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Monetary Policy in Crisis

*An Assessment of the Norwegian Monetary Policy Response
to the Covid-19 Pandemic*

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Abstract

In order to assess the monetary policy response to the ongoing crisis, this thesis combines a broad case study with detailed graphical analyses of key events and economic variables. We discuss how a broad range of policies has been used to tackle the crisis, interpreting central relations through the lens of macroeconomic models. Furthermore, we discuss the shortcomings of existing literature in incorporating the policy tools used in the policy response. We construct a "Taylor gap", which reveals a systematic divergence between the policy rate and a simple Taylor rule in periods of economic unrest. The most prominent gap, of 4 percentage points, is observed in the third quarter of 2020. We interpret this to result from the prioritization of other policy objectives in addition to reducing the output and inflation gap. Comparing projections of the two rates shows that in the long-term, no-shock scenario, the policy rate seems to converge with our policy rule. Liquidity measures seem to have successfully aided transmission from policy to market rates, stabilized risk premiums, and met interbank liquidity goals. The diverging indicators of selected financial variables explain the moderate reduction in the countercyclical capital buffer and shed light on the trade-off between different policy objectives. We find that financial stability risk in specific indicators may develop from the expansionary policy. Yet, we argue that macroprudential policy has likely softened the blow of the crisis. The monetary policy response to the covid-19 crisis illustrates how combining various measures is necessary to balance conflicting monetary policy objectives in a crisis.

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1. Introduction

On March 11, 2020, The World Health Organization (WHO) declared covid-19 a pandemic (WHO, 2020). The outbreak of covid-19 triggered unprecedented containment measures globally, resulting in an extraordinarily sharp and deep economic downturn worldwide. The following day, on March 12, the Prime Minister of Norway, Erna Solberg, addressed the nation, announcing that "today, the Government takes the strongest and most invasive measures we have had in Norway in peacetime [freely translated]" (Solberg, 2020). To limit the spread of the virus, extensive social-distancing regulations, including virtually all aspects of the social scene, were implemented. This included the temporary closing of schools, stores, cultural venues, gyms, and restaurants. The businesses that could remain open were encouraged to let employees work from home, and production was severely restricted due to supply chain disruptions, immobile workers, and social distance recommendations.

In a press conference on March 13, 2020, following an extraordinary meeting of the Monetary Policy and Financial Stability Committee, the Governor of the Norges Bank, Øystein Olsen, stated that "the most important measures taken to limit the consequences of the spread of the coronavirus are those that will save lives. Norges Bank's task is to promote economic stability" [freely translated] (Olsen, 2020a). Various shocks have since been hitting the Norwegian economy in rapid succession, and monetary policy has played an essential part in counteracting the long-term adverse effects of the crisis.

1.1 Motivating the Research Questions

The motivation behind this thesis is to understand current economic conditions by analysing the monetary policy response to these extraordinary circumstances. Norges Bank Watch is a series of annual reports written on commission from the Norwegian Ministry of Finance (BI, 2021). These reports aim to critically assess Norges Bank's conduct of the monetary policy in the previous year. Inspired by these reports, this thesis aims to assess the tools and strategies used to achieve the policy objectives of the monetary policy response to covid-19. We do this by addressing two research questions.

1.1.1 Research Question I

The first research question is related to the primary <u>Monetary Policy Response</u>:

Which monetary policy objectives were prioritized in 2020, and which measures comprised the Norwegian monetary policy response to covid-19?

To answer this research question, we start by exploring the extent to which a simple instrument rule can describe the interest rate response. Using the simple Taylor rule (1993), we attempt to disclose a pattern in how monetary policymakers use rules and discretion during crises in Norway, with particular focus on covid-19. Finding this rule insufficient to answer the research question, we move on to applying a more complex theoretical framework; a model for monetary policy under inflation targeting by Røisland and Sveen (2018), attempting to understand the nature of the covid-19 crisis by conceptualizing it primarily as a demand-side shock, a supply-side shock or risk premium shock to the economy.

Since the composite crisis was met with a composite policy response, supplementing monetary policy tools were utilized, which cannot be accounted for within this framework. Where the simple rule and the model for monetary policy under inflation targeting are no longer applicable, we discuss the shortcomings of this existing literature. The conventional and unconventional tools supplementing the interest rate decision consist of both liquidity and capital measures. To answer our research question, we need to outline and analyse these tools' respective objectives, mechanisms, and effects.

1.1.2 Research Question II

To conduct a holistic decomposition of the monetary policy response and assess the aggregate effect on the Norwegian economy, we also need to analyse the <u>Impact of the Policy Measures</u>. The second research question is therefore:

To what extent has the prioritization of monetary policy objectives contributed to future risk factors, and how are important macroeconomic and financial variables developing?

To answer this research question, we take a step back from the proximate effects of the primary response and map how this response has impacted important economic variables in the

aggregate economy. We interpret these developments through the lens of macroeconomic models and theory. Since a main objective for monetary policy is the transmission from the policy rate to commercial bank rates, we analyse to what extent this objective has been met. Furthermore, we evaluate selected financial variables to analyse whether a trade-off between conflicting objectives prioritized in the monetary response to the covid-19 crisis has resulted in financial imbalances.

As a small, open economy, Norway is impacted by global developments in fundamental economic variables, as well as the domestic ones. To fully answer the research question, we thus find it necessary to include analyses of the inflation outlooks and the development of the neutral real interest rate level, as these are intrinsic variables in the aggregate economy. Finally, we compare the overall development in macroeconomic and financial variables, as summarized by Norges Bank's decomposed projected policy rate, to a simple Taylor rule, tying our two research questions together.

1.2 Scope and Outline

The scope of this thesis is limited to the Norwegian monetary policy response directly related to covid-19. To identify the effect of the crisis and response, we use time-series data for central variables from a selected period leading up to the crisis. Our analysis is primarily based on graphical discussions that allow us to identify interesting correlations and make general remarks about Norway's current macro political situation. Thus, this thesis contributes to existing literature by providing a holistic decomposition of the Norwegian monetary policy response to covid-19 by the means of macroeconomic models and data.

The thesis proceeds as follows. In this introductory chapter, we motivate and present our research questions and provide a brief context. Chapter 2 presents the relevant economic theory and literature that form the basis for analysing our research questions. This chapter includes a detailed outline of the macroeconomic models utilized throughout the thesis and a brief description of the de facto mechanisms of the central banking system and money market in Norway. Chapter 3 contains a description of the data and the data transformations used. Our analysis consists of two parts. Chapter 4 addresses the first research question, while the second

is addressed in chapter 5. We discuss limitations and robustness of the thesis in chapter 6. Finally, in chapter 7, we present our conclusion.

1.3 Covid-19 and Monetary Policy

The Government is responsible for deciding between shutting down non-essential activities to preserve as many lives as possible, and keeping society open to avoid economic losses. One way to illustrate this situation in a simplified way is described by Jones (2021). The model is built on the assumed negative relationship between GDP loss in relative terms and the number of covid deaths per million people.
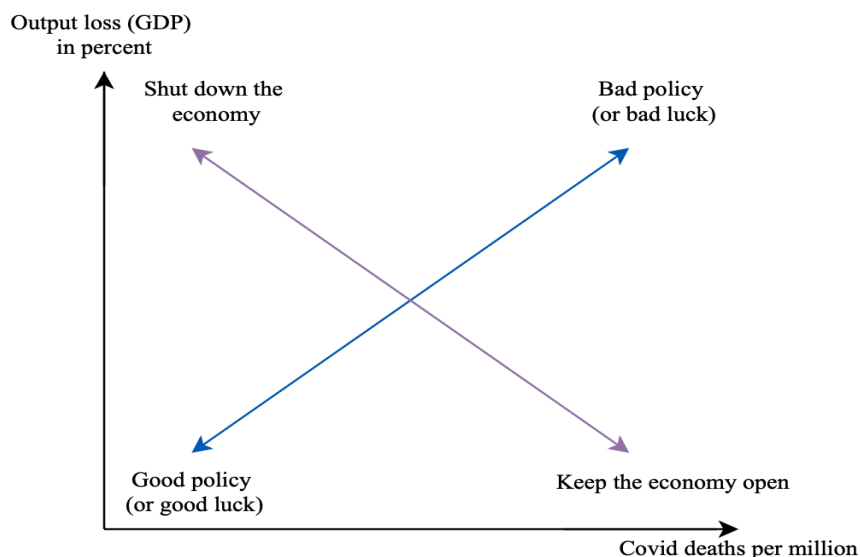
Figure 1 - The covid-19 crisis and monetary policy, adapted from Jones (2021)

The purple line in figure 1 illustrates the short-term trade-off between economic activity and deaths from covid-19. Imposing strict societal regulations, the Government expects a reduction in the number of deaths. The spread of the virus is halted but at a high cost in terms of GDP because the economy is in effect shut down in the process. In the model, the "Covid deaths per million" axis is pre-determined as a function of the degree of shut-down. Monetary policy can impact the "Output loss" axis through good policy measures, as described by the blue line. Monetary policy cannot aid health measures directly or provide solutions for furloughed workers. What it can do, however, is to reduce the costs of shutting down the economy given the degree of social lockdown imposed by the Government through good policy. The next chapter is dedicated to describing how.

2. Theory

In this chapter, we present two theories for monetary policy. We begin by outlining the fundamental concepts these theories rest upon before presenting them in order of increasing complexity. The first one, the simple Taylor rule, provides an interesting point of departure, allowing for a comparison between covid-19 and previous periods of economic unrest. The second one, the Røisland and Sveen (R&S) model is better suited to analyse covid-19 as a composite shock because it takes short-run changes and monetary policy into account. Combining the two provides a framework for a holistic understanding of the underlying mechanisms of the covid-19 crisis and subsequent policy response. These theories have certain limitations, which will be discussed at the conclusion of their respective sections. The new developments in monetary policy that these theories do not account for are presented in separate, subsequent sections. We link theory to practice in a section describing the Norwegian liquidity management and the money market, before we end the chapter with a brief note on money supply.

2.1 The Role of Monetary Policy

Monetary policy can have many objectives, such as promoting employment, stabilizing exchange rates, controlling money supply or balancing market conditions. In many economies, the primary objective is to maintain monetary stability by keeping inflation low and stable. In Milton Friedman's paper "The Role of Monetary Policy", he states: "our economic system will work best when producers and consumers, employers and employees, can proceed with full confidence that the average level of prices will behave in a known way in the future- preferably that it will be highly stable" (Friedman, 1968, p.13). The activities of Norges Bank are regulated by the Central Bank Act. According to The Act, the central banking mandate is "to maintain monetary stability, promote the stability of the financial system and ensure an efficient and secure payment system. The central bank is also responsible for contributing to high and stable output and employment" (Sentralbankloven, 2020, §1-2).

The effect of monetary policy on the real economy is temporary. Output, that is, GDP, is determined by the level of technology, preferences, access to resources in the country. Dictated by the principle of money neutrality, an increase in money supply will then result in one-to-

one increase in inflation in the long run. The long run growth of GDP cannot then be controlled by monetary policy. Hence, there is a clear separation of the nominal side and the real side of the economy in the long run (Jones, 2014). This phenomenon is commonly referred to as the classical dichotomy (Patinkin, 1965) and gives rise to Friedman's (1970) famous quote: "inflation is always and everywhere a monetary phenomenon".

In the short run, however, the classical dichotomy does not seem to hold and is rejected by Keynesians and monetarists alike. In the short run, the argument is that prices are *sticky*, in the sense that nominal prices are resistant to changes. This means that, for instance, an increase in money supply can in fact lead to an increase in aggregate demand, thereby affecting real variables. Changing the nominal interest rate level (given by for instance the policy rate) can then lead to changes in the real interest rate. The real interest rate can be interpreted as the cost of capital, and thus the nominal rate can affect the investment level in the economy (and thereby also affect output). This relationship is described and coined by Irving Fisher (1930) and is commonly simplified in the following form:

$$r = i - \pi \tag{1}$$

where r, i, and π denotes the real interest rate, nominal rate, and inflation, respectively. In the long run, a change in the nominal rate is countered by a corresponding inflation change, and so the real interest rate remains unchanged. However, due to nominal rigidity, the nominal rate can affect the real interest rate in the short run.

When inflation is low and stable, relative prices are transparent, which is essential for market economies to function properly. If inflation is very high and volatile, it is hard to judge whether prices have increased in relative or absolute terms, making price signals unclear. High inflation is costly because it generates uncertainty in the market, leading to either under-investment or over-investment. This may result in fluctuations in the economy. However, some inflation over time is necessary to maintain a positive real interest rate (Gjedrem, 2019).

The role of monetary policy is to stabilize the level of demand that corresponds to the normal utilization of resources. This means guiding the activity in the economy to a level that is consistent with potential output; the level that can be sustained in the long term in other words, closing the output gap, which is the difference between actual output and potential output.

2.2 Business Cycles and Crises

The notion of short run versus the long run is perhaps given meaningful interpretation when introducing the concept of economic fluctuations, namely business cycles. A commonly adopted definition by Burns and Mitchell (1946) states that business cycles are:

> "a type of fluctuation found in the aggregate economic activity of nations that organize their work mainly in business enterprises: a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle; the sequence of changes is recurrent but not periodic [...]" (1946, p.1)

As the term "business cycle" is accompanied by some ambiguity, these cycles of positive and negative output gaps are commonly categorized as either classical cycles or growth cycles. Classical cycles describe fluctuations in the level of economic activity, measured by e.g., GDP (in volume terms). Growth cycles, on the other hand, describe fluctuations in the activity level around the long run potential level (or fluctuations in the output gap) (OECD, 2001). In figure 2, we illustrate these concepts. Classical cycles are described on top of the diagram, while growth cycles follow the description below the x-axis.
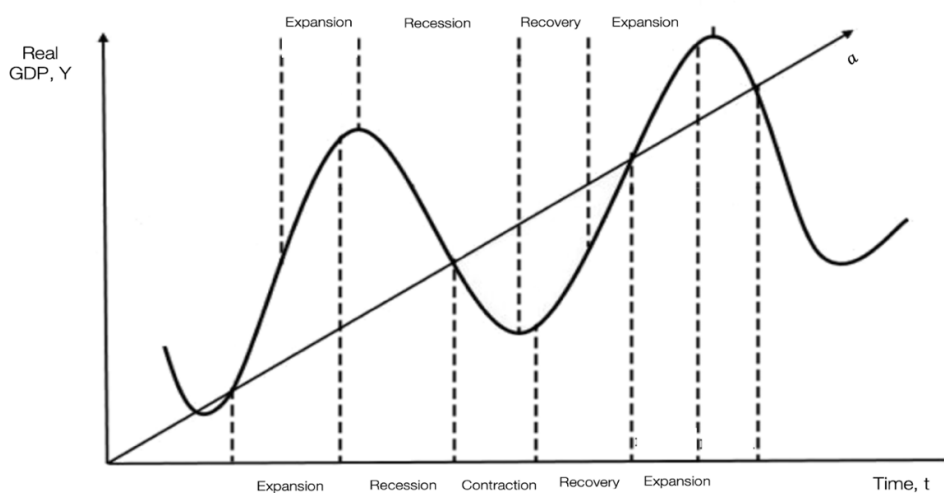
Figure 2 - Classical cycles, growth cycles and the growth trend

A key difference is therefore that classical cycles have turning points (so-called "peaks" and "troughs") corresponding to the local maximum and minimum values of the trend-cyclical curve, implying $\frac{d\pi}{dt} = 0$ while growth cycles have turning points where the trend-cyclical curve grows at the same rate as the long-run trend, implying $\frac{d\pi}{dt} = a$ where a is the trend growth. Section 3.3 outlines the Hodrick-Prescott filter technique we use to separate the cycle from the trend for different macroeconomic time series central to our analysis.

From Burns and Mitchell's definition, it is clear that recessions are considered inevitable (at least in market economies) and a natural dynamic of the economy. The debate concerning why these cycles occur is comprehensive[1]. Kydland & Prescott (1982) put forward the "Real Business Cycle Theory", which emphasizes how cycles are driven by real shocks[2]. Examples include sudden price changes of important inputs of production, technological change, war, or natural disaster, such as a pandemic, which in turn affect aggregate supply. We now turn to crises.

Eichengreen and Portes (1987) put forward the following definition of a *financial* crisis: "a financial crisis is a disturbance to financial markets, associated typically with falling asset prices and insolvency among debtors and intermediaries, which spreads through the financial system, disrupting the market's capacity to allocate capital". In contrast, a crisis originating from the *real* economy manifests itself primarily at the production level, leading to a decline in output (Grytten & Hunnes, 2016). There is limited literature describing this phenomenon, perhaps because most economic crises are brought about due to the financial markets.

In the aforementioned "Role of Monetary Policy", Friedman writes: *"Monetary policy can contribute to offsetting major disturbances in the economic system arising from other sources"* (Friedman, 1968, p. 14). Moreover, according to Sørensen & Whitta-Jacobsen (2010), there is

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[1] See for example Fisher (1933), Keynes (1936), Stiglitz and Weiss (1981), and Minsky (1992).

[2] The Keynesian theories dominated the topic of business cycles in the early postwar period. Such theories were based on variations in aggregate demand (willingness to invest and consume) so stabilization policy should control aggregate demand (Keynes, 1936). In light of the 1970s stagflation in the US, which Keynesians interpreted as failure by the market mechanism to coordinate demand and supply, Lucas (1976) criticized the Keynesian theories on the basis of the assumptions behind their models, stating that the policy itself would influence the the macroeconomic variables, and so solid microeconomic foundations were required. In many respects, Kydland and Prescott created this operational framework (which Lucas called for) in their paper "Time to Build and Aggregate Fluctuations".

extensive international evidence of a positive correlation between economic stability in the short run and income creation per capita in the long run. This gives rise to the motivation behind stabilization policies. We now turn to how such policies can be determined in the next section.

2.3 Rules and Discretion

A natural question to ask is whether monetary policy should follow explicit rules or be determined at the discretion of the monetary policy authority. Rules, in this context, refer to "a prescribed guide for monetary policy conduct" (Svensson, 1999, p. 614). Arguments in favour of discretion focus on the uncertainty behind the mechanisms and behaviour of the economy. In many cases, it is perhaps unclear if an exogenous shock hitting the economy is driven by factors related to the demand side or the supply side. As we will see later in our analysis, shocks of different natures require different monetary policy responses.

A central motivation behind the rules vs. discretion debate is the time-inconsistency problem[3], first put forward by Kydland and Prescott (1977). There is a risk of time-inconsistency in the performance of monetary policy resulting from authorities' incentive to create positive inflation shocks, which leads the private sector to expect positive inflation. Central banks may be motivated to pursue short run expansionary policies at their discretion to create temporary gains in output by taking advantage of the fact that inflation expectations are constant in the short run. Kydland and Prescott have demonstrated that time inconsistency can generate higher inflation.

American economist John Taylor (1993) puts it simply: "If there is anything about which modern macroeconomics is clear, however - and on which there is substantial consensus, it is that policy rules have major advantages over discretion in improving economic performance" (p.197). By committing to a fixed rule, the central bank can make its announcements more credible. This view is supported by followers of the rational expectations hypothesis[4]. If

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[3] They were awarded the Nobel Prize in Economics in 2004 for their contribution to the topic of macroeconomic policy.

[4] This theory states that agents in the economy cannot be routinely "fooled" by policymakers if the policies implemented are meant to steer agents in a specific direction. Instead, using all available information, agents will

policymakers follow seemingly random policies (discretion) or deviate from policy rules, forecasting becomes difficult, so the economy suffers.

Literature on monetary policy rules often distinguishes between "targeting rules" and "instrument rules". Central banks which use targeting rules have monetary policy objectives expressed in target functions. These functions are often expressed as loss functions. To follow the targeting rule the central bank will set the interest rate to minimize the loss function. For central banks with an explicit inflation target, the target could be to minimize the inflation gap; the deviation between actual inflation and real inflation over a certain time period. Production stability considerations are also a common feature in such loss functions.

Inflation targeting has proved advantageous for several reasons. Firstly, it reduces the time-consistency problem. Secondly, it increases policy transparency. Moreover, the accountability and responsibility of the central bank becomes clearer as it facilitates measuring the long run success of the conduct of monetary policy. Transparency has increased predictability for the business community and improved the central bank's credibility, thereby contributing to a more efficient monetary policy (Qvigstad, 2009).

The rigidity of inflation targeting can, however, limit monetary policy in responding to unforeseen circumstances (Mishkin, 2016). The problem of rigidity is dealt with when formulating low and stable inflation as a *long run* goal. If inflation targeting is the highest-ranking policy goal in all cases, and output gap is not a priority, excessive output fluctuations may occur. Therefore, the central bank can attempt to mitigate costly output fluctuations by allowing inflation to deviate from the target for short periods. This practice was later referred to as "constrained discretion", a term coined by Ben Bernanke (2003).

Instrument rules express monetary policy instruments as explicit functions. Classic examples of such rules include McCallum's (1988) rule for money supply and Taylor's (1993) interest rate rule. Taylor's rule expresses a relationship between the policy rate, and the inflation and output in a given country. As opposed to the targeting rules, instrument rules are not derived by optimization. As they are only dependent on a few variables, they are often referred to as "simple rules" (Lønning & Olsen, 2000).

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rationally forecast policy changes. A critical implication of this theory is then that only random actions taken by the monetary policy authority can fool the economic agents. See for instance Barro (1978).

2.4 The Simple Taylor Rule

Taylor is known for his influential perspective on central banks' strategies for stabilizing output and inflation levels. In his paper Discretion Versus Policy Rules in Practice (1993), he argued that central banks could, by simply adjusting the short-term interest rate, effectively reduce deviations in both output and inflation, bringing them back to their respective target levels.

2.4.1 Dynamics and Specifications

The rule states that the interest rate set by policymakers should vary positively with the output gap $(y - y^*)$ and with the inflation gap $(\pi - \pi^*)$.

$$i = \pi + \rho + \alpha(\pi - \pi^*) + \beta(y - y^*) \tag{2}$$

The neutral real rate, ρ, enters a constant relationship with the Taylor rate, i, equal to the one described in the Fisher equation, given that inflation and inflation expectations are stable at the target level and that the output gap is zero and stable in the medium term. α and β are weighting coefficients for the inflation gap and output gap, respectively. A positive value for α implies that the nominal interest rate should increase by more than one-to-one compared with the inflation rate, thereby ensuring that the real interest rate can halt a rise in the inflation gap. This is called the Taylor principle. In the opposite case, the nominal interest rate response is less than proportional to the inflation increase, and the interest rate rise will be insufficient to keep the real rate from falling.

By including weighting coefficients for the output gap and inflation gap, the rule can be adapted to economies with different emphases on these two sizes. In his paper, Taylor (1993) proposed the following rule, which "captures the spirit of the recent research" (p. 202):

$$i = p + 0{,}5y + 0{,}5(\pi - \pi^*) + 2 \tag{3}$$

In this classic version of the rule, the coefficients are given the value of 0,5. Taylor (1993) argued that assigning weight to output and inflation was "likely to be better than a pure price rule". Taylor assumed that the neutral "equilibrium" real rate to be close to the steady-state

growth rate, which at the time[5] was approximately 2. For this thesis, we employ the classic parameter values, however for the neutral real rate we calculate a weighted average based on four different estimates from Norges Bank. Section 3.2 describes the calculation in detail.

This simple interest rate rule, describing a systematic response to developments in inflation and output, has proven to be quite accurate, although central banks do not follow simple rules mechanically (Sørensen & Whitta-Jacobsen, 2010). Several papers, including Clarida, Galí, and Gertler (1998, 2000) and Orphanides (2003), have provided empirical evidence that the rule approximates the policy rate of a central bank fairly well when the coefficients are set to reflect the given country's prioritization of the two targets. These studies suggest that the Taylor rule is stable and correlated with the policy rate over time and across countries.

Different specifications of Taylor rules yield different results. Rules can be backward-looking or forward-looking. The classic version, as put forward in Taylor's original paper, is backward-looking, meaning that the nominal rate is based on data from previous time periods; in other words, lagged values. In contrast, a forward-looking rule relies on expected inflation and a projected output gap. Forward-looking models are consistent with rational expectations, meaning agents in the economy have (on average) unbiased expectations. In contrast, adaptive expectations may allow agents to be fooled by an activist central bank. Rules can also be hybrid, which means that the central bank considers both lagged values of variables and future expected variables when setting the interest rate.

Clarida, Galí, and Gertler (1998) reject the backward-looking rule in favour of a forward-looking rule. In their paper, they estimate monetary policy reaction functions on several large economies, including Germany, Japan, the US, France, and Italy. They find evidence suggesting that central banks account for anticipated inflation rather than lagged values.

We do not set out to estimate a Taylor rule. Literature concerning Taylor rule estimations for the Norwegian case is already relatively extensive. For instance, Bernhardsen and Bårdsen (2004) have estimated models based on the Taylor rule with different extensions on Norwegian data from 1999. Finding the estimations somewhat imprecise, they conclude that such models

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[5] This is based on the average growth rate of 2,2% in the US in the time period spanning from the first quarter of 1984 to the third quarter of 1992 (Taylor, 1993).

may still be useful as analytical tools. Several master theses have also conducted various Taylor estimations. Hanken and Syse (2020) have analysed the introduction of inflation targeting on inflation, business cycles, and financial stability using a backward-looking rule. Mjelde and Monsrud (2018) estimate a forward-looking rule, inspired by Clarida, Galí, and Gertler (1998), for the period 1999-2018 with particular focus on financial stability concerns. Skaaland and Vik (2016) estimate a backwards-looking rule for the period after the Financial Crisis of 2008. Our goal, however, is to illustrate the nature of a policy rule in relation to decisions made during the pandemic.

2.4.2 Limitations of the Taylor Rule

Simple rules like the Taylor rule have been criticised for providing overly mechanical descriptions of monetary policy (Røisland & Sveen, 2018). A strong voice speaking against such simple approaches to describing monetary policy is Svensson (2003), pointing to the flawed logic of assuming that household and consumer behaviour is guided by optimization, and central bank behaviour is not. It is important to note that the Taylor rule is at best meant to be an empirical description, not a normative prescription for monetary policy. As Gerdrup and Nicolaisen (2011) have done, one can argue that it is better to be roughly right than exactly wrong.

