WISEflow
Europe/Oslo(CEST)
30 Jun 2022

Handelshøyskolen BI

GRA 19703 Master Thesis

Thesis Master of Science 100% - W

Predefinert informasjon

Startdato:	16-01-2022 09:00	**Termin:**	202210
Sluttdato:	01-07-2022 12:00	**Vurderingsform:**	Norsk 6-trinns skala (A-F)
Eksamensform:	T		
Flowkode:	202210||10936||IN00||W||T		
Intern sensor:	(Anonymisert)		

Deltaker

Navn:	Federico Esteban Herrera og Elise Melsom

Informasjon fra deltaker

Tittel *:	The Effect of Monetary Policy on House Prices during the Covid-19 Pandemic in Norway
Navn på veileder *:	Hilde Bjørnland

Inneholder besvarelsen konfidensielt materiale?:	Nei	**Kan besvarelsen offentliggjøres?:**	Ja

Gruppe

Gruppenavn:	(Anonymisert)
Gruppenummer:	18
Andre medlemmer i gruppen:	

The Effect of Monetary Policy on House Prices during the Covid-19 Pandemic in Norway

Hand-In Date:
July 1st, 2022

Supervisor:
Hilde Bjørnland
Felix Kapfhammer (Co-supervisor)

Campus:
BI Oslo

Examination Code and Name:
GRA 19703 Master Thesis

Programme:
Master of Science in Applied Economics

Abstract: This thesis investigates the impact of monetary policy on the housing market in Norway over the past twenty years, paying particular attention to changes in the transmission of the policy rate to house prices during the Covid-19 pandemic. We also consider the effect of mobility and consumption restrictions associated with the pandemic on this transmission, as well as changes in household consumption, credit, and saving during the pandemic to give context to the decisions made by households regarding investment in housing. We employ local projections with rolling sample windows to compensate for the short time span of the pandemic. Our results indicate that the response of house prices to the policy rate in Norway was stronger during the Covid-19 pandemic relative to normal times and to other crises, both in the short run (3 months) and the longer run (up to 9 months).

Acknowledgements: We would like to thank our supervisor, Hilde C. Bjørnland, and our co-supervisor, Felix Kapfhammer, for their guidance and their invaluable contributions to this thesis.

Contents

1 Introduction

A topic that has been important in Norwegian society for many decades is the trend of house prices. Between 2015 and 2021, the house price index increased at an average rate 1.78 times that of median monthly earnings (see figure 1.1) (Eiendom Norge, 2022; Statistics Norway, 2022e). Furthermore, the Norwegian house price index more than doubled between 2003 and 2013 (Eiendom Norge, 2022). Monetary policy plays a significant role in the movement of house prices by affecting mortgage rates for households, as well as other interest rates in the economy.

Between March 2020 and the time of the writing of this thesis, Norway, along with the rest of the world, faced periods of high uncertainty and numerous economic challenges as a result of the Covid-19 pandemic. Government restrictions on mobility and shopping during the pandemic led to changes in the ability of firms and consumers to supply and demand goods, and fiscal and monetary policy actions also led to changes in the wealth of and trade-offs faced by individual households. Given the already precarious state of the housing market in Norway, a relevant question for the Norwegian central bank is the effect that monetary policy has had on housing prices during the Covid-19 pandemic. Specifically, how did the transmission and effect of monetary policy on house prices in Norway change during the Covid-19 pandemic, compared both to normal times and to previous economic crises?

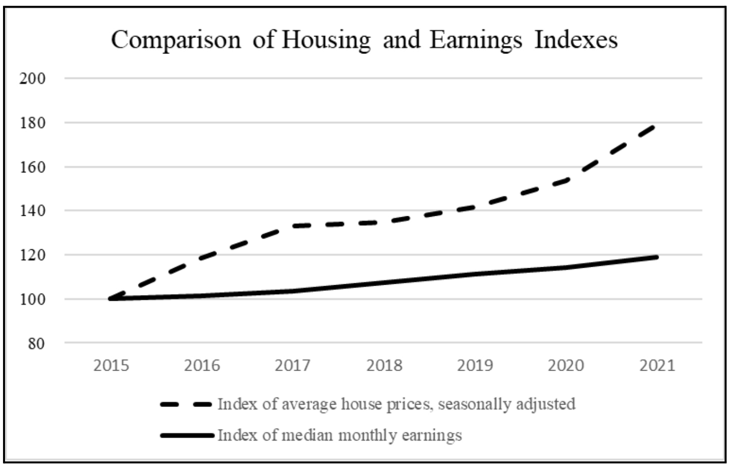


Figure 1.1. Comparison of the average annual Norwegian housing index with an index of median monthly earnings from 2015 to 2021. (Eiendom Norge, 2022; Statistics Norway, 2022e).

The three most relevant crises for Norway over the last two decades are the 2008 financial crisis, the oil crisis of 2014-2016, and the recent Covid-19 pandemic. Due to the recent and short nature of the pandemic, research surrounding the effects of the pandemic on the Norwegian economy is scarce and plagued by a high degree of uncertainty. Furthermore, there are a number of differences between the pandemic and prior crises that lead to questions regarding the robustness and applicability of prior research to the pandemic period. Some of these differences include the fact that, during the pandemic, the changes in demand were the result of artificially imposed mobility restrictions for the general public as opposed to natural behavioural or financial shocks; that the cause of the pandemic was an external force, namely a virus, which was exogenous to most economic and social variables; and that there were multiple waves, leading to fluctuations in the severity of infections and government restrictions over time.

Central banks typically practise expansionary monetary policy during times of economic crisis, which involves lowering the overnight deposit rate that banks receive on their holdings at the central bank, also known as the policy rate. In theory, a decrease in the policy rate leads to an increase in the levels of consumption and borrowing, a decrease in savings, and, importantly, a predicted increase in housing prices resulting from eased credit constraints for households (Romer, 2019, pp. 226, 369, 386). Our research attempts to answer whether economic theory and prior research continue to hold up under conditions as unprecedented and unique as those during the Covid-19 pandemic. We hypothesise that a change in the policy rate led to a larger effect on house prices during the pandemic compared to normal times and to past crises, due in part to consumption being artificially limited by government Covid-19 restrictions. Under normal conditions, a decrease in the policy rate stimulates both consumption and the housing market. The restriction of consumption by the government during the pandemic would suggest that the housing market may be stimulated more strongly than in the absence of these restrictions, and it is this potential effect that we are interested in measuring.

Our data consists of time series for saving, credit, consumption, production, interest rates, and house prices since 2003. We utilise a rolling-window time series approach with an econometric technique known as local projections. The combination of a rolling window approach with a local projection addresses one of the main limitations of research surrounding the Covid-19 pandemic, namely the short time span and the corresponding small number of observations. The rolling windows allow for time-varying estimates of the impulse responses, and we produce a time-varying plot of the impulse responses for each window at a six-month horizon.

Our results indicate that monetary policy has a significantly larger effect on house prices during the Covid-19 pandemic than during normal times, as well as compared to other crises. This is visible by the increase in the magnitude of the impulse response of house prices to a negative policy rate shock, both during the recent pandemic-induced economic recession as well as during the 2008 financial crisis and the oil crisis.

The remainder of the thesis is organised as follows. We begin with a review of the literature surrounding the Covid-19 pandemic, as well as that surrounding the general effects of monetary policy on house prices throughout the past decade, in order to illuminate the research gap that we are addressing. Next, we discuss our methodology and the specifics of our data. We end with a discussion of the results, robustness checks, and the implications of these findings.

2 Economic Theory and Literature Review

2.1 Historical views on monetary policy

Examples of expansionary policy that help to ease economic hardships in times of crisis include reductions in the policy rate and higher fiscal stimulus spending. With regards to the consequences of such policies on other markets, such as the housing market, there is a consensus among economists that a lower policy rate has an expansionary effect on the overall economy as well as on individual market segments. In the housing market, this is through the stronger incentive that commercial banks now have to extend more loans to consumers and investors.

Prior to the 2008 financial crisis, monetary policy was not thought of as having a significant effect on the housing market or as responding to asset price fluctuations, as commented in Aziz (2012) and Aastveit et al. (2021). This mainstream idea was challenged when it was discovered that the housing market lay at the heart of the problem underlying the financial crisis. As stated in Bjørnland and Jacobsen (2010), “The recent U.S. subprime crisis and the subsequent financial crisis have increased the focus on asset price developments, especially among central banks. This is primarily due to the central collateral role of asset prices such as prices of dwellings,” (p.1).

The economic recession associated with the Covid-19 pandemic has again brought about new challenges and opportunities to analyse the robustness of mainstream economic thinking. During the first year of the Covid-19 pandemic, the Norwegian central bank decreased the policy rate from 2.5% in March 2020 to a low of 1% by May 2020 (Norges Bank, 2022). By the nature of monetary policy, this decrease implies a larger increase in house prices than would have occurred in the absence of this policy rate change, and this house price increase is in addition to the increases we expect to see as a result of other economic factors such as government restrictions and changing consumer preferences. Thus, the pandemic contributes to unique economic circumstances that change the landscape for economic research on monetary policy.

