

# Norges Bank Watch 2023

## – An independent evaluation of monetary policy in Norway

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*March 2023*

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# Foreword

Each year the Centre for Monetary Economics (CME) at the Department of Economics, BI Norwegian Business School, appoints an independent group of experts to evaluate monetary policy in Norway.

This year the NBW committee consists of Martin Blomhoff Holm, Assistant Professor at the University of Oslo, and Kjetil Martinsen, Chief Economist at Swedbank Norway.

The NBW committee is solely responsible for the report and the views therein. The report does not necessarily represent the views of the CME or of its members. The Ministry of Finance uses the Norges Bank Watch reports as input to their annual Financial Markets Report to the Parliament, when assessing the conduct of monetary policy. The Ministry of Finance partly funds the Norges Bank Watch reports.

Oslo, March 1, 2023  
Centre for Monetary Economics  
Tommy Sveen

# Introduction

This report, Norges Bank Watch 2023, evaluates the conduct of monetary policy in Norway in 2022. In section 1 we list our main assessments of the conduct and communication of the monetary policy. Section 2 describes the economic and monetary policy developments throughout the year. In section 3, we re-estimate the output gap for the Norwegian economy over the pandemic years using a bottom-up approach. In section 4, we discuss the usefulness of Regional Network's price variables and suggest future improvements of the survey. In section 5, we discuss what matters for how the central bank should respond to high inflation, highlighting the role of the source of inflation, the monetary transmission channels, and the marginal cost of inflation in determining the interest rate response.

The committee met with the Ministry of Finance on December 8, 2022, and Norges Bank on December 21, 2022. We thank Norges Bank and the Ministry of Finance for interesting and productive discussions, and Karl Harmenberg and Marianne Sturød for comments and suggestions. Additionally, we would like to thank Gisle James Natvik for discussing the estimation of the output gap in section 3.

## 1. Executive summary and main recommendations

When evaluating Norges Bank's monetary policy for 2022, it is hard not to look at the past three years more in combination. Monetary policy usually works with long implementation lags, and central banks often tend to look ahead when designing their monetary policy strategy. However, looking far ahead into the future and projecting economic developments with high precision has been difficult over the past years. 2022 was no different. Since the outbreak of the pandemic in 2020, the Norwegian economy has been riddled with pronounced economic shocks and heightened uncertainty regarding the future path of economic developments and the correct monetary policy response.

Looking back, Norges Bank raised the policy rate by 2.25 percentage points during 2022, the most since 1998. 2022, first and foremost, stands out as a challenging year for monetary policy. Pandemic-related containment measures, high stocks of retained household and corporate savings, reopening of the economy with rotation of demand from the goods to the services sector, a war in Europe, highest inflation since the 1980s amid surging energy prices, cost pressures from high demand and supply issues during the pandemic years and tight labour markets have all contributed to making the optimal monetary policy response challenging. Still, we deem Norges Bank's decisions well-balanced and well-timed, considering the current situation of pronounced global shocks.

Norges Bank should be acknowledged for remaining open and clear in its communication and striving to fulfil its mandate. For example, after raising the policy rate in August, Governor Ida Wolden Bache held a presentation explaining to the public at Arendalsuka and widely broadcasted why they were hiking the policy rate faster. Moreover, at the interim policy meeting in November, Norges Bank hosted an extra press conference explaining its decisions and outlook on the economy. While press conferences have not been common at these interim policy meetings in recent years, this has been a welcome addition to Norges Bank's communication.

Additionally, Norges Bank included several boxes in their Monetary Policy Reports on inflation in 2022. These boxes have aimed to describe more thoroughly how Norges Bank assesses the current inflation situation and the outlook for the near term. They have discussed drivers and channels for inflation and deliberated whether these drives and channels have changed after inflation started to surge. Indeed, Norges Bank has included two "Special topics" on cost pressures, capacity utilisation, and prices in their Regional Network reports to further shed light on how businesses see the changing conditions during the year. Moreover, as Norwegian households are highly indebted and most have floating mortgage rates, Norges Bank has utilised its access to micro data on households' balance sheets to evaluate how different household types are affected by higher mortgage rates. All these efforts add to the credibility of Norges Bank's strategy of hiking the policy rate at a fast pace in 2022.

Monetary policy has limitations to what it can achieve with the policy rate. While we credit Norges Bank for being open and clear in its communication regarding its policies and striving to understand developments in their target variables, such as inflation, output, and employment, Norges Bank could also have been discussing the totality of policies undertaken

during 2022. Norges Bank should remain an independent central bank, but there should be room for Norges Bank to be vocal on what it deems to be the best interaction of economic policies for the Norwegian economy. Discussing the optimal policy mix is a sensitive topic, as it might border on the central bank's independence. However, Norges Bank has several times before been clear on a different policy mix that could improve the economy's long-term prospects and result in a more stable economic development. For example, at the Annual Address in 2022, former Governor Øystein Olsen argued in favour of adjusting the fiscal spending rule. Also, during the downturn in oil almost ten years ago, Norges Bank was vocal about the limitations to monetary policy when facing a supply shock to one sector.

In the current situation, monetary and fiscal policy must work together, as Governor Ida Wolden Bache commented in the Annual Address (2023). Monetary policy is often referred to as the first response of economic policy. Fiscal policy can, however, also impact economic activity and price growth – as seen through 2022. For example, after the Government's electricity support scheme for households was introduced in late 2021, headline CPI inflation has been reduced by almost two percentage points on average. For comparison, researchers at the Swedish Riksbank (Laséen et al., 2022) have estimated the effect of increasing the policy rate by one percentage point to reduce average inflation by 0.20 percentage points over the next one to three years, given a "normal" passthrough in the economy. A more permanent rise in interest rates strengthens the effect on inflation but has a markedly more negative impact on GDP growth.

This example underscores that there could be situations where fiscal policy is effective when aiming to tame inflation, perhaps more so when the primary inflation source stems from external sources, such as higher energy prices. However, there is no free lunch. All fiscal spending either increases the fiscal impulse or requires adjustments to the fiscal budget. Still, it should be in Norges Bank's interest to find and communicate how they see the optimal way, regardless of the policy mix, to achieve its mandate of low and stable inflation over time, combined with high employment and financial stability. We thus encourage Norges Bank to research the effects on inflation from tighter monetary policy, á la Laséen et al. (2022), and include the effects of different fiscal policy measures.

Last year's Norges Bank Watch (2022) called for Norges Bank to improve the system for foreign exchange transactions as the system causes volatile money market premiums. We want to extend this recommendation, especially after a year in which FX transactions have been record-high based on unprecedentedly high gas prices, which resulted in large tax payments from oil and gas companies to the state. While it is difficult to project with a high degree of certainty the level of tax payments from the oil and gas companies, the fluctuations in the money market premiums over the past three years illustrate that there may be a scope for improvement to reduce the impact from the volatility in tax payments' effect on the money market. As we understand, Norges Bank is already working on improving data availability on its prognosis for structural liquidity, which we deem could already reduce some of the short-term volatility in money market premiums. There is also planned a working group led by the Ministry of Finance with efforts to look more deeply at several elements of the system for FX transactions (Ministry of Finance, 2022). We support this effort.

While being among the first Western central banks to start normalizing monetary policy, Norges Bank still underestimated the strength of the economic upswing during the last year and how

fast and how high inflation would rise. In the coming chapters, we would thus like to emphasise different topics where we discuss important elements of the Norwegian economy and how Norges Bank's monetary policy has been conducted over the past years.