Despite its simplicity, or perhaps because of it, the Taylor rule reveals correlations in the period leading up to the pandemic and provides a historical perspective on current events. An obvious limitation of this framework for an analysis of a case such as this is that it does not incorporate variables for sudden changes to the underlying parameters, or the effect of (unconventional) monetary policy. In order to isolate and analyse an exogenous shock to the economy like covid-19, we therefore need a more complex model.

2.5 Monetary Policy under Inflation Targeting

In order to analyse the Norwegian monetary policy response, we need a clear understanding of Norges Bank's objectives. Norges Bank officially implemented an inflation target in March 2001. As briefly discussed in section 2.3, this involves using an explicit nominal anchor to achieve the primary long run goal of price stability by stabilizing inflation expectations. The

Norwegian Government set the initial target to be 2,5%. This was later reduced to 2% in 2018 (Norges Bank, 2018).

In the case of Norway, inflation targeting is forward-looking and flexible in order to balance reaching the target level of inflation with the other considerations stated in Norges Bank's mandate. The aim of the policy is thus to stabilize inflation levels around this target in the medium term. In 2004, the time-horizon for reaching the inflation target was widened from 2 to 1-3 years, which implicitly gave the state of the real economy a more significant role. The time horizon depends on which disturbances the economy suffers and how such disturbances affect the prospects of inflation, production, and employment (Norges Bank, 2020a).

Many of the basic macroeconomic models are not suited to analyse monetary policy under inflation targeting. In this section, we present a framework by the Norwegian economists Røisland & Sveen (2018), which was specifically developed to fill this gap in the literature. The model is central to our analysis both through direct application and as a basis for discussion. The model is built on New Keynesian principles in the sense that demand consumption depends on *current* disposable income[6], as well as the short-run interest rate. The model assumes constant inflation expectations, and so there is a one-to-one relationship between the nominal and the real interest rate.

In its essence, the model is based on modified versions of an investment savings (IS) model, Monetary Policy (MP) model, and Phillips model. The framework is essentially static[7] and must be understood as the result that would occur after the monetary policy implemented has affected the economy[8]. One main advantage of using this model is its suitability for "graphical

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[6] Another approach would be to use the Euler equation, which is based on the permanent income hypothesis. Demand is considered to be forward-looking; expectations of future demand will also affect current demand. This implies rewriting the IS equation as $y = y^e - \alpha(i - \pi^e - \rho) + v$ where y^e is the expected output gap. If one assumes rational expectations and the expectation hypothesis holds, demand ultimately depends on the long run interest rate rather than the short run. However, empirical studies show that the difference between these two approaches is not critical when studying monetary policy (Røisland & Sveen, 2018).

[7] Røisland and Sveen (2006) have also introduced an extended dynamic model. Generally, the dynamics of inflation and the output gap mechanisms become somewhat more nuanced because various time lags are included in the transmission mechanism. This model allows for a discussion of the time horizon to reach the inflation target, which is not possible within our static framework. They show that for a given shock, this time period will be longer the more weight the central bank attributes stability for the real economy. Moreover, the time period to adjust to the target after the shock will also depend on its characteristics, size and duration.

[8] Røisland & Sveen (2018) uses the example of 1-3 years, however in our case we must a assume a slightly shorter time period due to the extraordinary circumstances of the Covid-19 crisis.

studies of various shocks in diagrams with inflation and the output gap" (Røisland & Sveen, 2018).

Røisland and Sveen distinguish between the dynamics of a closed and an open economy, providing two alternative variations of their model (2018). There is a specification accounting for financial stability in the closed economy variation. This version incorporates a variable, q, representing relevant financial stability indicators, such as the credit-gap. It is based on the so-called principle of leaning against the wind, i.e., setting the interest higher than the loss function would suggest. The most distinct difference between these variations is that the open economy version dictates that the optimal policy is given by opposite signs on the inflation and output gaps. This is not necessarily the case when incorporating financial stability due to financial acceleration effects. However, this is perhaps a more suited model variation in the case of a booming economy than financial imbalances, as empirical evidence shows that financial imbalances tend to build up during booms (Grytten & Hunnes, 2016). As we are in the midst of a global recession and our focus is on Norway, a small, open economy, we find the open economy version the most suitable for this thesis.

2.5.1 The Exchange Rate

Before we describe the fundamental equations of the model, we pause to outline the exchange rate dynamics, as these are largely incorporated into these equations. Small, open economies have negligible impact on international economic factors, participate in trade, and are price takers, as described in equation:

$$e = s + p^* - p \tag{4}$$

where s is the logarithm of the nominal interest rate, p^* denotes the logarithm of the price of foreign goods (denominated in the foreign currency) and finally, p is the price for domestic goods. In the R&S-model model, it is assumed that purchasing power parity holds in the long term, implying that the long-term real exchange rate is one. The equation for determining the exchange rate is based on uncovered interest rate parity (UIP):

$$s = s^e - (i - i^*) + z \tag{5}$$

which states that the expected return will equal the relative change in foreign exchange rates over the same period. In this equation, s^e is the expected nominal exchange rate, i^* is the interest in the foreign country, and z denotes a currency shock (a deviation from UIP).

2.5.2 The Demand-Side of the Economy: The IS-Curve

The investment-savings (IS) curve depicts the traditional Keynesian demand function. It shows the set of all levels of interest rates and output where the total investment in the economy equals total savings. It is characterized by demand depending negatively on the real interest rate and positively on current disposable income. Let the following equation depict aggregate demand, where y represents the output gap:

$$y = -\alpha_1(i - \pi^e - \rho) + \alpha_2 e + v \tag{6}$$

where i denotes the nominal interest rate, and π^e is the expected inflation. Following the Fisher relation, $i - \pi^e$ is then the real interest rate, that we can denote r. Furthermore, ρ represents the long run equilibrium real interest rate. The variable e is the logarithm of the exchange rate. Note that an increase in e corresponds to a weakening of the currency. The α_1 and α_2 are weighing constants that we will return to in section 2.5.4. Finally, v denotes a demand shock variable.

Shocks, in this model, are defined as temporary changes in the equilibrium values of the real economy, resulting from some exogenous occurrence. Such occurrences include drastic changes in fiscal policy or sudden disruptions to households' savings behaviour. The main feature that can be drawn from this equation is that a higher real interest rate will reduce demand and lower the output-gap, and vice versa (Røisland & Sveen, 2018). This means that the central bank can affect the market interest rate[9] and thereby demand. We assume that the central bank sets the interest rate, i, which reflects the interest level in the economy. Moreover, as implied by the Fisher equation, the central bank can affect the real interest rate provided that inflation expectations are stable.

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[9] The basis for this mechanism is outlined in section 2.7 and is further explored in section 5.1. However, the details are unimportant for the dynamics of the theoretical framework.

2.5.3 The Supply-Side of the Economy: The Phillips Curve

The Philipps curve (PC) represents the supply-side of the economy. More specifically, it depicts the notion that there is an inverse relationship between unemployment (activity) and inflation. Simply put, a positive output gap leads to increased inflation. The Phillips curve is given the following equation:

$$\pi = \pi^e + \gamma_1 y + \gamma_2 e + u \tag{7}$$

Note that in this curve, both domestic and imported inflation are accounted for[10]. The imported inflation is partially determined by the exchange rate. The additional variables in this curve are weighting constants γ_1 and γ_2, which we return to in section 2.5.4. Finally, u represents some inflation shock. An important feature of the Phillips curve is its assumption of rigidity in prices (Phillips, 1958). Pressure from the demand side creates a positive output gap, which results in inflation through *gradual* price increases. Higher demand leads to increased profit margins as companies can raise prices. This is often accompanied by increased costs and higher wages, as workers must be more productive to keep up with demand. To adjust the Phillips curve to New-Keynesian theory, the inflation expectations contribute to determining the current inflation level.

2.5.4 The Transmission Mechanism

The transmission mechanism, as illustrated in figure 3, is the connection between the key policy rate and inflation. This mechanism central to understanding the dynamics of the R&S-model. The key policy rate, set by policymakers, determines the short-term money market interest rates, with the objective of either heating up or cooling down the economy. Inflation can be affected through the demand channel (yellow), exchange rate channel (blue), and inflation expectations channel (green).

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[10] For a complete derivation of the equations presented in this section, we refer to Røisland and Sveen (2018), as it does not add relevant insight for the main purpose of this thesis to outline them here.
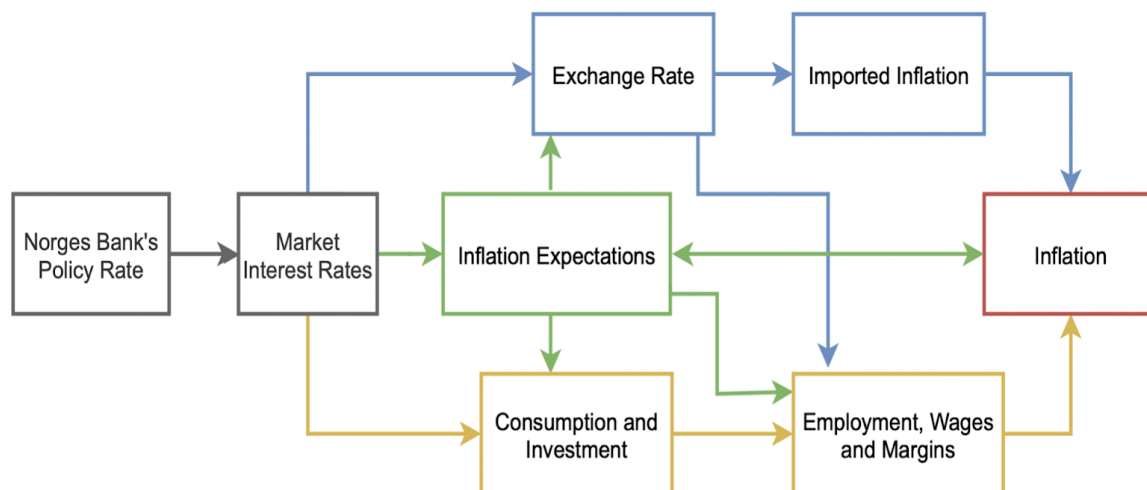
Figure 3 - The transmission mechanism, adapted from Gjedrem (2019)

In order to describe the demand channel, we consider the case of a reduction in the interest rate. The cost of borrowing falls, and consequently, people can finance more debt. The returns on saving will also fall, shifting the optimal intertemporal consumption trade-off such that consumption today is valued relatively higher and therefore rises. The required rate of return decreases, and since the cost of investment falls, the profitability of new investments for businesses rises. This is the *interest rate channel to aggregate demand*. A lower policy rate thus contributes to higher levels of production and employment in the short run. Then, pressure on the labour market drives wage levels up, thereby adding to business costs. This, in turn, impacts profitability. The high demand for goods and services is driven by the low interest rate allowing for increases in consumer prices, alleviating the pressure on business margins (Jacobsen, 2012). The policy rate is therefore negatively correlated with inflation level through the *aggregate demand channel to inflation*. In the opposite case, when interest rates go up, consumption, investment, and employment are negatively influenced, meaning that an increase in the policy rate eventually reduces the rate of inflation in an economy.

Next, we consider the exchange rate channel. Changes in the policy rate also affect the Norwegian krone (NOK) value as measured in other currencies. This is the *interest rate channel to the exchange rate*. The overall effect of the policy rate on the exchange rate depends on several factors in the currency market. A lower policy rate will negatively impact the return on savings in NOK, which reduces demand for NOK, weakening it relative to other countries' currencies (Jacobsen, 2012). Since import now becomes relatively more expensive, there is a rise in imported inflation. This is the *direct exchange rate channel to inflation*. A depreciating

currency simultaneously contributes to augmenting the value of exported goods, and making products exposed to import competition relatively cheaper. Demand for domestically produced goods should then increase. This is the *exchange rate channel to aggregate demand*.

Finally, the policy rate can affect inflation through the expectation channel. Expectations of how interest rates will develop, play an important role when prices are being set and directly impact wage negotiations and how businesses adjust the prices of their goods and services (Jacobsen, 2012). Furthermore, past inflation and recent trends in price level development affect expectations about future inflation, reinforcing de facto inflation and expected inflation. Long-term interest rates reflect expectations of future short-term interest rates. How the central bank communicates about monetary policy and builds credibility in the actual conduct of said policy can strongly influence expectations. Expectations of how the policy rate will develop determine consumption and investments. By guiding expectations, the central bank can, for instance, convince households and investors that the rate will stay low for an extended period. This allows the bank to boost the economy further and have a stronger impact on economic activity.

Since inflation expectations are assumed to be constant, this last channel is not accounted for in the R&S-model. The transmission mechanism for this model is summarized in figure 4.
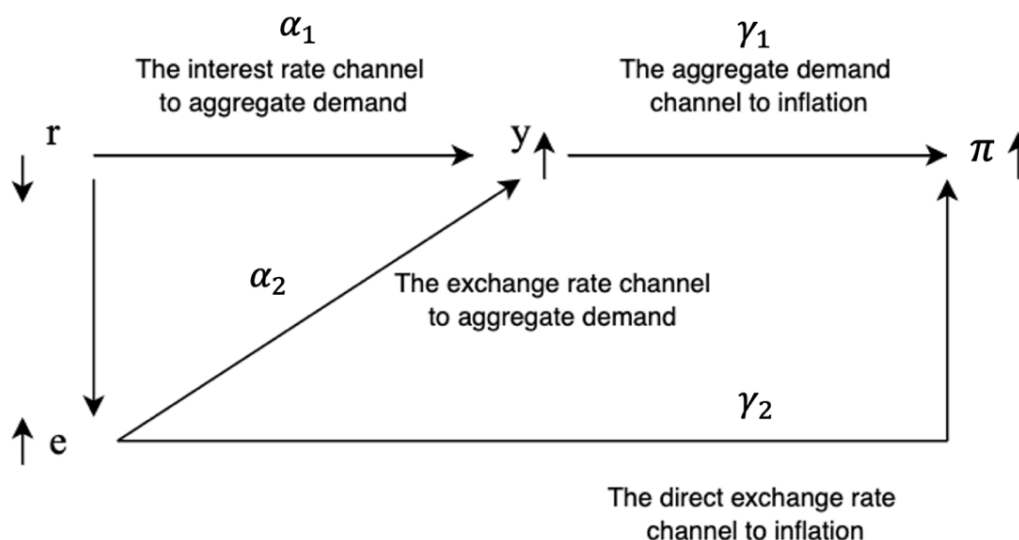

Figure 4 - Model based transmission path, adapted from Røisland & Sveen (2018)

In the model-based transmission path, α_1 determines the strength of the interest rate channel to aggregate demand, α_2 measures the strength of the exchange rate channel to aggregate

demand. The strength of the aggregate demand channel to inflation is denoted γ_1, while γ_2 is the direct exchange rate channel to inflation.

2.5.5 Optimal Monetary Policy: The Loss Function

The model also incorporates output as a deciding factor in determining the interest rate. The simple reasoning is that stability in the real economy can be translated into keeping the output gap as close to zero as possible (Røisland & Sveen, 2018). This is specified by the loss function[11]:

$$L = \frac{1}{2}[(\pi - \pi^*)^2 + \lambda y^2] \tag{8}$$

Different weights can be given to the two determinants of the rate. Here, λ determines how much weight is put on the output gap. It is the objective of the central bank to minimize this loss function. King (1997) coined the term "inflation nutter" regarding central banks whose mandate dictates strict inflation targeting at all costs to the real economy. This would correspond to λ equal to zero, while a positive value for λ is termed "flexible inflation targeting", which is the case for the Norwegian monetary policy mandate. It is within Norges Bank's mandate to consider development in the real economy and choose the appropriate weighting parameter. The quadratic form specification emphasizes that it is equally costly to operate with negative gaps as positive ones. Moreover, another implication is that it shows that the central bank prefers a balanced development in output and inflation[12] since large gaps result in proportionally larger losses (Røisland & Sveen, 2018).

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[11] The exchange rate is indirectly accounted for in the loss function. The reasoning is that stability in the exchange rate follows output and inflation stability.

[12] There also exists a specification in the loss function which incorporates financial imbalances. By placing a weighting parameter on a relevant financial variable q, such as the credit gap or debt-loan ratio, the central bank also needs to consider the financial gap in their optimality condition. The implication is that more weight is implicitly placed on avoiding fluctuations in the real economy. This policy of "leaning against the wind" is still controversial. However, Norges Bank does, in fact, take financial imbalances into account. For the scope of this thesis, we focus on the effects of the exchange rate, and so we do not further elaborate on this specification and refer to Røisland & Sveen (2018, p. 23-30).
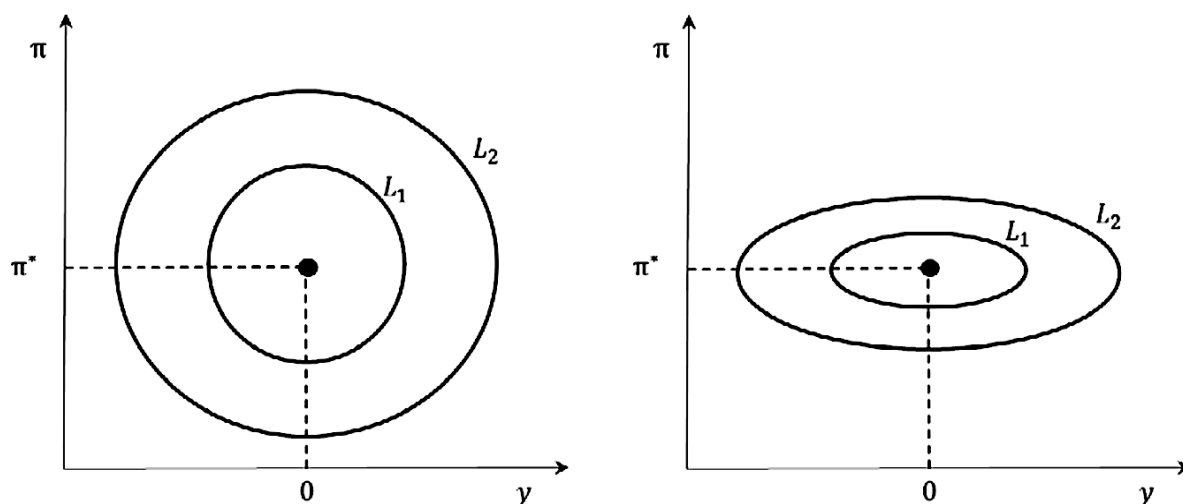
Figure 5 - The loss function (Røisland & Sveen, 2018).

Figure 5 illustrates the loss function. The indifference curve depicts the combination of output gaps and inflation gaps which yields the same losses. Intuitively, the further away the curve lies from the inflation target (with a corresponding output gap of zero), the larger the losses. As a basis for the interest rate decision, the central bank minimizes the loss function and obtains the following first-order condition (FOC):

$$(\pi - \pi^*)\frac{d\pi}{dr} + \lambda y \frac{dy}{dr} = 0 \tag{9}$$

Furthermore, from equation 6 and 7, we have that:

$$\frac{dy}{di} = -(\alpha_1 + \alpha_2) \tag{10}$$

$$\frac{d\pi}{di} = (\gamma_1(\alpha_1 + \alpha_2) + \gamma_2) \tag{11}$$

which yields the following expression for the FOC:

$$\pi - \pi^* = -\frac{\lambda}{\gamma_1 + \dfrac{\gamma_2}{\alpha_1 + \alpha_2}}y \tag{12}$$

The interpretation for equation 12 is that monetary policy is optimal when the inflation and output gap are zero, or of opposite signs. The optimal trade-off of the two gaps depends on the

strength of the interest rate channel (and the exchange rate channel to demand). Finally, we depict the model with all three equations, where optimal monetary policy is denoted MP, in its equilibrium state in figure 6.
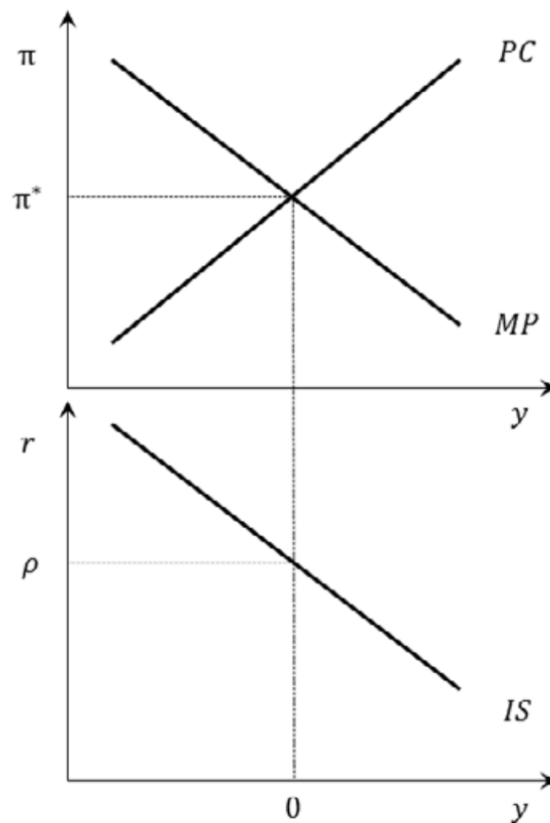
Figure 6 - The PC-MP-IS chart (Røisland & Sveen, 2018)

2.5.6 Limitations of the R&S-model

Despite the model's suitability for studying monetary policy under inflation targeting, the framework does not come without limitations. The model does not account for the fact that, in practise, implementing monetary policy actions comes with time lags. This means that the notion of different time spans in the conduct of monetary policy cannot be analysed within this model. Røisland and Sveen (2018) explicitly state that the intended period for monetary policy to work is one to three years. During the covid-19 crisis, we know that policymakers acted much quicker, even adjusting the interest rate before actual shocks took place. The transmission mechanism has, in reality, been severely altered due to government regulation. The model cannot take this into account.

Certain types of shocks, such as a confidence shock in which consumers in the economy expect the inflation level to lie above the stated inflation target, will depend on parameters beyond what the model can capture. The central bank cannot, in this model, differentiate strategies based on the nature of the inflation shock. It will respond in the same manner, regardless. Confidence can be determined by past actions and communication of the central bank in the given economy. Policy needs to be consistent over time in order for the guidance to be credible. Therefore, committing to reaching the inflation target through firm responses to such shocks could be prevented in the future. Therefore, the impact of the level of trust in monetary policy through forward guidance is therefore not captured.

Like the Taylor rule, this model solely concerns itself with the interest rate in terms of monetary policy instruments. Although it is more sophisticated in the sense that it does take shocks into account, it still lacks the inclusion of any other central banking tool. We know that liquidity measures, currency interventions, and capital measures were utilized in the wake of the crisis. These must be discussed without the assistance of this theoretical framework.

2.6 New Developments in Monetary Policy

When the economy experiences a crisis, the conventional monetary policy tools may not be sufficient to stabilize the economy. The reason is that the financial system seizes up to the extent that its ability to allocate capital to productive uses vanishes, and so investment spending and the economy collapses (Mishkin, 2016). As the US Federal Reserve (Fed) experienced during the Financial Crisis of 2008 and Norges Bank experienced in 2020, negative shocks to the economy can lead to the so-called zero-lower-bound problem. Conventional monetary policy can thus be of limited use, and other tools must be considered. Backus (2017) phrased this problem in the following way "What else can a central bank do to be expansionary when it has pushed its policy-target interest rate as low as it can? The answer is to resort to unconventional monetary policy" (p.195).

An example of such policy is forward guidance; open communication from the central bank about how it assesses the state of the economy and future outlook. "Forward guidance has become increasingly valuable over time in helping the public understand how policy will respond to economic conditions and in facilitating commitments by monetary policymakers to so-called lower-for-longer rate policies, which can add stimulus even when short rates are at

the lower bound." (Bernanke, 2020). Using this tool allows the central bank to steer expectations, extending the effect of conventional monetary policy.

Other unconventional tools include quantitative easing and credit easing. In a speech named The Monetary Policy Toolkit, Olsen stated that "Under quantitative easing, the public sector in its widest sense, including the central bank, purchases one form of debt – government bonds – and replaces it with another – central bank reserves. Quantitative easing affects the economy via lower long-term interest rates." (Olsen, 2019). There are several reasons why affecting the long-term interest rates is not a particularly relevant objective in Norway. Firstly, most households and enterprises have floating rate loans, which makes the long-term rates less relevant (Vikøren, 2019). Secondly, introducing government bond purchase programs in Norway could lead to market disruptions, for instance, due to foreign investors moving money out of Norway, thereby destabilizing the exchange rate (Olsen, 2019). Quantitative easing is therefore not being used in Norway.

2.6.1 Macroprudential Policy

The robustness of a financial system determines how effectively capital, and risk can be redistributed in the economy when it is affected by different disturbances. Unstable financial systems will be more severely affected by crises and suffer higher costs for more extended periods. While the traditional microprudential policies ensure the soundness of individual financial institutions, the Financial Crisis of 2008 exposed system-level weaknesses. Macroprudential policies aim to mitigate systemic financial risks (Norges Bank, 2016). The objective of macroprudential policy is to ensure sustainable economic growth as well as financial stability. As illustrated in figure 7, policymakers have various instruments available to reach this objective. The instruments contribute to stability both in economic upturns and downturns and can be applied in different combinations depending on the state of the economy. Following the implementation of practicing flexible inflation targeting in Norway, the goal of stabilizing output and employment was also emphasised. Broadly, this involves countercyclical measures to smooth out business cycles.
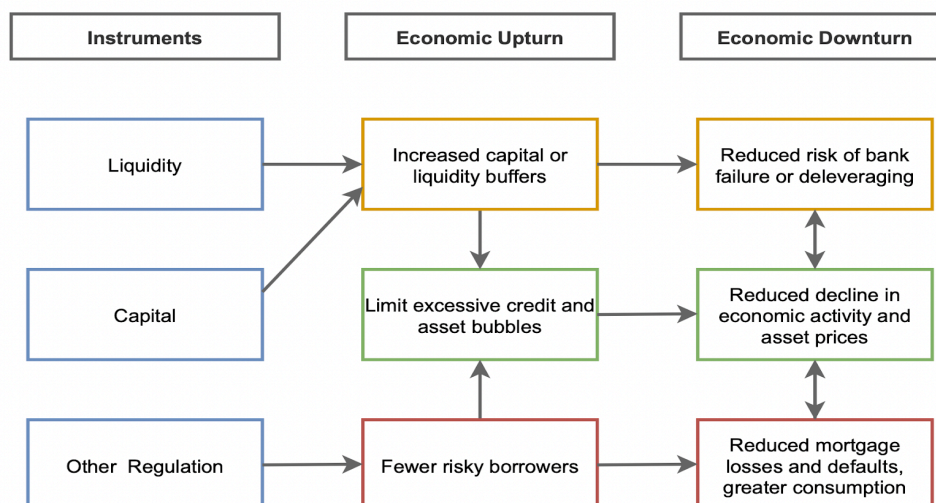
Figure 7 - Macroprudential policy instruments, adapted from Ovenden (2019)

Macroprudential instruments can be categorized by whether they relate to capital or liquidity. A third category of instruments is direct regulation. These instruments all have different transmissions to financial stability. In effect, using such instruments can increase the central bank's room to manoeuvre the economy.