2.2 Literature Review

The primary research gap that our thesis attempts to address is the change in the impact and transmission of monetary policy during an unusual economic period, namely the economic circumstances associated with the Covid-19 pandemic. While much research has been conducted on the topic of monetary policy and house prices in general, the research on this topic specifically during the Covid-19 pandemic is limited due to the recent and ongoing nature of the pandemic. This same reason leads to limitations in the range of econometric techniques available to researchers interested in examining the Covid-19 period, as having a sufficiently long time period of observation is a typical requirement for time series estimation methods. In what follows, we provide insight into existing research on monetary policy and housing prices, as well as research relating to the Covid-19 pandemic.

A recent article examining the effect of monetary policy shocks on housing prices is Robstad (2017), which is an extension of Bjørnland and Jacobsen (2010). Robstad (2017) investigates the effect of monetary policy shocks on Norwegian house prices and credit for the period 1994 to 2013 using Bayesian structural vector autoregression (SVAR) models. The results of his analysis indicate a sizable positive effect of monetary policy on housing prices, as well as a moderate effect of monetary policy on household credit. Bjørnland and Jacobsen (2010) examined the aftermath of the subprime mortgage crisis and the ensuing financial crisis of 2008 using a VAR model with both short-run and long-run restrictions, and with data from Norway, Sweden, and the UK. As in Robstad (2017), the results indicated that housing prices react strongly and quickly to monetary policy shocks.

While our thesis employs a local projection technique as opposed to the SVAR used in Robstad (2017), our goal is the same: to identify the quantitative impact of monetary policy shocks on house prices in Norway. In addition to using a different estimation model, we extend the results by shifting the time period, using a rolling window approach to aid with the identification of shocks, and focusing on the differences between crises.

One reason for employing a local projection as opposed to an SVAR is that "the VAR literature [...] shows that results may change drastically depending on the model specifications," (Robstad, 2017, p.463). In other words, results regarding the transmission of monetary policy are likely to be influenced by the assumptions we employ. Jordà (2005) outlines the local projection technique for computing impulse responses and outlines the ways in which it may be superior to an SVAR, one being that local projections are more robust to misspecification than SVAR models. Local projections require fewer assumptions about the true data generating process compared to an SVAR, such that the results are more likely to be representative of the data as it actually is, as opposed to how we assume the underlying structure to be. Another advantage of local projections is that they provide local approximations as opposed to global averages. Jordà (2005) emphasises that the use of a series of local projections is superior to an SVAR that averages over an entire sample. As our sample spans three distinct economic crises, it is preferable to use a technique that allows for more local, time-specific approximations. This topic is discussed further in section 4.1.

Jarociński and Smets (2008) use a Bayesian VAR model with housing, output, and interest rate data to inform a discussion about the impact of monetary policy and GDP developments on the housing sector. The time series used in this analysis spans from the mid 1980s to the mid 2000s, and the results suggest a strong effect of monetary policy on housing prices. However, as in Robstad (2017), the results of their analysis depend on the specifications of the restrictions and the conditional forecasting in their VAR model.

One of the most recent publications on the subject of house prices and monetary policy is Fischer et al. (2019), which presents that the response of house prices varies considerably in both directions based on geographic region, and that these discrepancies arise largely from differences in regulations and housing supply elasticities. While 2019 is relatively recent in terms of academic publishing, it is prior to the outbreak of the Covid-19 pandemic and therefore does not reflect changes that may have happened in the economy as a result of the pandemic.

Another recent article on the topic of monetary policy and housing prices is Aspergis (2021), which takes a contrasting approach by examining the role that the housing market has on the effectiveness of monetary policy. Aspergis (2021) argues that the housing cycle plays a role in banks' willingness to lend, among other things, and investigates how the current state of the housing market in 31 different countries impacts the effectiveness of monetary policy in the wake of the pandemic. Battistini et al. (2021) describes changes in the European housing market during the first year of the pandemic and posits that the increase in house prices has likely been fuelled by a combination of factors besides monetary policy, including that housing as an investment option has been increasing in popularity due to the lower relative uncertainty associated with physical assets, and that there have been supply-side restrictions in the housing market as a result of the slowing down of many construction projects during the pandemic. The availability of research and literature surrounding the Covid-19 pandemic is growing as time passes and as data becomes available, and our research aims to contribute to filling the research gap relating to monetary policy in pandemic times.

2.3 Norway

One of the reasons Norway is particularly interesting to analyse in terms of the response of housing prices during the Covid-19 pandemic is that Norway possessed considerable flexibility to adjust its policy rate. At the start of the pandemic in early 2020, the policy rate was set to 2.5% (Norges Bank, 2022). Over the following months, the policy rate was incrementally lowered to 1%. This change of 1.5% reflects the fact that the Norwegian central bank had monetary policy tools at its disposal at the start of the pandemic, whereas many other countries were already at the effective lower bound for their policy rate. In Switzerland, for example, the policy rate has been -0.75% for many years and remained unchanged throughout (at least) the first two years of the Covid-19 pandemic (Swiss National Bank, 2022). The fact that the policy rate was already below zero at the start of the pandemic implies that the Swiss central bank had virtually no policy rate tool at its disposal to stimulate the economy in the wake of the economic hardships arising from restrictions related to the pandemic. Norway, on the other hand, had more flexibility.

Another reason for investigating Norway specifically is that, as Norway is a wealthy country with a high degree of political and economic stability, results from Norway will likely be applicable to other developed countries and will perhaps align more closely with economic theory compared to more volatile or developing countries.

3 Data and Historical Trends

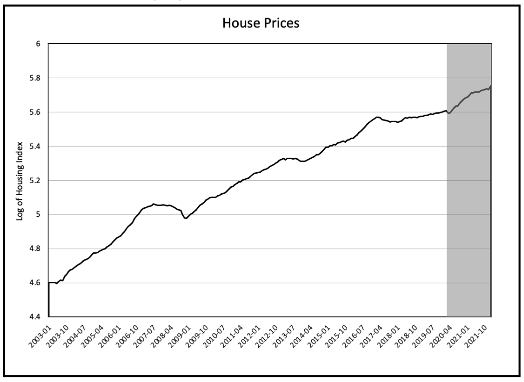
3.1 Data collection and historical trends

Our main data consists of seven Norwegian monthly time series spanning the period January 2003 to February 2022, six of which are used in our main model and one of which is used for supplementary analysis. We take the natural log of all variables before running the estimations, with the exceptions of the interest rate and the Covid-19 restriction stringency variables. The six macroeconomic variables that we include in our estimation model are (1) household credit as measured using loans to households from banks and mortgage companies

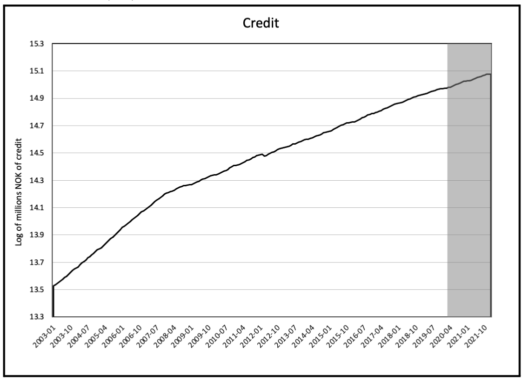
(Statistics Norway, 2022b), (2) consumption as measured by the index of household consumption of food, electricity, fuel, and miscellaneous goods (Statistics Norway, 2022a), (3) saving as measured by households' bank deposits at commercial banks (Statistics Norway, 2022d), (4) the index of industrial production, including extraction, mining, manufacturing, and electricity (Statistics Norway, 2022c), (5) house prices across Norway measured using a seasonally adjusted index with 2003 as a base year (Eiendom Norge, 2022), and (6) the policy rate at the end of each month, set by the Norwegian central bank (Norges Bank, 2022).

The last variable used in our analysis that is not included in the local projection model is government-imposed restrictions during Covid-19 as measured by the stringency of restrictions regarding public transit, mask mandates, and stay-at-home orders, among others (Blavatnik School of Government, 2022). Summary statistics for all seven of our main variables are presented in the appendix.

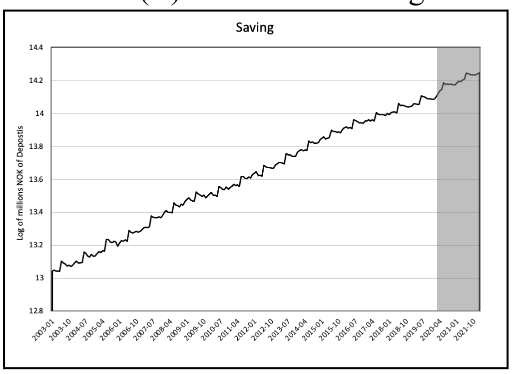
(A) House Price Index



(B) Household Credit



(C) Household Saving



(D) Household Consumption Index

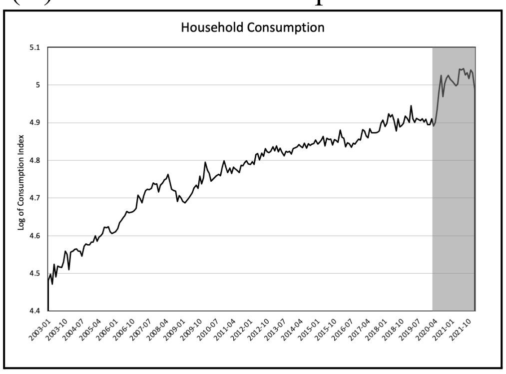


Figure 3.1. Historical time series data for housing index, credit, saving, and consumption. The shaded region indicates the Covid-19 pandemic. The log scale allows for the interpretation of the distances between points as the percent changes. (Eiendom Norge, 2022; Statistics Norway, 2022a, 2022b, 2022d).