To shed light on the situation, we first summarise the most important developments through 2022, focusing on Norges Bank's assessment of the current situation and conduct of monetary policy. Second, we question Norges Bank's estimation of the output gap for the Norwegian economy over the pandemic years of 2020 and 2021, with the risk of keeping the policy rate at a too low level for too long. As the pandemic has been unprecedented for the global economy and policymakers were put to the test without any modern historical references, the uncertainty was greater than normal. With the benefit of hindsight, it is easier to conclude that Norges Bank likely saw the pandemic as too much of a negative demand shock, thus having a large negative impact on the output gap, rather than a negative supply shock also impacting potential output in the economy.

We estimate the output gap using a more unconventional method, looking at different sectors of the economy individually and finding that the negative impact on the output gap was smaller than Norges Bank still asserts. Our output gap estimate is also more in line with other crosschecks for capacity utilisation in the Norwegian economy, such as labour market tightness and the Regional Network. Moreover, our estimate of the output gap suggests, in isolation, that the policy rate should have been lifted earlier than Norges Bank did in September 2021. While this analysis is counterfactual, it is an important discussion on the impact of accommodative monetary and fiscal policy through the pandemic years. Additionally, our bottom-up approach for estimating the output gap should serve as a crosscheck for estimating the output gap also going forward. We thus recommend Norges Bank research and adopt more micro-founded versions of the output gap to have a more robust estimate of the output gap in the future.

Third, considering the sharp rise in inflation over the past year, the need for understanding the drivers of inflation and the passthrough of higher prices in the economy has increased. In that regard, we have looked more into the usefulness of the Regional Network. While the Regional Network is widely used and recognised for its ability to assess the current situation for the Norwegian real economy and the near-term expected developments, we find that the parts of the survey concerning inflation and price pressures are less useful. On the other hand, the Bank of England's Agents' Summary on Business Conditions divides the questions on inflation into consumer and producer prices. On that basis, the results from their survey also show a much higher correlation with actual consumer and producer price inflation.

Unfortunately, Norges Bank announced on 8 February 2023 to discontinue the questions on inflation in the Regional Network. Rather than removing the questions, we recommend Norges Bank draw experience from the Bank of England survey and alter the questions to be more directed towards consumer and producer inflation and with a sharper division between the two parts, potentially getting a better fit with actual inflation. Our view is that a better correlation between the survey and actual inflation will also improve the qualitative attributes of the survey, hence describing the risks to the outlook. Moreover, this could make the Regional Network survey more useful in understanding the forces behind inflation changes, for example, through indirect effects such as energy prices or wage growth or other reasons such as mark-ups, changed market competition, or input factors. Not only has the last year proven that

understanding the passthrough of inflation in the economy is of instrumental significance to monetary policy, but there is also a great limitation to surveys that capture inflation dynamics in Norway. Removing one of the flagship surveys on this topic could increase the risk of misunderstanding inflation dynamics.

Lastly, we present a model to understand which factors are important for determining the interest rate response to high inflation episodes such as today. The section has three messages. First, understanding the source of inflation (demand vs. cost-push) is key to determining how monetary policy should respond. If the higher prices are due to domestic demand, the central bank should raise the interest rate to reduce demand. However, if inflation is due to other factors, such as energy prices or imported price pressure, it is more complicated because trade-offs exist between reducing inflation and inducing a recession. Therefore, understanding the deeper source of inflation is important to understand how the central bank should respond.

Second, if inflation is not demand-driven, even the sign of the optimal interest rate response is ambiguous and depends on which monetary transmission channels operate. Indeed, suppose households respond to changes in disposable income and monetary transmission works primarily via the nominal interest rate (e.g., the cash-flow channel). In that case, the optimal interest rate response may be to reduce the interest rate when prices increase. The intuition is that when households respond to disposable income, a price increase is contractionary because real disposable income declines. It is then unclear whether the central bank should dampen or deepen the recession. Hence, understanding how monetary policy transmits to the economy matters for how the central bank should respond to inflation.

Third, the interest rate response depends on what we deem to be the marginal cost of inflation, that is, how important it is to reduce inflation quickly. In a standard framework, such as presented in Norges Bank's Handbook of Monetary Policy (2022), the marginal benefit of reducing inflation is very high when inflation is as high as today. Hence, the optimal response is to induce a recession even though the central bank knows the cost-push to be transitory and that the recession only marginally affects prices. Small deviations from this assumption about the marginal cost of inflation greatly affect the interest rate policy. Hence, there should be a discussion about the cost of inflation and its importance because it has a first-order impact on the interest rate path.

## 2. 2022 - The year of monetary policy tightening

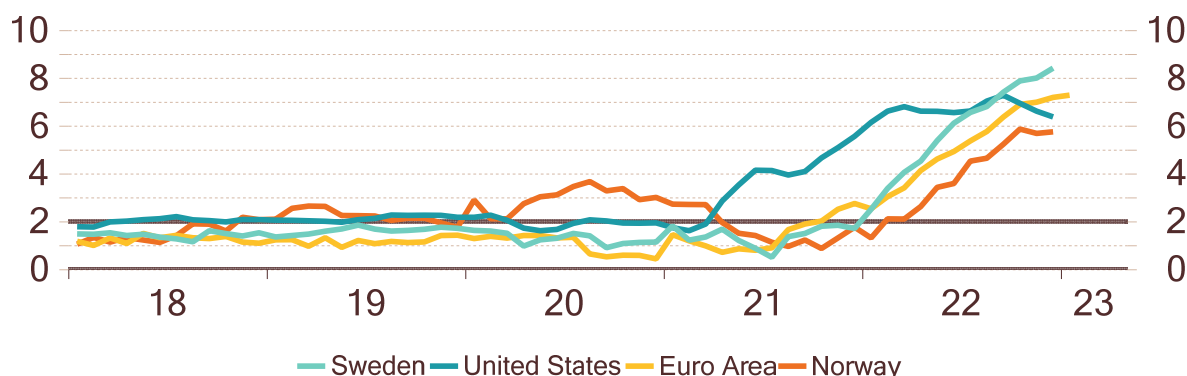
Norges Bank was among the first Western central banks to start raising policy rates during the autumn of 2021, from a record-low level of 0% to 0.25% as the economy showed signs of recovering. Still, it took only a few months before a new covid variant, omicron, became dominant, and once again, society encountered new lockdowns at the end of 2021. During new lockdowns amid the uncertainty of the severity of the omicron variant, with potential impact on the labour market, Norges Bank went ahead as communicated and hiked the policy rate for the second time in December to 0.50%. While it was expected that the Norwegian Government would come up with new measures to ease the lockdown strains for laid-off workers, this was not announced when Norges Bank's Monetary Policy and Financial Stability committee met to decide the policy rate.

### *2.1 From Covid to 2022: Cautious normalization of policy rates*

At the beginning of 2022, activity in the Norwegian economy had already recovered to levels higher than before the pandemic. Still, the unemployment rate was somewhat higher than in late 2019, but there were clear signs of improvement. Importantly, those sectors not directly impacted by containment measures posted strong growth and signs of rapidly declining spare capacity. Accumulated household and corporate savings from the pandemic were high, underscoring that a stronger upswing in the economy was expected. Norges Bank's Monetary Policy and Financial Stability Committee (henceforth, "the Committee") stressed in December 2021 that the monetary policy stance was still expansionary. However, they remained concerned with the potential negative impact the new covid variant could have on the economy, and for how long containment measures would be in place. The trade-offs in monetary policy were more pronounced; on the one hand, stricter and more prolonged lockdowns with its negative impact on economic growth and employment could mean that future rate hikes could be postponed. On the other hand, persistent global price pressures, stemming from strong demand and pandemic-related supply issues, combined with increasing domestic capacity constraints that could lead to upward pressure on domestic wages and inflation, suggested that the policy rate could be raised faster should there be prospects of persistently high inflation.

