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Abstract

We use narrative monetary policy shocks and local projections to estimate the impact of monetary policy on consumption and investment. We use granular data to investigate how the response varies across consumption categories, investment types, and sectors. Our findings indicate that both consumption and investment respond - albeit with a notable lag - to monetary policy. The results reveal significant heterogeneity within the subcomponents of both consumption and investment. The consumption response is primarily driven by a drop in services consumption and consumption of durables, indicating that monetary policy also affects the composition of consumption. In terms of investment, the aggregate investment response is driven by tangible investment. Additionally, sectors with high interest costs relative to earnings, such as commercial real estate, are highly sensitive to monetary policy, whereas sectors such as manufacturing, are relatively unaffected.

1 Introduction

Consumption and investment are two of the biggest demand components of GDP. Understanding how monetary policy affects these components is therefore vital for the overall understanding of the transmission of monetary policy to the real economy. While a large body of literature has documented how aggregate consumption and investment are affected by monetary policy, much less is known about the transmission to the various components of consumption and investment.

This paper provides novel evidence on how monetary policy affects consumption and investment and their different subcomponents in Norway. We develop narrative shocks following Romer and Romer (2004); Holm, Paul, and Tischbirek (2021); Cao, Hegna, Holm, Juelsrud, and Konig (2022). We use granular data from the Norwegian National Accounts on consumption and investment and their various subcomponents. We combine these data and the monetary policy shocks in a local projection framework, following Jordà (2005), to investigate the impact of monetary policy.

We make two contributions to the literature. First, we show that the consumption response largely depends on the nature of the consumption good, and in particular its durability. Durable goods generally respond more strongly to changes in monetary policy compared to non-durable goods. In fact, non-durable consumption partly *increases*, suggesting a compositional shift in consumption. Additionally, services consumption is also significantly affected by monetary policy, both economically and statistically. The effects on disaggregated goods consumption are consistent with the view that monetary policy primarily affects consumption typically financed with debt. Consistent with Holm et al. (2021), our findings suggest that monetary policy affects household demand beyond intertemporal substitution.

Second, we show that the investment response is heterogeneous across sectors and capital goods. To the best of our knowledge, we provide novel evidence on how firm profitability (in addition to interest-coverage ratios) generates heterogeneity across sectors.[1] Consistent with Cao et al. (2022), we find that differences in investment responses can largely be explained by the sectors' levels of interest rate expenses relative to earnings. In contrast to the earlier literature, we also document an important role for firm profitability.

Our paper consists of three main steps. First, we develop narrative monetary policy shocks for Norway. The monetary policy shocks are derived as the residual in a regression of policy rate changes on current and projected values of relevant target variables. Second,

[1] Cao et al. (2022) provides evidence consistent with ours at the *firm level* but does not investigate the role of firm profitability.

we use the estimated monetary policy shocks in a local projection framework to explore the response of disaggregated consumption and investment.

Third, we explore what drives differences in investment response across firms. In order to explore the sources of heterogeneity, we use firm-level microdata on balance sheets and income statements to investigate which dimensions of firm heterogeneity are significant, including the relevance of heterogeneity in firms' capital mix.

Our paper contributes to a growing body of research that uses local projections to identify the responses of consumption and investment following a monetary policy shock, e.g. Barsky, House, and Kimball (2007); Sterk and Tenreyro (2018); Holm et al. (2021); Cao et al. (2022); Döttling and Ratnovski (2023); Durante, Ferrando, and Vermeulen (2022); Ottonello and Winberry (2020), and many others. On the consumption side, there is a longstanding consensus that durable goods are more sensitive than non-durable goods. However, studies that focus on more granular sub-categories of consumption are more scarce. The paper that comes closest to ours is the study by Chernis and Luu (2018) which estimates responses to monetary policy shocks in 18 different subsets of household consumption. The results confirm conventional wisdom, i.e. that durable consumption linked to expenditure on housing and vehicles is highly interest rate sensitive, whereas consumption of necessities, such as food and health appear to be unaffected by changes in the policy rate.

On the investment side, our analysis is similar to Ottonello and Winberry (2020) and Cao et al. (2022). These studies use firm-level data for the US and Norway, respectively, and document a large degree of heterogeneity across firms. We show similar evidence at the sectoral-level for Norway, and, in addition, provide novel evidence on the role of firm profitability. At the aggregate-level, we show that the aggregate investment response is confined to tangible investments, thereby further unpacking how aggregate investments responds to monetary policy.

2 Data and measurement

We use data from three different sources. Data for investment and consumption are from the Quarterly National Accounts (QNA), see Appendix A. The data are adjusted for seasonality and price changes. For business investment, we include all industries featured in the QNA, except for the public sector and all offshore activities related to the petroleum sector. Consumption classification by expenditure is grouped in accordance with definitions outlined by Eurostat[2].

[2]See, for example, Eurostat-OECD Methodological Manual on Purchasing Power Parities (2012 Edition).

Figure 1 illustrates the relative size of investment and consumption types, while Table 1 shows a summary of descriptive statistics. Altogether, consumption comprises of roughly 50 % of GDP, while investment accounts for another 18 %, highlighting that these two categories make up a significant share of overall value added. We distinguish between services consumption, which accounts for slightly below 50% of consumption, and goods consumption, which comprises just above 40 % of overall consumption expenditure (as of 2023). The latter is further split into different categories according to durability. In terms of investment, the bulk of what we cover is business investment.

