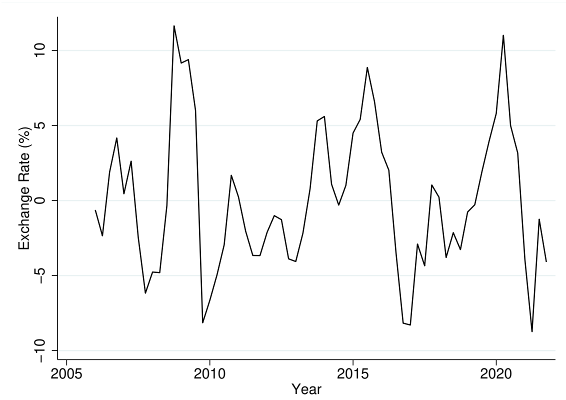

Figure 20: Exchange rate, Annual Change, Detrended

Source: Norges Bank, author's calculations

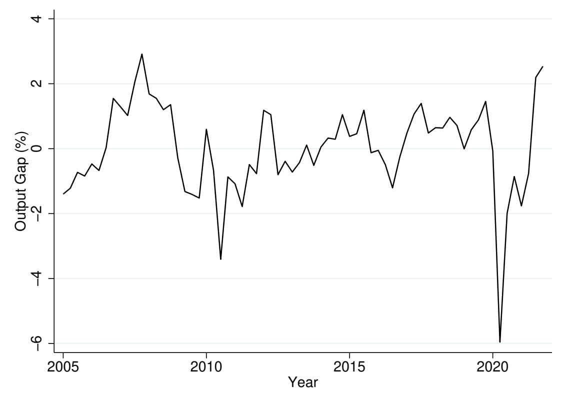

Figure 21: Output Gap

Source: FRED St. Louis, author's calculations

Appendix B - Calculation of Asset Values

The statistics regarding the balance sheets along the Norwegian wealth distribution gathered from Statistics Norway are based on tax reports. However, these statistics are likely to underestimate the wealth as only wealth subject to taxation will be manifested in the data. Additionally, not all citizens have reported their values for some classes, which makes the total net wealth not precisely equal to the sum of all other portfolio classes. However, an assumption is made throughout the analysis that all citizens' non-reported values are equivalent to zero. The difference between the average wealth of all citizens and the average wealth of all citizens who have reported their holdings is presented in Table 4.

Table 4: **Average Taxable Wealth NOK**

Asset Class	Number of People with Reported Tax Value	Average for People with Tax Value Reported	Average for All People
Taxable Gross Wealth	4 568 206	1 486 600	1 467 700
Taxable Gross Financial Capital	4 541 328	756 100	745 200
Bank Deposits	4 531 083	348 500	343 100
Capital Assets in Mutual Funds	965 462	146 400	31 800
Share Savings Account	868 365	230 300	45 300
Shares & Securities	676 368	1 700 500	258,900
Taxable Real Capital	3 263 400	985 900	722 500
Assessed Tax Value of Dwelling	2 548 924	1 028 300	593 400
Other Real Property	899 092	291 200	58 000
Taxable Net Wealth	4 604 338	573 600	568 100
Debt	3 297 771	1 227 200	899 600

The main reason for this difference is the fewer reports of values for certain asset classes, a trend particularly prevalent in the lower parts of the wealth distribution. However, the effect of this difference diminishes and becomes negligible when examining wealth distribution at deciles separately. Therefore, the values used in the analysis in this paper are calculated by multiplying the average amount reported in each class by the number of individuals that have reported holdings in that category which are then divided by one-tenth of the total number of individuals included in the annual tax data.