Figure 1: Core CPI excluding energy

y/y, percent



Sources: Swedbank &amp; Macrobond

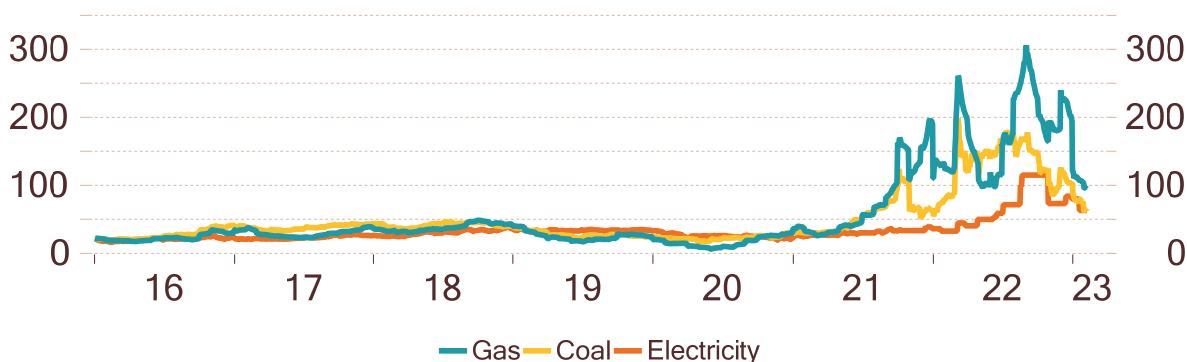
Core inflation, as measured by CPI-ATE, had declined through 2021 and stood below the target of 2% during most of that year, see figure 1 above. Part of the decline must be seen in connection to the weak Norwegian krone during 2020 that acted as a drag with negative base effects on core inflation during most of 2021. However, total inflation, as measured by CPI, had increased markedly and exceeded 5% in December 2021. Most of the rise was attributed to higher energy prices, which also lifted inflation rates in other European economies. Already before the end of 2021, the Norwegian Government had announced an electricity support scheme for households, and this support scheme was expanded at the beginning of 2022. The support scheme was a direct subsidy scheme for electricity expenses, also reducing the impact of electricity prices on CPI.

## 2.2 War, reopening, and rising inflation

On 24 February, Russia launched a full-scale invasion of Ukraine. The invasion was widely regarded as an act of aggression that violated the Charter of the United Nations. Consequently, many Western economies retaliated by enforcing strict economic sanctions against Russia. Globally, the invasion and following sanctions led to spiking commodity prices, especially for oil, natural gas, and wheat; commodities where Russia and Ukraine are large exporters, see figure 2 below. In financial markets, risk premiums increased, leading to large declines in prices for equities and corporate bonds, while prices on government bonds increased as interest rate expectations declined on heightened worries of more negative economic implications for the Euro area and neighbouring countries. Given the stark increase in commodity prices, break-even inflation rates rapidly increased. At the same time, real yields of government bonds, for example in Germany, declined to the lowest levels ever recorded. For Norway, the strong increase in oil and gas prices and, consequently, expected higher petroleum tax payments, caused money market premiums to increase markedly. Just in a matter of days, the 3-month Nibor money market premium increased by roughly 0.20 percentage points.

Figure 2: Nordic power price vs. fuel prices

rebased to January 2016 electricity price, EUR/MWh



Sources: Swedbank & Macrobor

In the weeks and months that followed the invasion, uncertainty regarding the impact on global and domestic growth and inflation remained elevated. At the first monetary policy meeting of the new Governor of Norges Bank, Ida Wolden Bache, the Committee decided in March to raise the policy rate by 0.25 percentage points to 0.75%. The countercyclical capital buffer was also further raised to 2.5%, effective from 31 March 2023, the level deemed as normal, and the level the buffer stood at before the outbreak of the covid pandemic.

Activity in the Norwegian economy continued to rise after pandemic-related restrictions were lifted. Employment increased further, while the unemployment rate declined to levels seen before the pandemic. Additionally, new job vacancies returned to record-high levels before the containment measures were imposed in late 2021. Capacity utilisation increased further from already high levels, and labour shortages were at the highest levels in more than a decade, according to Regional Network. Concurrently, core inflation had been markedly higher than expected, and the outlook for inflation had increased, amid a tighter labour market and rising energy prices.

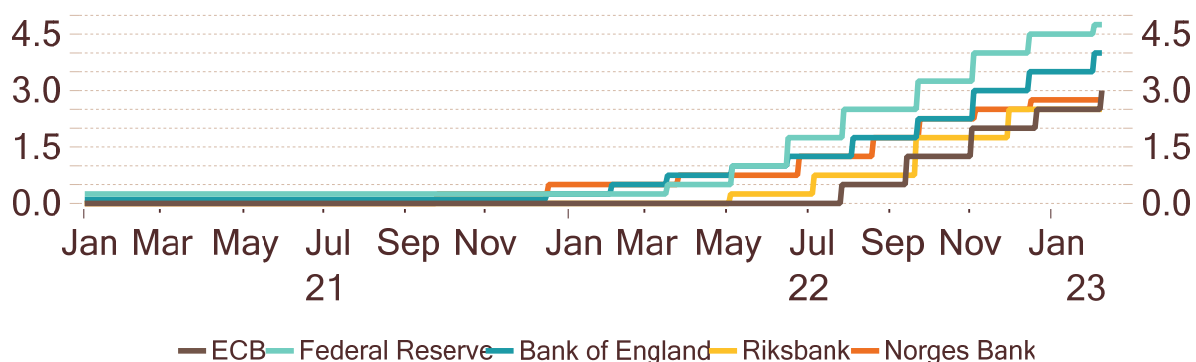
The accompanying message from Norges Bank at the March meeting was that they were more worried about the price pressures in the economy. It remained open for the policy rate to be raised faster if inflation prospects remained persistently high.

### 2.3 Unprecedented monetary policy response

During the late spring and into the June meeting, inflation continued to increase markedly and more than expected. Wage expectations increased based on strong developments in the labour market and rising inflation expectations. Moreover, other central banks started a more aggressive hiking campaign, including the Federal Reserve which hiked by 0.5 percentage points in early May and clearly stated that they intended to hike at a historically fast pace to combat rising inflation. Also, the Bank of England hiked at a faster pace, and by May, the Bank of England's policy rate was higher than Norges Bank's, although starting three months later in their hiking cycle.

Figure 3: Central banks' policy rates

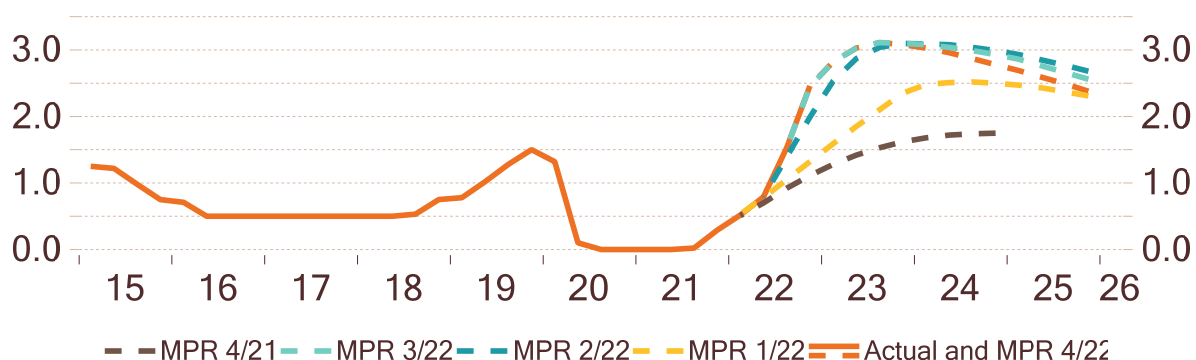
percent



Sources: Swedbank &amp; Macrobor

Figure 4: Policy Rate, Baseline Scenario, Norges Bank estimates

percent



Sources: Swedbank &amp; Macrobor

Concurrently, the Swedish Riksbank hiked for the first time in early May, while the European Central Bank prepared for hiking at their June meeting, see figure 3 above. The late spring months marked a significant shift in the global central banks' monetary policy stance. Inflation was no longer seen as transitory and had to be combated with large and fast policy rate hikes against an economic backdrop of strong reopening effects in most economies and rapidly improving labour markets.