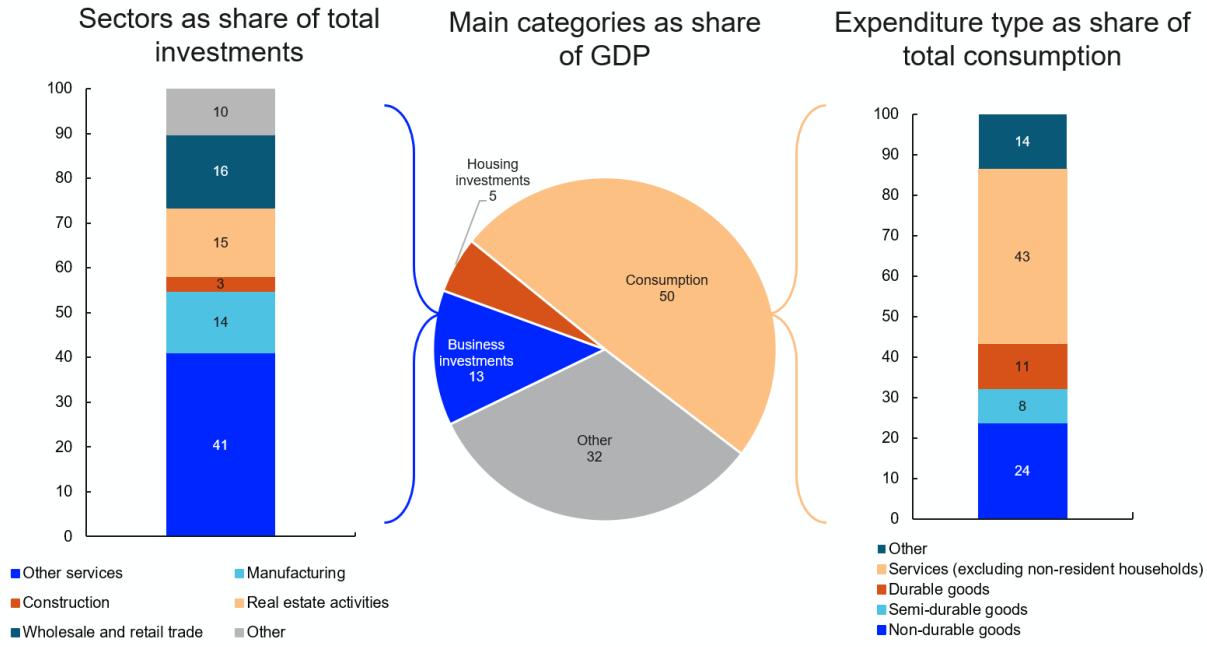

Figure 1: Investment and consumption shares in 2023. Percent

To shed light on investment response drivers, we aggregate firm-specific variables to the sectoral level, using micro data on balance sheets and income statements from Bisnode for the universe of limited liability companies in Norway.

Finally, we rely on current and projected data on GDP and CPI, along with data on registered unemployment from the Norwegian Labour and Welfare Administration (Nav), the exchange rate, defined as an import-weighted basket of 44 currencies (I-44), and the key policy rate to compute narrative monetary policy surprises.

	Mean	SD	p5	p95	share of GDP
Consumption	0.7	2.0	-1.8	3.4	49.5
Housing investments	0.5	3.6	-4.4	7.0	5.3
Business investments	1.1	8.6	-15.6	13.0	12.7
Consumption by expenditure type:					
Non-durable goods	0.3	1.6	-2.0	3.2	11.8
Semi-durable goods	1.1	2.5	-2.8	4.8	4.1
Durable goods	1.2	6.3	-7.9	8.5	5.5
Services (excluding non-resident households)	0.7	1.9	-0.8	2.3	21.4
Business investments by sector:					
Services	1.3	7.6	-10.4	14.6	8.7
Manufacturing	0.7	9.0	-16.3	14.7	1.8
Construction	1.3	11.0	-15.0	19.9	0.4
Real estate activities	1.5	9.8	-13.0	16.1	2.0
Other services	1.2	10.8	-15.4	21.0	5.2
Wholesale and retail trade	1.5	12.7	-20.8	20.8	2.1
Business investments by asset type:					
Buildings and constructions	0.6	2.9	-4.2	5.9	13.6
Machinery and equipment	1.0	5.5	-7.7	11.2	4.4
Intellectual property products	1.2	4.1	-3.7	8.8	4.2

Table 1: Summary statistics for investments and consumption. Quarterly growth rates. 1995 Q1 - 2023 Q4.

3 Methodology

To identify the effect of monetary policy on consumption and investment, we use narrative-based monetary policy surprises within a local projection framework.

3.1 Monetary policy surprises

In a first step, we identify the exogenous component of the policy rate following Romer and Romer (2004) and Holm et al. (2021). Specifically, the monetary policy surprise ($\epsilon^{MP}_{m,t}$) is defined as the residual in a linear regression of the change in the actual policy rate from one policy meeting to the next on corresponding revisions in current and expected values

of CPI and output, the unemployment rate relative to a trend (unemployment gap) and the exchange rate.

$$\begin{aligned}\Delta_m r_m = \alpha_0 + \alpha_1 r_{m-1} + \sum_{j=0}^{1} \beta_j^{\pi} \pi_{m,t+j} + \sum_{i=0}^{1} \delta_j^{\pi} \Delta_m \pi_{t+j} + \sum_{j=0}^{1} \beta_j^{y} \Delta y_{m,t+j} \\ + \sum_{i=0}^{1} \delta_j^{y} \Delta_m \Delta y_{t+j} + \beta^{u} u_{m,t} + \gamma_1 s_{m-1} + \gamma_2 D_m s_{m-1} + \epsilon_{m,t}^{MP}\end{aligned} \tag{1}$$

where $\pi_{m,t}$ denotes the four-quarter inflation rate in quarter t as projected at meeting m. The operator Δ_m captures the change in estimates of current and future outcomes from meeting $m-1$ to meeting m. Hence, $\Delta_m r_m$ is the change in the policy rate from one meeting to the next, whereas $\Delta_m \pi_t$ refers to the revision of the four-quarter inflation rate in quarter t. We also include the current and expected growth rates in GDP (Δy_t), and its revisions, and the current and revised estimates of the unemployment rate gap (u_t) along with lagged observations on the effective NOK exchange rate (s_{m-1}) .