Appendix C - IRFs of the Extended Model

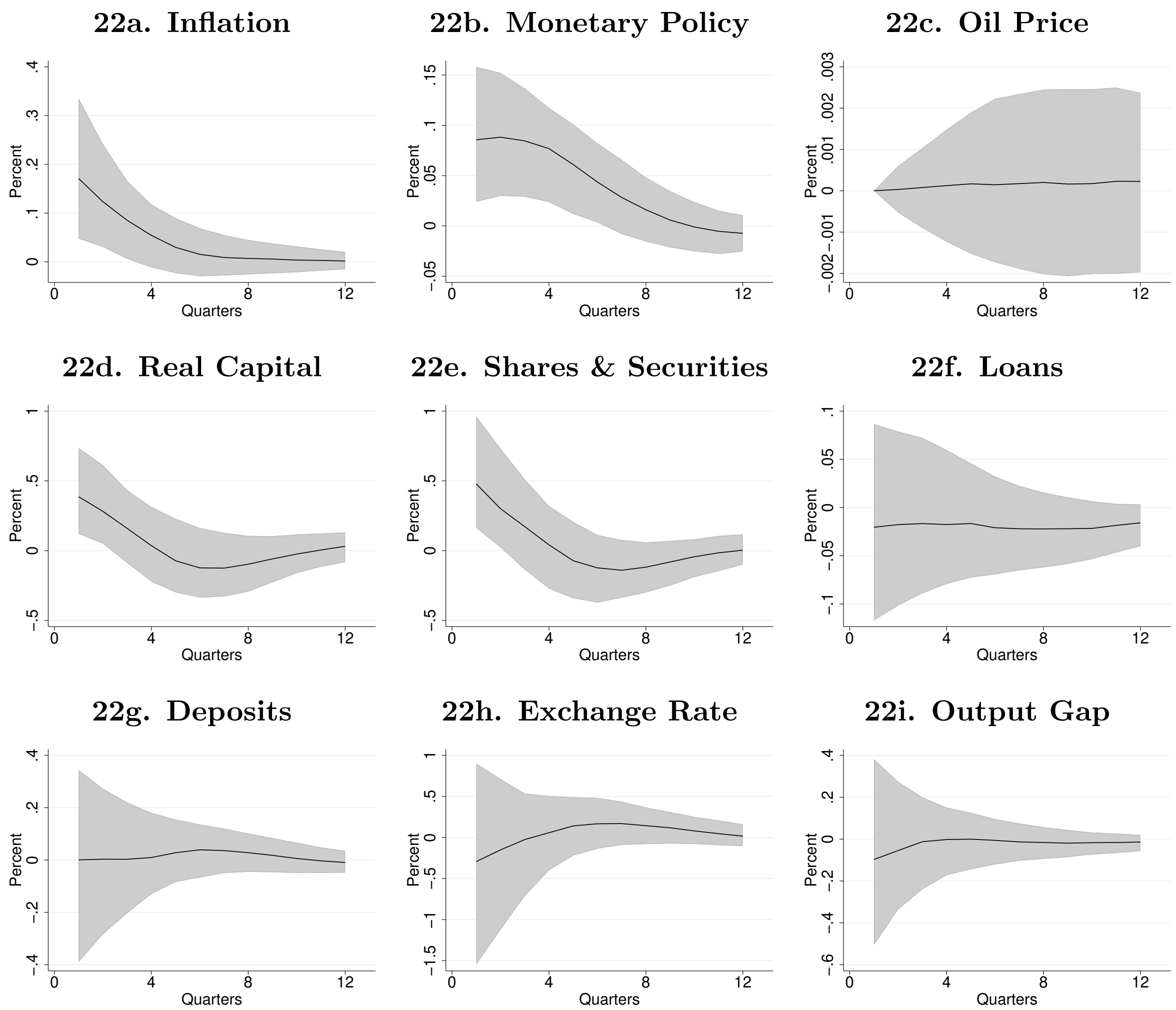

Figure 22: IRF for the Extended Model After an Inflation Shock

Note: The shaded area around the median response represents one standard deviation

Figure 22h with the IRF of the exchange rate induced by an inflation shock exhibits an initially highly volatile response, commencing with a decrease before shifting to a slight increase after several quarters, ultimately reverting to its steady state. The classic Mundell-Fleming model explains the initial decrease, which signifies an appreciation of the NOK. An inflation shock leads to expectations of a monetary policy tightening, causing an appreciation of the domestic currency. The slight increase after several quarters indicates a depreciation could be due to market participants eventually expecting the Norges Bank to tighten monetary policy in response to the inflation shock.

Figure 22i depicting the IRF for the output gaps reaction to an inflation increase shock shows a highly volatile response, marked initially by a decrease before reverting to its steady state. The initial decrease is due to eroding purchasing power, which causes a decline in demand, resulting in a contraction of actual output relative to potential output, i.e., a widening output gap. In addition, inflation can also disrupt firms' cost structures and profitability, potentially leading to a slowdown in production and thus further widening the output gap. Then the output gap reverts to its steady state as the inflation shock dissipates, e.g., due to the increased interest rate.