The June meeting marked a significant change to Norges Bank's monetary policy strategy. Not only did they raise the policy rate by 0.5 percentage points, the largest hike since 2002, Norges Bank also signaled that they would hike the policy rate further at the interim meeting in August – the first interim meeting hike since before the financial crisis. The policy rate path was also lifted substantially, by almost 1 percentage point, about the largest upward revision to the policy rate path since Norges Bank started publishing rate paths, see figure 4 above. High activity, limited spare capacity, a tight labour market, and inflation overshooting the inflation target were

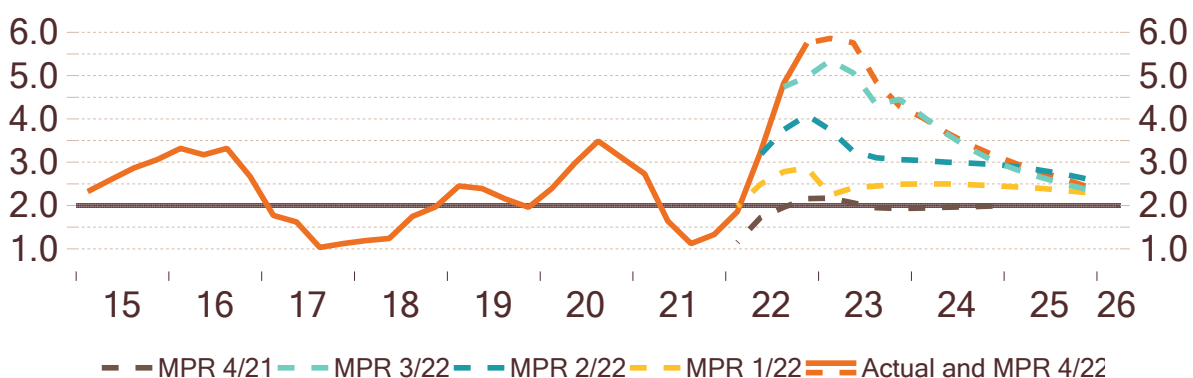
all arguments for accelerating the hikes. Rising cost pressures were also confirmed by the Special topic in the Regional Network Report 2/2022, where more than half of the businesses surveyed said they were affected by the war in Ukraine. On the balance of risks, rising inflation and limited spare capacity together with sustained global inflationary pressures and a weak Norwegian krone added to upside risks for the policy rate ahead. On the contrary, the risks of rapidly rising policy rates could lead to a more abrupt slowdown and curb especially household consumption more than expected.

Keeping pace from the June meeting, Norges Bank also hiked the policy rate by 0.50 percentage points at the meetings in August and September. Inflation had continued to increase while activity in the economy had continued to expand. Norges Bank backed their deviation from the June guidance of hiking by 0.25 percentage points based on inflation being “considerably” higher than projected and that activity in the Norwegian economy was “high, with little spare capacity”, while the labour market had tightened further. These developments suggested that inflation could be higher than projected in the short and medium term, see figure 5 below. European energy prices, and especially electricity futures, suggested inflation could continue to surprise on the upside also going forward.

Hence, Norges Bank deemed their risk management to favour hiking faster now, to avoid the potential risk of being forced to counter with even faster hikes later as wage growth could spiral further on the back of high and rising inflation in an environment with tight labour market and increasing wage growth expectations.

Figure 5: CPI-ATE, Baseline Scenario, Norges Bank estimates

y/y percent



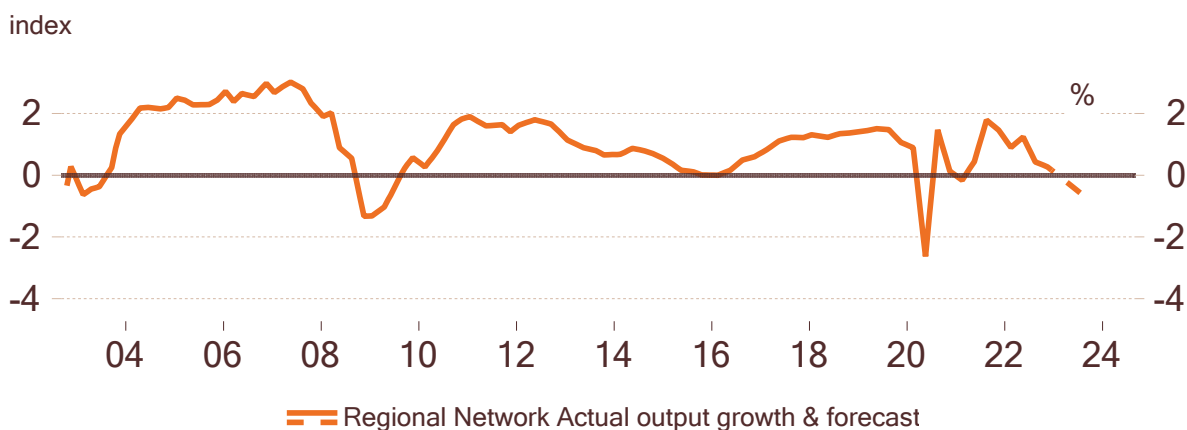
Sources: Swedbank & Macrobor

## 2.4 Changing down gears

In the Regional Network Report 3/2022, the outlook for economic growth was gloomier, see figure 6 below. Especially household-related sectors indicated that activity could decline over the coming quarters. Norges Bank acknowledged that a weaker outlook for the real economy reduced the need for more aggressive hikes. In the September MPR projections, GDP was seen to decline in 2023, with the unemployment rate slowly increasing over the coming years.

Hence, the trade-off between future above-target inflation and a negative output gap was now more balanced than at the previous policy meetings during the year.

Figure 6: Regional Network actual output growth and forecast



Sources: Norges Bank, Swedbank & Macrob

However, according to the rate path, Norges Bank expected to hike the policy rate at the November and December meetings by 0.25 percentage points, respectively. Another hike was projected in the first quarter of 2023, and the rate path reached a peak of 3.11% by end of the first half of 2023.

Taken together, Norges Bank quickly raised the interest rate to catch up with the strong economy and high inflation over three monetary policy meetings during the summer and autumn of 2022. Given the expected lagged impact of higher rates on households and businesses, Norges Bank's outlook for growth was now more cautious, knowing that the policy rate was around a restrictive territory at 2.25%. Still, high inflation and a continued tight labour market risked seeing wage growth continue to spur, risking inflation to remain above target for longer.

Norges Bank decided at the meeting in November to slow the pace of hikes, following three consecutive double hikes since June. The key policy rate was raised to 2.5%, and Norges Bank signaled that they most likely would raise the policy rate again at the December meeting.

The Committee backed their decision by stating that economic activity was still high in the country and inflation had continued to rise. However, the Committee saw some parts of the economy cooling down and expected inflation to slow more ahead based on easing global supply chain issues and lower energy prices. Additionally, they pointed out that the policy rate had been raised fast over the past year and its lagged effects would further cool the economy.

At the last meeting of the year, in December, Norges Bank also hiked the policy rate by 0.25 percentage points, to 2.75%. The decision was very much expected by both markets and analyst consensus. Further, Norges Bank guided that they most likely would hike the policy rate further during the first quarter of 2023, and peak at around 3%.