Under inflation targeting, which was officially introduced in Norway in 2001, the exchange rate will affect monetary policy indirectly through inflation on imported goods. However, the exchange rate might also be a leading indicator of future imported inflation, especially in a small open economy, and could thus potentially be correlated with current policy rate changes. Hence, we also include the lagged (observed) exchange rate as one of the regressors. In the early part of our sample, i.e. the period 1994-2000, the monetary policy regime could be described as a "managed float". Hence, we would expect a stronger link between changes in the policy rate and the exchange rate in this period. Thus, we include a dummy that takes the value of 1 in the period preceding inflation targeting and 0 thereafter, allowing for a potentially stronger role for the nominal exchange rate.

Figure 2: Estimated monetary policy shock series for Norway on quarterly frequency

Figure 2 shows the time series of our estimated monetary policy shock, $\epsilon_{m,t}^{MP}$, aggregated to the quarterly frequency. Notably, the period in the late 1990s and early 2000s was associated with sizable monetary policy shocks. With the exception of the financial crisis, the volatility of monetary policy shocks diminished somewhat from the early 2000s with a slight uptick again in recent years.

Figure 3 makes clear that a monetary policy shocks have a sizable impact on the actual policy rate, lifting the policy rate by about 2 percentage points after four quarters. Consistent with the shock being transitory, the effect on the policy rate gradually dissipates and vanishes after about three years.

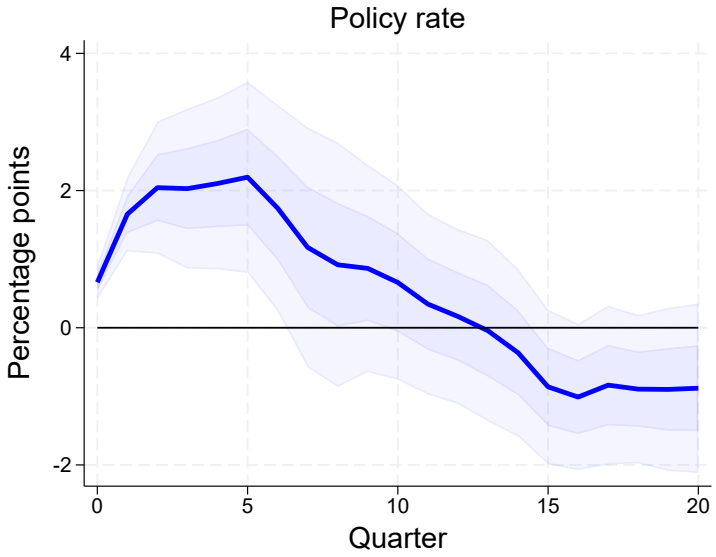

Figure 3: Response of the policy rate to $\epsilon^{MP}_{m,t}$

3.2 Local projections

To explore the impact of monetary policy shocks on consumption and investment, we estimate local projections following Jordà (2005). Specifically, the local projection impulse responses for horizons $h = 0, 1, 2, ..., H$, $\{\beta_h\}_{h\geq 0}$, can be obtained by estimating

$$y_{t+h} - y_{t-1} = \mu_h + \beta_h \epsilon^{MP}_{m,t} + \sum_{i=0}^{P} \delta'_{h,i} w_{t-i} + \epsilon_{h,t} \tag{2}$$

where y_t refers to the (log) value of a particular consumption or investment item, $\epsilon^{MP}_{m,t}$ denotes exogenous changes in the policy rate derived from equation (1) and w_t is a vector containing four lags of the dependent variable, the monetary policy shock and the policy rate. The key identifying assumption is the exogeneity of $\epsilon^{MP}_{m,t}$ conditional on the controls w_{t-i}. Having estimated equation (2) for different horizons h, the sequence of β_h plots the impulse response of variable y_{t+h} to the monetary policy shock in time t.

4 Results

In this section, we show the sensitivity of investment and consumption to monetary policy. We start by exploring the impact of monetary policy on consumption, before turning to the response of housing and business investments.

4.1 Monetary policy and consumption

Figure 4 shows the estimated effect of a monetary policy shock on private consumption. In the aggregate, tighter monetary policy lowers consumption with a slight delay, leading to a 2 % decline in consumption after 14 quarters. The effects are broadly in line with related literature reporting empirical estimates of monetary policy on Norwegian data (IMF (2023), Holm et al. (2021)).