An important macroprudential instrument in Norway is the time-varying countercyclical capital buffer requirement for banks. The countercyclical capital buffer was the key innovation in the Basel III framework created by the Basel Accords[13] regulation. It is designed to counteract procyclicality in the financial system through capital intervention. To increase the banking sector's resilience, capital should be accumulated when cyclical systemic risk is judged to be increasing (ESRB, 2021). The purpose of the countercyclical capital buffer is to mitigate the risk that banks amplify downturns by reducing their lending (Norges Bank, 2020n).

A central consideration in macroprudential analysis is the risk that indebted households cut their consumption during an economic downturn. If households start defaulting on their loans, they reinforce severe downturns (Ovenden, 2019). Regulations, such as mortgage regulations, that directly constrain debt accumulation for borrowers with limited equity effectively help mitigate the risks associated with elevated household debt.

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[13] The Basel Accords is a banking supervision accord and maintains its secretariat at the Bank for International Settlements (BIS). All major G-20 economies are members. Basel III was agreed upon in 2010 and introduced in 2013. Norway was one of the earliest adopters of this regulation in Europe (Wezel, 2019).

2.7 Liquidity Management and the Money Market

Generally, in macroeconomic theoretical frameworks, it is common to assume that the central bank sets the market rates directly. Since we analyse real events, we find it useful to outline the interbank and money market mechanism in Norway. The aim of the central bank's liquidity policy is to ensure that the short-term market rates do not deviate much from the policy rate. The central bank accomplishes this by setting the terms of banks' loans and placements with the central bank and adjusting the liquidity level in the banking system (Syrstad, 2011). Norges Bank has a policy goal of keeping their liquidity provision in NOK at 35 billion after liquidity operations have been conducted. This ultimately limits the pool of liquidity in NOK.

The overall goal of Norges Bank's liquidity operations is (1) to ensure that the short-term money market rates are close to the policy rate level. However, Syrstad (2011) also outlines four other criteria for a robust liquidity management system: (2) payment system must function effectively and securely, (3) lending to banks must be against sufficient collateral, (4) the money market must allocate liquidity amongst its participants in the most efficient manner, and (5) the system must be able to handle extraordinary measures in periods of crisis. For the central bank to operate according to these principles, Norges Bank provides standing facilities, regulations for collateral, and instruments for market operations (Norges Bank, 2020j). The most used instruments in their market operations include F-loans and F-deposits (Norges Bank, 2020j). An *intraday* facility is also available in the form of a (daytime) D-loan, which is interest-free against collateral. If the loan obligation is not fulfilled, the overnight lending rate will apply.

There are two main systems for managing liquidity that emphasise interest rate control in central banking, namely a corridor system and a floor system (Keister, Martin & McAndrews, 2008). For an overview of these systems, we refer to Syrstad (2011). Today, Norges Bank operates with a quota-based system for loans and deposits[14]. In short, this means that banks keep reserves in the central bank, which earns interest equal to the policy rate until their quota is filled. Banks' excess liquidity earns the *reserve rate*, which is usually lower than the policy rate (one percent per day) (Norges Bank, 2020b). Finally, the *overnight lending rate* is the

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[14] From the 1990s to October 2011, Norges Bank operated a floor system. This system seemed to satisfy the criteria outlined by Syrstad (2011), with the exception of criteria (3). This motivated the change to the quota system.

interest paid on borrowed reserves banks would need to take up if they had a correct negative balance in their account in Norges Bank. The D-loan (overnight) interest rate is usually higher than the policy rate (one percent per day), incentivizing banks to find funding in the interbank market if the rate is lower.

The interbank market is the section of the money market[15] that enables loans and deposits among banks. Both loans with and without collateral are used, but unsecured interbank loans are considered the most important instrument. Activity is concentrated on overnight lending, which results from the banks' need for daily liquidity management to complete transactions and fulfill its obligations (Bernhardsen, Kloster & Syrstad, 2012). In order to achieve this, banks often need interbank loans or interbank deposits. Norwegian Overnight Weighted Average (NOWA) is the interest rate used for overnight interbank loans in the interbank market.

As a result of the limited liquidity provision in NOK, banks use the Eurokrone market[16] to access NOK through currency swaps (Norges Bank, 2004). The interest involved in such transactions constitutes the money market interest rates. In Norway, the Norwegian interbank offered rate (NIBOR) is considered the central money market rate. NIBOR is a collective term for the primary money market interest rates in Norway at different maturities. It essentially reflects the rate at which a commercial bank requires for unsecured lending in NOK to other banks. An important aspect of NIBOR is that it is constructed as a synthetic swap rate[17]. It is quoted at 1 week, 1 month, 2 months, 3 months and 6 months. The rate calculation is done by taking a simple average of the interest rates submitted by NIBOR panel banks[18] and omitting the highest and lowest value (NoRe, 2019). NIBOR must be regarded as the best estimate of market rates and is merely indicative, as the banks are not obligated to trade at the stated rates

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[15] The money market is essentially the part of the financial system for large loans with maturities up to 1 year (Norges Bank, 2019b)

[16] The Eurokrone market is the market where a commercial bank can borrow NOK by selling foreign currency to another bank at today's rate (spot) and at the same time enter a forward contract to repurchase the currency at a predetermined date to a predetermined rate (currency swap) (Meinich, 2014).

[17] For a comprehensive decomposition of NIBOR, we refer to Tafjord (2015).

[18] The panel banks include DNB Bank ASA, Danske Bank A/S, Svenska Handelsbanken AB, Nordea Bank ABP, SEB AB and Swedbank AB (NoRe, 2019).

(Norges Bank, 2010). Lastly, NIBOR has a risk premium which essentially reflects direct operating costs for banks. The risk premium is defined as the difference between the actual rate (NIBOR) and the expected policy rate (Overnight Index Swap)[19] over the same time horizon.

2.8 Money Supply

To conclude the theory chapter, which forms the basis for our analysis, we include a brief section on the topic of money supply. The total amount of money in the economy makes up the money supply. Historically, the quantity theory of money has been central in describing the relationship between money supply and inflation. According to this theory, the price level of goods and services in an economy is proportional to the money supply. The relationship can be expressed as:

$$M \cdot V = P \cdot T \tag{13}$$

which states that for an economy, the nominal money supply, M, multiplied with the velocity, V, is equal to the price level, P, multiplied by the real value of aggregate transactions, T. The model's merit may be in its simplicity and applicability. However, the model has received extensive criticism, especially concerning the stability of the *velocity* of money. Furthermore, as discussed, prices are sticky in the short run, and so economists disagree on exactly how proportional and how fast prices adjust following modifications in the quantity of money supply.

In theory, persistently high growth of money supply could lead to undesirable high inflation if the quantity supplied of goods and services is growing at a slower rate. Money supply growth is usually split into two components, an inflation rate and growth in the real economy (Klovland, 2020c).

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[19] Overnight Index Swap (OIS) is an interest rate swap where the one participant pays a fixed interest rate determined today (OIS-rate, e.g., 3 months), while the other participant pays a geometric average of observed daily compounded interest rate in the same period. The actual payment of this participant is not determined until after the period is over. It is most common to use the central bank's policy rate. The main idea is that the OIS-rate reflects the market's expectations of the level at which the policy rate will be set. Another essential aspect is that this interest rate is free of all credit and liquidity premiums (Klovland, 2020b).

3.   Data and Method

This chapter includes a brief description of the research design, as well as an overview of the data sources. Central time series are presented in a separate section. The chapter is concluded with an assessment of validity and reliability in the data and method.

The covid-19 related shocks to the economy, and their respective policy responses, are recent and interconnected. In order to understand the aggregate effect of the pandemic and the policy response, we attempt to maintain a holistic perspective while systematically and consistently illustrating our discussion with detailed graphical and descriptive analysis. We do this through a dual approach where we combine a broad case study of the monetary policy response to covid-19 with more detailed studies of certain important events. This allows us to focus on our primary objective of elucidating the broad lines of the crisis, while plausibly pinpointing the main effects of the different responses to support our conclusions.

We create our own Taylor rule rate using the 0,5 weighting coefficients proposed by Taylor (1993) and visually compare it to the de facto policy rate in the same period, to see if Norges Bank followed a rule-based approach when cutting the interest rate to zero in 2020. Gaps between the policy rate and the Taylor rate represent periods where Norges Bank has used either a distinctly different rule, or discretion, in setting the rate; or relied more heavily on unconventional monetary policy tools. In the following sections we present how our data has been collected and describe the time series underlying the other Taylor variables.

3.1 Data Collection

We are primarily using time-series data collected from Statistics Norway (SSB) and Norges Bank. SSB is Norway's official statistical institute and primary producer of official statistics. Most data are recent and collected for the year 2020, as our primary focus is on the immediate policy response after the outbreak of covid-19. However, for the calculation of the Taylor rule, we go a bit further back. We deem it interesting to visually compare the Taylor rate with the policy rate in two other crises as well as the one we are currently in, and so these time series date back to Q4 2003, as this can be considered a trough in the business cycle (Hanken & Syse, 2020). This allows us to study economic development in the years leading up to the Financial Crisis of 2008 and compare our case to both this and the oil price drop in 2014; the

two most recent recessions in Norway preceding our case. A selection of the most central time series is presented in table 1.

Data	Description	Time period	Source
Output	Gross domestic product (market value) in constant 2018-prices, seasonally adjusted, quarterly	2003Q4 – 2020Q4	SSB Table 09190
Inflation1 (CPI-ATE)	CPI-JAE, 12-month percentage change with reference year 2015 (CPI-JE used for Q4 2003), monthly	2004M9 – 2020M12	SSB Table 05327
Inflation2 (CPI)	CPI (all items), monthly	2019Q1 – 2020Q4	SSB Table 05327
Neutral Real Rate	Average of four model estimations, annually	2003 – 2019	Norges Bank MPR 3/20
Principle Policy Rate	Interest rate on banks' overnight deposits in Norges Bank up to a specified quota, daily/monthly/annually	2003 – 2020	Norges Bank

Table 1 - A selection of central time series (complete list in appendix)

We also draw upon a selection of qualitative data, such as speeches and press releases. These are primarily used to supplement our discussion and are, in several cases, quoted directly to avoid misinterpretation. Our data sources are listed in References and table A1 in Appendix.

3.2 Central Time Series

In this section, we provide a brief explanation for the choice of data which our discussion largely rests on. All other data is listed and described in table A1 in the appendix.

Output

Potential output cannot be observed directly and must therefore be estimated. We outline a common estimation method in the next section. As our measure of output, we use seasonally adjusted mainland gross domestic product (GDP) in constant 2018 prices. The series is produced quarterly. This specification involves all domestic production activity excluding activity directly related to crude oil and gas, as well as pipeline transport and maritime transport (SSB, 2017). This choice is consistent with Norges Bank's preferred measures of GDP. One reason why this is preferable, is that the oil and gas industry is frequently hit by exogenous shocks that the central bank in no way can control, leading to large fluctuations to both supply and demand. It can be argued that this volatility could disturb the estimation, as these fluctuations may not be representative of the rest of the economy.

Inflation

As our measure of inflation, we use the consumer price index (CPI) adjusted for tax changes and excluding energy commodities (CPI-ATE). This specification is referred to as core inflation. The reasoning behind this choice is twofold. Firstly, Norges Bank does not normally intend to respond to taxation changes. This belongs primarily in the area of fiscal policy. Secondly, following the same argument as with GDP, Norway being a small open economy, is a price taker, and so energy and commodities prices are volatile and are excluded in the core inflation development. Since we use monthly data, (12-month change in percent), we calculate arithmetic averages for each quarter. To calculate the inflation gap, we subtract the inflation target from the actual inflation rate.

Neutral Real Rate

The neutral real rate is defined as the rate that is "consistent with balanced developments in the economy in the medium term, when the effects of short-term shocks have faded" (Norges Bank, 2020s). It changes over time, and we cannot know its exact level in the short-term. Since it is not directly observable, it must be estimated. To compute the Taylor rule, we will use Norges Bank's updated estimates since the neutral real rate has declined significantly in the last decades. In the September 2020 Monetary Policy Report (MPR), four different models[20] are used to estimate the real rate. They are based on factors such as the market's expectations of futures rates since the effects of shocks will be limited in such a short time span and implied five-year swap rates for both Norway and selected trading partners (Norges Bank, 2020s). We have taken a simple average of the four models as our real rate variable for each year. Further, we have assumed that the neutral real rate is the same for all quarters in a year. Since there is no data for 2020, we rely on the estimates for 2019 for this period as well.

3.3 Identifying Trends and Cycles

Our analysis is based on a combination of theoretical models and data, mainly macroeconomic time series. In order to remove the short-run fluctuations from the underlying trend, we apply a Hodrick-Prescott (HP) filter to estimate the trend and cycles separately (Hodrick & Prescott, 1997). In the following, we briefly outline the method as described by Sørensen & Whitta-Jacobsen (2010).

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[20] Two State-Space models, one VAR model with time varying parameters and one BVAR-model.

We let Y_t denote output in period t, where Y_t is the product of a growth component, Y_t^g, which represents the trend, and a cyclical component Y_t^c, which fluctuates around the trend:

$$Y_t = Y_t^g \cdot Y_t^c \qquad (14)$$

Firstly, we note that the cycle component has a mean value of 1. This implies that Y_t is equal to the growth component Y_t^g on average. This also implies that fluctuations rise in proportions to the trend level, so percentage deviations of the actual value of the observation from the trend remain constant over time. Secondly, we log transform the variables as such transformation approximates percentage change:

$$\ln Y_t = \ln Y_t^g + Y_t^c \qquad (15)$$

For simplicity we use lower case letters *y*, *g* and *c* to refer to their natural logarithms, respectively:

$$y_t = g_t + c_t \qquad (16)$$

The objective of this operation is to estimate the cycle component and growth component, separately, given only observations of y_t. This can be achieved by minimizing the following equation with respect to all of the g_t observations.

$$\sum_{t=1}^{T} (y_t - g_t)^2 + \lambda \sum_{t=1}^{T} [(g_{t+1} - g_t) - (g_t - g_{t-1})]^2 \qquad (17)$$

By definition, the first term, y_t - g_t, measures the cyclical component, while the term in square brackets measures change in the estimated trend growth rate from one period to the next. It is clear that, there is a trade-off between two objectives: minimizing the variance of the cycle component and minimizing the changes in the estimated trend growth over time. The choice of the value of λ determines the relative weight given to each objective.

If λ is set too low, then excessive weight is given to the conclusion that all observed fluctuations in y_t reflect changes in the underlying growth trend. On the other hand, a too high value of λ would conceal a gap, as one would assume the estimated trend growth is very smooth, perhaps constant. Choosing the value of λ represents a certain arbitrariness in the method, as there is no objectively correct value for the parameter. In Norway, it is customary

to set λ equal to 40 000 for quarterly data, while in the US it is customary to use 1600 (Doppelhofer, 2019). Since we use Norwegian data, we employ the first practice. Figure 8 illustrates our log adjusted GDP data. We have calculated the trend of this time-series using a HP-filter with a λ value of 40 000.
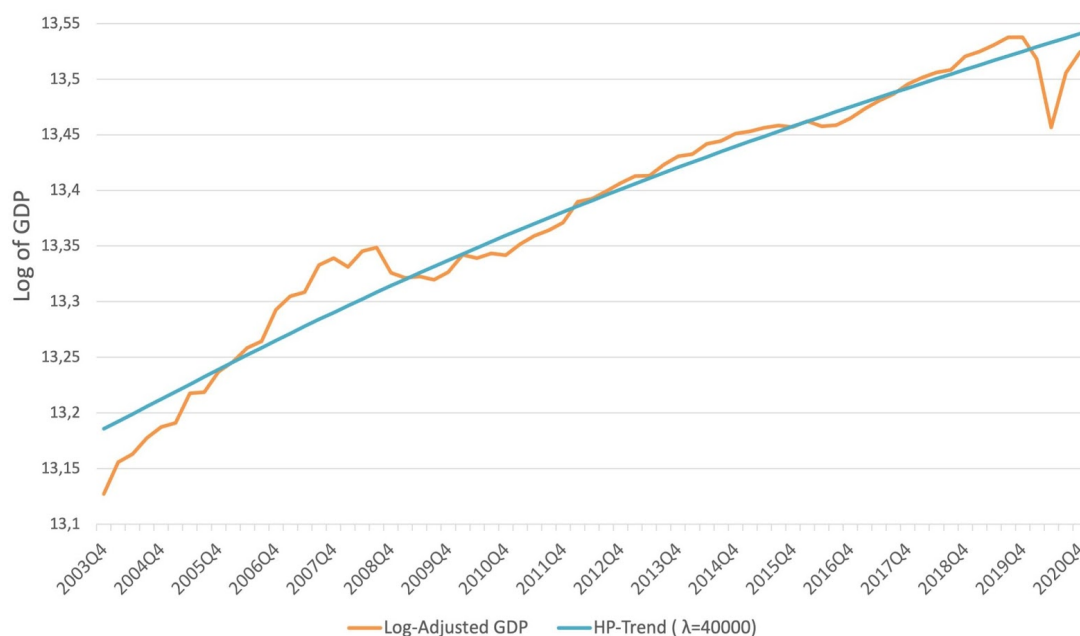

Figure 8 - Real GDP and its underlying trend

Other weaknesses of the method include imprecise estimates at end points of the series. This is because the traditional filter is two-sided and uses both older and newer observations compared to the point one is filtering. At endpoints one is simply missing observations in one direction or the other. This is problematic as we are primarily interested in the most recent developments. An alternative is to apply a one-sided HP filter, that is, the "real-time", which only uses observations dated *t* or earlier. One drawback of this version is that it fails to discard low-frequency fluctuations to the same degree as the standard version (Mokinski, Schuler & Wolf, 2020). Although several methods exist[21], such as the Band-Pass filter and other multivariate methods, HP-filtering is one of the most widely used techniques. Because of its simplicity and prevalence, we therefore judge this method to be a suitable choice for the purposes of this thesis.

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[21] This is a univariate method that only requires information from the relevant time series to calculate the trend and cycle of the data series, unlike multivariate methods, which make use of more variables to decompose the time-series into its underlying trend and cycle. Bjørnland, Brubakk, and Jore (2004) find that the different methods give approximately interchangeable results for the historical cyclical component in Norwegian GDP development.

The Taylor rule dictates the use of the output gap and inflation gap to estimate the Taylor rate. For comparison purposes we illustrate the HP-filtered output gap estimation with two different values of λ in figure 9.

Figure 9 - Estimated output gap using HP-filter with different values of λ

The output gap is defined as the percentage deviation between the potential output and actual output, while the inflation gap is the difference between the actual inflation and the inflation target. The output gap in figure 9 is calculated by subtracting the HP-filter trend from the GDP time-series.

As opposed to the GDP data used in calculating the output gap, calculating the inflation gap does not require the use of the HP-filtering technique presented in this section. The inflation time-series we use in the analysis, as well as the inflation target in the period, is illustrated in figure 10.

Figure 10 - Inflation and the inflation target

3.4 Validity and Reliability

In ascertaining the quality of the research design, two main factors should be considered. The reliability and validity we ascribe to the data are functions of the method by which the data has been collected and the sources from which it has been collected (Saunders, Lewis & Thornhill, 2019, p.363). In this section we assess the reliability and validity of the data in order to judge the foundation for our analysis and identify possible weaknesses and limitations.

The degree of reliability depends on both replication and consistency. Because the data our research design is based on is available to all and can be accessed and downloaded directly from the sources presented in table A1 it can easily be replicated. Our method of data adjustment is described in detail to ensure transparency and consistency. Because we mainly base our analysis on data generated by accountable institutions with reliable procedures for collecting and compiling data, we consider the design to have a high degree of reliability.

The validity of the research is measured by whether the method and data used are appropriate for answering the research question. Both internal and external validity is important for the analysis to yield accurate and generalizable results. As we are studying a complex and ongoing situation, we face certain internal validity limitations with regard to drawing conclusions about causal relationships, but this is neither our aim nor conviction. The simple nature of analysis

does not allow us to claim causality but still can yield interesting and valid results, albeit at a more general level. Since most of our data series are new, data will likely be updated and revised so that more complete and precise analyses will be possible at later points in time. Finally, as of today, it is difficult to separate the effects of containment measures, self-regulation of households with regards to uncertainty, disruption in international trade from the effects of monetary policy.

4. Analysis I: The Monetary Policy Response

This chapter addresses the first research question by applying our theoretical frameworks to analyse how different monetary policy objectives were prioritized in 2020 and which measures comprised the Norwegian monetary policy response to covid-19. First, the developments in the policy rate are compared to the simple Taylor rule to see if Norges Bank has indeed set the policy rate based on simply the output gap and inflation gap, and if not, what could be the reasons for the divergence. Next, we study the various shocks in the R&M-model. As put by Baqaee and Farhi (2020), the pandemic constituted "a messy combination of disaggregated supply and demand shocks", and so we evaluate optimal policy response according to the nature of the different shocks. Several monetary policy tools do not fit within our framework, as discussed in chapter 2. We end the chapter by discussing these extraordinary liquidity and capital tools in light of relevant data and economic theory.

Norges Bank's primary monetary policy response consisted of gradual cuts to the policy rates by 0,50 percentage points on March 13 2020[22], another 0,75 percentage points on March 20, and a final reduction to zero on May 7 (Norges Bank, 2020l). These rate cuts are illustrated in figure 11.
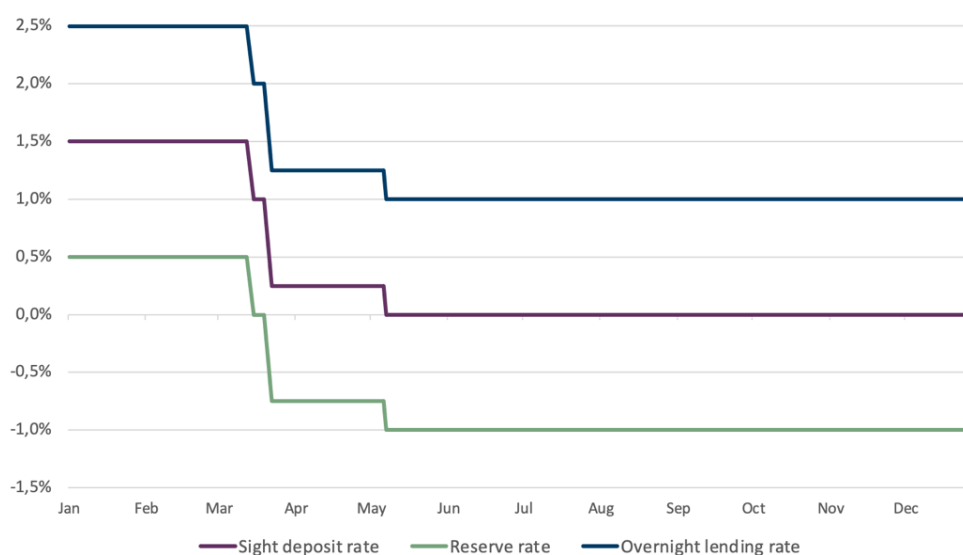
Figure 11 - Norges Bank's principal interest rates

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[22] The sharp decline in oil price was also mentioned as a contributing factor in the weakening economic conditions. On March 7, there was an unexpected disruption to a three-year agreement between Russia and Opec as there was no agreement in the negotiation of production cuts. Russia did not support larger cuts (proposed as a result of the outbreak of Covid-19). OPEC's response was to discard limitations on its production (Brunborg & Kristiansen Stave, 2020a). This resulted in a halving in price in the span of a month and reaching the lowest pricing level in 17 years (Hovland, 2020).

The change in policy rate[23] was, unlike typical textbook mechanisms, not aimed at or able to boost economic activity; rather, due to the strict containment measures, the risks of large-scale bankruptcies, and strained indebted households, the policy aimed at keeping the financial conditions as lenient as possible by forcing interest-rate costs down to a lower level through the transmission to the money market rates. To conclude this introduction, we note that Norges Bank has kept the policy rate unchanged at 0% throughout 2020.