The rate path was unchanged from the September path in the near term, as the Committee continued to balance out still too-high inflation and robust growth in the mainland economy with a much bleaker growth outlook indicated by the Regional Network Report 4/2022. The discrepancy between the signals from business surveys and actual National accounts data made Norges Bank more uncertain regarding the turning point for the real economy. It addressed this by keeping the peak of the rate path unchanged from the September rate path while lowering the endpoint of the rate path further out in the forecasting horizon. Inflation had again been higher than expected, but the new projections were little changed over the coming years, reflecting easing global supply issues and an outlook for a more negative output gap over the coming years for the Norwegian economy.

Overall, 2022 stands out as the year of monetary policy tightening. The comeback of inflation forced nearly all central banks to raise interest rates rapidly. Norges Bank should be credited for undertaking well-anchored decisions and striving to communicate its decisions more profoundly to the greater public. Additionally, Norges Bank's effort to actively research the factors behind the surge in inflation and the impact of higher policy rates on different parts of the economy - households in particular - deserves recognition. Also, compared to other western central banks, Norges Bank's decisions were overall well-balanced and well-timed, taking the current situation of pronounced global shocks into account. It was reasonable to accelerate the pace of hikes during the summer, but also to return to standard policy rate increases of 0.25 percentage points toward the end of the year. While the decisions were well-founded given the information available at the time, they appear even more appropriate with the benefit of hindsight, with signs of price pressures remaining high and demand keeping well up, despite declining purchasing power and rapidly rising policy rates.

### 3. Estimating the output gap during the pandemic using a bottom-up approach

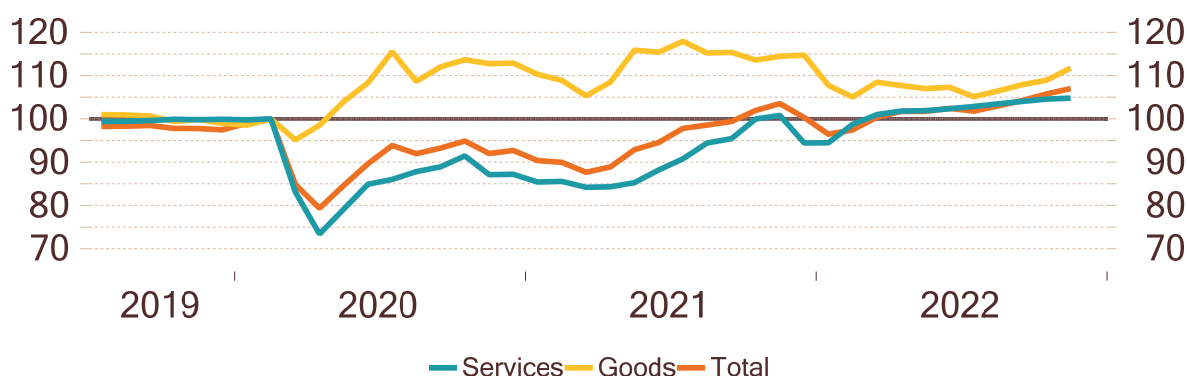
According to Norges Bank's Monetary Policy Handbook (2022), a good measure of the output gap should provide information about future developments in inflation and wage growth. It should also indicate future output growth and developments in the unemployment rate. Hence, being a flexible inflation-targeting central bank, having a precise estimate of the economy's output gap is essential to a well-adjusted monetary policy strategy.

Norges Bank uses a wide set of models and indicators to assess the output gap for the Norwegian economy. The output gap is defined as the difference between actual and potential output, where potential output should be the highest level of output and employment compatible with price stability over time. Potential output is not observable and must be estimated. Common ways of estimating potential output are using trending techniques such as HP or Kalman filters to estimate the trend in GDP. Cross-checking these HP or Kalman filter estimates of the output gap against the labour market often gives a robust estimation of the output gap.

However, estimating potential output during a pandemic where strict containment measures were enforced is even more challenging than usual. As seen in figure 7 below, household services consumption declined sharply during the pandemic, while goods consumption increased. As a result, total consumption stood below the level from the beginning of 2020 through the pandemic until the end of 2021. In this period, output declined, but given the introduction of containment measures, it is likely that these measures also affected the economy's potential output; the aim of the containment measures was, after all, to reduce activity in the economy.

Figure 7: Household consumption

rebased, Feb 2020=100, constant prices, SA

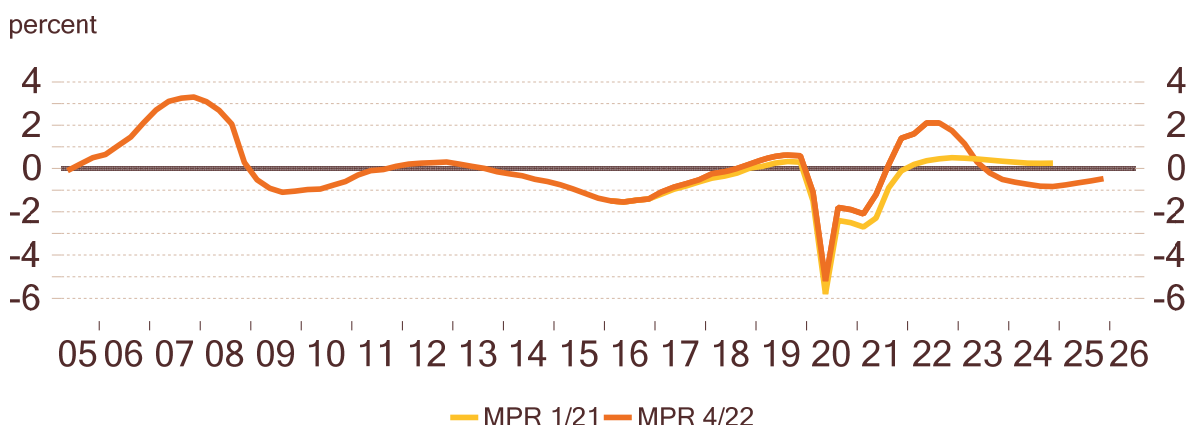


Sources: Swedbank & Macrobtor

Norges Bank's estimate of the output gap portrays a deep recession in the economy during 2020 and 2021. The output gap is often revised, also backward in history, and is published

quarterly in the Monetary Policy Reports. Figure 8 below shows Norges Bank's estimates of the output gaps from the Monetary Policy Report 1/21 and 4/22, respectively. While Norges Bank has been positively surprised and revised its estimate for the output gap by the end of 2021 and into 2022, revisions of the deep recession from the outbreak of the pandemic and into the beginning of 2021 are less pronounced.

Figure 8: Output Gap, Baseline Scenario, Norges Bank estimates



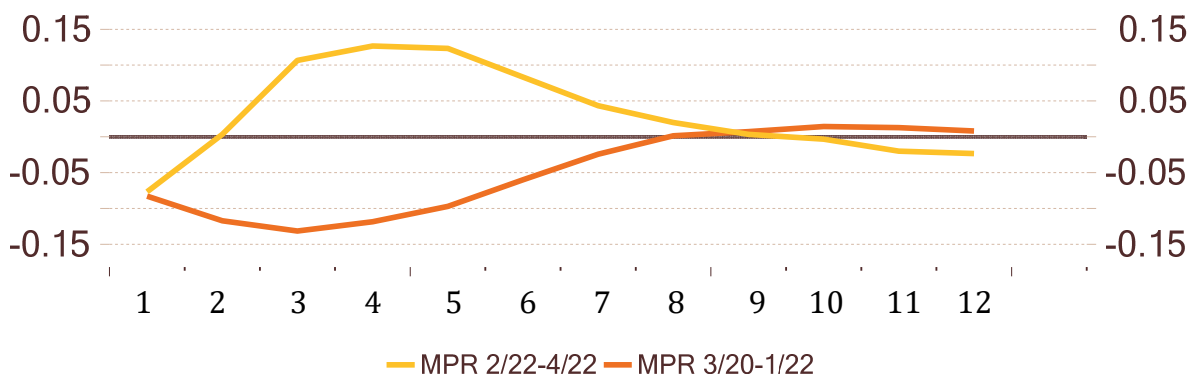
Sources: Swedbank & Macrobtor

Understanding the output gap during the pandemic is important for how we should conduct monetary policy in similar situations in the future. If the decline in actual output was more pronounced than the decline in potential output, it is an argument for having a more accommodative monetary policy. If the decline in actual output resulted from a decline in potential output, monetary policy should tighten more. Norges Bank evaluated the output gap as strongly negative during the pandemic, suggesting that the policy rate should have been cut to below zero percent in model simulations. However, the Committee viewed that a negative policy rate was not beneficial for the Norwegian economy and the policy rate was left at zero percent. To compensate for not reducing the policy rate into negative territory, Norges Bank did not increase the policy rate until the model-based rate path suggested that the policy rate should be increased.