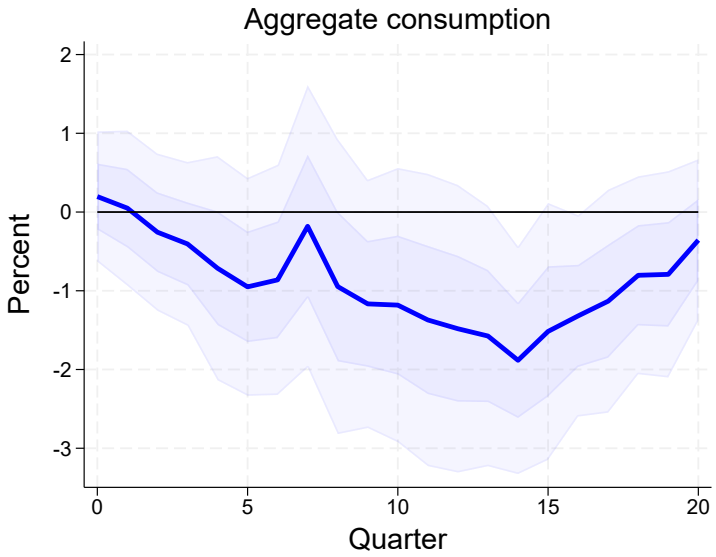

Figure 4: Impulse response functions for aggregate consumption to a monetary policy shock

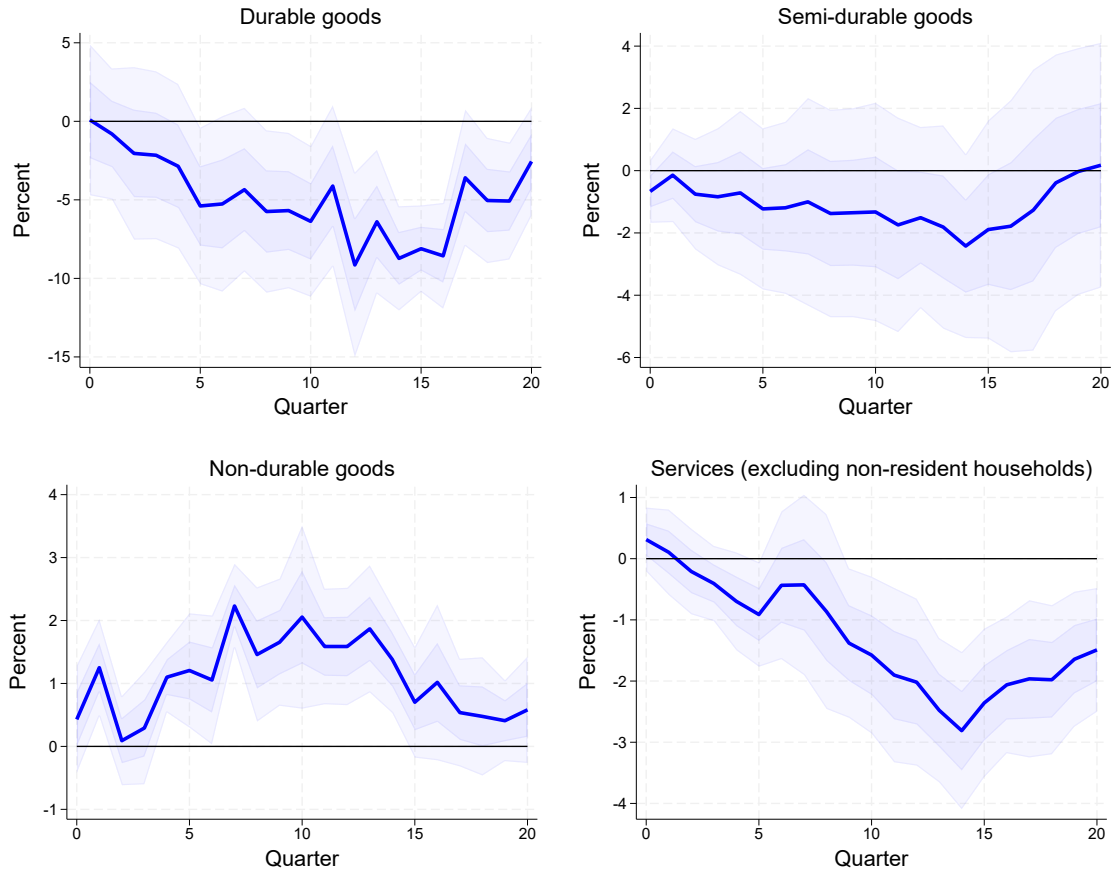

Figure 5: Impulse response functions for disaggregated consumption categories to a monetary policy shock

In Figure 5, we explore the impact on the various subcomponents of consumption, focusing on durable, semi-durable, non-durable, and services consumption. The figure illustrates two important results. First, the strength of the goods consumption response depends on the durability of the consumption good. Durable goods contract more than semi-durable goods, consistent with the existing literature (Barsky et al., 2007; Erceg and Levin, 2006; Sterk and Tenreyro, 2018). This is also consistent with the cash-flow channel being significant for Norwegian households (Gerdrup and Torstensen, 2018), which especially influences purchases with a high up-front cost if households are credit constrained. The overall contraction in durable goods investment reaches close to 10% after 15 quarters.

Second, part of the aggregate consumption decline in durable goods is offset by an *increase* in non-durable consumption. At peak impact, non-durable consumption increases by about 2%. As such, monetary policy leads to substantial changes in the composition of household consumption.

Given that durable consumption is in part debt-financed, our findings are consistent with the view that monetary policy affects consumption via channels other than intertemporal substitution. Importantly, while Holm et al. (2021) show that different types of households have different responses in terms of aggregate consumption, our results complement their findings by showing that the response depends on the type of consumption as well.

4.2 Monetary Policy and investment

Next, we turn to the impact of monetary policy on investment. We start by exploring the impact on housing investment in section 4.2.1, before moving on to business investment in Section 4.2.2.

4.2.1 Housing investments

Figure 6 shows the response of housing investment to monetary policy. The response is fairly quick, with housing investment dropping by roughly 7 % after about five quarters. Housing investment stays depressed until the change in the policy rate has reversed. Given the fact that housing investment is predominantly undertaken by households, the impulse response highlights that a major part of households' adjustment to monetary policy passes through to changes in housing investment. This is consistent with the findings for household consumption, where durable goods respond more to policy, as housing investment is very durable.