An analysis of the raw historical time series data for the housing index, saving, credit, and consumption reveal interesting trends both prior to and during the pandemic. Figure 3.1 shows each of these variables in natural log terms and reveals strong trends for house prices, credit, saving, and consumption prior to the pandemic. These trends largely continued on their prior trajectory once the pandemic began, but with two notable exceptions, namely an increase in the trend slope for house prices and a jump in consumption occurring a few months into the pandemic. We discuss the latter phenomenon in section 3.3 below.

Figure 3.2 shows the time series for the policy rate from January 2003 to February 2022. The policy rate experiences a sharp drop at the start of the pandemic, followed by a period with a low, constant policy rate until the end of 2021. Notably, the policy rate was on an increasing path prior to the Covid-19 pandemic.

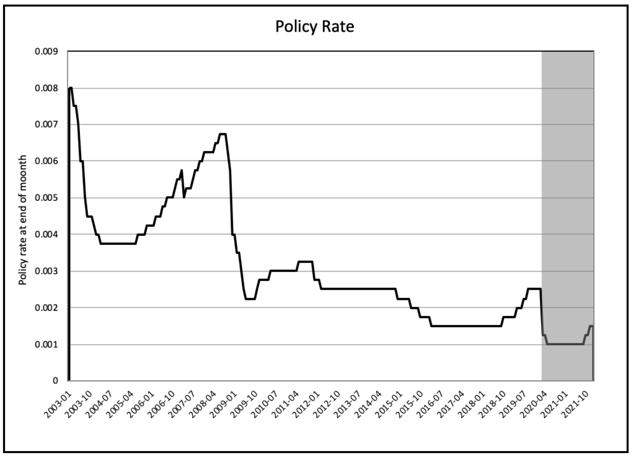


Figure 3.2. Norwegian policy rate, 2003 – 2022. (Norges Bank, 2022).

Government restrictions aimed at preventing the spread of the Covid-19 virus were first imposed in Norway in March 2020, followed by episodic weakening and strengthening of these restrictions throughout the course of the pandemic. While these restrictions helped to minimise the severity of the pandemic and likely saved lives, they also had consequences for the levels of consumption, saving, and production. Restricted mobility prevented much of the typical in-store shopping that is prevalent across Norway, and there were widespread disruptions to global production and supply chains. These three variables are also affected by changes in the policy rate, such that the historical trends are a result of both a changed interest rate as well as Covid-19 restrictions.

In addition to the expansionary monetary policy conducted by Norges Bank, the Norwegian government also utilised expansionary fiscal policies to ease the burden that the restrictions were creating in terms of reduced economic activity. Table 3.1 shows estimates of the increased fiscal spending by the Norwegian government during the first year of the Covid-19 pandemic.

Estimated costs of economic stimulus measures (NOK billions) (as of 8 June 2020).	
Mitigate income loss for businesses including compensation for large losses	74.1
Aviation sector loss provision and guarantee scheme	14.1
Government guaranteed loans to businesses through the banking system	10.0
Counteract loss of income for individuals	27.3
Strengthening critical infrastructure sectors	23.3
Other compensation schemes	7.2
Other measures	6.1
Increased spending on unemployment benefits	23.9
Total	186.0

Table 3.1. Estimated costs of economic stimulus measures in Norway. Table taken from Ursin et al. (2020).

The combination of mobility restrictions and increased fiscal spending will predictably lead to higher household saving rates. Due to the low return provided on bank deposits during the pandemic, however, households may have sought out alternative investment opportunities. One alternative, and the basis of our hypothesis, is that the demand for houses increased as a result of the combination of households' increased perceived wealth and fewer consumption opportunities during the pandemic.

3.2 Restrictions affecting household consumption

Research on the topic of monetary policy and the Covid-19 pandemic needs to consider that during the first two years of the pandemic, many variables aside from the policy rate were changing at the same time. The pandemic represents an unusual period in economic history due to the extraordinary measures undertaken by governments around the globe in an attempt to constrain the rates of infection and mortality, while simultaneously minimising disruptions to the economy. In addition to simple restrictions like mandating the use of masks in public spaces, many governments enacted a series of societal shutdowns that constitute some of the largest economic disruptions in recent history. In Norway, all stores and public services deemed not critical to the functioning of society were under orders to remain closed for weeks at a time, severely restricting the ability of consumers to purchase goods in stores, visit restaurants, and utilise for-hire services.

Table 3.2 shows an overview of the severity of some of the restrictions imposed in Norway since the start of the first major wave of infections in Norway. As there were multiple waves of infection triggered by the emergence of new variants of the Covid-19 virus, the severity of the restrictions varied over time and often changed rapidly.

	2020										2021												2022	
Month	03	04	05	06	07	08	09	10	11	12	01	02	03	04	05	06	07	08	09	10	11	12	01	02
Schools	3	3	1	1	1	1	1	1	1	1	2	2	2	2	2	1	1	1	1	1	1	2	1	1
Work	2	2	2	1	1	1	1	1	2	2	3	3	3	3	2	2	2	1	1	0	0	2	2	1
Transit	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
Gatherings	2	4	3	3	3	3	3	3	4	4	4	4	4	4	4	3	3	3	0	0	0	4	4	0
Stay Home	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	0

Table 3.2. Overview of average monthly stringency of Covid-19 restrictions in Norway. (Blavatnik School of Government, 2022).

An important question for our research is whether Covid-19 restrictions affected household consumption and spending on goods. If our hypothesis is that these restrictions caused the lower policy rate to stimulate housing purchases as opposed to stimulating consumption, a logical prerequisite is that household spending on consumption goods demonstrably decreased as a result of the Covid-19 restrictions. If this is not the case, there is little reason to believe that house prices increased as a result of consumers redirecting their increased perceived wealth from consumption to housing.

We investigated the effect of restrictions on consumption using a simple linear regression model with various types of government restrictions as the independent variable and various types of household consumption as the dependent variable. Our regression equation takes the following general form:

$$Consumption_t = \beta_0 + \beta_1 Restriction_t + \varepsilon_t$$

The available data from Statistics Norway for Norwegian household consumption includes categories for food/drink/tobacco, electricity/energy, fuel for transport, and miscellaneous goods (e.g., housewares, clothing, entertainment) (Statistics Norway, 2022a). The individual restrictions that we considered for this analysis were those placed on schools, workplaces, public transit, social gatherings, and stay-at-home orders.

We ran the above regression using all of the possible combinations of these consumption categories and restrictions types. The results of the regressions are displayed in table 3.3. Our results indicate that the stringency of public transit restrictions and school shutdowns had statistically significant effects on the level of miscellaneous consumption at the 5% significance level, which is the consumption category one would associate with discretionary spending. A logical potential omitted variable in this linear regression is the severity of the Covid-19 pandemic. However, given that all of these restrictions are in essence a measure of the severity, we can say that, whether it is the specific restriction or the severity of the pandemic that is driving the effect, consumption is demonstrably decreasing in response to the pandemic and the restrictions.

	School	Work	Transit	Gatherings	Stay-at-Home	Stringency
Total	-7.622	-2.1923	-7.0371	1.4375	9.7	-0.095681
	(-4.9248)	(3.878)	(6.564)	(2.3618)	(6.3088)	(0.2056)
Food	-1.8178	1.4077	-0.66429	1.4375	6.2917	0.12894
	(4.5024)	(3.3905)	(5.8656)	(1.9785)	(5.6276)	(0.17793)
Electricity	21.223**	17.64**	5.3986	4.2233	22.025*	0.49009
	(9.3354)	(6.8492)	(13.42)	(4.6784)	(12.423)	(0.39988)
Fuel	-9.6915	-3.8481	3.5314	-1.037	12.033	-0.21524
	(7.1694)	(5.5595)	(9.6579)	(3.41930)	(9.2007)	(0.29369)
Miscellaneous	-19.619**	-9.9962	-21.757**	0.45416	8.4833	-0.40565
	(7.5194)	(6.1204)	(10.163)	(3.9503)	(10.866)	(0.33171)

Table 3.3. Results of linear regression models for the effect of various Covid-19 restrictions (along top) on the indexes of various household consumption categories (along left side). Standard errors are in parentheses.

*** Significant at the 5% level*
** Significant at the 10% level*

Another notable result is that restrictions on both school and on work had statistically significant effects on the level of electricity consumption at the 5% significance level. The introduction of stay-at-home orders also had a significant effect on electricity consumption at the 10% significance level. Logically, the closing of schools and workplaces leads to a greater need for daytime electricity at home for amenities like lighting and temperature control. While the use of electricity is not particularly relevant for the type of consumption we are considering, namely consumption outside the home, the increased household spending on electricity is certainly an important component for households' disposable incomes.