Norges Bank wrote in the Monetary Policy Report 1/21: *“Positive news may also result in negative judgement bars in the decomposition chart later as long as the model-based path lies below zero”*. Hence, Norges Bank decided to keep the policy rate at zero percent as long as the gap between the policy rate and the model-based rate path was positive. To illustrate this gap, the Committee added a negative “judgement” to the interest rate accounts. From the Monetary Policy Reports 3/20 to 1/22, the average negative contribution from “judgement” on the policy rate path was roughly -0.10 percentage points over the six first projected quarters, see figure 9 below. As is also evident in the figure is that this changed materially after Norges Bank deemed the economy to be above normal capacity, the policy rate gap was closed, and inflation continued to rise well above target. Hence, the deeply negative output gap during the pandemic likely contributed to Norges Bank keeping the policy rate at a historically low level before gradually raising the policy rate during the autumn of 2021.

Figure 9: Average "judgement" contribution to the interest rate path

y-axis: percentage points, x-axis: quarters ahead projections

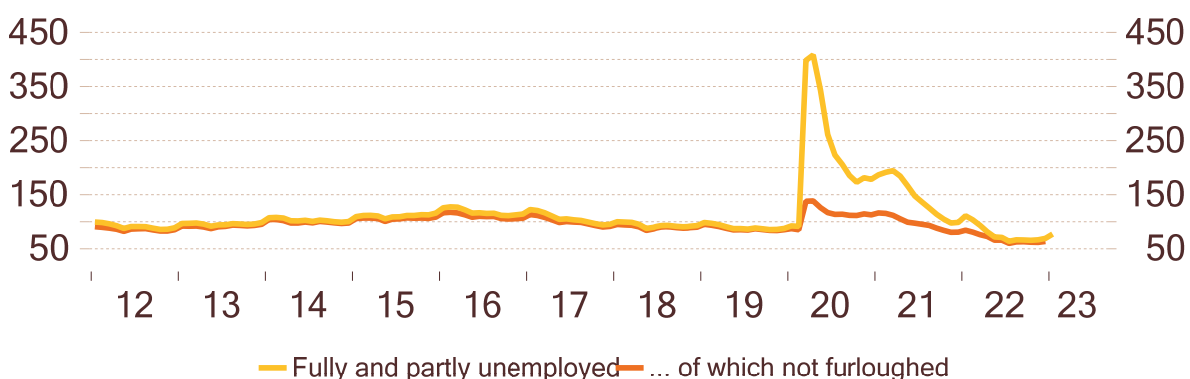


Sources: Swedbank &amp; Macrobor

The pandemic years represent an extraordinary period in macroeconomic history. As businesses were forced to temporarily close owing to strict containment measures, unemployment rates increased abruptly to historically high levels. Swift changes to furlough regulations by the Norwegian Government resulted in most employees being furloughed rather than fired. One could argue that furloughed workers are more attached to the labour market than unemployed workers. Figure 10 below shows that the increase in unemployment in Norway during most of the pandemic was related to workers being fully or partly furloughed. While also markedly rising at the initial outbreak of the pandemic, the number of dismissed workers was more comparable to the downturn in oil during the mid-2010s.

Figure 10: Unemployed persons

Thousands, persons



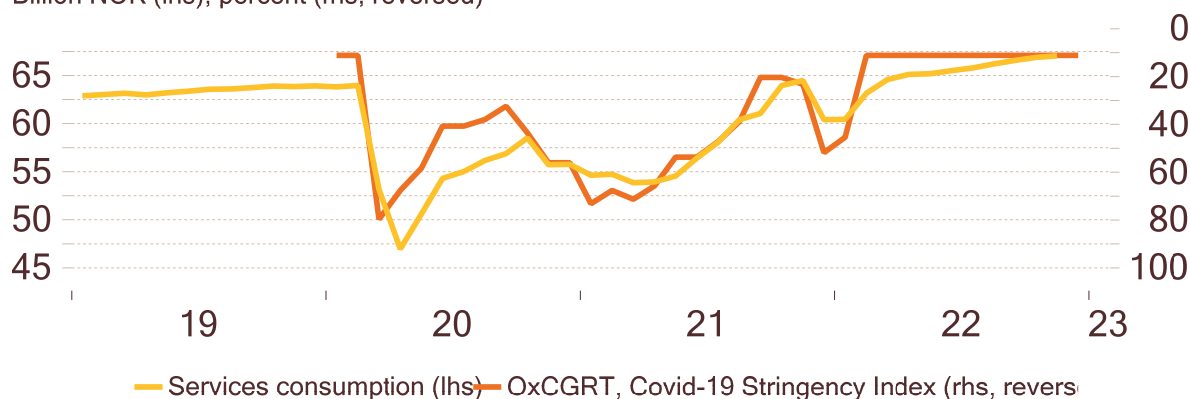
Sources: Swedbank &amp; Macrobor

Containment measures had a direct impact on service consumption. Restaurants, bars, and cultural events had to close or operate at much-reduced capacity whenever the containment measures were enforced. In a way to capture the extent of pandemic policy measures, the University of Oxford established The Oxford Covid-19 Government Response Tracker (OxCGRT) to help decision-makers and citizens better understand governmental responses

more consistently. The tracker covered over 180 countries and 23 indicators, such as school closures, travel restrictions and vaccination policies. The aggregate measure of the OxCGRT for Norway, combining all policy responses into one quantitative series, could qualify as a measure of how stringent the containment measures were over time. As seen in figure 11 below, there was a strong negative correlation between the Oxford stringency index and households' services consumption. In periods where strict containment measures were enforced, services consumption also saw a larger decline, and conversely, when the containment measures were relaxed, services consumption picked up again. Against this background, it could be argued that the development in service consumption during the pandemic was a function of how much capacity was open for the public. Hence, the decline in actual services consumption could thus reflect, to various degrees, the change in potential services consumption and reduce the negative impact on the overall output gap.

Figure 11: Services consumption and stringency index

Billion NOK (lhs), percent (rhs, reversed)



Sources: Swedbank & Macrobtor

While a common approach when estimating the output gap is to use aggregate series for GDP, this might not be appropriate when the economy faces periods of voluntary – or involuntary – lockdowns. Assessing which sectors of the economy are impacted negatively by containment measures, and thus seeing also capacity is reduced, and which are not, is instrumental to getting a good estimate of the pandemic output gap. Importantly, we do not aim to evaluate the output gap for other periods than during the pandemic years, hence we have concatenated our estimates of the output gap to that of Norges Bank for the periods outside the years of the pandemic.