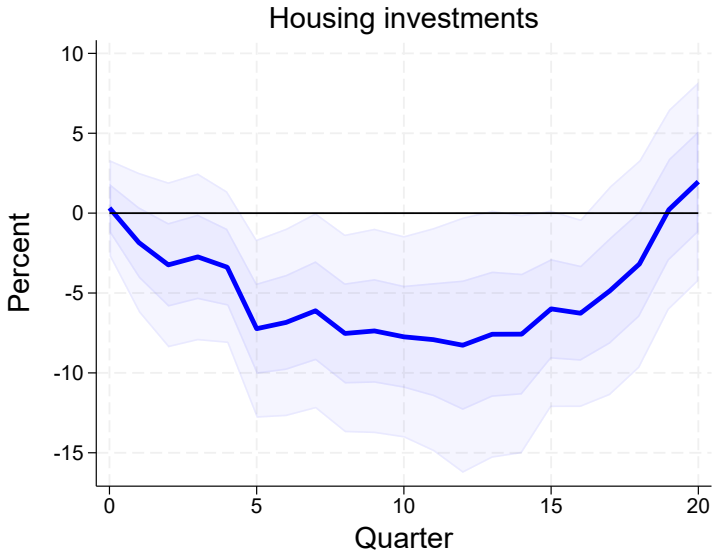

Figure 6: Monetary policy and housing investment

4.2.2 Business investment

Figure 7 shows the estimated effect of the monetary policy shock to aggregate business investment. The trough response is approximately -15%, which would indicate that business investment is significantly more sensitive to monetary policy surprises than both consumption and housing investment. Similar to consumption, the results indicate long lags in the responses following a monetary policy shock, reaching a low point after about 14 quarters.

The results for aggregate business investment are in line with other studies that use similar methods. Our results are closely related to Cao et al. (2022). Based on administrative data for Norwegian firms and the same methodological approach, Cao et al. (2022) also find marked effects for business investment.[3]

Heterogeneity across capital good types A growing body of literature focuses on the interest rate sensitivity of different types of fixed capital goods, in particular making a distinction between tangible and intangible capital (Döttling and Ratnovski, 2023). There are several reasons to expect intangible capital to be less responsive to monetary policy surprises than other types of capital. For instance, intangible capital is less likely to be accepted as collateral to finance investment. It is also associated with higher deprecia-

[3]In Cao et al. (2022) the effects are smaller. They limit their sample to fewer sectors than we do. They also find sluggish effects, reaching a low point about 3-4 years after the monetary policy shock.

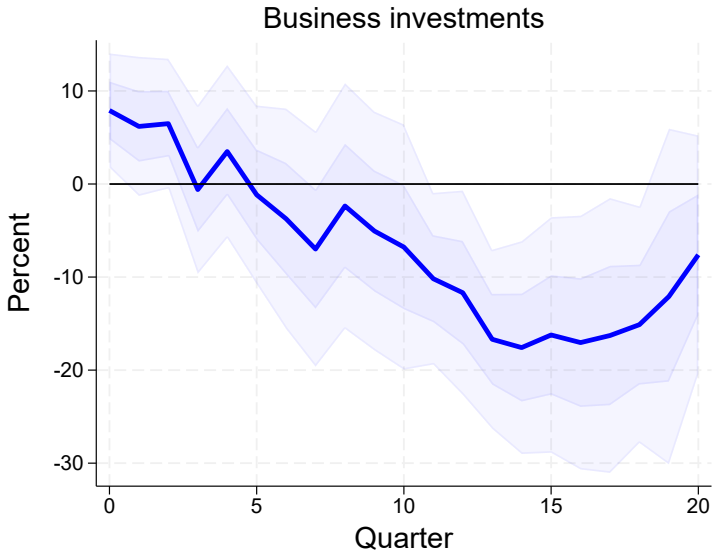

Figure 7: Impulse response functions to a 1 pp monetary policy shock

tion rates and higher adjustment costs (Döttling and Ratnovski, 2023), making interest expenses less important in relative terms.

To explore whether the aggregate investment pattern documented above is also masked by heterogeneity across the types of capital goods, we estimate equation 2 for the major capital good types: buildings and constructions, machinery and equipment, and intellectual property.[4] The impulse response functions (IRF) are shown in Figure 8 and they document important heterogeneity regarding capital types. While both machinery and equipment and buildings and construction decline in response to a positive monetary policy shock, intellectual property *increases*. Overall, these results suggest that monetary policy - while affecting aggregate investment - also affects the mix of investment in the economy.

Heterogeneity across sectors Next, we explore the extent to which investment responses differ across sectors. Figure 9 shows that the aggregate response masks a large degree of heterogeneity. We find pronounced effects for investment in both the *services sector* and the *construction sector*, whereas investment in the *manufacturing sector* and *other goods-producing sectors* do not appear to be sensitive to interest rate surprises.

[4]This corresponds to the most important types of capital goods in the national accounts.