3.3 Consumption smoothing and the permanent income hypothesis

In addition to restrictions on movement and consumption, the Norwegian government undertook a series of fiscal policy stimulus measures during the pandemic in order to provide economic relief for Norwegian households and businesses. While many of these fiscal stimulus measures targeted specific populations, there was naturally some overspill in the larger economy. Between the start of the pandemic and June 2020, the Norwegian government had fiscal spending equal to 186 billion NOK (Ursin et al., 2020, p.670). This fiscal stimulus took the form of stimulus checks, salary replacement, and subsidies, among others. Two important economic models for contextualising and describing the trade-offs that households face when choosing between consuming and saving are the permanent income hypothesis and the consumption Euler equation. These models form the theoretical basis of our hypothesis that households shifted spending from consumption to housing.

According to the permanent income hypothesis from Milton Friedman (1957), economic agents will react only to permanent changes in their income. This implies that households will not change their spending and consumption habits in response to a temporary or transitory change in their income, such as the one experienced during the Covid-19 pandemic. Instead, households will increase current savings in order to compensate for future periods where their income is perhaps lower than expected. The permanent income hypothesis arises as a result of the theory of consumption smoothing, which posits that economic agents prefer a stable level of consumption over time in order to maximise lifetime utility. Thus, individuals will be more likely to borrow in times when their income is low and to save in times when their income is high, which will allow them to maintain a relatively constant level of consumption throughout their lifetime. Consumption smoothing predicts that consumption and spending remain constant in the face of transitory shocks to and fluctuations in macroeconomic variables, and that saving will be the variable that responds. Given that Covid-19 restrictions artificially restricted the feasible amount of consumption of goods, a reallocation from spending on consumption goods to spending on housing aligns with the theory of consumption smoothing, provided that spending on housing provides economic utility.

Extending the theory of consumption smoothing to monetary policy, a change in the policy rate affects households via the consumption Euler equation by changing the relative trade-off between current and future consumption (Jones, 2009, p.8). The optimality conditions arising from the Euler equation imply that a decrease in the policy rate incentivises households to save less and consume more. This occurs because a lower policy rate means that the opportunity cost of consuming today decreases due to both the return on saving being lower and borrowing being less expensive for households. In the context of the Covid-19 pandemic, the decrease in the policy rate throughout the first half of 2020 would imply a subsequent increase in consumption and spending, further fuelling the theoretical result that, since spending on consumption goods is being artificially restricted, the demand for and price of houses will increase even more than in normal times. The data on consumption suggests that consumption levels in Norway increased to some extent during the first two years of the Covid-19 pandemic (as was seen in figure 3.1-D), in line with the predictions from the Euler equation given the higher perceived wealth. While this jump appears contrary to the idea that consumption was hindered by restrictions, the regression results in table 3.3 suggest otherwise, and we do not have access to the counterfactual scenario, such that the increase in consumption may indeed have been tempered by the restrictions that were in place for parts of 2020 and 2021.

To summarise, the fiscal stimulus provided during the pandemic acts as a transitory income shock that increases saving and has little or no impact on spending due to the permanent income hypothesis. The lower policy rate during the pandemic made credit more accessible and incentivized a shift from saving toward consumption and spending in accordance with the consumption Euler equation. Government restrictions on movement and spending limited the amount of consumption goods that households were able to purchase, suggesting that any increase in households' desired consumption levels may have needed to shift to other sectors than pure consumption goods. One sector that would accommodate both the desire to increase savings as well as to consume more is the housing sector, which remained more or less open and functioning throughout the pandemic. The question now is whether these relationships are in fact observed in the data. We investigate this using a time series model that directly estimates the impact of a change in the policy rate on house prices, as well as on other variables such as household consumption, credit, and saving.

4 Methodology

4.1 Discussion of SVAR vs LP

Two popular econometrics models that are used to investigate the relationships between multiple time series and the effects of shocks are the structural vector autoregression model (SVAR) and local projections (LP). The SVAR model has been in use since the 1980s and is well established in the impulse response literature (Bjørnland & Thorsrud, 2015, p.213), whereas the local projection method is a newer alternative introduced by Jordà (2005). An SVAR is a structural representation of a VAR model, which in turn is the extension of a univariate autoregressive time series model to create a multivariate model. The introduction of restrictions based on economic theory allows for the identification of structural shocks (Bjørnland & Thorsrud, 2015, p.189). Local projections, on the other hand, incorporate a similar multivariate approach while directly estimating responses to shocks without assuming an underlying autoregressive process (Jordà, 2005).

Both techniques utilise regressions and restrictions on the movements of variables to estimate the relationships between variables and to plot impulse responses. A property of SVAR and LP models is that the impulse response estimates will be the same for both models up to a horizon equal to the number of lags used in the estimation, as demonstrated by Plagborg-Møller and Wolf (2021). For our LP estimate with one lag, for example, this implies that the impulse response for the first period will be the same as if we used an SVAR model, but the estimates will likely differ as we move past the first period. In the event that the true data generating process is in fact autoregressive, the impulse response estimates generated by an SVAR and an LP will be identical (Jordà, 2005, p.165). This is also the case when using an infinite sample size and lag length, as demonstrated by Plagborg-Møller and Wolf (2021, p.956). However, the two methods may differ considerably if the sample size and the number of lags are limited, as is the case with our model, and the decision regarding the desired estimation method will be subject to the bias-variance trade-off.

One of the primary advantages of using an LP as opposed to an SVAR is that, as mentioned in section 2.2, local projections make no assumptions on the true data generating process that underlies the data, whereas the SVAR relies on the assumption that the data is generated through an autoregressive process. While misspecified models may yield satisfactory results for short-term forecasts, errors in model specifications are compounded as the forecasting horizon increases due to impulse responses being functions of earlier estimations (Jordà, 2005, p.162). Local projections avoid this compounding error by utilising an alternative sequential regression technique that computes multi-step forecasts without making assumptions that may lead to misspecifications (Jordà, 2005, p.162).

4.2 Local Projections

The mechanism underlying local projection is a series of ordinary least squares (OLS) regressions conducted for each variable and for each horizon of the impulse responses of interest. The ordering of the variables in the structural model is important, since we assume a recursive identification similar to the Cholesky identification assumption used in a structural VAR model, namely that variables are able to respond contemporaneously only to the variables ordered above it in the structural matrix. The identification assumptions underpinning the recursive identification are very often based in economic theory and their validity is tested with robustness checks. Our ordering is as follows: consumption (c), saving (s), credit (cr), house prices (h), production (p), and policy rate (r). Thus, house prices are able to respond contemporaneously to consumption, saving, and credit, which is logical due to the fact that the demand for houses is quite related to the amounts that households choose to save, borrow, and consume each month. House prices are not able to respond contemporaneously to changes in the policy rate, however, which may be justified on the basis that the decision to purchase a house is a process that typically takes more than one month, such that the demand for houses responds with a delay to any changes in the policy rate.

The shock variable that we are using is the policy rate, and as such, it is ordered last in the structural model. This ordering is reasonable based on the assumption that when a central bank decides to change the policy rate, the decision is likely made using a comprehensive, up-to-date picture of the economy. When the Covid-19 pandemic reached Norway in late February 2020, the first interest rate announcement was made on March 20th, less than one month after the first case was reported in Norway. All variables are able to respond to the lagged values of all other variables beyond the first horizon of the impulse response, as the recursive identification assumption restricts only contemporaneous responses in the first period.

Our full dataset consists of 20 years of monthly data. The chosen window length is six years, as this is long enough to provide a sufficient number of observations to compute a robust estimate and to obtain significance, yet still short enough to identify specific events. We shift the window by one month at a time as we estimate, resulting in 158 unique rolling windows and equally many time-varying impulse response estimations. We estimate the local projection for each window using robust standard errors. The value corresponding to each window in the time-varying plot is the value of that window’s impulse response at a six-month horizon, such that we capture the medium-term response to a shock.

We have selected a lag length of one period (i.e., one month), which is justifiable based on the relatively short window length. Models with longer lag lengths capture more of the dynamic interactions between the endogenous variables following a shock, leading to potentially different results. However, including more lags in an estimation requires more observations, implying a trade-off between the specificity of our windows and the robustness of our results. Therefore, we have conducted robustness checks using different lag lengths in order to ensure that our results are robust to the model specifications. These checks are discussed in section 5.3.

Another common method for lag length selection is the use of information criteria that evaluate the lag length selection trade-off automatically. Two common criteria are the Akaike and the Bayes information criteria (Bjørnland & Thorsrud, 2015, p.69). These criteria work by testing different lag lengths on the data sample to return the optimal lag length based on some pre-determined measures within the criteria functions. Due to the fact that we are using 158 different samples, however, using a common lag length for every sample will provide more comparable results than using the "optimal" lag length for each sample. Therefore, we rely on the theoretical and practical arguments for our lag length selection of one lag and refer to our robustness checks.

The estimation of the impulse responses for each of our variables in response to a shock to the policy rate is computed using a linear regression for each horizon of the impulse response. For five response variables and an impulse response horizon of 10 periods as in our model, we need to use fifty regressions to create five impulse response plots. Given the rolling window nature of our analysis, the total number of regressions that is required quickly grows, as our rolling window procedure involves the analysis of 158 independent samples. In order to provide insight into the regression procedure, we consider house prices as an example below.