Utilising the OxCGRT for Norway, we have identified which parts of Norway's mainland GDP were most negatively affected by various containment measures from 2020 to the beginning of 2022. Not surprisingly, it was mostly the domestic services sectors and travel-related sectors that posted the strongest negative correlations with the stringency index. More precisely, we have identified *household services consumption*, *non-profit institutions serving households*, *direct purchases abroad by resident households*, *direct purchases in Norway by non-resident households*, and *other services* as the most impacted parts of mainland GDP. Prior to the pandemic, these sectors accounted for roughly 36% of the total mainland GDP, while this

proportion declined to 30% during the periods when containment measures were enforced. Moreover, the decline in these combined sectors was roughly twice as much during the outbreak of the pandemic than mainland GDP and more than five times larger during the beginning of 2021 when the rest of the economy had adjusted more to the pandemic situation, and the economy had started to recover more.

Technically, we exploit Statistics Norway's data on *final expenditure and gross domestic product for mainland Norway*. For all the macroeconomic indicators we estimate individual HP-filter trends from 2000 through the last available data point in 2022 Q3. However, for the mentioned services components of mainland GDP we separately assess the pandemic period and calculate potential output based on coincident correlations with the OxCGRT, letting the correlation coefficient work as an estimate of the relative impact on actual and potential output from the containment measures. For example, household services had a -0.9 correlation with the OxCGRT measure during 2020 through 2022 Q3. We ascribe 90% of the decline in actual output during this period to a drop in potential output, suggesting that the output gap was negative in the pandemic years, but not to the same extent as if the potential output should follow the trend from the pre-pandemic years. The various correlation coefficients are found in table 1 below.

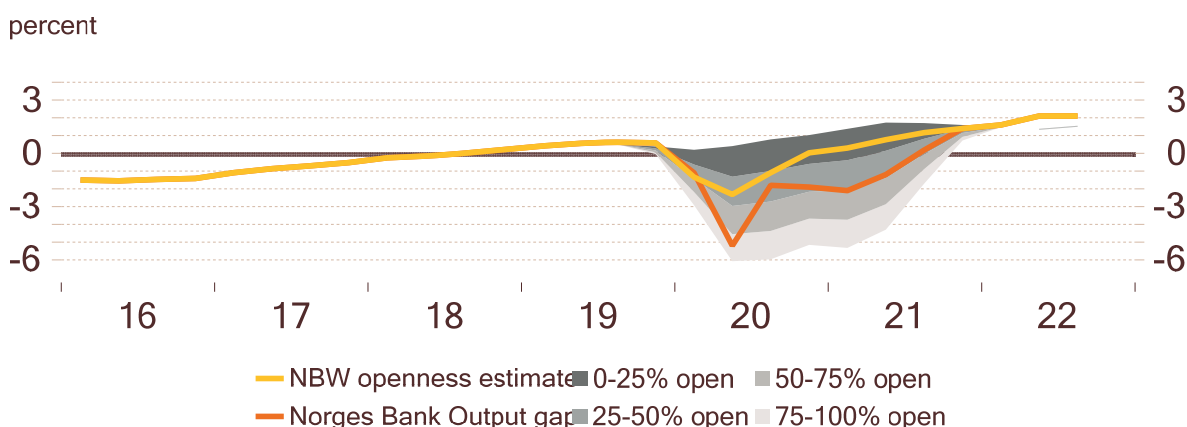
Table 1: Overview of indicators used for the bottom-up output gap

| <b>Macroeconomic indicator</b>                      | <b>Share of mainland GDP (2019 Q4)</b> | <b>Maximum drawdown during the pandemic</b> | <b>Coincident correlation with OxCGRT (2020-2022)</b> |
|-----------------------------------------------------|----------------------------------------|---------------------------------------------|-------------------------------------------------------|
| <i>Household services</i>                           | 24.1%                                  | 20.7%                                       | -0.90                                                 |
| <i>NPISH</i>                                        | 2.9%                                   | 21.8%                                       | -0.82                                                 |
| <i>Households' purchases abroad</i>                 | 4.2%                                   | 97.8%                                       | -0.81                                                 |
| <i>Non-resident households' purchases in Norway</i> | -1.7%                                  | 88.5%                                       | +0.80                                                 |
| <i>Other services</i>                               | 6.5%                                   | 11.7%                                       | -0.71                                                 |

We sum up all macroeconomic indicators' actual and potential output to get the aggregated mainland GDP series. From the aggregated series we thus compute an output gap for

mainland Norway which also considers the impact on the service sector's capacity utilisation during the pandemic years, see the yellow line in figure 12 below. It is evident from the figure that our measure of the output gap suggests that the decline in capacity utilisation in the Norwegian economy was smaller than what the output gap of Norges Bank indicates. While correcting for the lapse in service sector potential and seeing other, more open parts, of the economy booming based on accommodative fiscal and monetary policies, our estimate also suggests that the economy was back to normal capacity by late-2020.

Figure 12: Output gap estimate based on degree of openness



Sources: Swedbank & Macrobör

There is a high degree of uncertainty regarding the degree of openness in the services sector while containment measures were enforced. Hence, to utilise our bottom-up approach to the output gap further, it is convenient to perform some scenario analysis. Manipulating to which degree of openness, based on how much of the decline in actual output concurrently coincided with a decline in potential output, we produce an interval for the output gap based on the degree of openness, as seen in the various shades of grey in the figure above. 100% openness means that the services sector's potential output was unaffected by containment measures. Conversely, 0% means that all the drop in actual output could be ascribed to a drop in potential output. For simplicity, we do not distinguish between the different parts of the services sectors in the scenario analysis - as we do for the output gap estimate.

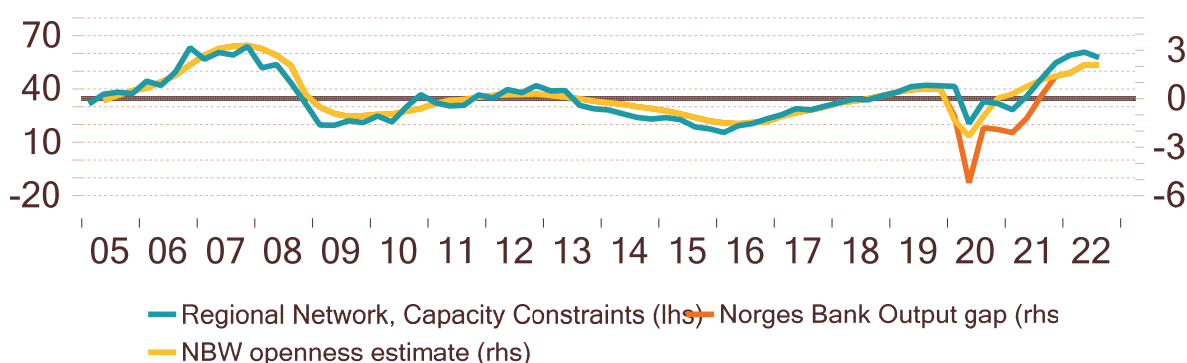
The scenarios suggest that if all the decline in actual output in the services sector during the pandemic was a function of reduced and closed capacity, the output gap would be positive throughout the pandemic years. While, on the other hand, if all the services sectors were kept fully open, the output gap would have been deeply negative over the two years. Our estimate of the output gap suggests that the initial decline in activity was larger than the drop in potential output, as also other parts of the economy saw a drawdown during the spring of 2020. But as soon as regulations were in place and people started to get more used to containment measures and rotating demand to more goods consumption, the output gap estimate implies an openness more in the lines of roughly 20%. To compare, the initial drop in Norges Bank's output gap suggests almost a fully open economy with no particular effect on potential output,

while later a roughly 50% open services sector is implied by Norges Bank's output gap, much higher than our estimations based on utilising OxCGRT.