4.1 The Taylor Rule Fit

In this section, we present our calculated Taylor rate and compare it to the policy rate for the period 2003Q4 to 2020Q4, quarterly average. The two rates are displayed in figure 12.
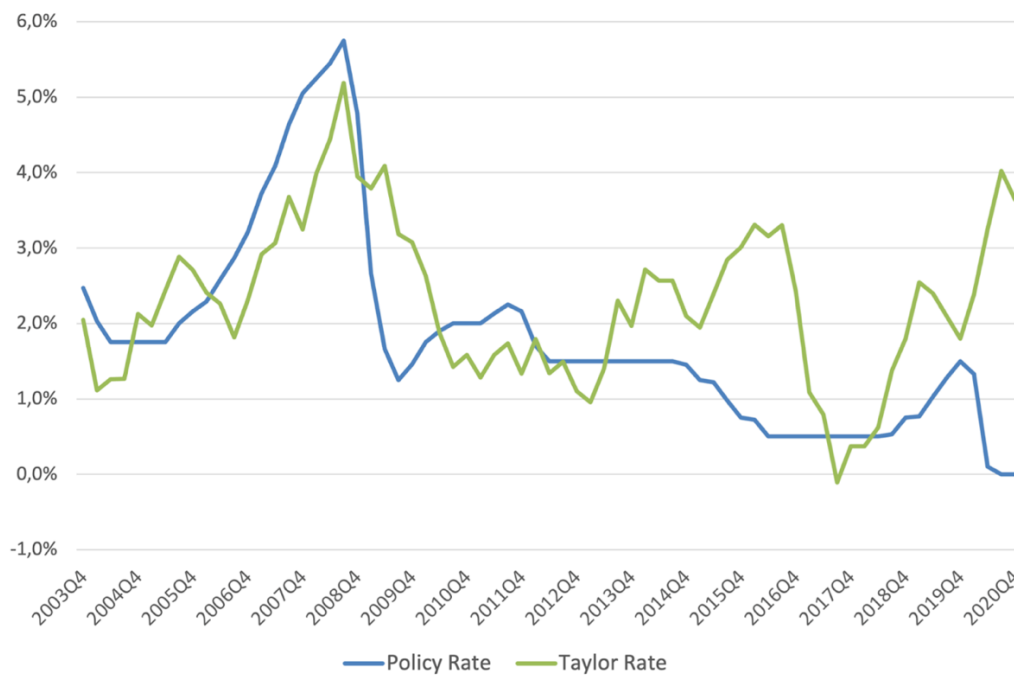

Figure 12 - The policy rate and the calculated Taylor rate

The figure shows that the simple Taylor rate and the policy rate are not perfectly aligned, although they seem to be rather closely correlated. There are several reasons why this is the case. Of course, the most obvious reason is that Norges Bank does not actually follow the

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[23] Despite the negative reserve rate, this alone does not imply a negative overnight lending rate if the policy rate is positive, and Norges Bank keeps the reserves at a level which is lower than the total reserve quota. A negative reserve rate has only one purpose; to maintain its function as an alternative return for banks which do not offer their excess reserves to the market. The reserve rate is meant to incentivize banks to trade reserves overnight instead of using the central bank's facilities.

simple Taylor rule in their interest rate decision, but rather base it on extensive monetary policy assessment, including other comprehensive calculations[24], discretion and factors included in the loss function. Recall from section 2.5.5 that ideally, the output gap and the inflation gap entering the loss function should be of opposite signs. It must then be the case that in periods of large deviations, other factors than those that the Taylor rule relies on are considered when setting the policy rate, or the weighting coefficients used by Norges Bank differ from 0,5, as we have used in our Taylor rate.

Another important factor is that the policy rate is decided in real-time, meaning that the data available (and which we have used to calculate the Taylor rate) is not available to the central bank at the time of their interest rate decision. Instead, they must rely on projections and nowcasting estimations, both of which are accompanied by high uncertainty. This better aligns with Norge Bank's mandate, as it is explicitly specified that inflation targeting shall be forward-looking. Our Taylor rule is not forward-looking but rather backward-looking, as the model is based on observed data. This means that the Taylor rate does not respond to new information. On the other hand, the central bank can update their estimates of the output gap and inflation gap on a daily basis in accordance with new economic developments, such as the collapse of international financial institutions in 2008 and the coronavirus spread in 2020.

Moreover, Norges Bank does not only utilize a simple HP-filter for estimating gaps. Instead, several multivariate models are used. A simple average of a range of models shows consistently better projection properties than each individual model does (Hagelund, Hansen & Robstad, 2018). Finally, Norges Bank is not transparent in the choice of weighing the inflation and output gap. The best one can do is perhaps to make educated guesses based on implicit information found in the MPRs.

In times of unpredictable events and uncertainty, the difference between our backward-looking Taylor rule and the policy rate seems to increase. This was anticipated by Taylor (1993, p.197), who stated that "there will be episodes where monetary policy will need to be adjusted to deal with special factors".

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[24] Norwegian Economy Model (NEMO) was introduced in 2006 and is used as a core model in the monetary policy process. NEMO is a DSGE model with 26 observable variables and shocks and 80 - 90 exogenous shocks. It is based on (among other features) developments in several industrial sectors, utility maximizing households with rational expectations, real and nominal rigidities, and more (Gerdrup, 2020).

4.1.1 The Taylor Gap

Figure 13 shows a graphical illustration of the gap between our estimated Taylor rate and the policy rate. It is simply the difference between the two time-series presented in the previous figure: the Taylor rate minus the policy rate. This format highlights the relative size of the gap over the time period, facilitating visual comparison and providing a better foundation for graphical analysis.
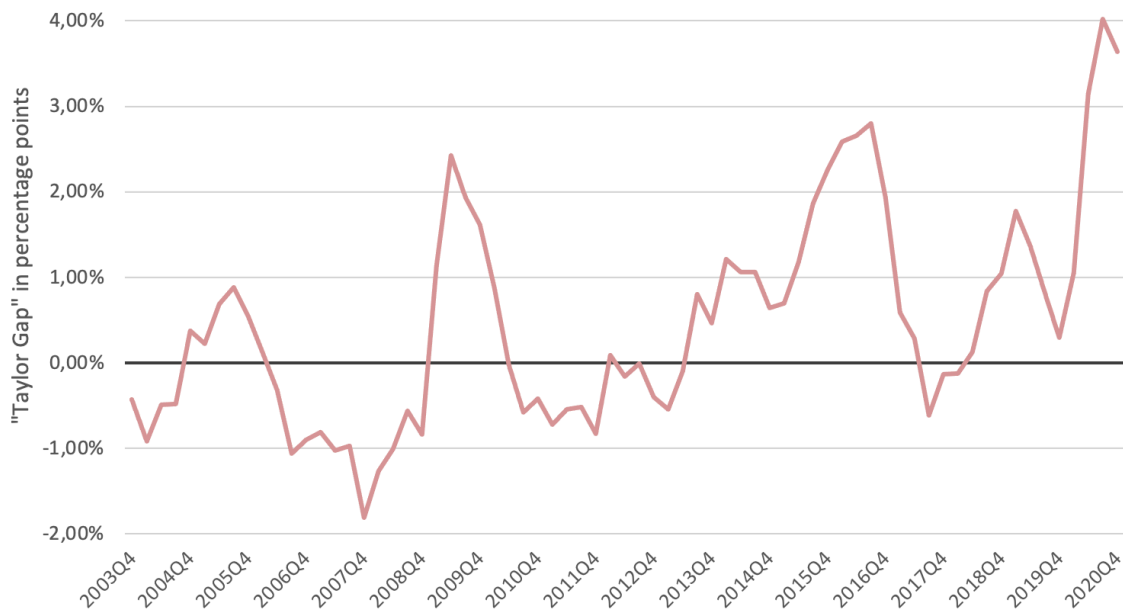

Figure 13 - The "Taylor gap"

Intervals of unrest stand out clearly in the sample period, as seen by the spikes around the time of the Financial Crisis of 2008 and the period after the oil price drop in 2014, as well as in 2020. There is some variation between these periods as well, but the two series seem to have been following each other relatively closely in the "inter crises" periods, indicated by smaller fluctuations around zero. This asymmetric relationship supports the theory presented above regarding monetary policy in crisis.

The policy rate seems to be responding more aggressively than the Taylor rule specifies in downturns. This pattern is displayed both in the case of the Financial Crisis in 2008 and at the outbreak of the covid-19 crisis. From Q4 2008 - Q3 2009, the policy rate was cut by 450 basis points, representing a much more drastic cut than the total of 70 basis points which the Taylor rate suggests. This is shown by a positive "Taylor gap" through four consecutive quarters in 2009. The Taylor rate eventually also falls to roughly the same level as the policy rate was cut

to in Q3 2009, but four quarters later. In other words, this is an indication that the Taylor rate responds sluggishly. There is also a large "Taylor gap" in the period of the oil price shock in 2014, where the economy exhibited a slightly positive inflation gap and a slightly negative output gap. The Taylor rate suggests an increased interest rate, while the policy rate remains low[25]. This could indicate that other considerations that are not captured by this simple rule, for instance, financial stability concerns, were prioritized.

The assessments of the potential consequences of the covid-19 shock have compelled the central bank to lower the policy rate to 0%, where the Taylor rate that it correlates with quite closely in normal times suggest a higher rate of 2,4% in Q1, 3,3% in Q2 approaching, 4% in Q3, and finally 3,6% in Q4. As can be observed from the last peak of 4 percentage points in figure 13, this resulted in the largest deviation between the Taylor rate and the policy rate in our sample period.

Figure 10 illustrates a positive inflation gap for all of 2020, while the output gap in figure 9 was negative in the same period. However, a dramatic drop in the output gap did not manifest itself in the data until after Q2, and so there is a lagged reaction in the Taylor rate. The primary driver upwards of the Taylor rate seems to be the actual inflation in the previous four quarters, which exceeded the target throughout the period by 1% on average. The somewhat lower value of the last calculation could indicate that the Taylor rule is adjusting downward in response to the most recent information. This would suggest that the Taylor rule responds sluggishly to the outbreak of covid-19.

In theory, increased inflation follows increased output, which is clearly not the case for Norway's economy in 2020. If Norges Bank were to attempt to halt the rising inflation, it should have increased the policy rate, which is what the Taylor rate suggests. Instead, decreasing the rate down to zero suggests that Norges Bank put more weight on the critically large negative output gap than the inflation gap.

The distinct pattern of larger deviations between our Taylor rate and the policy rate suggests that the simple Taylor rule, is in fact, quite apt at describing the monetary policy conducted

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[25] This can be partially explained by the separation of the Norwegian economy into two parts: the oil related sectors and the rest of the economy. Despite lower oil prices, the rest of the economy did not suffer to the same extent. Export in other industries actually increased due to the weak currency following the low policy rate.

by Norges Bank in normal times. It also seems to be the case that the Taylor rate is asymmetric and overshoots in terms of describing the policy rate decision in specific periods, meaning there is some other factor impacting the decision at such points in time. The policy rate thus seems to respond more aggressively than the Taylor rule specifies in the downturns. The characteristic of these periods, where the central bank does not stick to a policy that a simple rule can predict, is that they can be referred to as economic crises stemming from external shocks.

An argument in favour of acting quicker and cutting rates faster than what the Taylor rate suggests is that agents in the economy adjust to expected conditions as well as the current ones. The lockdown in March 2020 gave the public reason to expect low productivity and demand in the near future. Without strong expansionary policy, households and businesses would, to a more significant extent, have cut spending based on this expectation, making current conditions worse. Considering this effect underlines the importance of a more complex evaluation of the economy than a simple rule can provide in times of economic crisis. The Norwegian economy would likely be worse off had the policy rate been dictated by the Taylor rule when it was hit by the covid-19 shocks.

4.2 Covid-19 as a Demand Shock

In the MPR released March 13, 2020, Norges Bank states that "a marked drop in travel demand and cancellations of events are heavily impacting various sectors. Households are cutting back on consumption, and businesses are postponing investment out of fear of further contagion" (Norges Bank, 2020d). In the same report, the projection for GDP was heavily revised, as illustrated in figure 14. The most extreme revision was the projection for Q3 2020, which deviated by 1,74 percentage points (from 1,61% in MPR 4/19 to -0,13% in MPR 1/20), and projected a temporary negative growth rate. This can be understood in the way that Norges Bank anticipated a negative domestic shock. To analyse this situation, we use the R&S-model.
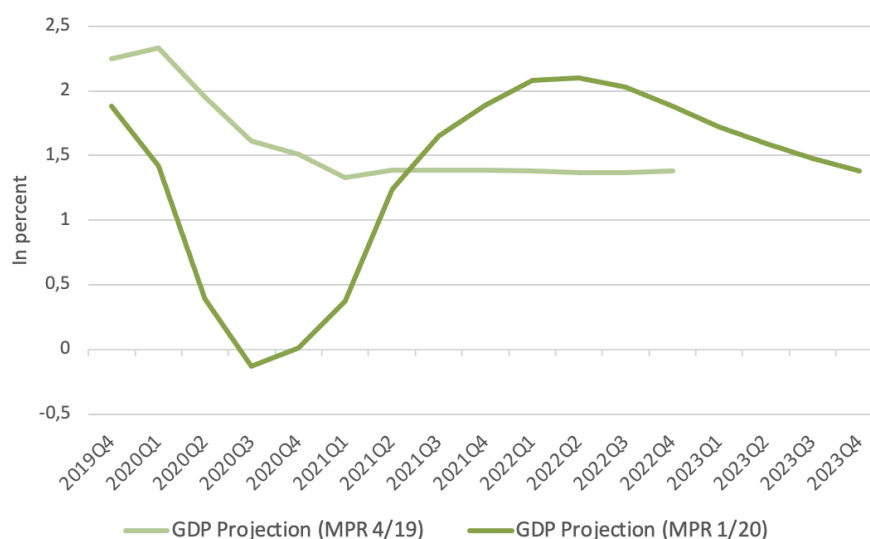
Figure 14 - Revision in projection for quarterly GDP growth

First, the exogenous negative demand shock hits the economy. The shock manifests itself in the parameter *v* in equation 6, implying a downward shift in the IS-curve and thereof a widening output gap in negative direction, as illustrated in figure 15. This could be attributed to the precautionary savings induced by the uncertain economic outlook in combination with an unforeseen increase in unemployment[26]. The Phillips curve, equation 7, exhibits an upwards shift. This follows because the shock must imply a depreciating real exchange rate of the NOK if the level of demand is to remain the same (for any given level of output).

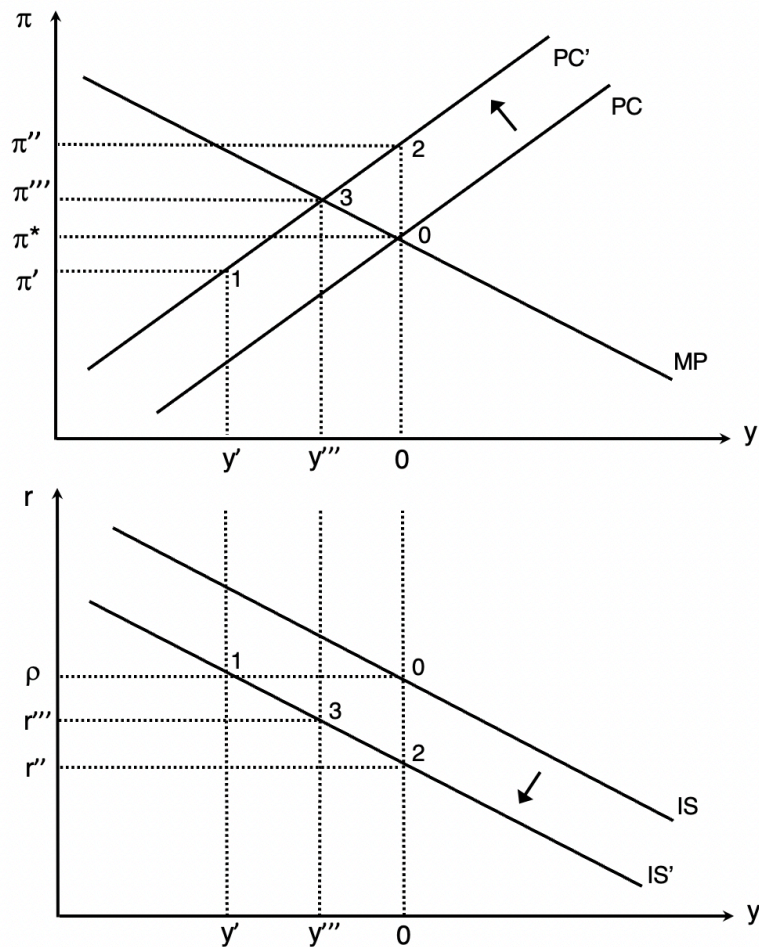[26] Mostly temporary in the form of employee furloughs.

Figure 15 - Negative demand shock in an open economy, adapted from Røisland & Sveen (2018)

Although we know that Norges Bank responded even before the anticipated shock manifested itself, we turn to the hypothetical case in which they did not respond. Then, the demand reduction would fully materialize, illustrated at point *y'*, and so inflation also falls, illustrated by π'. This is in line with a statement made in the MPR 1/20: "it is assumed that the measures to limit contagion of the coronavirus [Government regulated lockdown of society] will pull down on inflation in the near term" (Norges Bank, 2020d). To do nothing clearly cannot be the optimal policy. By lowering the policy rate, both output and inflation can be moved closer to their target levels.

The question is then, how much should the rate be lowered? We know that eventually, the rate dropped to zero, but following the framework, we first assume it is set such that the demand shock is fully compensated for, and so the output gap is neutralized. This would correspond to cutting the policy rate to *r''* in the figure. In this situation, downward pressure on domestic

prices is fully mitigated, and domestic inflation is subdued. In a small, open economy, however, this depreciates the NOK. Of course, several other exogenous factors drive the exchange rate; the oil price is perhaps most pronounced. We return to this when discussing risk premium shocks of the NOK in section 4.5. A weak real exchange rate makes domestically produced goods relatively cheaper and should, in theory, both increase the demand for domestic goods[27] as well as lead to an increase in imported inflation. The latter is a result of the lower level of purchasing power of foreign goods. In the very short run, this effect may not be experienced by consumers due to the imperfect pass-through effect[28] (Ghosh & Wolf, 2001). Regardless, it is not optimal to fully neutralize the shock because of the resulting high inflation, illustrated at π''.

In the framework, the optimal response is dictated by the monetary policy curve, equation 12. In the illustration above this response is given by the intersection between the upward-shifted PC-curve, and the MP-curve. Given that the covid-19 shock and its effect on the economy can be interpreted as a demand shock, the optimal response is ultimately to allow for some inflation up and above the target and as a somewhat lower level of output, illustrated at π''', y'''. From the downward-shifted IS-curve, one can read that this is achieved by setting the policy rate at r'''.

In reality, this situation did not unfold quite in this manner. It can be argued that the transmission mechanism did not fully function as it would in normal times. Unlike other demand shocks, one reason why demand plummeted must also be attributed to the fact that it simply was not possible to consume due to the lockdown. As such, the shock in itself was primarily not a result of the "classical factors" such as a sudden decrease in purchasing power or substantial changes in fiscal policy like increased taxes. Moreover, due to uncertainty, the interest rate channel to stimulate demand was perhaps less effective as many households choose to increase savings instead of consuming, despite the fact that this contrasts standard economic theory. This is further discussed in section 5.4.

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[27] For the sake of simplicity, we have not in this analysis put weight on the fact that increased demand for domestic goods also increases domestic inflation.

[28] Importers do not pass on the full cost of the nominal exchange rate movements over short time horizons.

4.3 Covid-19 as a Supply Shock

Grytten (2020) argues that the covid-19 crisis must be considered as, first and foremost, a supply-side crisis. The argument is that since the Government temporarily shut down production and supply of services, the decline in demand was not the driver of the economic downturn. This also means that conventional monetary policy response, that is; lowering interest rates and injecting liquidity into the crisis, is less effective. Both interest costs and investment costs will decrease, but if firms cannot sell their product or continue production, such a response may be of little effect. This argument in its simplest form can be illustrated with a basic diagram of the aggregate economy, as displayed in figure 16.
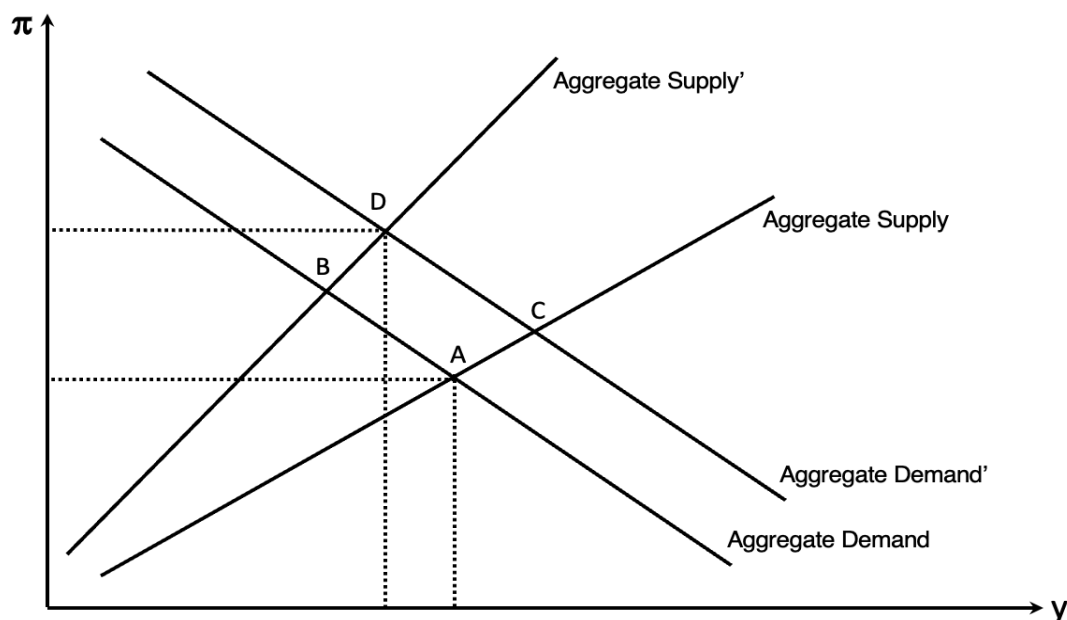

Figure 16 - A simple illustration of the aggregate economy

First, we assume that the economy is in an initial equilibrium at point A. When the Government shuts down the economy, the aggregate supply curve (AS) shifts inwards and becomes steeper due to halted production and heavily restricted offer of services. This shift results in a new equilibrium at point B, where output is lower, and prices are higher; in other words, creating higher inflation. If the Government now wants to mitigate the effect of the crisis by offering crisis relief packages and simultaneously sees a decreased policy rate at zero, what can this result in? The goal is to push the equilibrium back to point C, where production has increased with some inflation. However, the aggregate demand curve (AD) shifts out, but since the shock is a negative supply shock, the economy ends up in point D rather than C.

Here, production has still declined, but there is increased inflation risk as the supply still cannot increase because of the imposed regulative restrictions.

Moreover, the crisis relief packages essentially pumped money into an economy where it could not be used. In combination with low interest rates, the economic argument is that these measures should lead to investment. However, because there are strict restrictions on production, there are few available investment alternatives. For this reason, pressure develops in markets that are not made unavailable by the pandemic, such as, for instance, the housing market and stock market. Pressure is increased further as the low deposit rate eliminates the bank as an alternative placement for rational investors. Therefore, the result of these policies is an economy in point D. Do we see this in the data?

The raised inflation in question was not primarily in the form of CPI but manifested itself in the stock and asset markets as well as through rising house prices. For instance, Oslo Børs Benchmark Index (OSEBX) saw a net positive result of 4,56% (Brunborg & Kristiansen Stave, 2020b). Many economists predicted that the crisis would drive these prices down. Even in Norges Bank's Survey of Bank Lending for Q1 2020, Norwegian banks predicted a decline in the demand for overall residential mortgages (Norges Bank, 2020k). Chief Economist in DNB Markets, Kjersti Haugland, stated in March that "we believe in a price fall in the next half-year" (Løtveit, 2020). Many professionals shared this view (see for instance NHO (2020) and SSB (2020a)). With today's information, we know that the drop in the growth of housing prices was short-lived.
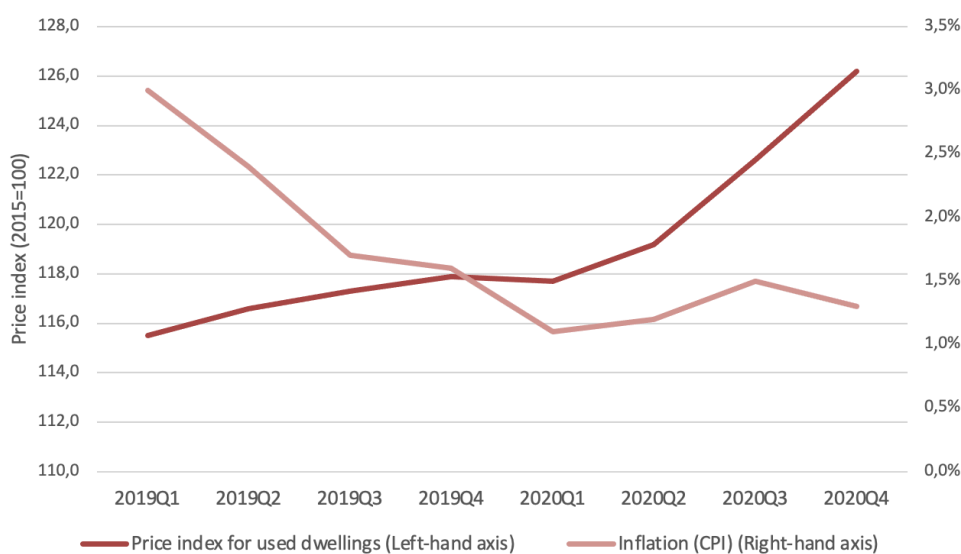

Figure 17 - Development in housing prices and inflation

In figure 17, we illustrate the development in housing prices and inflation. From the end of 2019 to the end of 2020, the housing prices increased roughly 7% as opposed to more modest growth of 2,6% in the same period the year before. On the other hand, CPI only displays a low four-quarter average growth rate of 1,3% throughout the year.

There are few arguments in favour of a higher interest rate in the current economic climate. Perhaps one is that the currency would appreciate, providing an argument in favour of an increase. This is because imported production inputs would become relatively cheaper, enabling higher supply levels at lower price increases. This argument is further developed in the next section. On the other hand, through the mechanism of the interest channel to demand, a high interest rate could incentivize unwanted saving at the expense of investment activity, and increase the interest burden for businesses, leading to more bankruptcies which further limits supply.

Grytten (2020) concludes that the "cure" applied to mitigate the damage of the crisis was not adjusted for the very characteristics of the crisis. We note that the concern raised is targeted at the combination of the fiscal liquidity injections, social restrictions, and decrease in policy rate, rather than the interest rate decrease alone. Perhaps then, Grytten's concern is rooted in the lack of coordination between the fiscal policy makers and Norges Bank, as there seemed to be no other more appropriate response in terms of monetary policy than cutting the rate.

At a seminar in 2018 hosted by the Department of Finance, the (then) Minister of Finance, Siv Jensen stated in relation to the Financial Crisis of 2008: "when the interest rate is close to zero [...] monetary policy becomes less effective and fiscal policy becomes more efficient." In other words, if the interest rate is close to zero and the economy finds itself in a deep recession, it can be effective to use fiscal policy to boost the activity" (Jensen, 2018). Reminding the reader that this thesis is limited to monetary policy, we abstain from discussing the fiscal policy response further. Jensen's statement makes an evaluation of the effectiveness of other monetary tools particularly relevant in light of this new crisis. We discuss other monetary policy measures in section 4.6 and 4.7.