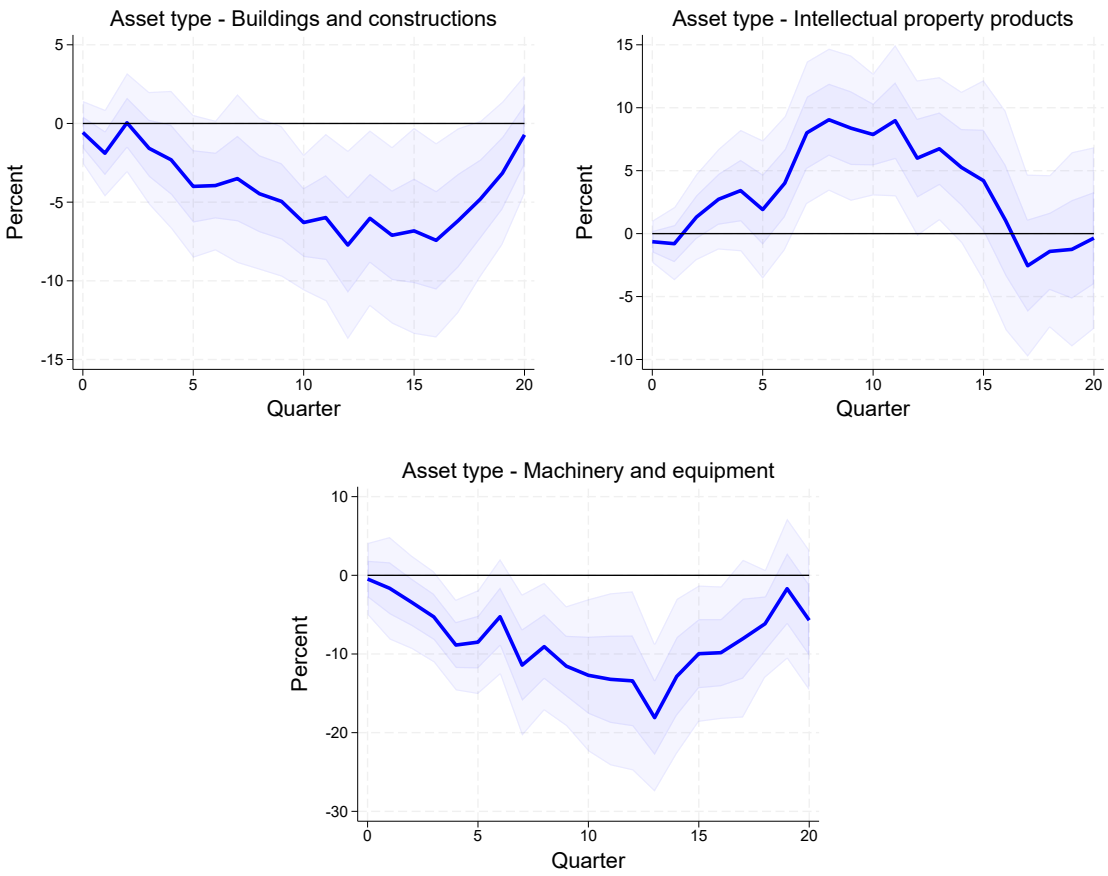

Figure 8: Impulse response functions to a 1 pp monetary policy shock

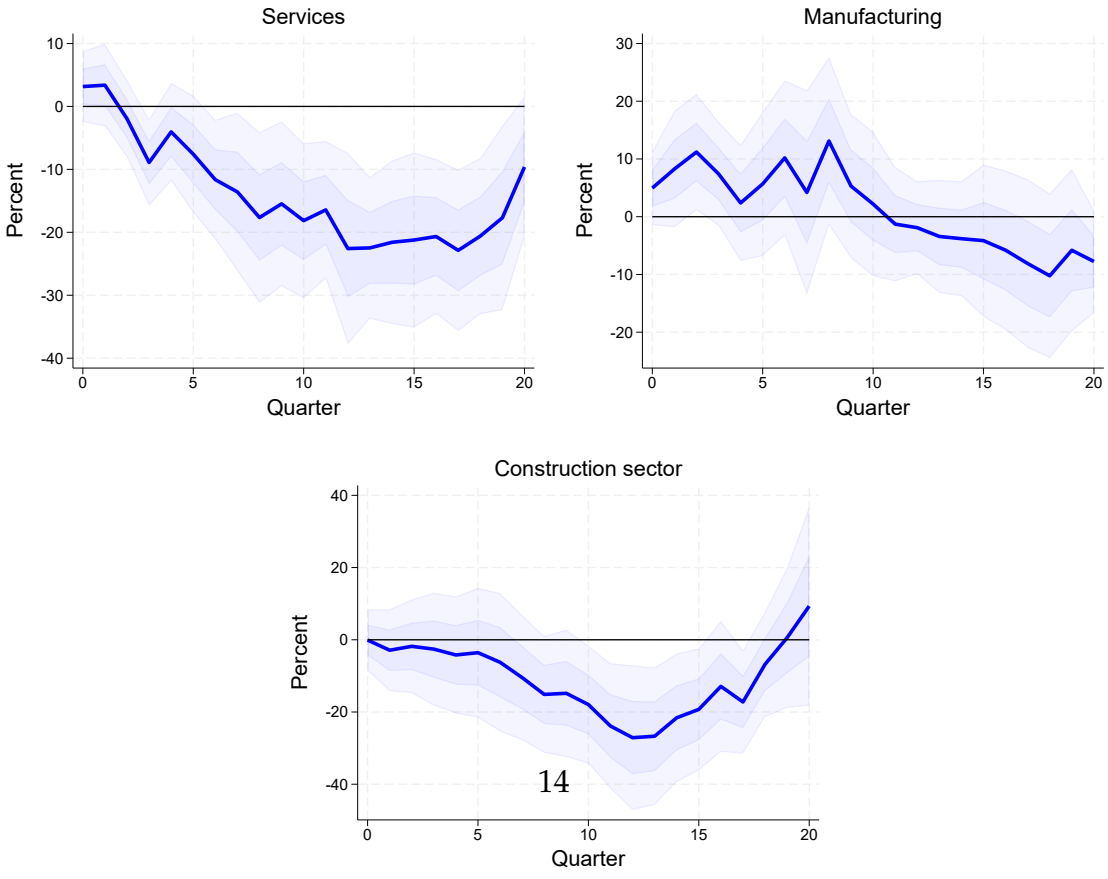

Figure 9: Impulse response functions to a 1 pp monetary policy shock

Figure 10 further disaggregates the services sector.[5] In particular, the results indicate that the drop in investment in the services sector is driven by investments in *real estate activities*. This sector accounts for a considerable portion of business investment and predominantly comprises commercial real estate firms. This sector is largely debt-financed[6] and investment in this sector will naturally be sensitive to interest rate changes[7]. Regarding investment in the *Wholesale and retail trade* sector, which also accounts for a considerable share of business investment, we find no significant effect of monetary policy shocks. While for *other services* we find pronounced effects, indicating that interest rate sensitivity in the services sector is not exclusively driven by *real estate activities*.