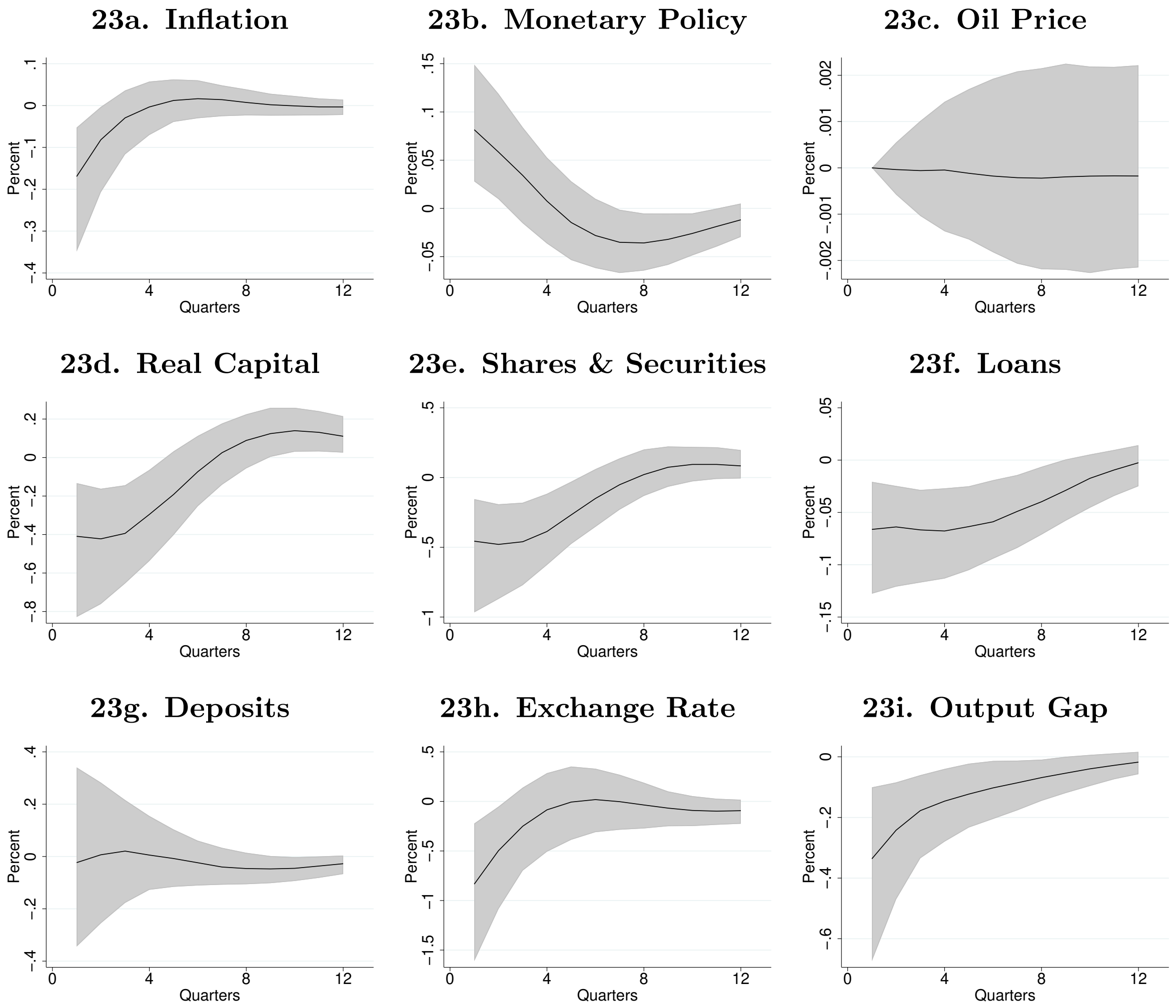

Figure 23: IRF for the Extended Model After a Monetary Policy Shock

Note: The shaded area around the median response represents one standard deviation

The IRF in Figure 23h of the exchange rate to an interest rate increase shock shows an initial decrease, indicative of an appreciation of the NOK. However, a reversion to the steady state follows this, and then a slight decrease after, implying a modest subsequent appreciation of the NOK. The initial appreciation is due to the conventional dynamics of monetary policy transmission. An increase in the interest rate makes domestic assets more attractive to foreign investors, leading to an inflow of capital that appreciates the domestic currency.

The IRF of the output gap in Figure 23i shows an initial decrease, which suggests a contraction of economic activity relative to its potential. It can be attributed to the standard dynamics of monetary policy transmission. An increase in the interest rate typically dampens aggregate demand as the cost of borrowing rises, discouraging investment and consumption. This leads to a lower actual output relative to potential output, thereby widening the output gap. After that, it returns to its steady state as Norges Bank policy responds with a subsequent adjustment to the interest rate.

The IRF in Figure 24h of the exchange rate to an oil price increase shock is highly volatile and uncertain. Oil price shocks can, in several ways, affect an oil-exporting economy like Norway's. An increase in oil prices can boost the country's export revenues, leading to an inflow of foreign currency, which can cause the domestic currency to appreciate. Higher oil prices can also stoke inflationary pressures, which might lead the central bank to adjust interest rates, affecting the exchange rate. Similarly, global financial conditions and market sentiment changes can influence oil prices, capital flows, and exchange rate dynamics. Moreover, the uncertainty in response to the exchange rate could be due to factors such as the unpredictability of future oil prices, the potential for policy responses, and the diverse reactions of different sectors and agents within the economy.