For the response of house prices to a policy rate shock, the generalised version of the regression used to calculate the impulse response at some horizon i is given by the following:

$$\begin{aligned} h_{t+i} = \rho + \beta_i r_t + \gamma_{i,1} h_t + \gamma_{i,2} c_t + \gamma_{i,3} s_t + \gamma_{i,4} cr_t + \gamma_{i,5} p_t + \phi_{i,11} h_{t-1} \\ + \phi_{i,12} r_{t-1} + \phi_{i,13} c_{t-1} + \phi_{i,14} s_{t-1} + \phi_{i,15} cr_{t-1} + \phi_{i,16} p_{t-1} + \eta_{i,t} \end{aligned}$$

This regression relates the response of house prices in period $t + i$ to the policy rate shock r in period t. Note that the variables on the right hand side remain the same in the estimation for every horizon (i.e., for all i), and it is only the left hand side variable that is changing as the horizon changes. The variable η captures the residual variation in house prices that is not attributable to the other included variables, and ρ is a constant term. The regression also needs to include the relevant contemporaneous and lagged variables. Given our impulse response horizon of ten periods, we calculate the regression for the values $i = 1, 2, ..., 10$. The value that we pull out of each window estimation to use in the time-varying plot is the value β_6 for the six-month horizon.

The 10-period horizon impulse response for house prices given one of our rolling windows is shown in figure 4.1. While it is technically sufficient for our purposes to run the single estimation for each window with $i = 6$ to obtain the value of β_6, we run the regressions for the full horizon and plot an example of the full impulse response in figure 4.1 to provide context and clarity for our method.

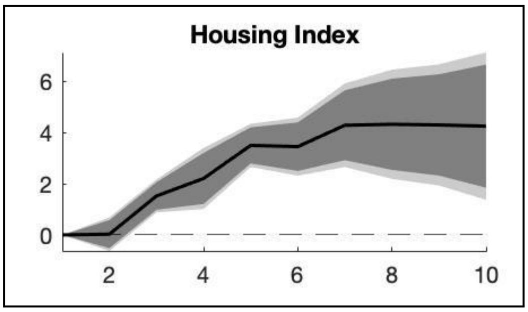


Figure 4.1. Example of an impulse response of house prices to a negative shock (i.e., a decrease) to the policy rate of 1%.

For a shock to the policy rate in period t, the impulse response of house prices for the first period (i.e., upon impact of the shock) will simply be given by $\beta_0 = 0$ (see Plagborg-Møller & Wolf, 2021). This is due to the fact that the house price variable is ordered above the policy rate, and as such there is no contemporaneous effect from the shock. We see evidence of this lack of response in figure 4.1. For the sixth period (and similarly for all other periods), the response of house prices to a policy rate shock is given by the value of β_6 in the following regression:

$$h_{t+6} = \rho + \beta_6 r_t + \gamma_{6,1} h_t + \gamma_{6,2} c_t + \gamma_{6,3} s_t + \gamma_{6,4} cr_t + \gamma_{6,5} p_t + \phi_{6,11} h_{t-1} + \phi_{6,12} r_{t-1} + \phi_{6,13} c_{t-1} + \phi_{6,14} s_{t-1} + \phi_{6,15} cr_{t-1} + \phi_{6,16} p_{t-1} + \eta_{6,t}$$

As this is the regression for the sixth period, the contemporaneous variables we need to include are all of the variables in the model. Our model includes only one lag, and thus we include only one lag of each of these model variables: h_{t-1}, r_{t-1}, c_{t-1}, s_{t-1}, cr_{t-1}, p_{t-1}.

The time-varying plot that we create for each variable plots the value of β_6 for each rolling window sample. The confidence bands are plotted for the 90% and 95% confidence levels. Potential autocorrelation of the residuals in each of the regressions is dealt with by using heteroskedasticity and autocorrelation consistent (HAC) standard errors in the estimation procedure. While we will not go into the mechanisms behind constructing HAC residuals, using them is important given that LP models yield residuals that are autocorrelated by construction (Lusompa, 2021, p.6).

4.3 Rolling Windows

With both SVAR and LP models, problems arise when the number of observations is limited, as the models will then be limited in the degrees of freedom for the estimation. This limitation is relevant for studying the Covid-19 pandemic, which has had a relatively short duration and therefore few observations (specifically, 25 months of available data). As we are interested in studying the change in the impulse responses during the Covid-19 pandemic and other crises, we need to utilise our entire dataset to be able to see changes over time, as opposed to using only the pandemic period data.

To ensure that our data covers a long enough time period to obtain significant results but yet is short enough to identify the pandemic period, we are using a rolling window technique to obtain time-varying estimates. The rolling window method for time series involves estimating the same model multiple times, using different sections or windows of data for each estimation. "Rolling" refers to the fact that the window is moved along the sample between each estimation according to the specified number of periods (in our case, one month). Each window will provide an impulse response estimate, which can be compared to the estimates from other windows to reveal changes in the estimates over time, based on the evolution of the data. In summary, applying a rolling window technique and using a time-varying model allows us to estimate the changes in the results, namely the variable impulse responses, over time. Thus, even though we are unable to estimate a model using only the time period spanning the Covid-19 pandemic due to an insufficient number of observations, what we can analyse is how the results for the windows that contain the pandemic period differ from those windows that do not and from other economic crises. Shifting the window by small increments for each estimation provides us with high-frequency data for the time-varying model.

4.4 Identification of the pandemic period

Results for the Covid-19 pandemic will be those impulse response estimates based on windows that overlap with the period March 2020 to February 2022. Intuitively, the windows will have increasing proportions of their observations occurring during the pandemic as the windows move forward in time. Each window is six years in length, but an important observation is that the calculation of the impulse responses results in data loss, such that the six-year window effectively becomes a 5.5 year window. Furthermore, we lose one additional observation from the sample as we create the one lag. To see why, we must look into the mechanisms behind the local projection methodology.

When we estimate impulse responses, producing the estimates for a horizon of length h leads to the loss of the last h periods of the response variable data, as we need to create an h-period lead of the shock variable in order to evaluate the responses h periods later. Thus, in order to estimate the impulse response at the six-month horizon for each six-year rolling window in our model, our model drops the last six data points of the response variables in order to create the leading policy rate shock variable. The creation of lags leads to data loss at the front of the sample, as we must push the response variables forward in time relative to the shock variable. As a result, for a sample period ending in August 2020, the creation of leads implies the loss of the data for the six-month period between March and August 2020. The sample window ending in August 2020 will therefore be representative of data through February 2020, which is just around the start of the Covid-19 pandemic in Norway. This is important to keep in mind when we consider the time-varying impulse response plot that comprises our main results.

5 Results and Discussion

5.1 Plots of sample window impulse responses

As discussed in section 4.2, we construct the time-varying local projection plots by computing the impulse responses for each variable and for each of the 158 rolling six-year windows from January 2003 to January 2022. Figures 5.1 and 5.2 show a selection of these impulse responses for a negative shock to the policy rate of 1% (e.g., a change from 5.5% to 4.5%). All variables are in log terms with the exception of the policy rate, implying that the responses of these log variables are measured in percentage change from their pre-shock value.

Figure 5.1 shows the impulse responses based on the entire sample period January 2003 to February 2022, as opposed to for a six-month window. We see that the response of house prices to the policy rate shock is significant when using the entire sample, so the rolling window approach allows us to break down this overall effect to see the differences in the response over time.

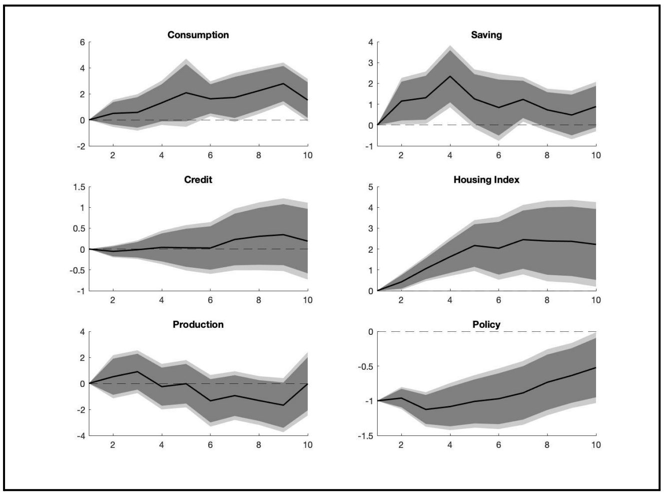


Figure 5.1. Impulse responses for a negative shock to the policy rate, computed using the full sample period 2003 – 2022.

The value of the response at a six-month horizon was extracted from each impulse response plot and used to construct the time-varying plots that constitute our main results. From the six-month window impulse response functions in figure 5.2, we can see that, with the exception of production, the impulse response of each of the variables changes quite drastically both in the short- and long-run depending on whether the window overlaps with one of the three economic crises mentioned.