4.4 Covid-19 as a Risk Premium Shock

In section 2.5.4 we outlined how the exchange rate can affect domestic economic conditions. On March 19, 2020, the NOK reached a low of 11,94 USDNOK, symbolising a fall of 25%.

This was the most significant one-day depreciation since the introduction of the floating exchange rate regime (Grytten, Haugland & Sveen, 2021). The rapid movements in currency were indeed characterized as "historically large" (Norges Bank, 2020h). Figure 18 displays the development in the import-weighted krone exchange rate. This index is called I-44 and is based on an effective exchange rate measured against the currencies of Norway's most important trading partners. An increasing index implies a depreciating krone[29]. Figure 18 shows a clear spike in the time leading up to the Norwegian lockdown. On March 19, the index reached a peak of 131,53. This represented an increase of 6,45 points only from the previous day and the largest weakening, both in terms of one-day change and absolute value of the NOK since the introduction of inflation targeting.

Figure 18 - Import-weighted krone exchange rate

According to chief economist of Danske Bank, Frank Jullum, the exchange rate had been relatively weak in the previous month, closely following the oil price (Lie Jor, 2020). He further stated that the "extremely low" exchange rate could become a severe problem for the real economy. Norges Bank stated in MPR 1/20 that: "the krone depreciation in recent weeks implies that the exchange rate is now weaker than developments in oil prices and the interest

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[29] The index is set at 1995 = 100

rate differential in isolation would suggest. Some of the recent krone depreciation is therefore interpreted as an increase in the risk premium." (Norges Bank, 2020d).

The sudden exogenous shock to the NOK, as displayed in figure 18, can thus be understood as a positive risk premium shock. According to the R&M-model, this type of shock is generally defined as a situation where foreign investors suddenly demand higher return requirements on domestic securities and implies that the shock parameter z from equation 5 is positive.
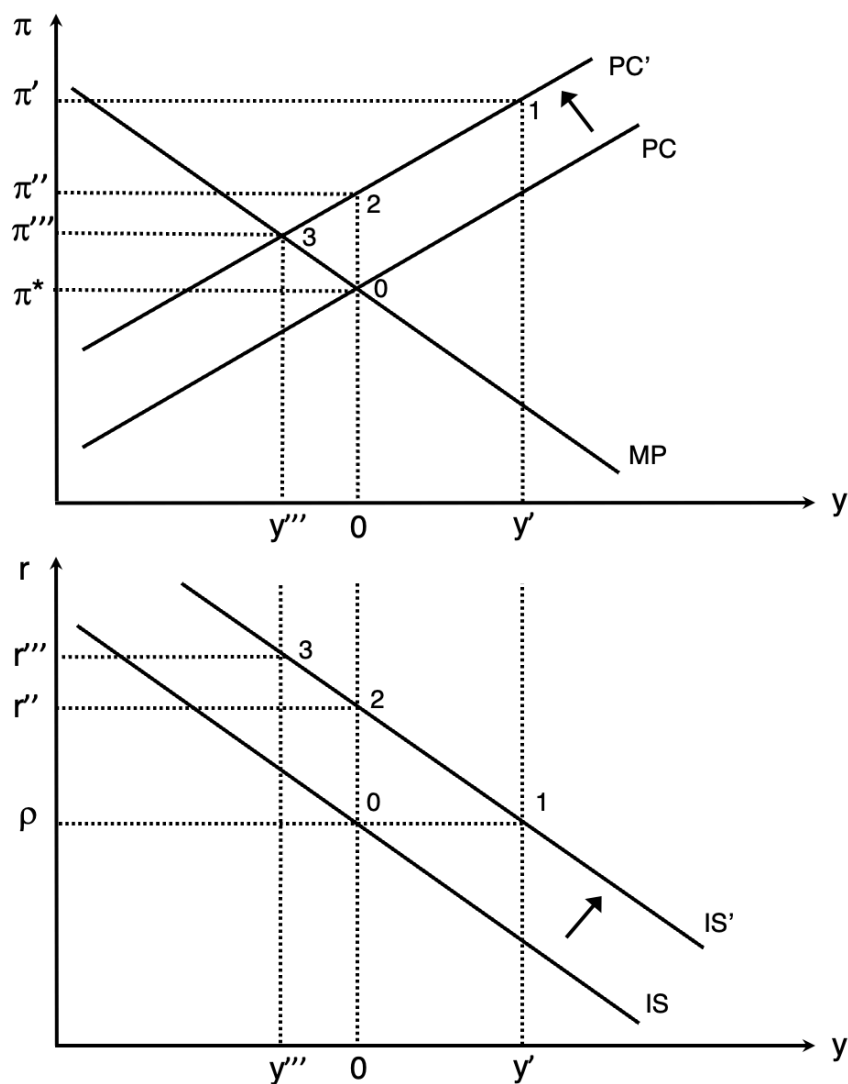

Figure 19 - Positive risk premium shock in an open economy, adapted from Røisland & Sveen (2018)

We analyze the mechanisms following the spike in the exchange rate. First, we consider the depreciation of the NOK in isolation. The real exchange rate[30] is a variable that is integrated

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[30] Which incorporates the shock parameter z, see equation 5.

in both the IS-curve, equation, 6 and the PC-curve, equation 7, in such a way that both curves must shift upwards. This is illustrated in figure 19 as IS' and PC'. Following the depreciation of the NOK, the economy would face higher imported inflation due to the increase in the relative price difference between domestic and foreign goods. This should lead to increased demand for export (in normal times) and steer demand from import to domestically produced goods. As a result, the activity level increases, resulting in a positive output gap and upwards inflation pressure domestically. This is illustrated at point (y', π'). At this point, both the output gap and inflation gap are far above their initial equilibrium target levels.

Improving such a situation within this framework would involve the central bank to increase the interest rate. Norges Bank could choose to act by neutralizing the output gap by increasing the policy rate to r''. This would imply an appreciated NOK, but at the cost of an inflation rate above the target; π''. This cannot be the optimal policy, as this point is not on the MP-curve. According to the model, increasing the policy rate even further to r''' is the optimal policy despite bringing about a negative inflation gap. In this case, the optimal new equilibrium is (y''', π'''). The trade-off of a stronger NOK is then the fact that the appreciation in itself contributes to dampening the imported inflation, but at the same time, it reduces the domestic activity level as well as domestic inflation.

However, the model cannot capture the fact that the Norwegian domestic activity level was severely restricted by lockdown regulations, employee furloughs, etc. In contrast to the modelling world, activity could not simply accelerate despite what the model suggests. We must also be reminded that the time period for which the complete lockdown took place, as well as the risk premium seemed to be at uncontrollably high levels, was not in line with the time span on which the model is founded.

Of course, we also know that the monetary policy response to this shock did not involve increasing the policy rate but rather the opposite. Increasing the interest rate would be in complete and direct opposition with other economic objectives, as we have seen in the two previous sections, and so it cannot take into account that several shocks occurred at once. Moreover, the strength of the currency in itself is not within the mandate of Norges Bank to control. It is, therefore, not a surprise that we do not really observe the dynamics suggested by the model. What we can observe, however, is that Norges Bank does take into account the

negative effects of a weak currency in their projection of rate path, which is also illustrated in figure 38.

Norges Bank did respond, using other more unconventional monetary policy tools not described by our model; first, through forward guidance. On March 19, Norges Bank sent out a press release stating that "against this background [extraordinary situation in the market for Norwegian kroner] Norges Bank is continuously considering whether there is a need to intervene in the market by purchasing NOK" (Norges Bank, 2020h). If this intervention were to materialize, it would be the first time since the Asia crisis in 1997 that Norges Bank intervened in this way[31] (Feratovic, Solgård & Winter, 2020).

Following the press release concerning the possible intervention, the NOK appreciated substantially (Feratovic, Solgård & Winter, 2020). On March 19 and 23, Norges Bank made the extraordinary purchase of 3,5 billion NOK in total (Olsen, 2020b). Essentially, this represents a contraction of the supply of NOK which, following the law of demand, should lead to an appreciation of the currency. Grytten, Haugland & Sveen (2021) concluded that the intervention was "timely and necessary […] and seemed to have the intended calming effect". Revisiting figure 18, we notice that a massive increase in the index seems to be halted in the wake of the actions from Norges Bank. However, we cannot, of course, isolate the effect of the currency purchases from other potential sources of impact.

4.5 Liquidity Measures

Norges Bank introduced extensive liquidity measures in order to avoid disruptions to the financial system. Such measures are over and beyond what the Taylor rule or R&S-model can account for. The Taylor rule is only concerned with the policy rate. This is indirectly also the case for the R&S-model, as it assumes that the central bank sets the prevailing market interest rate directly, while in reality, the central bank has no direct control over these rates. The policy rate is, of course, central in determining the money market rates, but changes in the policy rate do not translate one-to-one to market rates. We explain the transmission of the policy rate to lending rates in more detail in section 5.1.

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[31] Norges Bank purchases NOK for 1600 million daily, but this is mandated by the Department of Finance as a link in the oil-fund mechanism, not as a method of controlling the Norwegian exchange rate.

As mentioned in the theory chapter, the overall goal of Norges Bank's liquidity operations is to ensure that the short-term money market rates are close to the policy rate level. In addition, Norges Bank has a target for total liquidity in the form of reserves in the central banking system. A main concern is that banks' funding cost, which depends, among other factors, on available liquidity and risk premia, will impact borrowers' costs. To ensure that the policy rate would indeed translate into lower money market rates, Norges Bank utilized other tools more directly targeting this objective.

4.5.1 Extraordinary F-Loan Scheme

To ensure that the policy rate would translate into lower money market rates, Norges Bank chose to offer extraordinary F-loans in NOK against collateral with three months maturity effective from March 13 (Norges Bank, 2020e). Norges Bank stated that this offer would be available "as long as deemed appropriate" (Norges Bank, 2020c). This was already announced on March 12 at 14.30 (Norges Bank, 2020c), only thirty minutes after Prime Minister Solberg announced the national lockdown and one day ahead of the interest rate cut. From this rapid response, two observations can be made. Firstly, Norges Bank actively used forward guidance to ensure that commercial banks could form expectations concerning their future liquidity situations despite the uncertain economic conditions. By doing this, Norges bank aimed to keep market rates stable. Secondly, the extraordinary F-loan scheme was implemented roughly at the same time as the interest rate cut, and so was deemed a critical component in the first response. The importance of this speed of action from the central bank is supported by the argument made in section 4.1, concerning how agents in the economy adjust to expected economic conditions and current ones.

Norges Bank extended the F-loan scheme announced March 12 by offering loans with maturity of 1 week, 1 month, 3 months, 5 months and 1 year on March 19 (Norges Bank, 2020f). For loans with maturity up to 3 months, the policy rate served as the effective interest rate, while for loans from 6 months, the policy rate plus 15 basis points. 30 basis points were added to the 1-year loans (Norges Bank, 2020t). For the shortest maturities, this implied interest-free loans, as the current policy rate was zero at the time.

Temporary changes to the criteria for collateral for loans from Norges Bank were also made, liberalising the requirements to enable more applicants to use the F-loan arrangement (Norges Bank, 2020f). Similar measures were taken during the Financial Crisis of 2008. Through this measure, commercial banks could obtain short-run liquidity without having to take up loans from other banks' reserves in a stressed situation. The interest rate for loans with maturities up to three months was equivalent to the current policy rate. As opposed to the regular arrangement involving auctions, all applicants were granted loans.

Despite the increased liquidity infusions, Norges Bank stated that the overall goal of keeping the level of reserves (overnight) at 35 billion NOK with an interval of ± 5 billion NOK remained (Norges Bank, 2020f). Since the commercial banks operate with a deposit quota for which the policy rate is the applicable rate, the slightly lower reserve rate is used as an interest rate for excess reserves. In order to extract excess liquidity at the end of the day from the market, daily F-deposits with one-day maturity were issued. The goal is then to keep within the blue vertical line segment, as illustrated in figure 20.
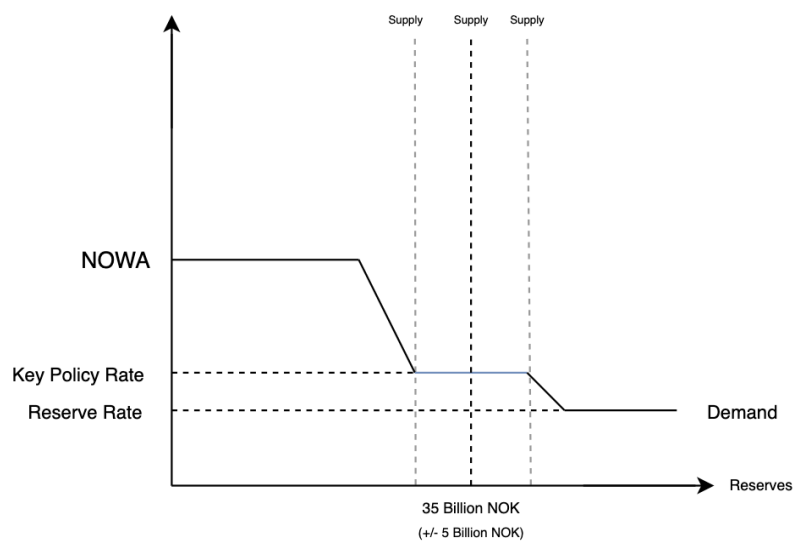

Figure 20 - NOWA and the liquidity system, adapted from Klovland (2020d)

The F-deposits offered had the effect that banks did not need to place reserves at the reserve rate. If Norges Bank did not also withdraw liquidity, the policy rate could sink to the reserve rate.

Banks have, to a large extent, used this arrangement, which is apparent from figure 21 below. There is a marked increase on both F-deposits and F-loans on and after March 13, 2020,

illustrated by the dotted line. Considering the favourable conditions of these loans, several Norwegian banks surveyed by Ouden and Grotle Nore (2020) in their master thesis stated that banks had taken up loans over and beyond their strict liquidity needs. This made it possible for banks to buy back their debt in the market with profits. Additionally, they were also informed that banks could use the loans to purchase municipal bonds with a solid rate of return (Ouden & Grotle Nore, 2020).
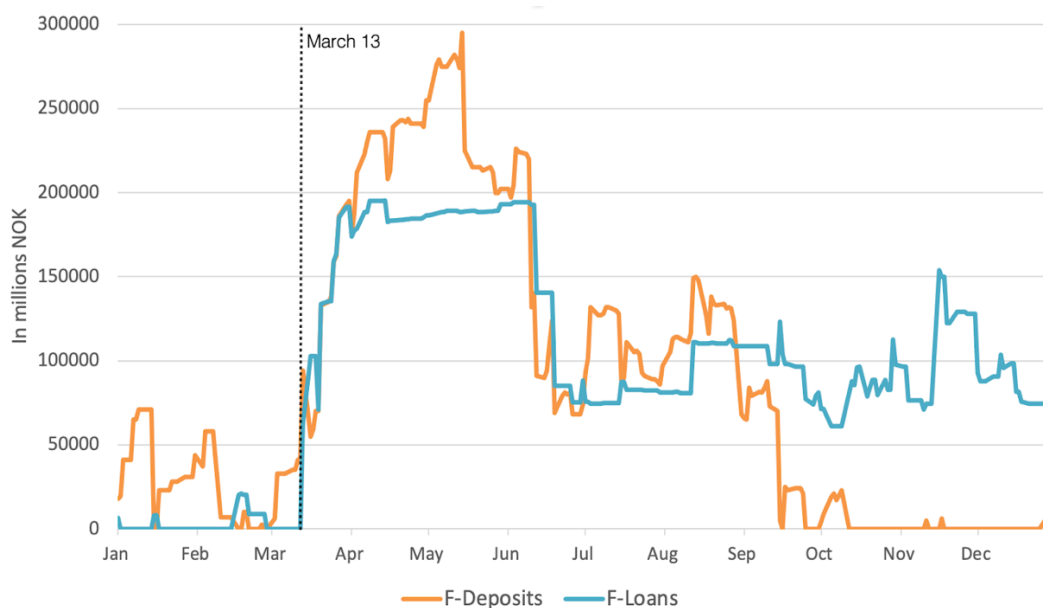

*Figure 21 - Development in F-deposits and F-loans*

In theory, the change in the interest rate should not change the incentives for activity in the market, ceteris paribus. However, as the banks faced what seemed to be unrestricted access to liquidity, incentives to loan or lend in the intermarket were effectively removed. There was simply no need to take on risk by lending to other banks (without collateral) when Norges Bank offered to take on the role as allocator of liquidity. Moreover, the F-deposits, which were daily offered, meant that banks with excess reserves did not need to place these to the reserve rate or trade in the interbank market. Instead, they could place their excess liquidity at the extraordinary F-deposit rate.

Recalling section 2.7, Syrstad (2011) argues that a criterion for a robust liquidity system is that it should be robust to crises which demand extraordinary liquidity measures. Essentially, this entails that supplying more liquidity into the interbank system should not lead to undesirable interest rate movements. NOWA was relatively stable in the whole period, following the policy rate closely, as displayed in figure 22.

Figure 22 - NOWA and the policy rate

It perhaps seems, then, that Norges Bank has prioritized the transmission to the money market rates criteria over fostering interbank activity and allocation of liquidity among participants. That is, criteria (1) over (4) from section 2.7. Moreover, as figure 23 displays and illustrates with the dotted line marked March 13, it seems that the F-loans and F-deposits were quite successful in stabilizing liquidity around 35 billion NOK shortly after the covid-19 crisis hit. Despite this, the period for extraordinary F-loans (in NOK) was extended throughout 2020, with a monthly offer of a 3-month maturity loan set at the policy rate plus 15 basis points. The withdrawal of excess liquidity using F-deposits daily would also continue (Norges Bank, 2020q).
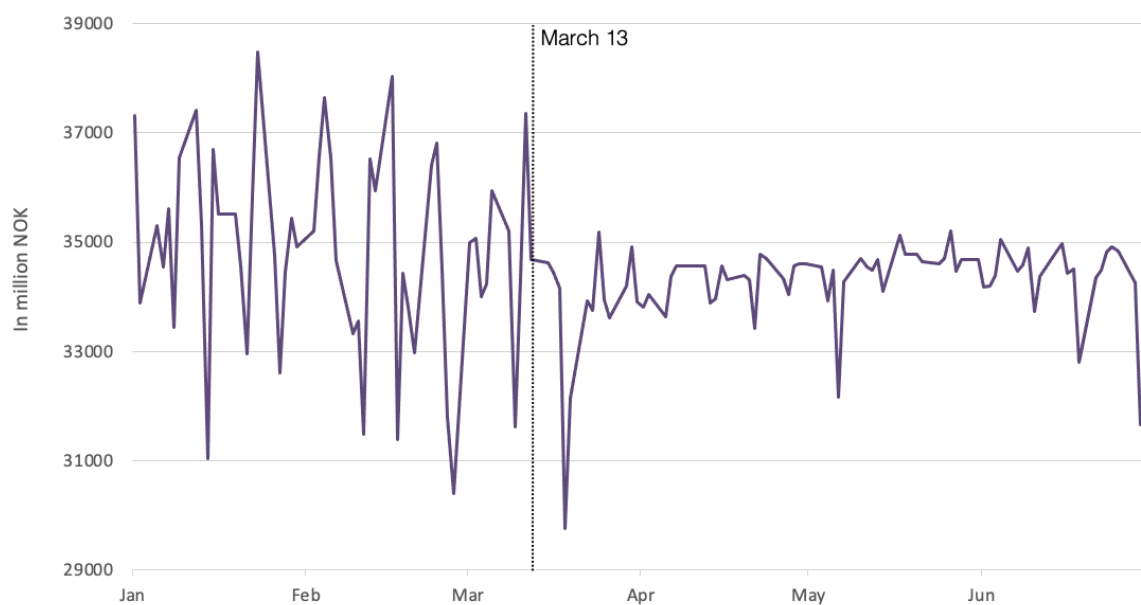
Figure 23 - Total liquidity

4.5.2 NIBOR and the NIBOR Premium

Although NOWA is the primary interbank market rate on overnight loans, banks funding costs largely rely on NIBOR. Changes in the key policy rate is an important determinant for NIBOR, but changes in the policy rate do not translate one-to-one in NIBOR due to the risk premium[32]. The three most prominent factors driving the risk premium include liquidity in the Norwegian money market, developments in the US financial markets, and market participants' expectations of the expected policy rate (OIS-rates). The latter complicates our analysis, as a market for OIS does not exist in Norway[33]. However, Norges Bank publishes estimates of a hypothetical Norwegian OIS-rate, which forms the basis for the risk premium spread in figure 24 below, where the risk premium is the difference between the expected policy rate and 3M NIBOR.

Figure 24 - Risk premium for 3M NIBOR

The uncertainty shock following the covid-19 outbreak led to higher money market interest rates despite adjustments to expectations of lowered key policy rates worldwide. As shown in figure 24 above, the 3M NIBOR spread increased substantially from 25 basis points on March

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[32] Several papers examine the specific factors which drive the risk premium in 3-month NIBOR, see for instance Lund, Tafjord & Øwre-Johnsen (2016).

[33] There are currently ongoing discussions on if and how to establish an OIS-market in Norway, see for instance Finans Norge (2020) for further details.

1, to 56 and 63 on March 12 and 13 respectively, before peaking on March 20 with 98 basis points. Currency strategist Magne Østnor from DNB Markets described the situation in the following way: "the financial markets are about to come to a meltdown. There are markets which are not functioning" (Nilsen, 2020).

Norwegian banks have, in normal times, easily been able to obtain USD in the Eurodollar market due to their solvency and reputation. Access to USD is critical for the mechanisms of the Norwegian money market to function properly. Before the Financial Crisis in 2008, the LIBOR-OIS[34] spread was on average around 10 basis points. Following the bank run on Northern Rock in New Castle in September 2007, the collapse of Bear Stearns in March 2008, and, finally, culminating in the bankruptcy of Lehman Brothers in September, the LIBOR-OIS spread shot up to roughly 360 basis points. The spread has thereafter been a central size in how the market prices risk in the international banking system (Syrstad, 2014). Liquidity denominated in USD dried up as trust vanished from the actors in the markets, leading to disruption in interbank activity.

Following the 2008 experience of the USD shortage in the international interbank market, Norges Bank (along with several other central banks) established a "swapline" (reciprocal currency agreement) with the Fed (Norges Bank, 2020g)[35]. In a press release March 24, Norges Bank announced the decision to offer F-loans denominated in USD with three months maturity against collateral with maximum allotment volume of 5 billion USD (Norges Bank, 2020i). This type of currency F-loan was to be offered on a handful of other occasions: April 2, April 16, May 7, May 28, and June 18 (Norges Bank, 2020o).

The development of the policy rate and 3M NIBOR is depicted on figure 25 below.

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[34] London Interbank Offered Rate (LIBOR) is the average interest rate charged on short-term loans calculated from estimates of the largest banks in London. The LIBOR minus OIS is essentially the risk premium in the LIBOR rate.

[35] This was also done in 2008, where USD$5 billion was made accessible through a swap facility in the case of need for dollar liquidity in Norway (Norges Bank, 2008).
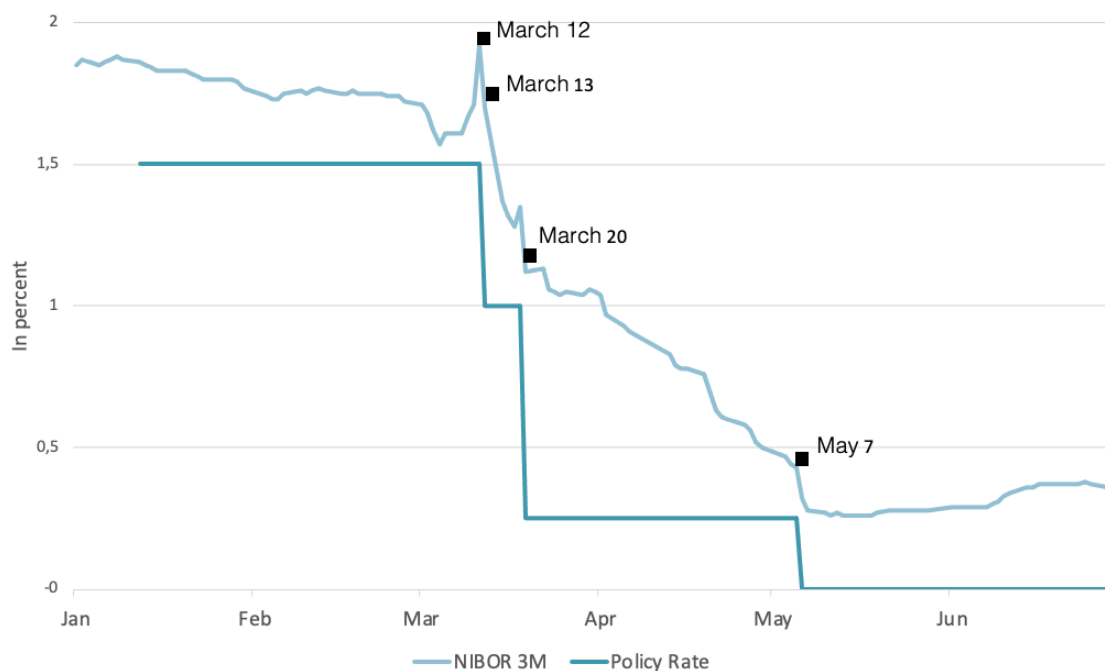
Figure 25 - Norges Bank's policy rate and 3M NIBOR, daily observations

From the diagram, there is a spike in NIBOR in the days leading up to the lockdown, with 70 basis points separating the two rates on March 13. The following (business) day, NIBOR abruptly declined, following Norges Bank monetary policy press conference on March 13. Still, the most noticeable feature is perhaps the deviation between NIBOR and the policy rate in the period from the policy rate cut on March 20 from 1% to 0,25% on May 7. Despite the fact that the policy rate cut did not seem to translate to cuts in NIBOR at the desired level, it seems to be the case that following the cut on May 7, the spread between NIBOR and the policy rate stabilized. This could indicate that Norges Bank succeeded in reaching Syrstad's (2011) criteria for robust liquidity management by ensuring short-term money market rates close to the policy rate level (if one can generalize these criteria and apply to the money market rates as well). Regardless, according to Norges Bank, the stabilization of NIBOR can, at least in part[36], be accounted for as a direct result of the liquidity measures (Norges Bank, 2020m). In a press release on August 14, Norges Bank stated that the financial and money markets were "functioning more normally" with declining risk premiums (Norges Bank, 2020q).