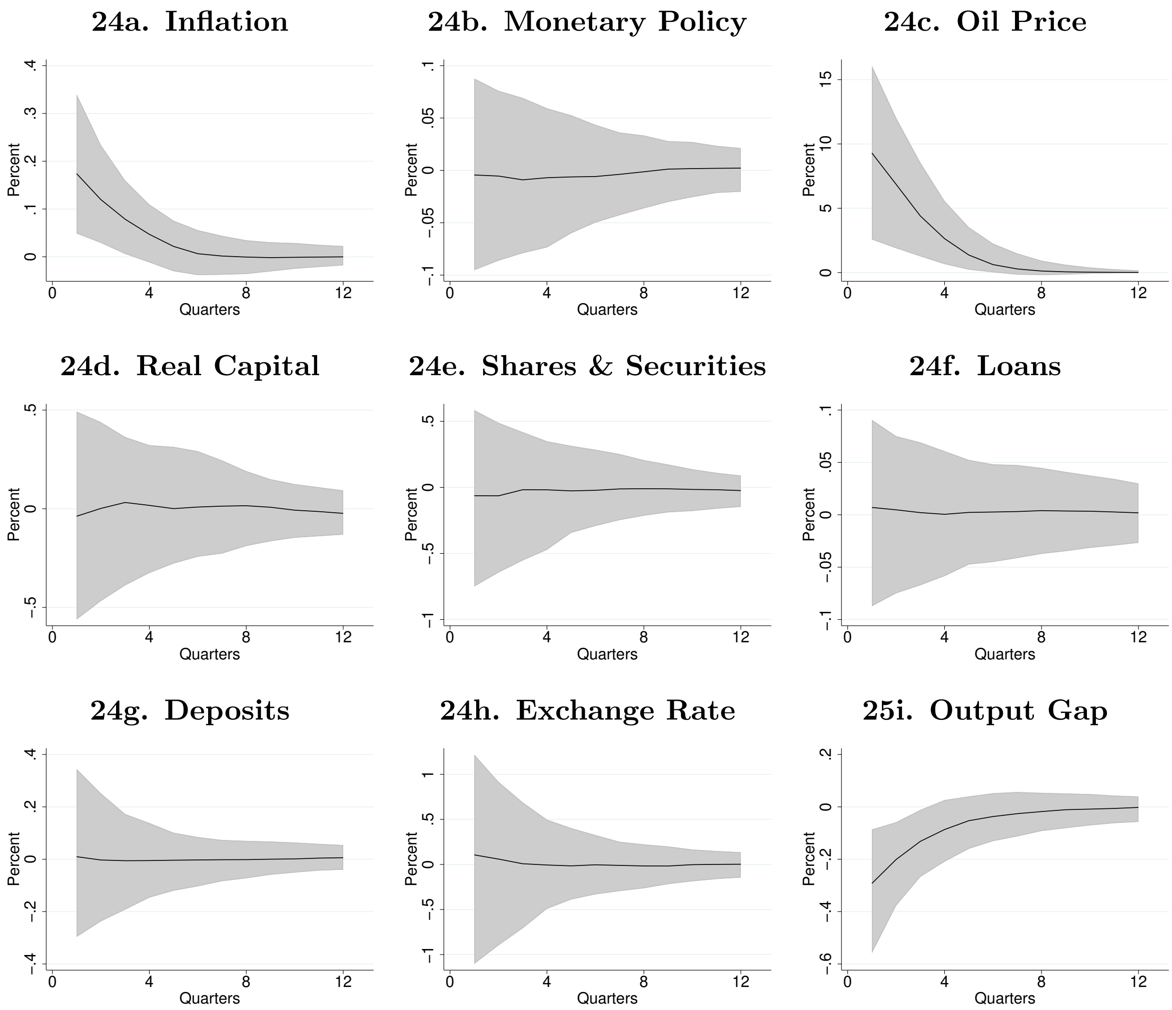

Figure 24: IRF for the Extended Model After an Oil Price Shock

Note: The shaded area around the median response represents one standard deviation

The IRF in Figure 24h of the output gap shows an initial decrease indicating a shrinkage of actual economic activity relative to potential. While an increase in oil prices can benefit the export sector in an oil-exporting country such as Norway, it can still induce a significant contractionary effect on the domestic economy. Higher oil prices could lead to elevated production costs, particularly for industries heavily reliant on oil as an input, thereby reducing overall output. Moreover, higher oil prices strengthen inflationary pressures, dampening consumer spending and consequently decreasing demand-driven output. This thus results in a widening of the output gap. As the economy adjusts to the new oil price landscape, the output gap reverts to its steady state.