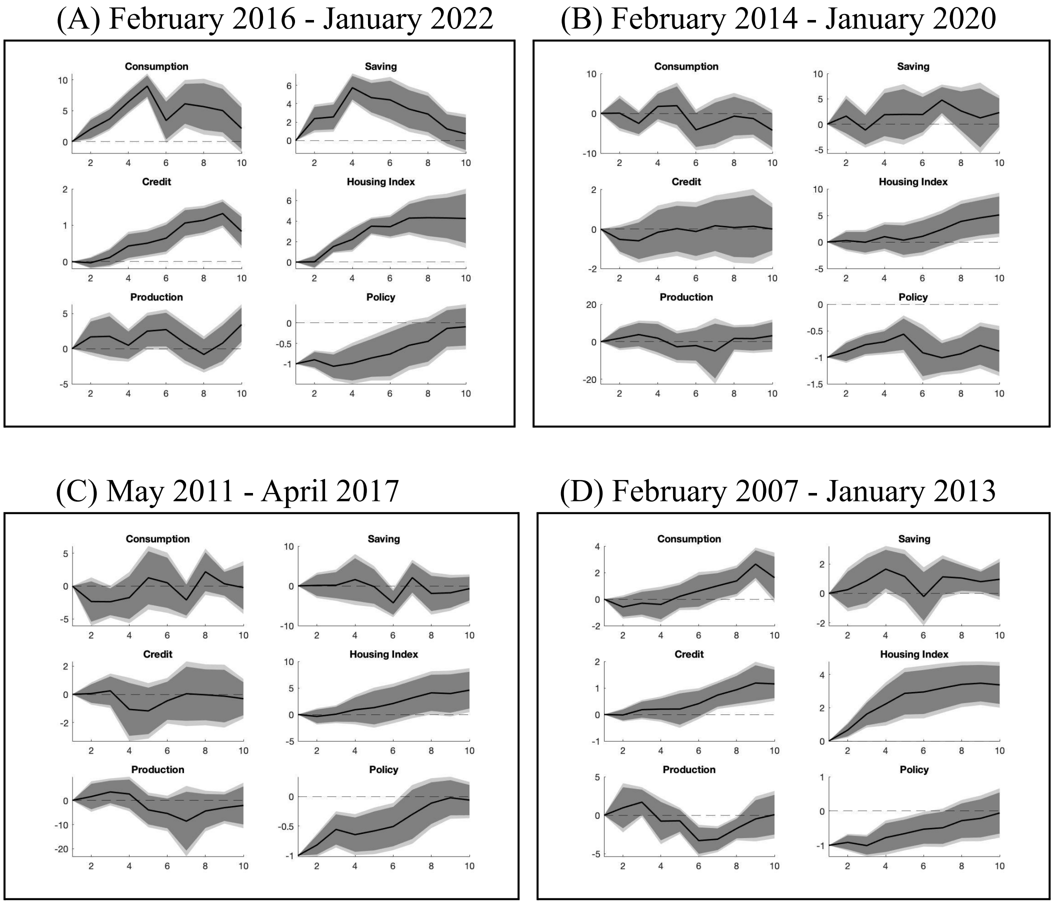


Figure 5.2. Examples of impulse responses for a negative policy rate shock based on different windows.

Figure 5.2-A spans the period February 2016 to January 2022 and therefore includes data from the first two years of the Covid-19 pandemic, while figure 5.2-D is the period February 2007 to January 2013 and includes data from the 2008 financial crisis. It is in these two windows that we see the strongest response of house prices to a policy rate shock, suggesting that large scale economic crises may be associated with a stronger response of house prices. The windows represented by the other two plots, specifically figures 5.2-B and 5.2-C spanning February 2014 to January 2020 and May 2011 to April 2017, respectively, reveal mild and statistically insignificant responses of house prices to a policy rate shock. The slight significance in both plots starting after 8 months suggests that there may be a stronger medium- to long-run effect, but the response is still relatively small compared to those in 5.2-A and 5.2-D.

The exception to the above finding that house prices respond more strongly during times of crisis is the apparent lack of response of house prices in figure 5.2-C, which considers the period May 2011 to April 2017 and thus includes the oil crisis. One possible reason for the lack of response is that the oil crisis differed from the 2008 financial crisis and the Covid-19 pandemic in terms of the length of the crisis and recovery periods, as well as the severity of the crisis on the global stage. The time-varying local projection plot in section 5.2 reveals that, despite the apparent lack of response of house prices during the oil crisis implied by figure 5.2-C, there is a slight significant effect in some of the later windows that span the oil crisis, suggesting that the oil crisis does indeed follow the pattern of the other two crises in terms of a stronger response of house prices.

For context, it may also be useful to compare the movements of the policy rate during the three crises. During the Covid-19 pandemic, the policy rate set by Norges Bank decreased from 2.5% to 1% throughout the first half of 2020 (Norges Bank, 2022). In response to the oil crisis during the second half of 2015 and the first quarter of 2016, the policy rate decreased from 2.25% to 1.5%. Thus, the decrease during the Covid-19 pandemic was twice as large as that during the oil crisis. Interestingly, the policy rate was on an upward trajectory in the early days of the 2007-2008 financial crisis, starting at 5% in mid-2007 and reaching a high of 6.75% in April 2008. Between October 2008 and June 2009, however, the policy rate decreased by 4.5 percentage points to 2.25%, and it remained below 3% until mid-2010. This delayed impact of the financial crisis in Norway is discernible in the time-varying plot below.

5.2 Time-varying local projection plot

Our main result consists of a time-varying local projection for our six variables, namely consumption, saving, credit, house prices, production, and the policy rate. Each point on the time-varying plot tells the value of the impulse response of each variable at a horizon of six months after a shock, computed using six-year rolling windows. The points are labelled on the horizontal axis by the corresponding midpoint of the window they represent. For example, the second to last point in figure 5.3 is labelled “Jan 2019” and corresponds to the window spanning January 2016 to December 2021. The vertical axis tells the magnitude of the response of house prices to a policy rate shock six months after the shock occurs, based on the data that falls within the specified window of time. The six-month impulse response horizon allows us to see the medium-term response of house prices to a policy rate shock.

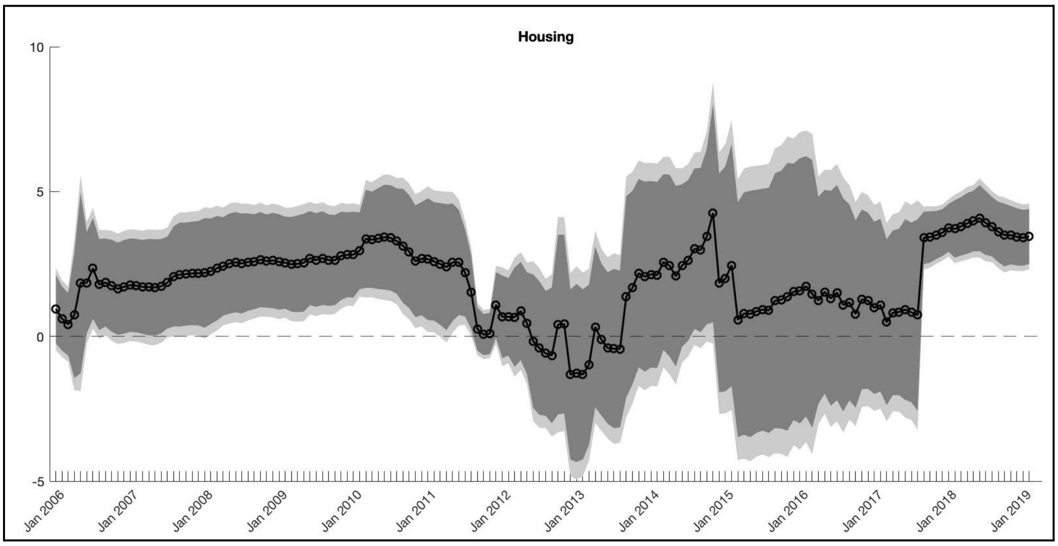


Figure 5.3. Plot of time-varying local projections at a 6-month horizon for house prices in response to a negative policy rate shock. The window length is 6 years, centred around the date labelled on the horizontal axis. The start of the Covid-19 pandemic is captured by the jump in late 2017. Shaded areas represent 90% and 95% confidence bands.

Upon the onset of the inclusion of the Covid-19 pandemic into the rolling windows around the end of 2017, the response of house prices to a change in the policy rate of 1% increased from 0.8% to 3.5%. This initial jump is followed by a further increase to 4.08% over the next year, and the response remains elevated through the end of the data set in February 2022. The peak impulse response during the 2008 financial crisis was 3.42% and occured when the windows were spanning early 2007 to early 2013. Similarly, the peak impulse response for the oil crisis was 4.26% around the windows spanning late 2011 to late 2017.

The shaded confidence bands in figure 5.3 combined with the time-varying impulse responses reveal that monetary policy has a statistically significant effect on house prices only during times of crisis, discernible by the fact that the impulse responses are significant only for the windows overlapping with the 2008 financial crisis, the oil crisis, and the economic crisis due to the Covid-19 pandemic. The effect is particularly abrupt and strong for the pandemic, which supports our hypothesis that the restrictions on mobility and consumption combined with fiscal and monetary stimulus measures led to a stronger reaction in the housing market.