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[36] Monetary policy measures by the Federal Reserve in the same time period also contributed to reducing the USD premiums, which in turn pulls down the NIBOR premium.

4.6 Capital Measures

Capital measures is another example of policy tools that do not fit within the form of simple policy rules like Taylor, nor the slightly more complex R&S-model. The countercyclical capital buffer is one such tool. In the press conference on March 13, 2020, Governor Olsen addressed this buffer (Olsen, 2020a). Norges Bank advised the Ministry of Finance to lower the countercyclical capital buffer from 2,5% to 1% with immediate effect. This advice was followed by the Ministry of Finance (Ministry of Finance, 2020a). In this section, we discuss the intention behind employing this capital measure in the context of covid-19, by studying some of the fundamental assessments that guided the decision to lower the buffer. In a later section, 5.2, we will use this as a foundation and point of departure for discussing important implications of this policy. As discussed in section 2.6.1, and illustrated in figure 7, this capital measure is an example of unconventional monetary. The focus is not on the interest rate, but on the holistic stability concern.

According to Jan Erik Kjerpseth, CEO of Sparebanken Vest, there has been a certain scepticism in the banking sector as to whether the buffers would indeed be cut in the event of a crisis, ever since countercyclical capital buffers were introduced in Norwegian banks in 2013 (Knudsen, 2020). The reduction to 1% contrasted other European countries, such as Sweden and Denmark, which cut theirs to zero as the pandemic hit. The lockdown of Norwegian society in March seems hard to outdo in terms of severity, and one may wonder whether this reluctance to reduce the buffers to zero was in line with the strategy for buffer level in crisis (Norges Bank, 2019a). Some have questioned the decision to withhold the buffer at such a time (Grytten, Haugland & Sveen, 2021).

Considering that the pandemic may be better characterized as a shock to the real economy, we find that the covid-19 crisis does not necessarily constitute a financial crisis as defined in the framework for advice on the countercyclical capital buffer. This makes for an interesting analysis of some of the fundamental indicators for the advice on the buffer level. The response is based on diverging indicators, and the optimal level of the buffer is founded on the four assessments illustrated in figure 26: banks' capacity to absorb losses, access to credit, effects of a change in the buffer requirement on banks, and the economy, and financial imbalances[37].

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[37] We remind the reader that it is not within the scope of this thesis to thoroughly discuss all of the indicators underlying these assessments. Our goal is to provide a brief overview of the most important factors.
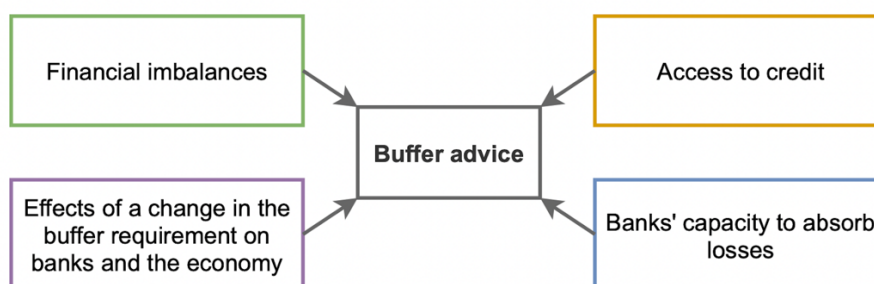
Figure 26 - Framework for advice on the countercyclical capital buffer, adapted from Norges Bank (2020r)

In its advice to the Ministry of Finance, the central bank emphasized that Norwegian banks were solid, with sufficient capital to absorb losses in the event of a severe downturn. In a speech in late 2019, Jensen, stated that Norwegian banks were among the most solid in Europe due to complying with the European Basel requirements, as well as even stricter Norwegian requirements. This has allowed banks to build up solid capital in good times and limit the downside in times of crisis (Jensen, 2019). Nevertheless, credit losses rose markedly in the first quarter of 2020, but declined throughout the year (Hægeland & Olsen, 2021).

Access to credit is primarily a consideration of whether or not households and businesses will have more difficulties accessing credit due to financial market stress, developments in the credit practices, and banks' profitability. As we saw in section 4.6.2, the risk premium of NIBOR shot up in mid-March, and this cost is closely linked to the banks' funding. We leave this discussion for now and return to this point in section 5.1.

Effects of a change in the buffer requirements on banks and the economy are concerned with dividend policy, increasing earnings by changing the price structure of loans, and raising capital. This matters because the authorities need to form appropriate expectations for whether or not reducing the countercyclical capital buffer will actually result in the intended effect of increasing banks' willingness to provide loans to households and enterprises. The Ministry of Finance addressed these issues by recommending that banks limit dividend payout until as far ahead as late September 2021. The recommendation was favourably received, and all large Norwegian banks proposed to follow this recommendation (Hægeland & Olsen, 2021).

Finally, we discuss financial imbalances. According to recommendations from the International Basel Committee, one important indicator that should guide the decision is the credit gap (Norges Bank, 2019a). Figure 27 illustrates the decomposed credit gap using a one-

sided HP filter with $\lambda = 400\ 000$, with credit as share of GDP for mainland Norway (Norges Bank, 2021c).
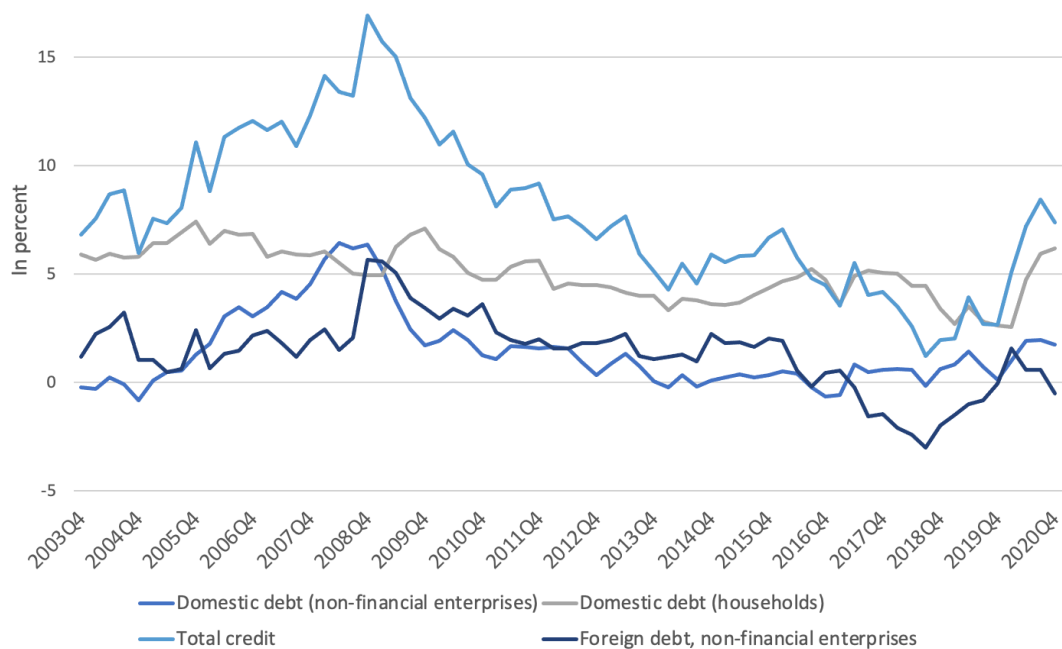

Figure 27 - Decomposed credit gap

In Q4 2019, the total credit gap was 2,65, implying that the credit gap was nearly three percent above its trend before the covid-19 crisis. It appears that household domestic debt was the main driver for this deviation, accounting for 2,61%. From a historical experience, the credit-to-GDP gap has risen markedly in times of crisis because the growth of GDP declines faster than that of credit. Looking at figure 27, this pattern can be observed for both the Financial Crisis of 2008 and the covid-19 crisis. In the Q1 2020, total credit as a share of GDP rose to 5,08. Continuing to rise throughout the next quarter, it peaked at 8,43 in Q3, and stayed above 7 in Q4 (Norges Bank, 2021c). The countercyclical buffer guide states that the buffer requirement should be cut to zero when the national credit gap is below 2. According to the framework, the buffer should increase linearly for credit gaps exceeding 2 and be set at the maximum level of 2,5% if the gap approaches 10 (Norges Bank, 2019a). In contrast to the previous areas of assessment discussed, this indicator pulls in the direction of actually *increasing* the buffer. This is because, in isolation, lowering the buffer could lead to further financial distress, at least in terms of the credit gap. This is further discussed in section 5.2.

However, both the Basel recommendations and the EU regulation emphasise that there should not be a mechanical relationship between the buffer guide and the level of the buffer. Other

information and the authorities' judgment should play an important role (Norges Bank, 2019a). The unprecedented nature of the economic crisis we are currently in may explain why the Norwegian authorities were hesitant to reduce the buffer further. This moderate reduction may have been driven by the fact that the buffer guide indicators were diverging, and assessments, therefore, must balance liquidity and credit considerations that implied conflicting strategies, as we have seen.

5. Analysis II: The Impact of the Policy Measures

In this chapter, we answer the second research question by analysing to what extent the prioritization of monetary policy objectives has contributed to future risk factors and how important macroeconomic and financial variables are developing. In the first section, we discuss the transmission of the policy rate to market rates. Next, we consider the potential development of financial imbalances, inflation, and the neutral real rate, respectively. Finally, we conclude the chapter by examining Norges Bank's policy rate decomposition compared to our Taylor rate.

5.1 Transmission of Policy Rate cuts to Bank Lending

In general, there is not considered to be a mechanistic relationship between increased liquidity and interest rate changes generated by central banks and the effects on the real economy (Klovland, 2020e). In the simplest macroeconomic models[38], the relationship is depicted such that the central bank lowers the policy rate, and this change has a predetermined effect on investment. In reality, due to the existence of commercial banks, this relationship is more complex. We must also consider how and at which intensity banks react to the various types of instruments that the central bank implements in addition to different risk and liquidity premia. In section 4.6, we discussed the effect of Norges Bank's liquidity measures on the interest rates NOWA and NIBOR. We now extend our discussion to the transmission of the money market rates into commercial lending, focusing on NIBOR.

Governor Olsen (2020 May 13) reported that the influx of liquidity provided by these measures gave the banking sector the ability to ease up the requirement of loans to stressed businesses and households. To properly see this, we need to consider the link between NIBOR and the policy rate and their transmission to the commercial banks' pricing of private lending. A bank's profit comes from the difference between the interest earned on outstanding loans and the money paid out as interest on the deposits, termed broadly the net interest margin. Operating

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[38] Such a model is, for instance, in the IS-LM framework, put forward by John Hicks (1937). The model shows the interaction of the market for goods (IS) and loanable funds market (LM), which is essentially the money market. The IS-LM assumes that *money supply* is the central bank's instrument and is an exogenous variable. The model has, in later years, met extensive criticism, especially since more and more economies have moved from steering money supply to focusing on an interest target. Most versions of this model do not allow us to analyse the optimal interest rate movements.

expenses constitute costs for the banks, as well as the funding cost of capital, which is to a large extent determined by NIBOR. From section [Under MP response: NIBOR and NIBOR Premium], we established that several factors are driving NIBOR, not solely the Norwegian policy rate. The financing sources of Norwegian commercial banks can roughly be split into equity (10%), deposits (55%), and debt securities39 (35%) (Klovland, 2020a).

The relationships can be summarized with a set of simplified equations (Erlandsen Erard, 2014):

Loans Margin = interest charged on loans - money market rate[40]

Deposit Spread = money market rate - interest paid on deposits

Net Interest Margin = loans margin - deposit spread

A bank's funding cost thus naturally translates into the price of loans for private consumers. Empirical studies, including studies conducted in Norway, show that an unexpected increase in the money market rate leads to banks reducing their lending activities to the public more than alternative credit issuers (Jacobsen, 2012).
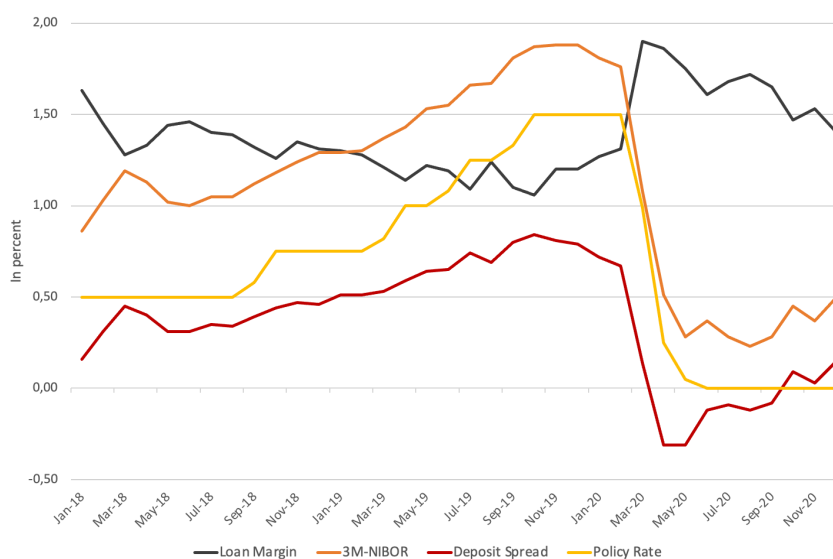

Figure 28 - Loan margin, deposit spread, 3M NIBOR and the policy rate

Figure 28 displays the development in loan margin on total outstanding mortgages and deposit spread of banks in the period prior to and at the outbreak of the crisis. A spike is visible in

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[39] Debt securities are often termed wholesale funding and involve a term premium beyond NIBOR.

[40] For Norway, this implies 3-Month NIBOR (Fidjestøl, 2009).

March, where the margin rose from 1,31% in February to 1,90% in March (SSB, 2021). This can be partially explained by the sharp decline in 3M NIBOR following the cut in the policy rate. The deposit spread also saw massive movements in the time immediately following the outbreak of the virus. From 0,67% in February, a drop down to 0,14% in March followed, reaching a low in April/May of -0,31%.

One factor explaining this last observation is that when the interest rate is low, and interest paid on deposits is approaching zero, cash becomes relatively more attractive to hold. For deposits, at least of relatively small amounts, there exists a zero-lower bound. To avoid losing customers, banks may be more reluctant to reduce interest paid on deposit rates further. Since these rates account for a significant portion of the bank's funding costs, the translation to lending rate can also be to not compromise the net interest margin. This phenomenon has been observed in countries where the central banks have set negative interest rates (Juelsrud, Nordal & Winje, 2020). Therefore, low deposit spread following a low policy rate level can perhaps be "subsidized" somewhat by high loan margins.

Panel data analysis of banks and other credit issuers conducted by Norges Bank has shown that in the period 2002 to 2020, roughly 80% of changes in the policy rate has directly been translated to changes in the average mortgage interest rate and interest rate for corporate loans (Juelsrud, Nordal & Winje, 2020). Essentially what this means is that about 80% of the change in the policy rate is directly reflected in the lending rate the following quarter after the change. The study found that in these cases of a lower policy rate than the median rate of 1,75 for the period, the reflection of policy rate changes in interest charges on loans was only 65% and 75% on interest paid on deposits (Juelsrud, Nordal & Winje, 2020).
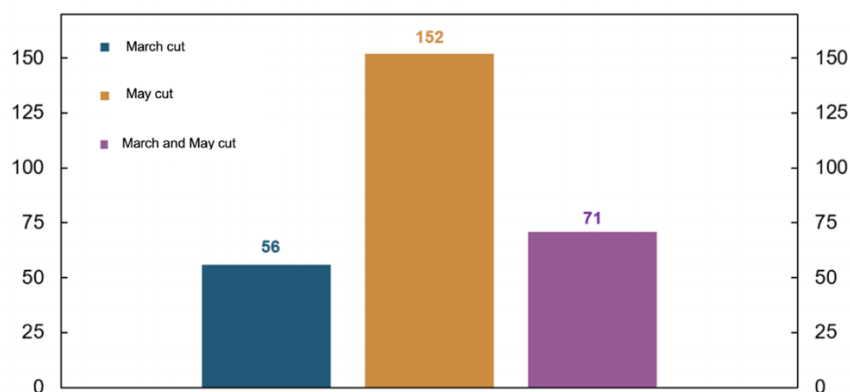

Figure 29 - Average transmission from policy rate cuts to banks' lending rates
(Juelsrud, Nordal & Winje, 2020)

Figure 29 displays the average translation from the cuts in the policy rate in May and March 2020 to banks' lending rates. The diagram is constructed such that for the March cut, the transmission is calculated as the change in interest rates at the end of February to the end of April as a share of the cut in the policy rate (125 basis points). For the May cut, the transmission is calculated as the change in interest rate at the end of April to the end of May as a share of the cut in the policy rate (25 basis points). For the March and May cut overall, the transmission is calculated as change in interest rates at the end of February to the end of May as a share of the full cut in the policy rate (150 basis points). The policy rate cut in March only translated roughly 56% into lending rates.

Despite this, commercial banks did not signal any cuts in their interest rate charged on loans (Winther, 2020). The explanation provided for not lowering interest on loans was that the cut in the policy rate had not sufficiently translated into lower money market rates and the risk premiums of the money market rates were still volatile (Juelsrud, Nordal & Winje, 2020). Another possible contributing factor could be that banks expected the most significant decline in demand for mortgages since the Financial Crisis of 2008 (Solgård & Mikaelsen, 2020) and anticipated a need to cover their potential losses. Recalling, figure 17, the growth in the housing market continued despite the uncertainty shock brought about by covid-19. In Norges Bank quarterly survey of bank lending[41], commercial banks reported that the demand for mortgages actually increased in the second quarter of 2020 (Norges Bank, 2020p).

Pressure on the banks to cut their lending rates further, stemming from the media and customers, could be contributing factors in increasing the translation from policy rate to lending rate in May. The bank lending survey also pointed out that the cut in interest rate brought about an increased focus on refinancing and consumers switching between banks. Moreover, as spring progressed, Norges Bank and other central banks, took action to put downward pressure on the risk premium in the financial markets, reducing the uncertainty in the financial situation. Recalling section 4.6.2, the risk premium for NIBOR was substantially lower in May than March 2020, which should also provide room to adjust commercial rates further. These factors combined can be reflected in the fact that banks lowered the lending rate more than the cuts in the policy rate, displaying a translation rate of 150 percent. In the next

[41] The survey is a qualitative assessment of the bank's credit demand and credit standards. The participating banks are DNB, Nordea, Danske Bank, Handelsbanken, Sparebank 1 SR-Bank, Sparebank 1 Østlandet, Sparebank 1 SMN, Sparebank 1 Nord-Norge, Sparebanken Sør, and Sparebanken Vest (Norges Bank, 2017)

section, we turn to some of the potential implications of historically low lending rates in terms of financial stability.

5.2 Financial Stability Concerns

In a lecture in the course Business Cycle Analysis held by rector Øystein Thøgersen named "Don't worry, be happy" at NHH in September 2019, he said the following: "household debt levels are high. This is a nightmare for the head of the Norwegian central bank" (Thøgersen, 2019). Since then, the loan debt has further increased, fueled by a zero-policy rate and a restricted supply of goods and services. Is there perhaps a reason to worry just a little bit now?

In this section, we focus on how the historically low policy rate may impact financial imbalances. As a point of departure, we present Norges Bank's ribbon heat map, illustrated in figure 30. This map was developed to keep track of systemic risk build-up in the financial system and complements the four assessments for the countercyclical capital buffer outlined in section 4.7 (Norges Bank, 2019a). This tool compiles 39 indicators based on data from BIS, OECD, Real Estate Norway, Bloomberg, Statistic Norway and more. The heatmap in figure 30, illustrates the complexity of financial cycles by including such a wide range of indicators and monitoring vulnerabilities and associated risks (Arbatli & Johansen, 2017). The colour green implies low levels of vulnerability, while red indicates high risk (Norges Bank, 2021c).
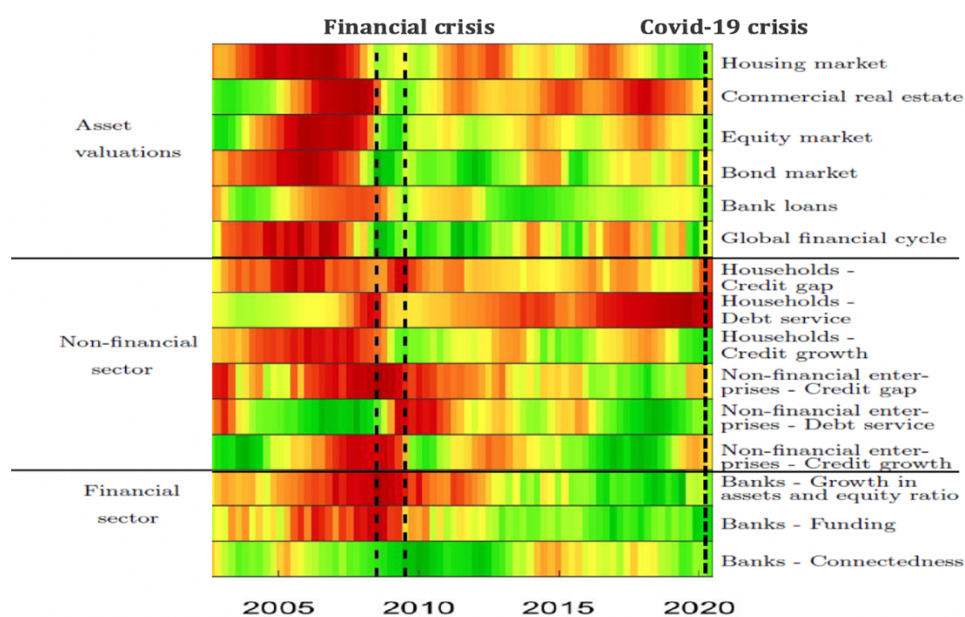

Figure 30 - Indicators of systemic risk, adapted from Norges Bank (2021c)

According to the heatmap indicators, considered in isolation, measures to mitigate the risks of credit and debt in the household sector should be employed. These do not seem to have been prioritized. The challenge is that in light of the ongoing pandemic, Norges Bank has two conflicting objectives. On the one hand, following for instance the arguments behind lowering the countercyclical capital buffer, the central bank wishes to counteract tightening of commercial banks' lending, as this could further amplify the economic downturn. On the other hand, high debt ratios and credit in the economy following increased indebtedness are a risk to financial stability. Amplifying financial vulnerabilities can result in longer and deeper recessions when (the next) crisis breaks out (Jordá, Schularick, and Taylor, 2013). In the wake of the covid-19 crisis, the first objective was prioritized.

We note from figure 30, which shows the development in indicators from 2003Q1 to 2020Q4, that many areas which were high risk before and during the Financial Crisis of 2008 have stabilized at green and yellow levels since then. This is likely correlated with the development of macroprudential policy in the following period. There are two indicators that reflect a particularly high level of vulnerability prior to 2020, namely "household-credit gap" and "households-debt service". We have already briefly assessed the decomposed credit gap and its relation to economic crises in section 4.7, noting that household domestic debt was, in fact, higher than total debt from 2016 up until the pandemic. This strong contribution by households to the total credit gap fits well with the illustration of the composite indicators above. The second indicator of interest to our analysis, household-debt service, which we will focus on in this section, is displayed in figure 31.
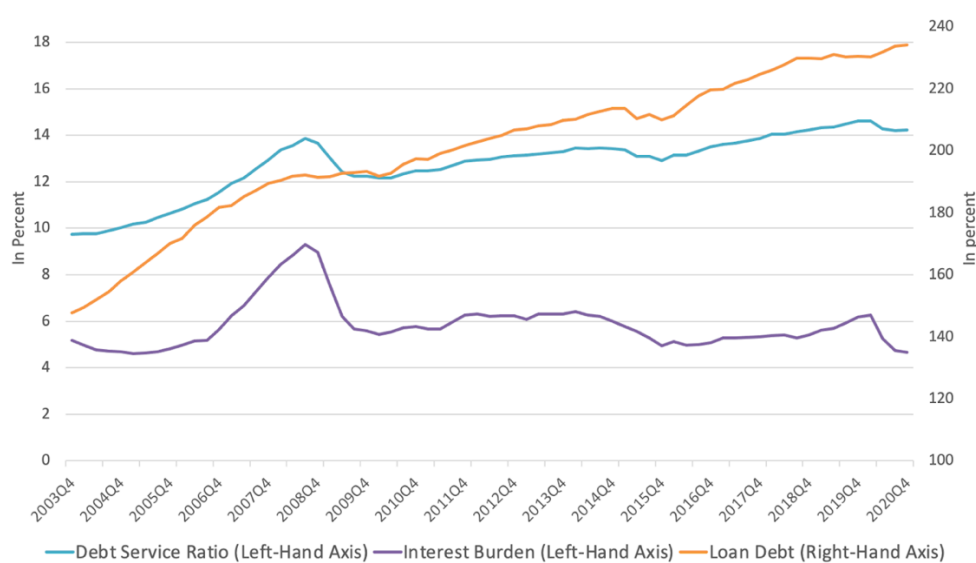

Figure 31 – Household debt service

At the end of Q4 2020, the loan debt reached 234% of disposable income and is projected to grow. All the debt taken up in recessions implies that the room for increasing the interest rate later on becomes smaller and smaller, resulting in a lower ability to absorb shocks (Thøgersen, 2019). Following the temporary policy rate cut, households should face lower debt service ratios and interest burdens[42], ceteris paribus. This pattern is clearly visible on figure 31.

The zero-policy rate will, in all likelihood, not persist, since the majority of loans is dictated at a floating interest rate (Gjedrem, 2020), the debt service ratio and interest burden will, in time, rise. If there is a sudden spike in the debt service ratio or interest burden, the effective purchasing power of households decreases, which can induce a negative aggregate demand shock. The impact of the policy response on household debt and credit, therefore, may pose a financial stability risk in the medium and long-term. Despite the developments in debt and credit, there has also been an increase in the savings rate, suggesting that while some households critically rely on access to loans in the very short run to maintain their level of consumption, many have increased their savings rate and bank deposits. This underlines the heterogeneity in households.