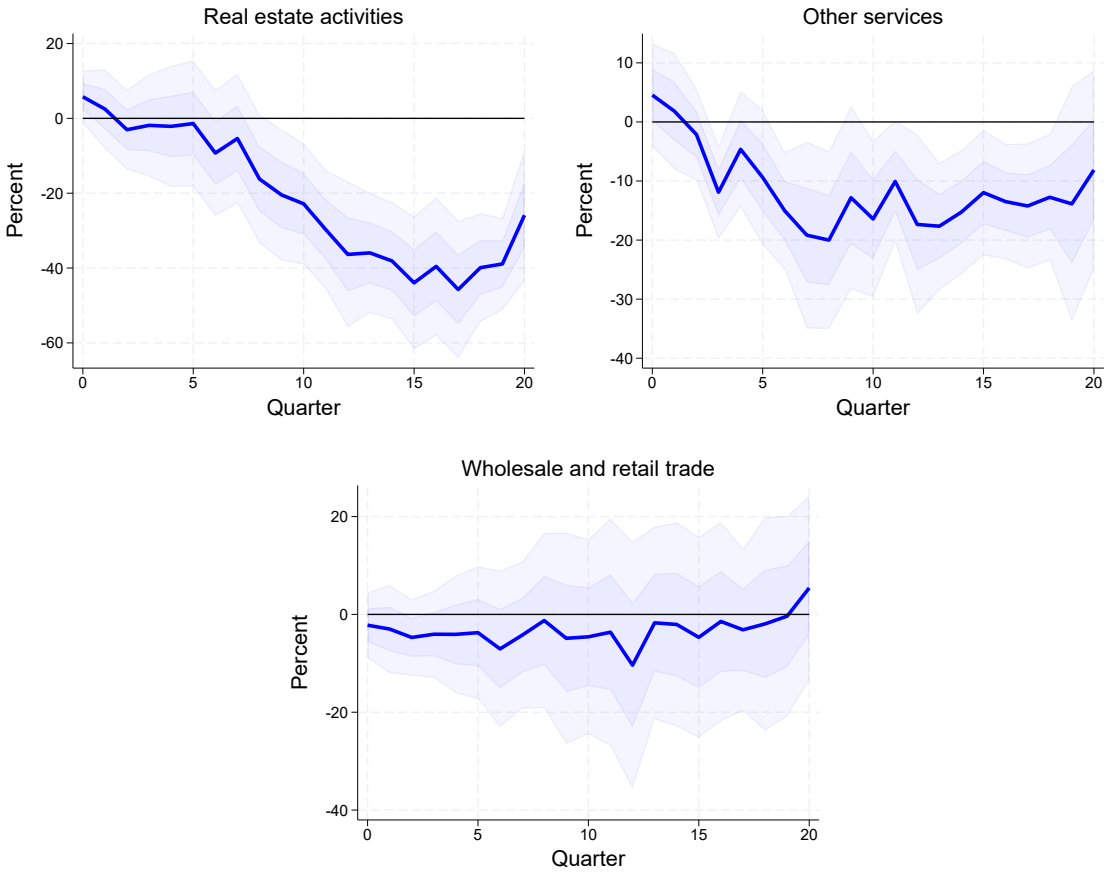

Figure 10: Impulse response functions to a 1 pp monetary policy shock. *Other services* is services excluding *real estate activities* and *wholesale and retail trade*.

[5] *Real estate activities* and *Wholesale and retail trade* are the two largest industries measured as a share of gross fixed capital formation for Mainland-Norway, accounting for 17 % and 11 % respectively (as of 2022).

[6] Norges Bank (2023) document that commercial real estate firms typically have relatively high levels of debt relative to earnings compared to other sectors.

[7] According to the National Accounts, gross fixed capital formation in this sector mainly consist of buildings and constructions.

What can explain the variation in response across sectors? The previous section highlighted significant heterogeneity in the investment response across sectors. This raises the question: what drives this heterogeneity? Given the heterogeneous responses of capital types, one potential explanation is that the share of tangible capital varies across sectors. Moreover, an extensive theoretical and empirical body of literature at the firm level points to various firm characteristics as key determinants of investment response. Given their significance at the firm level, it is reasonable to assume that these characteristics might also be significant at the sector level. We here discuss some of these characteristics that will be - in addition to the tangibility of capital - dimensions we explore to understand the heterogeneous investment responses across sectors.