An important note following from the discussion in section 4.4 is that the jump in the response of house prices for the pandemic occurs around September 2017, which corresponds to the sample period September 2014 to August 2020. Given that the first Covid-19 restrictions went into effect in March 2020, the identified window raises the question of why there appears to be no change in the response before a full 6 months into the pandemic. As discussed, the calculation of an impulse response via local projection up to some horizon h leads to a loss of the last h periods of data. This implies that the sample period ending in August 2020 is actually representative of data through February 2020. Therefore, despite an apparent delay in the response once the Covid-19 period begins to be a part of the sample, the changes in the impulse responses are in fact significant from the very first month of the pandemic in Norway.

Figure 5.4 plots the same time-varying local projection as figure 5.3 but for the other four endogenous variables. The increase in the impulse response of saving (fig. 5.4-A) following a negative policy rate shock during the pandemic is, while not significant, still contradictory to economic theory, and we see the opposite, expected result in the impulse responses during the 2014 oil crisis. The significant increase in the response of saving during the Covid-19 pandemic likely points to an economic situation outside of the norm and reflects both the Covid-19 restrictions and the high uncertainty levels in the face of a global crisis.

The plot for household credit (fig. 5.4-B) shows a significant jump in the response of credit once the Covid-19 period begins to be a part of the sample. This implies that households increased their credit to a greater degree in response to a given decrease in the policy rate during the Covid-19 pandemic compared to the years leading up to the pandemic. The combination of this result with the result that house prices also responded more strongly during the pandemic (fig. 5.3) allows us to add context to the observed house price response, as we can surmise that higher levels of loans will likely contribute to higher house prices.

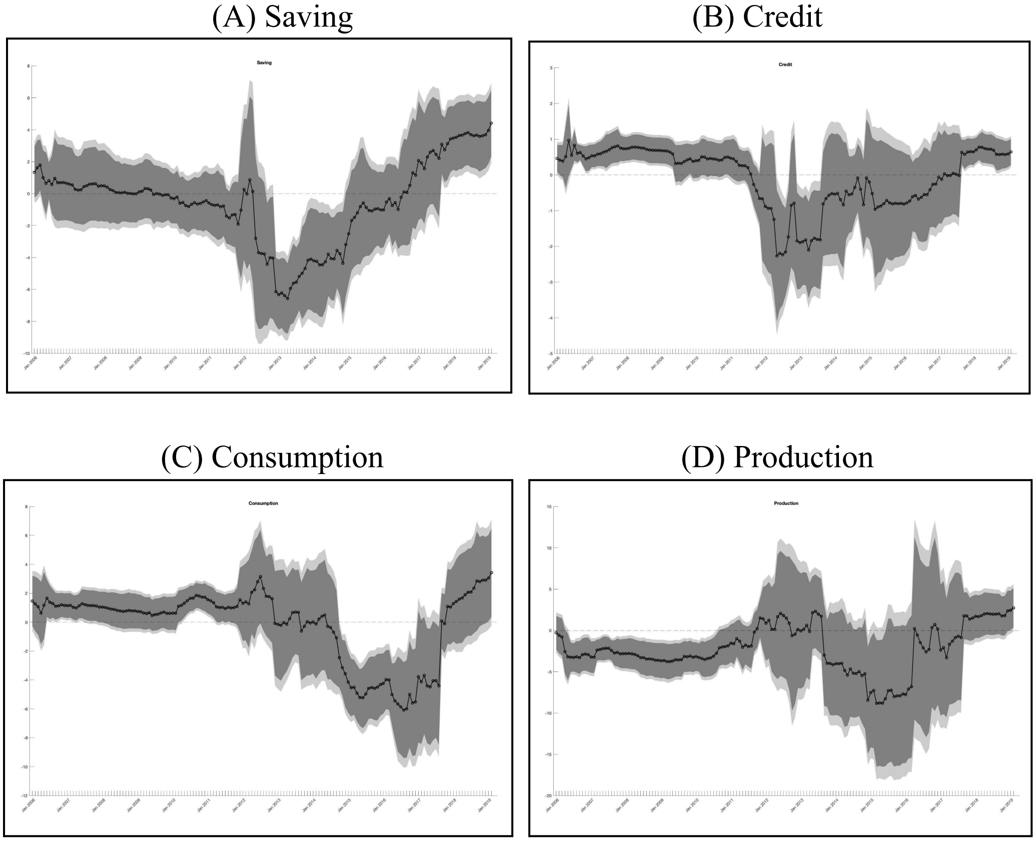


Figure 5.4. Plots of time-varying local projections for all variables in response to a negative policy rate shock.

The plot for consumption (fig. 5.4-C) shows that the response of consumption to a negative policy rate shock increased during the pandemic, but not to a statistically significant degree. The lack of significance in the response of consumption to policy rate shocks during the pandemic is indicative of the Covid-19 restrictions, under which consumers were limited in their ability to change their consumption levels. The response of consumption increased slightly in the years following the 2008 financial crisis, which indicates perhaps that the expansionary monetary policy undertaken by the government in the wake of the financial crisis had the intended effect, namely stimulating spending and the economy.

Production (fig. 5.4-D) shows limited movement in the impulse responses after 2011 in terms of significance, which is likely due to the decline in production that has been occurring since the late 2000s and the fact that industrial production, which includes extraction, mining, manufacturing, and electricity, consists of longer-term projects that typically respond more slowly to shocks.

5.3 Robustness checks

The specifications of our main model are a lag length of one month with a horizon length of six months for the time-varying impulse responses. We conduct two types of robustness checks in order to test these specifications, specifically on the lag length and the length of the impulse response horizon that is used.

As discussed in section 4.2, lag length selection for local projections involves a trade-off. Using more lags captures more potential endogenous interactions between variables, but at a cost to the robustness of the estimates due to the fact that using more lags necessitates data loss and results in fewer degrees of freedom. In our model, the sample size is limited by the frequency at which our data is available. Including more lags in each estimation may allow us to capture more endogenous effects, but losing data points from a sample that is already on the shorter side would lead to large uncertainty and potential loss of significance. If we choose to include more lags, we can make up for data loss by expanding the sample window, but this will lead to less specificity around the individual crises. Based on these trade-offs, we have opted to use only one lag in our estimates.

To check the robustness of our model to an alternative lag length specification, we have run the main model with three lags and compared this to the results from using one lag (see figures 5.5 and 5.6). The results are comparable, albeit with higher uncertainty and lower significance for both saving and credit when using three lags. This is as expected for two reasons: firstly, including more lags captures more endogenous interactions between the variables in the model, leading to more ambiguity regarding the causal effects of the shock. Secondly, including more lags leads to fewer degrees of freedom as more data points are dropped in the calculations, and this often leads to higher standard errors. Despite the higher uncertainty in the model with three lags, the results for the response of house prices to a policy rate shock are nevertheless significant, and they continue to suggest that the response of house prices to policy rate shocks increased during the pandemic.

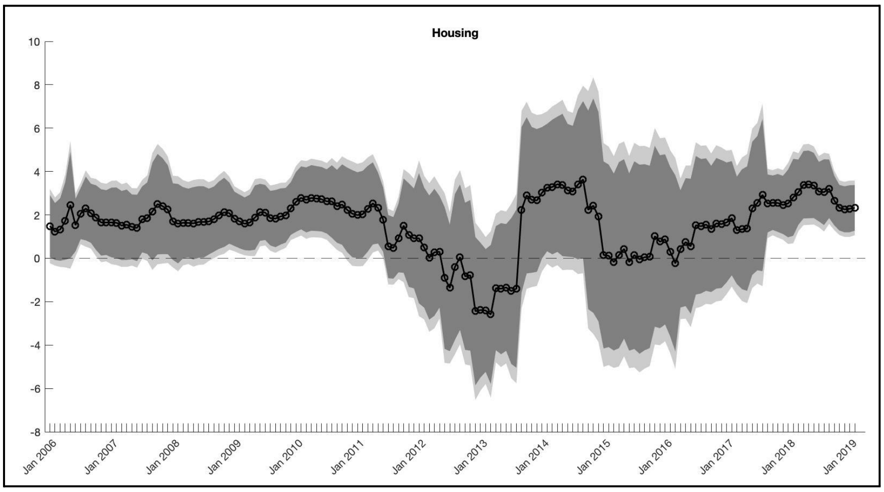


Figure 5.5. Robustness check with three lags for the time-varying impulse response for house prices to a negative policy rate shock.

Additionally, the significance of the time-varying impulse responses continues to hold in the model with three lags for the credit variable, but we do see a loss of significance for the response of saving (fig. 5.6). A fitting explanation is that much of the money that would have been used for saving was instead invested in housing, which would contribute to the increase in house prices throughout the pandemic.