From figure 31, the seemingly improved debt service ratio and interest burden following the covid-19 crisis is in stark contrast to that of the Financial Crisis of 2008, where it seems that the debt service ratio shot up. This is perhaps not surprising, as the policy rate was raised from 3,5% in Q4 2006 up to 5,75% Q3 2008. This period exhibited a negative inflation gap of -0,75% on average, while the output gap was positive and twice as large. As we already have seen in section 4.3, our model's optimal policy response in such a case would then be to decrease interest rate to enable higher levels of consumption due to lower debt service ratios and interest burdens to mitigate the negative output gap. This was done in Q4 2008. However, in the case of the covid-19 crisis, the interest rate level was already low, leaving less space to maneuver the interest rate.

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[42] Although not specified in the dataset, this may also be an effect of the temporary easings in the mortgage regulation, where banks were given room to defer interest payments and the principal payment for up to six months (Ministry of Finance, 2020b).

5.2.1 Residential Mortgage Lending

Only second to Denmark, Norway has the highest household loan debt ratio of all OECD countries (OECD, 2021). The growth in Norwegian household debt and house prices are closely related (Finanstilsynet, 2020). The high growth rate in housing prices, which was a stability concern even before the pandemic, has accelerated since June 2020 (Grytten, Haugland & Sveen, 2021). This development is fundamentally connected with the primary covid-19 policy response of reducing the policy rate. The mechanism is that rising house prices lead to increased housing wealth, providing more equity for households owning their own houses to further increase mortgages. Easier access to credit thus provides the opportunity to buy even more expensive properties. The low cost of loans also opens for more entrants into the housing market. As discussed in 4.4, the restrictions imposed by the government to prevent the spread of covid-19 have eliminated a lot of the alternatives for spending, and in all probability, also increased the time spent at home for the foreseeable future (Nordbø, 2021).

In combination, these factors have led to an alarming growth in both housing prices and debt levels. This is not something that monetary policy can easily solve. The interest rate is not actively used to keep housing prices stable, as this could have a significant negative impact on other areas of the economy. In the R&S-model, increasing the interest rate to counter the growth in house prices would, for instance, result in an appreciation of the NOK, leading to lower inflation, which would harm the industries exposed to international competition. After all, monetary policy follows the principles of inflation targeting.

As we touched upon in section 2.5, there is a variation of the R&S-model that incorporates financial stability variables, such as the loan debt ratio (with some weighting coefficient), into the loss function. This would allow for modelling how Norges Bank can operate with an inflation gap and an output gap with the same sign. We restrict ourselves to comment that if the weight on the financial indicator is sufficiently high, the interest rate would be set at a higher level than when excluding such variables, as we have done in our model. As the policy was set at zero despite the fact that this theoretically contributes to worsening the risk associated with the credit gap and loan debt ratio, these financial imbalance indicators were not prioritized. Norges Bank Watch (NBW) 2021 comments on this dilemma in its evaluation of the monetary policy of 2020. "However, the central bank deemed this [rising housing prices] a lower risk than the negative development of the real economy. Thus, the focus of

financial stability seems to have been less important and output gaps more important during the crisis." (Grytten, Haugland & Sveen, 2021, p.45).

It should then be the case that other tools than the interest rate must be employed to dampen the inflation in the housing market, such as the macroprudential policy tools summarized in figure 7. In order to preserve bank solidity and ensure financial stability, the financial supervisory authority of Norway, Finanstilsynet, proposed a stricter mortgage loan regulation to accompany the expansionary measures (Finanstilsynet, 2020), but this advice was not followed. Several regulations directly related to the housing market were in fact changed in March 2020 in response to the covid-19 crisis. These were, however, modified to be *more* lenient, and facilitate lending and borrowing. Examples include increases in the permitted number of loan applications to be accepted based on discretionary assessment, exemptions from certain credit criteria, and the government offering collateral (Brunborg & Knudsen, 2020). The current Minister of Finance, Tore Sanner, stated in relation to the temporary easings of the mortgage regulation; "I want to emphasize that these are not measures taken to stimulate the activity in the housing- or credit market [freely translated]" (Ministry of Finance, 2020b). Despite this, in effect, these measures likely contributed to the acceleration mechanism described in the previous paragraphs. Clearly, the regulatory specifications have not fully met their objective.

5.3 Inflation Outlook

Following the Federal Open Market Committee (FOMC) meeting in July 2020, Chair Jerome Powell stated the following to the press: "In terms of inflation, I don't know. I mean, I - you know, I think, fundamentally, this is a disinflationary shock. I know there - there is a lot of discussion about how this might lead to inflation over time, but, you know, we're - we're seeing disinflationary pressures around the world going into this" (Powell, 2020). A natural question to ask in light of the rapid and large fluctuations in the macroeconomic sizes is: what will happen to the inflation rate? Different factors pull inflation in different directions. Previously, we have discussed demand, supply, and risk premium shocks. In our model for inflation targeting, traditional inflation shocks are exemplified by sudden changes in commodity prices, sudden increases in wages, shock in international factors (that lead to shocks in imported inflation), or substantial increases in the money supply. Even if inflation does not manifest as shocks per se, we still find it interesting to analyse inflation outlooks.

This section will first consider the arguments in favour of a rise in inflation before analysing the factors that pull in the opposite direction. Finally, we discuss how uncertainty may impact inflation expectations.

Rising Inflation?

Central banks all over the world have initiated a massive influx of liquidity in the banking system to stabilize the economy in the wake of the pandemic. As discussed, Norges Bank has provided extensive loans to meet liquidity needs. Furthermore, the Fed has initiated an extensive quantitative easing program with similar objectives as well as with the goal of increasing the money supply. By March 2021, it reached 7,79 trillion USD (Federal Reserve, 2021). Fiscal policies initiated by various governments have also resulted in money pouring into the economy. The International Monetary Fund (IMF) reports that globally, fiscal support to fight the coronavirus exceeds 14 trillion USD as of January 2021. For Norway, this figure is roughly 131,3 billion NOK as of April 2021 (IMF, 2021).

Will such measures lead to inflation? Many central banks use metrics of money supply aggregates to make assessments regarding inflation outlooks. The Fed, for instance, has emphasised certain monetary aggregates for communicating monetary policy (Orphanides & Porter, 2001). Here, we consider the 12-month growth of Norwegian[43] money supply aggregates[44] displayed in figure 32. For instance, the 12-month growth rate for M3 rapidly rose from 3,7% in end-February 2020, to 7,5% by end-March 2020, making history as the greatest change in growth rate since the introduction of M3 as a monetary aggregate (SSB, 2020b). The 12-month money supply growth remained high throughout the year and continued into 2021. It is also interesting to note that by the end of February 2021, the growth in the money supply growth aggregates peaked at 17% (M3) and 15% (M2 and M1). This then

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[43] To only consider the domestic metrics as a potential source of inflation is, of course, a simplification, as we know from the R&S-model. The same line of arguments applies to all other economies, and we could end up in a situation of increased imported inflation even if the expansionary measures do not lead to a rise in the Norwegian inflation level directly.

[44] The money supply is broadly split into different aggregates to categorize who extends the money and which sectors hold the money. Briefly, the most important distinction is the money aggregate describing the monetary base, M0, which is defined as money within the central banking system (banks deposits in the central bank) and currency in circulation. For this category, the central bank is the money-extending entity, while banks hold the money. The other aggregates, called M1, M2, and M3, encompass the entire supply of money in the economy. The money-extending sector includes commercial banks, mortgage companies, and more, while the money-holding sectors include households and non-financial enterprises.

represents money supply growth of nearly one after the fiscal stimulus following the covid outbreak.
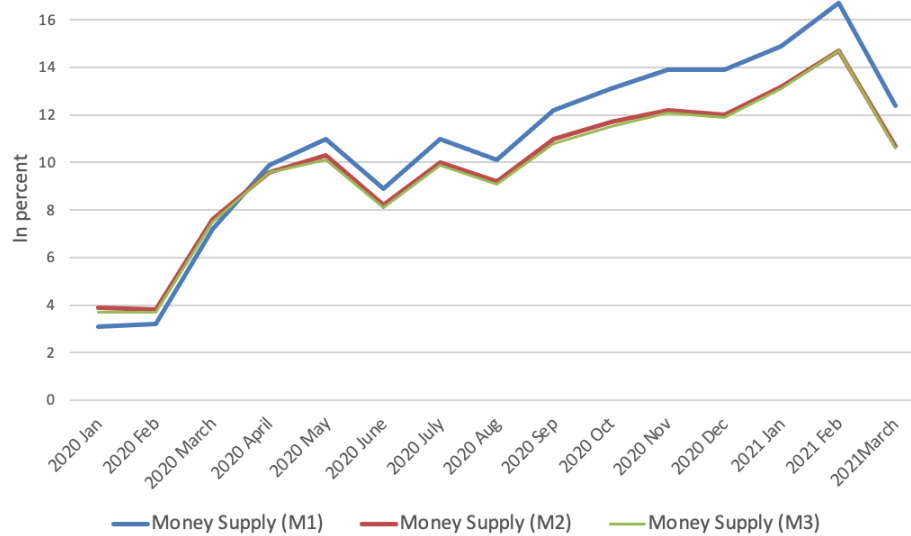
Figure 32 - 12-month growth in money supply aggregates

Recalling section 2.8, money supply growth is split into real growth and inflation. Clearly, the money supply is not rapidly increasing due to real economic growth. In the same period as Norway has experienced this rapid growth in money supply, we have also had a negative output gap. Following the arguments of the quantity theory of money, the price level must mechanically increase to counter the increase in money supply, so inflation is inevitable. For inflationary pressure to build up, the money supplied must actually be spent and manifest itself in the consumer price indices.

From figure 10 in section 3.3, we observe that in the period before and since the outbreak of covid-19, there has been a positive inflation gap in Norway, peaking at 1,5 in Q3 2020. There has thus been a moderate rise in inflation during the pandemic, but perhaps more modest than we find reason to expect when observing the development in figure 32. The inflation risk could, however, become more apparent once society opens and the demand, which has been curbed due to closed stores and restaurants etc., is no longer restricted. Moreover, price developments in certain financial markets could indicate that some investors expect the increased money supply to result in higher inflation in the future. This is, for instance, reflected in the recent rise in interest for long-term securities, particularly in the US (Norges Bank, 2020u). However, due to the covid-19 measures, the savings rate has massively increased,

keeping money out of circulation, or in terms of the quantity theory of money; restricting the changes in the *velocity* of money. We discuss saving further in the next section.

The sudden increase in money supply is also short run oriented, which is not a trivial factor. The quantity theory of money is largely discarded as a useful tool in the short run. The reason is simply that the relationship has not been empirically stable or significant in the short and medium-term (Lerbak, 2013). Regardless of this, Jordan, Peytrignet and Rich (2001) of the Swiss National Bank argue for using money aggregates to forecast inflation, but state that in isolation, money growth is likely to provide "misleading information on future inflation". It is still an active discussion whether the theory is expedient in the long run on the matter of price stability. If the money supply growth rate does not decline to normal levels in the span of a year or so, further studies and perhaps measures to hinder inflation would be needed (Klovland, 2020e).

When it comes to real growth, two observations are made. Firstly, disruptions in production and breaks in supply chains have resulted in substantial price spikes for certain goods, for example face masks and non-prescription antiviral medication. Social distancing, as well as strict border control hindering imported labour, puts upwards pressure on wages. Many businesses charge extra to cover their costs of mandatory virus containment measures. In isolation, this pushes up the price level without adding any extra output, so real economic growth does not necessarily occur despite the price increases. Some actions have been taken to counter these effects, such as reduced VAT (Norges Bank, 2020u), but despite this, there are perhaps reasons to believe that overall, the underlying inflation will be pushed upwards.

Low Inflation Ahead?

In the same press conference as quoted in the introduction, Chair Powell said: ''Now we see a big shock to demand, and we see core inflation dropping to 1%. And I do think for quite some time we're going to be struggling against disinflationary pressures rather than against inflationary pressures'' (Powell, 2020). A rise in inflation is not impossible, but disinflation, or even deflation, may be more pressing in the current economic climate as prolonged periods of unexpectedly low inflation have been present in many developed economies (Ciccarelli & Osbat, 2017). The underlying inflation level of many of Norway's trading partners is currently at the lowest level it has been over the last 20 years (Norges Bank, 2020s).

Several factors are pulling in the direction of lower inflation in the period to come. Returning to the Phillips curve presented in the R&S-model, we know that inflation is a function of inflation expectations and output[45], which in turn is a function of labour[46]. It is therefore relevant to assess the employment and wage level situation in the wake of the crisis. A consequence of the containment measures imposed by the governments, both in Norway and with Norway's trading partners (as well as indirect suppliers down the supply-chain), is that activity remains restricted, resulting in lower employment levels and, in some cases, a downward push on wages to avoid bankruptcies. In figure 33, we illustrate the case for the Norwegian labour market, where registered unemployment as a share of the labour force is displayed.
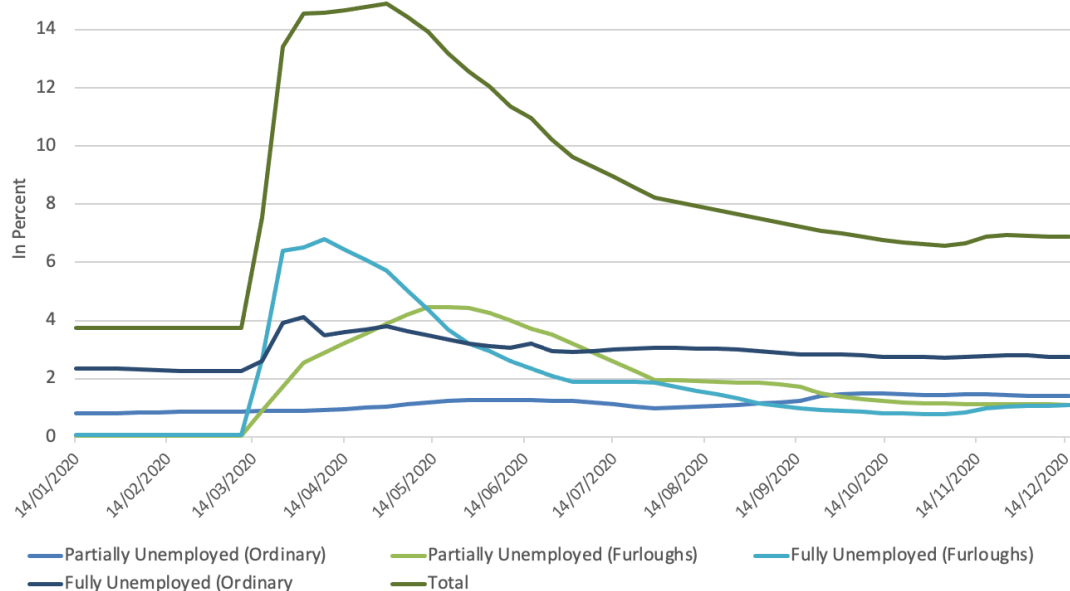
Figure 33 - Registered unemployment as share of the labour force

Following the lockdown announcement on March 12, there was a spike of more than 10% in total unemployment, as demonstrated in figure 33. From March 10 to March 17; the week that the Norwegian Government announced the lockdown, the share of the labour force registered as unemployed rose from 3,7% to 7,5%. The following week it continued rising to 13,4%, before reaching a peak level of 14,9% by the end of April. The sudden rise was especially

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[45] The standard version of the Phillips curve is a relation between inflation, expected inflation and cyclical unemployment, but in our framework, the variable y accounts indirectly for unemployment as output.

[46] The traditional expression for output is perhaps the Cobb-Douglas Production Function, which also takes other factors into account such as capital and total factor productivity. Here we only consider employment in terms of output and inflation.

prominent in furloughs. Seen in isolation, it follows from the Phillips curve that this should lead to low inflation levels, at least in the short term. From the diagram, it is clear that the largest proportion of the increase in total unemployment was temporary, only lasting a few months. Norges Bank still claims that it is expected to take time bringing unemployment levels down to pre-covid levels (Norges Bank, 2021b). The low capacity-utilisation in the economy indicates low levels of inflation.

However, empirical research on post crisis Phillips's curve dynamics finds that the Phillips curve has become flatter (Ebrahimy, Igan & Martinez Peria, 2020), meaning that inflation may rise less as unemployment increases than before. As an example, after the Financial Crisis of 2008, inflation remained surprisingly stable despite the substantial rise in unemployment. It seems to be the case that inflation in advanced economies is becoming less responsive to changes in economic slack (IMF, 2013). In practise, this means that we may not see deflationary pressure despite the increased unemployment rate[47]. The curvature change can perhaps be attributed to the trust in the central banks' inflation targets, which also plays a role in inflation developments under uncertainty. We will discuss this further in the next section. Other factors not directly related to unemployment, which pull in the direction of low inflation, include an increase in the savings rate, which we will also discuss in section 5.4.

Uncertain Outlook for Inflation Expectations

Uncertain outlooks in the global development of price levels make it difficult to form expectations. The Phillips curve is in part determined by inflation expectations. In Norway, expectations are largely anchored in the inflation target. In the R&S-model they are assumed to be constant. However, recent inflation expectation surveys conducted by Norges Bank, display some new developments which can, at least in part, be attributed to the pandemic. Although, in general, the inflation expectations have not shown much change, the variance in short-run inflation expectations has risen substantially, see figure 34. The figure displays the variance of households' inflation expectations as percentage points difference between 75th and 25th percentile in the inflation expectations for one year (Norges Bank, 2020u).

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[47] Fiscal policy measures, such as temporary easings in taxation, could also pan out in lower inflation levels.

A larger number of survey participants in Norges Bank's expectation survey[48] said they expected inflation to be lower than average. Simultaneously, the share of households which expected high inflation increased (Norges Bank, 2021a). The same general result seems to apply for the US and EU and even to a more considerable extent.
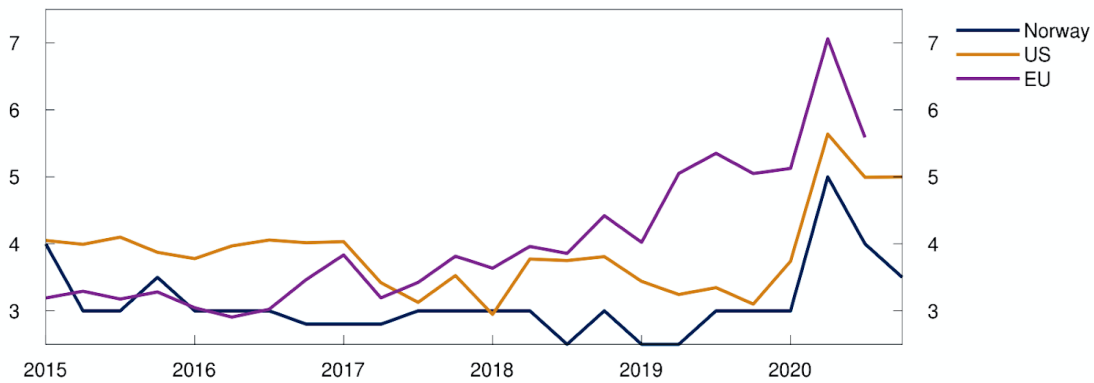

Figure 34 - Variance of households' inflation expectations (Norges Bank, 2020u)

One explaining factor to this could be the heterogeneity in the impact of the crisis regarding households' prioritizations of different consumption baskets (as their measure of inflation). Norges Bank writes that the variance of expectations declined throughout 2020 but remains larger than in normal times. The potential risk related to this development is that if the variance increases over time, expectations could de-anchor from the inflation target (Ebrahimy, Igan & Martinez Peria, 2020). In our R&S-model, this could lead to so-called *confidence shock* (Røisland & Sveen, 2018). As stated in section 2.5.6, this type of shock is more complex than the model aims to capture, so we do not attempt to illustrate this.

Norges Bank has communicated that although the policy rate usually shows gradual changes if the public's confidence in their ability to keep inflation low and stable deteriorates, it may be "appropriate to react more strongly in setting the interest rate than normal" (Norges Bank, 2020u, p.50). Erlandsen and Nielsen Friis (2020) conclude that although uncertainty regarding the short-run inflation expectations have increased, in the long-run, expectations seem to be anchored on the target. The effects of the expansionary policies are still uncertain.

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[48] Norges Bank conducts a quarterly survey of expectations. Roughly 1000 households are surveyed as well as 500 business leader and 80 experts representing labor unions, the finance industry and academia, see https://www.norges-bank.no/en/news-events/news-publications/Reports/expectations-survey/?tab=null&newstype=0&year=0&p=10 for complete database

5.4 Development in the Neutral Real Rate

Both the Taylor rule and the R&S-model incorporate the neutral real rate as a partial determinant of the optimal interest rate. Norges Bank states that they actively use estimates of this rate in their assessment of policy rate changes. This section discusses how two factors may impact the neutral real rate in light of the covid-19 crisis, namely increased precautionary savings and Government issuance of bonds.

Being a small open economy, Norway is heavily affected by international developments in the determinants of the global rate. The domestic neutral real rate closely follows the global rate. In the past decades, the long run interest rate has displayed a declining trend. This can, in part, be attributed to declining productivity growth since the Financial Crisis of 2008 and the increased global savings rate. This must be interpreted such that the neutral real rate is also in decline. We display this development in figure 35. Can the covid-19 crisis amplify this effect?
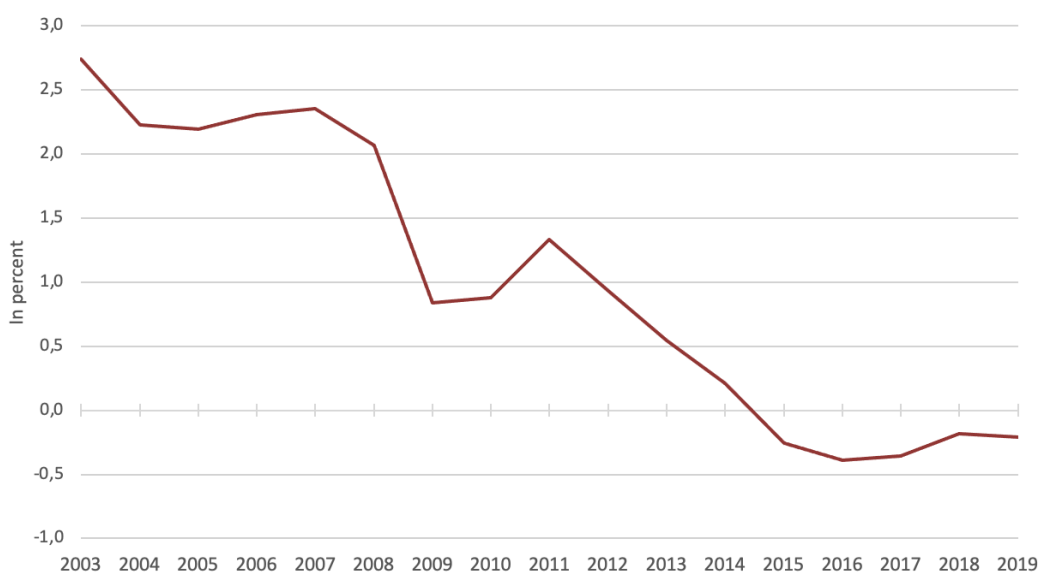
Figure 35 - Development of the neutral real rate

In the beginning of 2020, the market expectations of the level of the money market rate in five to ten years was approximately 2% (Norges Bank, 2020s). Following the Fisher equation, this means that if the inflation target is solidly anchored on 2%, the (expected) implied neutral money market rate is zero. After the outbreak of the pandemic, decreases in the long implied money market rate could be indicative of an even lower real neutral rate.

In the long run, the determinants of the neutral real rate are the demand for and supply of savings (Ng & Wesser, 2018). On a global level, according to Moody Analytics, the international community has stockpiled an extra 5400 billion USD (compared to 2019 spending patterns) since the outbreak of the pandemic (Romei, 2021). In the case of Norway, the savings rate for households, excluding dividends, increased from 3,0% in 2019 to 12,5% in 2020, as shown in figure 36. To provide some perspective, the average savings rate in the period 2003 - 2019 was 1,64%. Moreover, the four-quarter growth of bank deposits (owned by households) reached 119 billion NOK[49], constituting a new savings record for Norway (Cock Rønning, 2020).
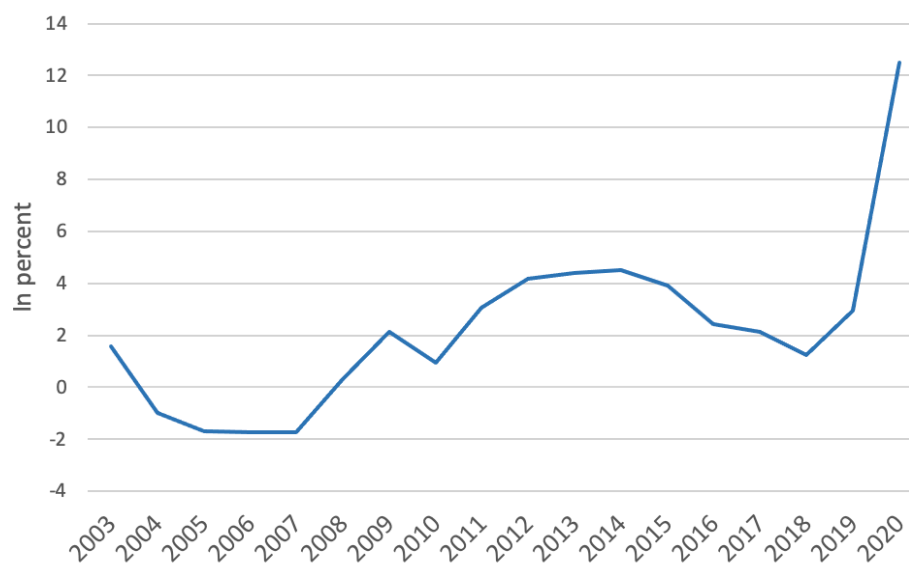
Figure 36 – Household savings rate

New investment in mutual funds by households has also displayed an increasing trend since March 2020, where, initially, the news of the pandemic led to a large-scale sell-off (Verdipapirfondenes Forening, 2020). In November, another record was broken as households' net purchases of mutual funds reached 5 billion NOK, the highest level of household's purchases of mutual funds registered in history.