First, according to classical economic theory, monetary policy influences investment primarily by altering the net present value of incremental profits from additional investment. In this framework, *investment opportunities* are key in determining the investment response. Consider, for instance, two firms: one with no viable investment opportunities and another with several. In such a scenario, the first firm would remain unaffected by changes in monetary policy. Second, recent studies have underscored the impact of financial constraints on investment response (Ottonello and Winberry, 2020; Cloyne, Ferreira, Froemel, and Surico, 2023; Cao et al., 2022). These constraints theoretically affect monetary policy transmission both directly and indirectly. For example, with earnings-based constraints—where a firm's interest expenses cannot exceed a certain proportion of its earnings— monetary policy could influence both the interest expenses and earnings. Empirically, firms with a higher ratio of interest expenses to earnings are observed to have a stronger response to monetary policy changes (Cao et al., 2022). Third, monetary policy can indirectly influence firm investment by affecting cash flow. Ippolito, Ozdagli, and Perez-Orive (2018) demonstrates that firms more prone to debt repricing in response to policy rate fluctuations correspondingly adjust their investments more significantly. This is echoed in findings by Gürkaynak, Karasoy-Can, and Lee (2022). Fourth and finally, Jeenas (2019) argues and documents that firm liquidity plays a crucial role in determining investment response.

In light of these findings, we aggregate firm-level proxies to the sector level to encapsulate these various channels. The proxies include log(total assets), debt to equity ratio, liquid assets to total assets, short-term debt to total debt, interest expenses to earnings and return on assets (RoA). To explore whether the differential propensity to invest in tangible capital is important, we also include tangible assets to total assets as a proxy. Representing these characteristics as X_s and defining the minimum investment response across all horizons h for sector s as $min(\beta_s^h) = \overline{\beta}_s$, we conduct a straightforward cross-sectional regression

analysis to analyze the impact of the different characteristics:

$$\bar{\beta}_s = \gamma_0 + \gamma_1 \times X_s + \epsilon_s \tag{3}$$

where γ_1 captures the relationship between sector-characteristic X_s on the strength of the investment response $\bar{\beta}_s$. The results from estimating equation (3) is shown in Table 2.

Dependent variable:	Investment response ($\bar{\beta}_s$)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log(Total Assets)	-0.0204							0.119
	(0.064)							(0.0654)
Debt to Equity		-2.740**						-2.501
		(0.827)						(1.377)
Liquid Assets to Total Assets			-4.653					1.913
			(3.554)					(4.725)
Short-term debt to Total Debt				-0.338				-1.174
				(0.45)				(0.846)
Interest Expenses / Earnings					-0.535**			-0.490*
					(0.191)			(0.223)
Tangible Assets to Total Assets						0.593		-0.484
						(0.45)		(1.314)
Return on Assets (RoA)							17.12***	11.79**
							(3.228)	(4.005)
N	45	45	45	45	45	45	45	45
adj. R-sq	-0.021	0.185	0.016	-0.01	0.135	0.016	0.381	0.505

Table 2: Investment response and firm characteristics

In our preferred specification, presented in column (8), we contemporaneously include all sector characteristics. In this context, two factors emerge as robust explanators of variation in investment response across sectors: the ratio of interest expenses to earnings, and Return on Assets (RoA). It is important to note that a more negative value of $\bar{\beta}_s$ indicates a *stronger* investment response. This implies that sectors with higher ratios of interest expenses to earnings exhibit a stronger investment response, whereas sectors with higher RoA demonstrate a weaker investment response. While we exercise caution in directly associating these proxies with specific channels, our results suggest that the presence of debt amplifies the sectoral investment response to monetary policy changes.

Regarding the magnitudes of these effects, sectoral heterogeneity is somewhat significant. For example, an increase in the ratio of interest expenses to earnings by one standard deviation (0.633) amplifies the investment response by approximately 0.3 standard devi-

ations. The impact is roughly similar when RoA changes by one standard deviation. However, it is noteworthy that, even after accounting for all the characteristics discussed, we can only explain about half of the variation in investment responses across different sectors.

5 Conclusion

In this paper, we have explored the impact of monetary policy on consumption and investment in Norway. In line with the existing literature, we find large but delayed responses in both consumption and investment to monetary policy. However, the aggregate consumption and investment responses are marked by substantial heterogeneity. On a more disaggregated level, we find that durable consumption decreases while non-durable consumption *increases*. Within investment, tangible investment drives the aggregate investment response. Moreover, sectors with high interest costs relative to earnings, such as real estate, are more responsive to changes in monetary policy. Our findings provide novel evidence on how monetary policy affects not only the level of consumption and investment but also their composition.

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A Data

Data used in local projections				
Data	Source	Frequency	Adjustments	Transformation
Private consumption	SSB: table 09190	Q	Constant prices, seasonally adjusted (NOK million)	Log
Housing investment	SSB: table 09190	Q	Constant prices, seasonally adjusted (NOK million)	Log
Business investment	SSB: table 09190	Q	Constant prices, seasonally adjusted (NOK million)	Log
Gross fixed capital formation by industry and type	SSB: table 09183	Q	Constant prices, seasonally adjusted (NOK million)	Log
Consumption expenditure by durability	SSB: table 09190	Q	Constant prices, seasonally adjusted (NOK million)	Log
Services (excluding non-resident households)	SSB: table 09190	Q	Constant prices, seasonally adjusted (NOK million), services - direct purchases by non-residents	Log
Policy rate	NB	Q		None (rate)
Data used for estimating monetary policy shock for Norway				
Forecasts for GDP	NB and CF	A		Annual growth
Forecasts for CPI	NB and CF	A		Annual growth
Unemployment rate gap	NAV	M	Seasonally adjusted, registered unemployment - NAIRU	Gap
Policy rate	NB	D		None (rate)
Import-weighted krone exchange rate, I-44	NB	D		

Frequencies: *Q: quarterly, M: monthly, D: daily*
Sources: *NB: Norges Bank. SSB: Statistics Norway. NAV: Norwegian Labour and Welfare Administration. CF: Consensus Forecasts*