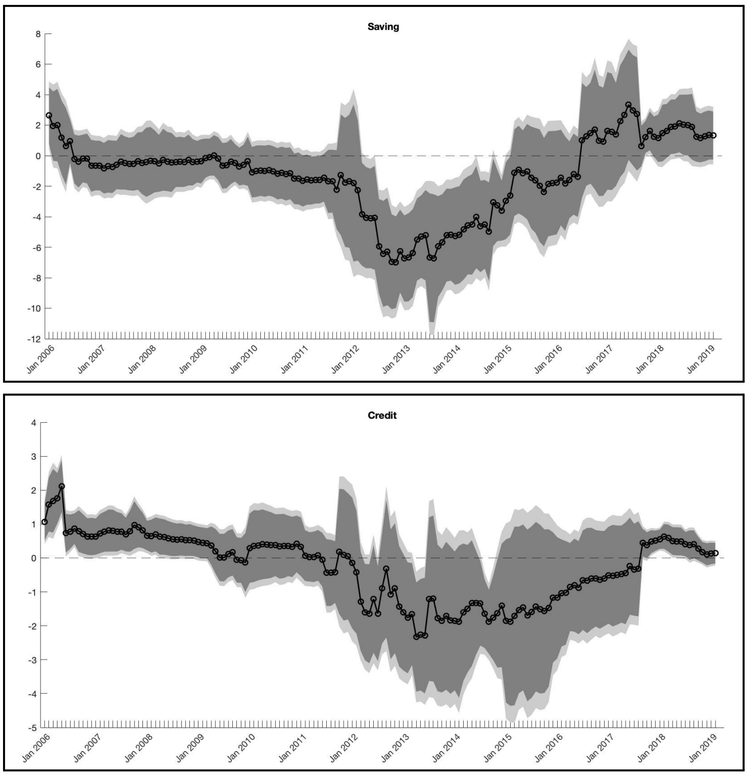


Figure 5.6. Robustness check with three lags for the time-varying impulse responses for saving (top) and credit (bottom).

The second robustness check that we have performed on our model is to test whether our results hold for impulse response horizon lengths other than six months. If we say that six months represents the medium-term response of house prices to a policy rate shock, it may be worthwhile to check the results using a short-term response (e.g., 3 months) and a longer-term response (e.g., 9 months). Running the model with these alternative specifications reveals that the results for house prices are in fact robust when considering both the short term and the longer-term response to changes in the policy rate (see figures 5.7 and 5.8). We find also that house prices are in general more responsive to interest rate shocks after nine months compared to within the first six months, which is logical given the long-term nature of house purchases in general.

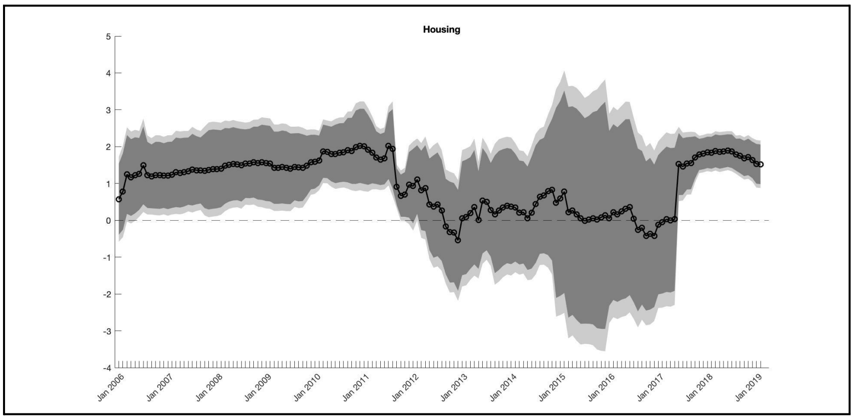


Figure 5.7. Robustness check for house prices using the impulse responses at a 3-month horizon. The short-run response of house prices increases significantly once data overlapping with the pandemic period is included in the rolling window.

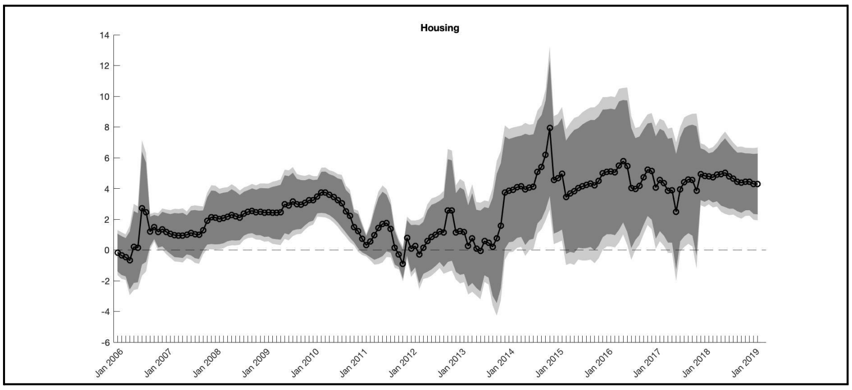


Figure 5.8. Robustness check for house price using the impulse responses at a 9-month horizon. The increase in the response of house prices at the 9-month horizon maintains significance at the onset of the pandemic, in addition to more significant effects throughout the rest of the sample.

5.4 Did the transmission of monetary policy change?

As mentioned earlier, a lower policy rate provides commercial banks with more possibilities to provide loans to households, and overall borrowing in the economy is stimulated. As such, economic theory predicts that the lowering of the interest rate leads to an increase in the total amount of household credit, as well as an increase in house prices (Gnan et al., 2021, para. 3). The Covid-19 pandemic has no precedent for comparison, but we are able to compare the movements of the variables during the pandemic to those during other economic crises. The impulse responses computed in our models align with economic theory in terms of the directions of the responses and the timing. Following a decrease in the policy rate, the responses of credit and house prices increased, which is central to our hypothesis. The response of saving increased as well, which is counter to theory but is reflective of the increased fiscal stimulus during the pandemic. The response of consumption did not change significantly, likely resulting from a combination of restrictions and redirected spending. Thus, our results align with economic theory and we posit that, while the magnitude of the responses to a policy rate shock may change during times of crisis, the qualified transmission of a monetary policy shock to macroeconomic variables is largely unchanged and behaves as expected.

5.5 Implications for monetary policy during pandemics

Given the finding that house prices respond more strongly to changes in the policy rate during times of crisis than during normal times, it is important that the monetary authority of an economy be aware of the potential unintended consequences of proposed expansionary policies. If a particular economy suffers from housing shortages, accessibility issues, or inflated housing prices, using the policy rate as the primary expansionary tool during a crisis may lead to a worsening of this situation, both in the short-term (i.e., during the crisis) and in the long-term after the crisis has ended (as supported by our robustness check on the longer-term effects of a policy rate shock). Paying attention to the state of the housing market prior to and during times of economic crisis is an important consideration for central banks when deciding the optimal policy tool to use.

6 Conclusion

The Covid-19 pandemic represents an unprecedented time in history in many ways. The impact on economies has varied significantly over the course of the pandemic, in addition to varying geographically as countries have responded in different ways. Researching the economic and societal changes brought about by the pandemic provides insight into the robustness of modern economic thinking and allows governments to better prepare themselves for the next crisis, both in terms of preventive measures as well as reactive measures once a crisis hits.

Norway was one of the countries that had the possibility of adjusting its policy rate in response to the Covid-19 pandemic. We observe that the lowering of the policy rate in Norway combined with fewer opportunities for consumption during the pandemic provided an unintended boost to the housing market. Upon the onset of the inclusion of the Covid-19 pandemic into the model, the response of house prices to a decrease in the policy rate of 1% increased from 0.8% to 3.5% at a six-month horizon. This general result is consistent across three different crises, namely the 2008 financial crisis, the oil crisis, and the Covid-19 pandemic, which suggests that macroeconomic variables and policy transmission mechanisms may be affected by crises in similar ways despite the crises perhaps having different origins.

A large component of our hypothesis is that housing prices responded particularly strongly during Covid-19 due to the presence of restrictions that limited many forms of consumption, including discretionary spending on goods, entertainment, and travel. The strength of the restrictions varied significantly during the pandemic, and the data suggests that consumption increased in some periods during the pandemic, contrary to some expectations. Regardless, the higher rates of saving and borrowing by households align with the observed increased demand for houses as the policy rate decreased, and our finding that some types of consumption contracted in response to Covid-19 restrictions contributes to the connection between decreased consumption possibilities and a higher interest in house purchases.

As discussed in section 4.3, a limitation of our research is the relatively small number of observations due to the monthly frequency of the data, which prompted the use of a rolling window approach as opposed to estimating using the Covid-19 period directly. Despite this limitation, our results prove to be robust to lag length specification and we are able to observe a statistically significant effect of the response of house prices to monetary policy shocks during all three crises of interest.

As the Covid-19 pandemic continues to unfold, opportunities for further research will increase automatically as a direct consequence of having more data. Increasing the length of the time series will improve the robustness of the results, as well as grant access to a wider array of time series techniques. Another opportunity for extending our research is the use of house prices in Oslo as opposed to house prices across all of Norway. Evidence suggests that house prices in Oslo are more sensitive to changes in the interest rate compared to prices outside of the city (Lindquist et al., 2021, p.6). Therefore, focusing on house prices specifically in Oslo may yield stronger results and provide insight into regional differences in responses to monetary policy.

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Appendix

A. Summary statistics

	Mean	Standard Deviation	Min	Max
Policy rate	3.04	1.63	1.00	8.00
Housing index	197	59	99	315
Credit (billion NOK)	2,060	796	751	3,534
Consumption Index	121	16	88	155
Savings (billion NOK)	9,089	312	460	1,536
Production	90.5	6.6	78.0	108.0
Covid stringency (from 1/2020)	46.15	19.21	0.40	76.20

Table A1. Summary statistics for the full data set spanning January 2003 to February 2022.