In isolation, following standard economic theory, it is perhaps surprising that the savings rate increased when the interest rates fell. Savings is, after all, an increasing function of the real

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[49] As discussed in section 5.3, this can perhaps exemplify money being kept out of circulation temporarily which could perhaps contribute to an inflation shock if there is an abrupt and strong shift towards consumption rather than saving

rate, while (real) investments are negatively dependent on the real rate. However, a consequence of the covid-19 crisis has been that the marginal propensity to consume have declined as the unemployment rate (and unemployment risk) have risen. Jordà, Singh and Taylor (2020) find evidence that a common characteristic in times of pandemics is a rise in precautionary savings, which, from figure 36, also seems to be the case for Norway in 2020. Increased savings following interest rate cuts is in opposition with standard economic theory, and, therefore, it is fair to say Norges Bank's policy rate cut was not aimed at stimulating the savings rate. Increased savings is also indicative that investment demand will likely subside. This is a result of labour scarcity suppressing the need for investments, further incentivizing saving. The effect of this mechanism on the real rate is illustrated in figure 37, where we see that savings curve shifts downwards, resulting in a lower real interest rate.
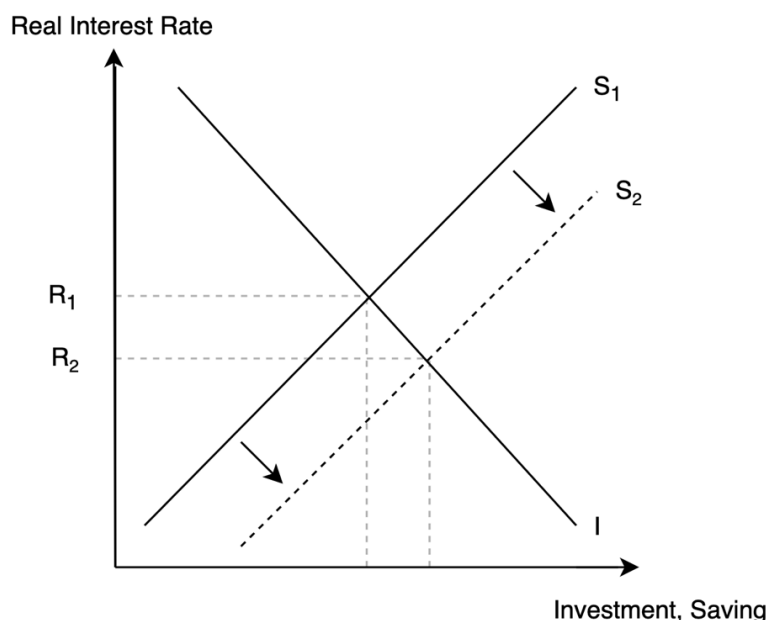
Figure 37 - The market for savings and investment

On the other hand, the massive increase in fiscal spending globally on containment measures (financed by debt) to counter the economic downturn may pull in the opposite direction. This can be explained by the fact that the neutral real rate of interest is equivalent to the real returns on safe assets, which equilibrates saving supply and investment demand in a country (Jordà, Singh & Taylor, 2020). By issuing debt through selling bonds, the supply of safe assets increases. The main mechanism of this is that the price of the bonds falls while the interest rate rises. Many countries depend on this approach to obtain sufficient resources to fight the

virus, and this will ultimately have a positive effect on the neutral real interest rate[50].

However, Norway's financial situation is unique in the sense that we do not need to finance a fiscal budget deficit with debt but can rely on the savings in the Government Pension Fund - Global (GPF-G). In contrast to other countries, the Norwegian government established a scheme on March 15, 2020, which gave Folketrygdfondet[51] mandate to purchase bonds from the largest corporations in Norway in order to increase liquidity and capital in the bond market with a starting capital of 50 billion NOK (Ministry of Finance, 2020c). Thus, the upwards pressure on the interest rate from bond issuance is not directly observed in Norway.

Thus, the two methods of financing virus containment measures result in different effects on the Norwegian nominal interest rate through the exchange rate channel in the transmission mechanism. GPF-G is in its entirety placed abroad, meaning that increasing transactions from the fund to cover the oil-adjusted budget deficit involves currency exchange, which, if done on a large scale, can appreciate the NOK. On the other hand, the interest effects from the issuance of the bonds globally work on the Norwegian economy by weakening the currency, pulling the interest rate upwards. The aggregate effect is therefore ambiguous.

To conclude this section, we point out that in the months at the outbreak of the Financial Crisis in 2008, Norges Bank's policy rate was 5,75%, while, as we have already stated, the policy rate in March 2020 was only 1,5%. Following, for instance, the Fisher relation, a low and decreasing neutral real interest rate can restrict the space to manoeuvre the policy rate. By not being able to conduct sufficiently expansionary monetary policy, downturns could last longer and become more profound than if the opposite case was true. This represents the contrasting challenges to the one outlined in section 5.2, where the loan ratio could possibly restrict the space to increase the rate. Different considerations pull in different directions. The next section discusses how different factors affect the changes in the projected interest rate path ahead.

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[50] Central banks in these countries may attempt to counteract the increased interest rate by lowering the interest rate in recessions. However, as many countries are near the effective lower bound, central banks use quantitative easing programs to reduce the rates.

[51] Folketrygdfondet is a professional investment manager whose primary objective is to manage the Government Pension Fund Norway on behalf of the Ministry of Finance (Folketrygdfondet, 2014).

5.5 Decomposition of the Rate Path

In the previous sections of this chapter, we have discussed movements in central macroeconomic sizes and outlined potential risk factors these movements may imply. Norges Bank publishes a graphical decomposition of the factors contributing to the projected policy rate path. In this last section, we conclude this chapter by taking a step back to discuss the composition of the first projection of 2021 in light of our analysis. Finally, we present a projected Taylor rate and compare it to the projected policy rate presented by Norges Bank.

5.5.1 Projected Policy Rate

Norges Bank's projected rate path is rising in the latter half of 2021 (Norges Bank, 2021b). The cumulative contribution of different factors determines the percentage point change in the projected policy rate path, illustrated by the black line in figure 38. Each factor is assigned a coloured bar, and the relative sizes of the included factors are apparent from the direction and height.
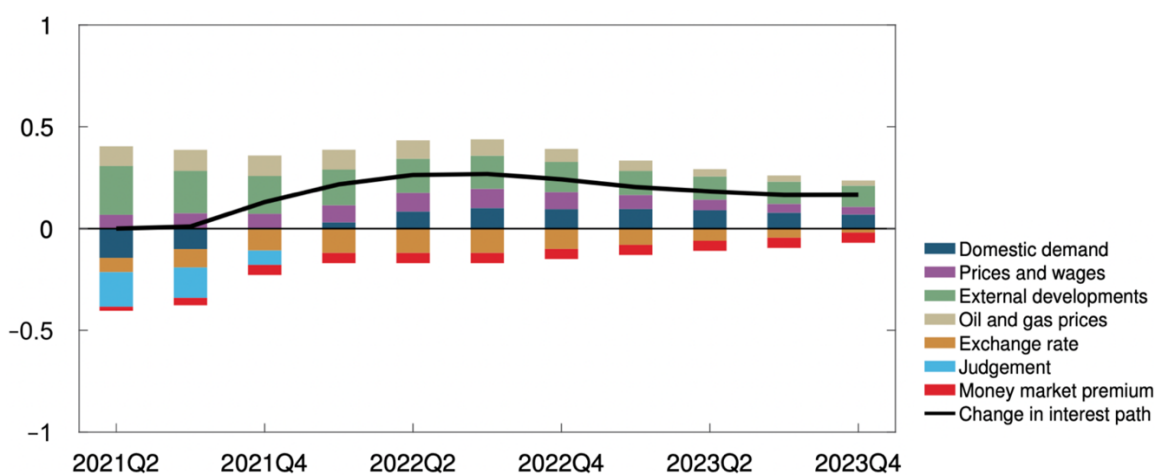
Figure 38 - Changes in rate path, 2021Q1 projection (Norges Bank, 2021b)

Domestic demand (dark blue) is projected to have a negative impact on the rate change in the first half of 2021, and an increasing positive impact from the start of 2022 onwards. In section 4.4 we pointed at the fact that the reduced demand is partly induced by Government regulation, and so projections of increased consumption may be following easing of social regulations, vaccination programs etc. Prices and wages (purple) pull the projected rate path upwards. In light of our discussion of inflation outlook in section 5.3, it seems that Norges Bank expects

that a higher interest rate will be necessary to prevent inflation levels from rising above target, and so seems to disagree with Powell's statement of disinflationary pressure. We discussed the impact of external developments (green) in section 5.4. We concluded that rising international interest rates, following the issuance of bonds to cover budget deficits, will put upwards pressure on the interest rate through the exchange rate channel. This fits the projected effect on the development of the rate path.

The light blue bars represent what Norges Bank refers to as judgement, which is an "overall assessment of the monetary policy stance" (Norges Bank, 2020u, p. 47). Judgement-based adjustments are made in order to moderate the response when the other contributing factor estimates are volatile or unbalanced and suggest a rate path that appears to generate higher costs than benefits. In the final MPR of 2020, the judgement bars for the first two quarters of 2021 pulled the interest rate path up (Norges Bank, 2020u). In figure 38, however, judgement pulls the forecasted path down significantly in Q2. According to the 2021 report, the judgement bars are negative because of the Monetary Policy and Financial Stability Committee's assessment that the rate should be raised only when clear signs that the situation is normalising can be observed (Norges Bank, 2021b). This demonstrates that there is considerable room for making discretionary assessments in Norwegian monetary policy.

NBW has, on several occasions, requested that Norges Bank be more transparent about the foundation for these discretionary assessments, seeing as they are less predictable than the purely model-based policy reaction to news regarding economic conditions (Doppelhofer & Knudsen, 2020). The pattern we observed in the correlation between the policy rate and a simple rule in section 4.1 indicates that such assessments are systematically used more in crises.

5.5.2 Projected Taylor Rate

We plot the projected policy rate alongside a projected Taylor rate to examine their relationship in figure 39. This is done by using the same Taylor rule coefficients as in section 4.1, while the data for the output gap and inflation gap is based on Norges Bank's projections published in MPR 1/21. The most distinct feature is the convergence, especially apparent from Q3 2022 onwards. How can this be interpreted?

Figure 39 - Projected Taylor rate and policy rate. Data from Norges Bank (2021b)

The projected Taylor rate is a better fit than the Taylor rate in section 4.1. This can partially be explained by the fact that two rate projections in figure 39 are based on the same data sets for output gap and inflation. In section 4.1, our Taylor rate was based on an estimated output gap and inflation gap where we used observed data, which have, perhaps, already been subjected to revision. In contrast, Norges Bank's policy rate decision was based on their projections and available information at the time of the interest rate decision. It could then be the case that at the time, Norges Bank had imperfect estimates, and so even if they did use a simple Taylor rule, the resulting rates would not be the same.

However, from figure 39, it is clear that the projections for the near-term deviate substantially, especially for Q1 2021, where 154 basis points separate the two rates. In section 4.1, our calculated Taylor rate started to exhibit a drop in Q4 2020. This projected continuation of figure 12 displays a sluggish reaction due to its backward-looking nature. The gap ultimately shrinks when the time horizon is extended. The rates do not converge entirely, but they seem to converge to a stable linear relationship. The remaining gap could stem from differences in neutral real rate, as we have used the data limited to include 2019, while Norges Bank, in all likelihood, has updated numbers.

It seems to be the case that fundamentally, in the longer run, and in a no-shock scenario, the policy rate is determined by a simple rule, strikingly similar to our Taylor rule. An explanation

for the difference between the projected rates in the near future, is that the effects from the shocks have not yet passed or been neutralized. Another explanation for this is that from Q3 2022, Norges Bank has not yet included any anticipated shocks into their interest rate model, and so there is no reason to diverge from the model-based policy rate and use discretion in their projections. The latter is also clear from the absence of judgement bars in the medium-term in figure 38. However, in real time, and in the short run, shocks and unanticipated events occur which the Taylor rule does not account for, and so discretion or other models are used.

6. Limitations and Robustness

We identify three main limitations to this thesis. The first relates to our data. Firstly, macroeconomic data such as GDP and inflation are collected with a considerable lag. Since we focus on recent events, most of the data series have been published relatively recently, which means they may be subject to revision. Moreover, there may be special considerations in the data series due to the erratic way in which the covid-19 virus has been spreading and rapid changes in the situation. For example, the most recent unemployment statistics may be less accurate as a result of under and over reporting of furloughed workers since the time horizon for furloughs is highly unpredictable. Secondly, some important variables in our models are estimated and not directly observed. For instance, our estimated output gap is limited by the precision and choices of the HP-filtering technique applied. However, the potential sources of error are limited, as we have collected data exclusively from reliable sources and used standard values for the relevant parameters.

The second limitation relates to our model frameworks. We have previously outlined the merits and shortcomings of our chosen models in their respective sections in chapter 2. The covid-19 crisis has changed the flow of basic economic mechanisms, and exposed new challenges requiring unconventional policy solutions. The Taylor rule only accounts for the interest rate decision and is therefore of limited use in explaining other policy measures. The RS-model can neither account for several shocks occurring at once nor the broad range of policy tools utilized. Despite the limitations we have encountered when applying these models to our case, we have found that they provide a sound foundation for understanding important mechanisms, lending valuable structure to our analysis. As famously stated by George Box: "..all models are approximations. Essentially, all models are wrong, but some are useful." (Box & Draper, 1987, p. 424).

Finally, the third limitation follows from our scope, largely excluding international factors and fiscal policy. We have, for the most part, strictly focused on the Norwegian macroeconomic variables. However, economic trends in a small, open economy are highly affected by international factors. Incorporating data from the international factors contributing to determining the Norwegian variables would have added robustness to our analysis. Additionally, comparing the monetary policy response of other countries to the Norwegian case, could have contributed to our understanding of alternative tools and measures.

Furthermore, fiscal policy has been extensive and impactful both in Norway and abroad. Analysing the interaction between monetary and fiscal policy response would make for a more complete analysis. We also note that separating the effects of monetary policy, fiscal policy, and self-regulating measures is difficult at this point in time. This analysis, aiming primarily at describing the broad lines and most prominent trends of the policy response, is not particularly limited by this.

7. Conclusion

This thesis has decomposed the monetary policy response to the covid-19 crisis and its potential impact on central economic variables. We have discussed how a broad range of policies have been used to tackle the crisis by utilizing macroeconomic data and interpreting central relations through the lens of macroeconomic models. Furthermore, we have discussed the shortcomings of existing literature in incorporating the policy tools used in the policy response. In order to structure our decomposition, we have addressed two research questions.

7.1 Research Question I

In order to answer the first research question, we analysed how different monetary policy objectives were prioritized in the initial phase of the pandemic in 2020 and which measures comprised the Norwegian monetary policy response to covid-19. Using a simple Taylor rule, we found that our Taylor rate is lagging the policy rate. This can, in part, be explained by its backward-looking specification. We also observed that the policy rate responds more aggressively than our Taylor rate indicated in downturns. The Taylor rate overshoots the interest rate level in all consecutive quarters in 2020, deviating from the policy rate by 4 percentage points at the most. Thus, we conclude that other considerations than the output gap and the inflation gap were prioritized.

Furthermore, we found that based on our data, the covid-19 crisis can best be understood as a supply-side shock, where restricted supply has pushed the price level of assets and dwellings upwards. When analysing the shock conceptualized as a positive risk-premium shock, we have found that the RS-model's optimal policy is increasing the interest rate. In isolation, this is supported by theory, but in our case, it exposes the inability of the model to take into account several shocks at once. In addition, the model disregards the transmission from the policy rate to market rates through a modelling short-cut.

To achieve the transmission, Norges Bank's interest rate response was supplemented by an extensive F-loan scheme in NOK and USD from Norges Bank. Through our analysis, we found that this arrangement was used to a large extent. It seems to be the case that Norges Bank has prioritized the transmission to the money market rates over promoting interbank activity and allocation of liquidity among participants. Additionally, we found that the F-loans

and F-deposits were quite successful in stabilizing liquidity their target. The unprecedented positive risk premium shock was met by the extraordinary currency interventions, which coincides with the appreciating NOK in time. NIBOR also stabilized in early May, which can partially be attributed to the liquidity measures. Finally, we conclude that the moderate reduction of the countercyclical capital buffer may have resulted from diverging buffer guide indicators.

7.2 Research Question II

In order to answer the second research question, we analysed the extent to which the prioritization of monetary policy objectives has contributed to future risk factors and how important macroeconomic and financial variables are developing. In the first section, we outlined the transmission from the policy rate to bank lending. We found that the loan margin increased, while the deposit spread dropped substantially following the policy rate cut. We point out that this may be attributed to the existence of a zero-lower bound on deposits. The low deposit spread can perhaps therefore be "subsidized" by high loan margins. Moreover, we argued that, in combination, the pressure on banks from the public to cut lending rates and the fall in NIBOR, aided the transmission from the policy rate cuts. This is in line with Norges Bank's analysis of the policy rate transmission to market rates.

When analysing financial imbalances in the second section, we noted that macroprudential policy introduced as a response to the Financial Crisis of 2008 likely softened the blow of the covid-19 crisis. The fact that most indicators were signalling low risk of financial imbalances prior to March 2020, implied that the risk associated with conducting expansionary monetary policy was more tolerable than it otherwise could have been. We identified household debt service and credit gap as high-risk areas, which have been amplified by the monetary policy response. We concluded that these areas may pose a financial stability risk in the medium and long-term, and that the increased risk associated with this is a direct consequence of the prioritization of other policy objectives. Additionally, we pointed out regulation of the housing market as a policy instrument suited to counteract these risks building up but noted that the modifications made to such regulations in relation to covid-19 go in the opposite direction. In theory, this more lenient regulation contributes to increasing the risk of financial instability. This is another indication that financial stability concerns have not been a priority for policymakers during covid-19, and therefore may pose a bigger threat in the future.

We also discussed the potential inflation path following the policy measures. We found valid arguments in favour of rising inflation outlooks, but also in favour of low inflation ahead. The arguments discussed in favour of the first, include substantial growth in money supply aggregates and rising production costs following social distancing. The arguments we presented in favour of low inflation, focused on the Government induced rise in unemployment, which heavily restricted economic activity, and represented low capacity-utilisation. Moreover, we argued that the rise in the savings rate may also pull in the same direction. Our analysis of the development in this economic variable was concluded by assessing how uncertainty may impact inflation expectations in light of changes in the variance of inflation expectations. We pointed to household heterogeneity as an explaining factor. Furthermore, we outlined whether or not there is a potential risk of expectations de-anchoring from the inflation target, concluding that in the longer run, there is not.

We also analysed the development of the neutral real rate. The analysis was centred on three main factors: the savings rate, the increase in bond supply in the global community, and increased transactions from GPF-G involving currency exchange. The latter two result from the need to finance virus containment measures. Firstly, we found that precautionary saving has led the savings rate to rise dramatically, resulting in downward pressure on the neutral real rate. Secondly, we argued that the increased bond supply globally may contribute to pulling in the opposite direction. We pointed out that the Norwegian case is unique in the sense that the Government can draw upon the GPF-G, and so the effect of increased bond issuance is only indirectly observed in Norway. However, we pointed out that transactions from the GPF-G may have currency effects if done on a large scale, which again can incentivize changes in the interest rate.

Finally, to conclude the analysis of our research question, we used Norges Bank's most recent projected policy rate path decomposition to summarize our findings. We noted the fluctuations in how the committee's "judgement" factors into the policy rate projection. This is in line with our findings related to the relative size of the "Taylor gap" in crises. Lastly, we compared Norges Bank's decomposed projected policy rate to a projection of our Taylor rate. The projected policy rate represents Norges Bank's assessment of, and best response to, the overall development in macroeconomic and financial variables. Our projected Taylor rate, on the other hand, is based on a simple instrument rule. We found a distinct convergence between the two, which is particularly noticeable from Q3 2022 onwards. Thus, the interest rate

decision seems to be fundamentally guided by the inflation and output gap in no-shock scenarios. However, the monetary policy we have analysed through our two research questions is significantly more complex. The Norwegian monetary policy response to the covid-19 crisis illustrates how combining a variety of measures is necessary to balance conflicting monetary policy objectives in a crisis.

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Appendix

Table A1 – Data Sources

Data	Description	Time period	Source	Direct Link
Output	Gross domestic product (market value) in constant 2018 prices and seasonally adjusted	4Q2003 – 4Q2020*	SSB Table 09190	https://www.ssb.no/statbank/table/09190/
Inflation1 (CPI-ATE)	CPI-JAE, 12-M percentage change, index year = 2015 (CPI-JE used for Q4 2003 since JAE not available)	2004M9 – 2020M12	SSB Table 05327	https://www.ssb.no/statbank/table/05327/table ViewLayout1/
Neutral Real Rate	Average of four model estimations	2003 – 2019	Norges Bank, MPR 3/20	https://www.norges-bank.no/contentassets/259302d7e57e4710b1f 8f3b3795e017e/tallsett-ppr-3-20-eng.xlsx?v=10/05/2020123224&ft=.xlsx
Principle Policy Rate	Interest rate on banks' overnight deposits in Norges Bank up to a specified quota (quarterly, monthly, daily)	4Q2003 – 4Q2020	Norges Bank	https://www.norges-bank.no/tema/Statistikk/Rentestatistikk/
Norges Bank's Bank Rates	Reserve rate and overnight lending rate	01.01.2020 - 30.12.2020	Norges Bank	https://www.norges-bank.no/tema/Statistikk/Rentestatistikk/
Projection for GDP1 and GDP2	Estimated quarterly GDP growth from MPR 4/19, revised in 1/20	1Q2019 – 4Q2020	Norges Bank, MPR 1/20	https://www.norges-bank.no/contentassets/7f54db78676a4e959ef abb0233ea1665/data-mpr-4-20.xlsx?v=12/17/2020092059&ft=.xlsx
Residential Housing Prices	Index (2015 = 100), seasonally adjusted quarters	4Q2018 – 4Q2020	SSB Table 07221	https://www.ssb.no/statbank/table/07221/
Inflation2 (CPI)	CPI (all items) 12-M percentage change, index year = 2015	1Q2019 – 4Q2020	SSB Table 05327	https://www.ssb.no/statbank/table/05327/table ViewLayout1/
Exchange Rate (I-44)	Import-weighted krone exchange rate	03.01.2020 - 01.09.2020	Norges Bank	https://www.norges-bank.no/tema/Statistikk/Valutakurser/?tab=curr ency&id=I44
F-deposits/ F-loans	Loan and deposit instruments as part of Norges Bank's market operation for liquidity management	01.01.2020 - 30.12.2020* ***	Norges Bank	https://www.norges-bank.no/tema/Statistikk/bankenes-likviditet/
NOWA	Interest rate on unsecured overnight interbank loans	01.012020 - 30.12.2020	Norges Bank	https://www.norges-bank.no/en/topics/liquidity-and-markets/nowa/
Total Bank Liquidity	Total liquidity in the banking system (reserves), daily data	02.01.2020 – 30.06.2020	Norges Bank	https://www.norges-bank.no/tema/Statistikk/bankenes-likviditet/
NIBOR Risk Premium	Risk premium for Norway's primary money market rate, NIBOR (3M)	01.01.2020 - 30.12.2020	Norges Bank	https://www.norges-bank.no/contentassets/7f54db78676a4e959ef abb0233ea1665/data-mpr-4-20.xlsx?v=12/17/2020092059&ft=.xlsx
NIBOR1	Primary money market rate (3M)	02.01.2020 – 30.06.2020	Bloomberg Terminal	
Credit Gap	Households' domestic debt, non-financial enterprises domestic debt, non-financial enterprises foreign debt as a share of GDP for mainland Norway	4Q2003 – 4Q2020	Norges Bank	https://www.norges-bank.no/contentassets/bcf221cb767b4dbe9df debbf283e4ecc/dataseries-indicators-q1-2021.xlsx?v=03/18/2021082105&ft=.xlsx
Loan Margin/ Deposit Spread	Interest on total outstanding mortgages loans minus NIBOR/ NIBOR minus interest on deposit	2018M1 – 2020M12	SSB	https://www.ssb.no/bank-og-finansmarked/artikler-og-publikasjoner/okt-fastrente-pa-nye-boliglan
NIBOR2	Primary money market rate (3M)	2018M1 – 2020M12	NoRe	https://www.referanserenter.no/wp-content/uploads/2020/04/Knapp-Average.png
Household's Debt Service	Debt service ratio, interest burden and loan debt for households, mainland Norway	4Q2003 – 4Q2020	Norges Bank	https://www.norges-bank.no/contentassets/bcf221cb767b4dbe9df debbf283e4ecc/dataseries-indicators-q1-2021.xlsx

Money Supply Aggerates	12-M percentage growth in the primary money supply aggregates for Norway (M1, M2 & M3)	2020M1 – 2021M4	SSB Table 10945	https://www.ssb.no/statbank/table/10945/
Unemployment	Registered unemployment as a share of the labor force; partially unemployed (ordinary), partially unemployed (furlough), fully unemployed (ordinary) and fully unemployed (furlough),	2020W3 – 2020W52***	Norges Bank, MPR 4/20	https://www.norges-bank.no/contentassets/7f54db78676a4e959ef abb0233ea1665/data-mpr-4-20.xlsx?v=12/17/2020092059&ft=.xlsx
Savings Rate	Household savings ratio excluding dividends, anually	2003 - 2020	Norges Bank, MPR 1/21	https://www.norges-bank.no/contentassets/6f148f296f154705a0d8 45839e638351/data-mpr-1-21.xlsx?v=03/18/2021095205&ft=.xlsx
"Projected Taylor" data	Estimated output gap (GDP, mainland Norway) and estimated inflation gap (CPI-ATE), quarterly projections	1Q2021 – 4Q2024	Norges Bank, MPR 1/21	https://www.norges-bank.no/contentassets/6f148f296f154705a0d8 45839e638351/data-mpr-1-21.xlsx?v=03/18/2021095205&ft=.xlsx
Projected Policy Rate	Quarterly projections of the policy rate	1Q2021 – 4Q2024	Norges Bank, MPR 1/21	https://www.norges-bank.no/contentassets/6f148f296f154705a0d8 45839e638351/data-mpr-1-21.xlsx?v=03/18/2021095205&ft=.xlsx

* qx20xx = Quarterly data, ** 20xxmx = Monthly data, ***2020wx = Weekly data, **** dd.mm.yy = Daily data