The output gap is not observable and must be estimated. A robust approach to estimating the output gap will thus be to crosscheck against other measures of capacity utilisation. One such crosscheck could be Norges Bank's Regional Network where the interviewed businesses are asked about to which degree they are facing capacity constraints. Since the inception of the Region Network, this survey has been a good indicator of gauging the degree of capacity utilisation in the mainland economy. Moreover, Norges Bank has put much emphasis on the survey, and Norges Bank's output gap has tended to fluctuate closely with the results from the Network. However, that changed during the pandemic, and while the Network suggested that the economy was back to almost normal capacity already by the second half of 2020, Norges Bank kept its deeply negative output gap for a longer period. The Network also suggests, in line with our estimates, that the initial drop in the output gap was markedly smaller than Norges Bank's estimate, as shown in figure 13<sup>1</sup>.

Figure 13: Output gaps and Regional Network Capacity constraints

percent (lhs), percent (rhs)

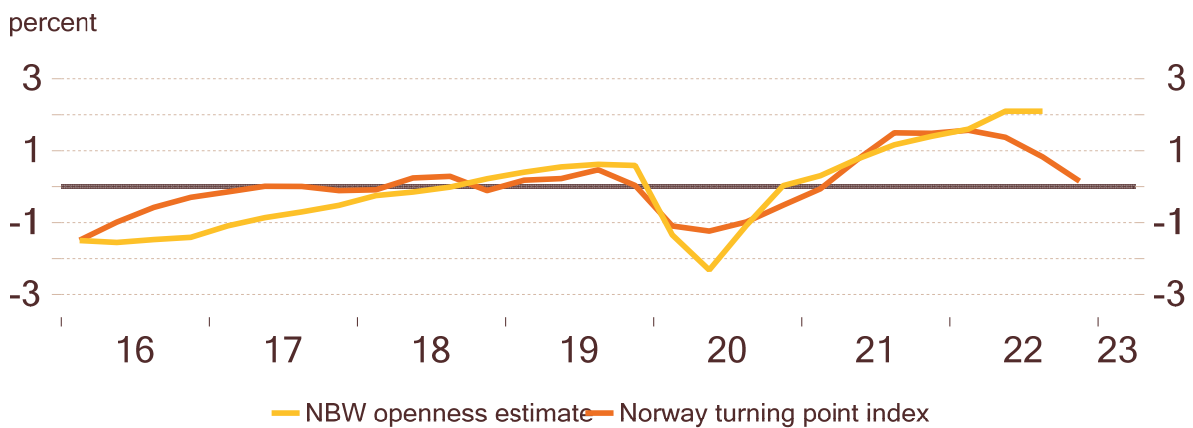


Sources: Swedbank & Macrobor

Another crosscheck for capacity utilisation could be to look at a wide set of indicators for the economy, trying to exploit a common trend in these economic indicators. We have developed a “turning point indicator” where we take data from the labour market, housing market, terms of trade, surveys on consumer confidence, business surveys and financial market data before we extract a common trend from this data set using principal component analysis. Also, this indicator for the output gap gives us a markedly smaller decline in the output during the pandemic than Norges Bank's official output gap, as visible in figure 14. The turning point indicator sees an even smaller initial decline in the output gap owing to the sharp recovery in the Norwegian housing market, consumer confidence and financial markets.

<sup>1</sup> According to the Regional Network reports 2/20 and 3/20, the data could have underestimated the initial pandemic decline in capacity utilisation owing to truncations in the scale.

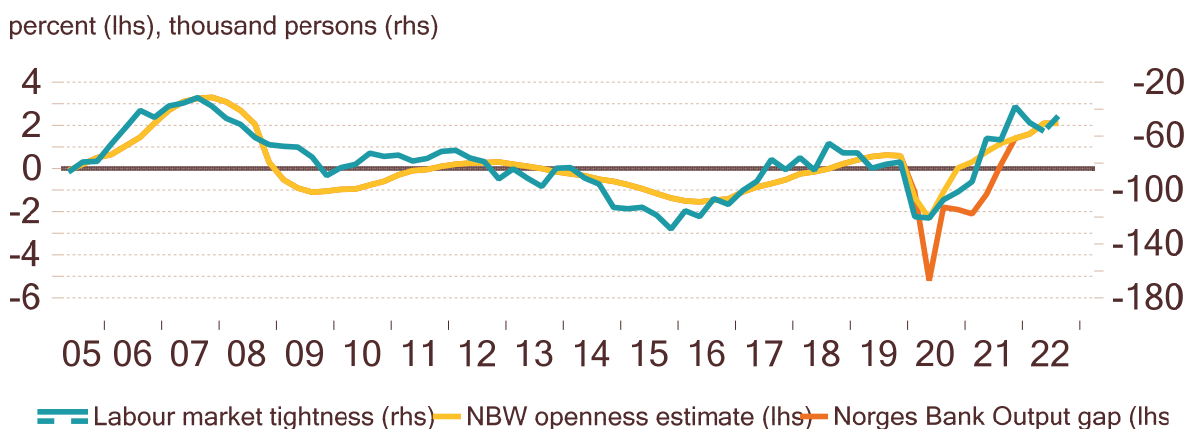
Figure 14: Two NBW estimates of the output gap



Sources: Swedbank &amp; Macrobor

Lastly, we are interested in whether our bottom-up approach indeed improves the output gap estimate in a way which it better explains future developments in inflation and labour market dynamics, as Norges Bank's Monetary Policy Handbook says a good measure of the output gap should. The two next figures, 15 and 16, respectively, illustrate that our approach to a better extent, at least ex-post, correlates with both the tightness in the labour market and domestic core inflation. Tightness in the labour market is defined as the sum of employed persons and new job vacancies less labour supply. i.e., labour demand versus supply, while domestic core inflation is the domestic part of CPI-ATE inflation. Both these findings underscore the usefulness of also exploiting the bottom-up approach when it comes to estimating the output gap.

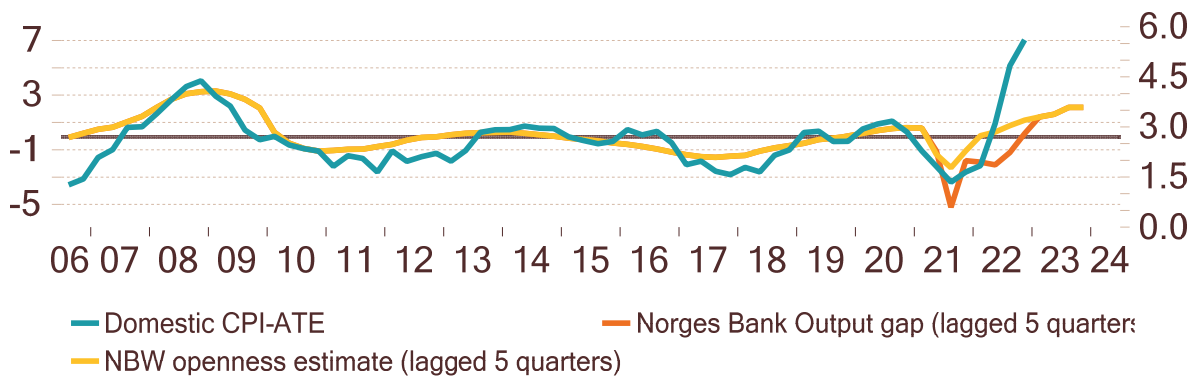
Figure 15: Labour market tightness and the output gap



Sources: Swedbank &amp; Macrobor

Figure 16: Domestic core inflation and the output gap

percent (lhs), y/y percent (rhs)



Sources: Swedbank &amp; Macrobor

The output gap is also instrumental in estimating the policy rate response based on how the central bank assesses the current situation and forms its near-term predictions. Utilising a simple version of the Taylor rule allows us to illustrate the partial effect on the policy rate from the new estimate of the output gap. The Taylor rule could be specified as follows,

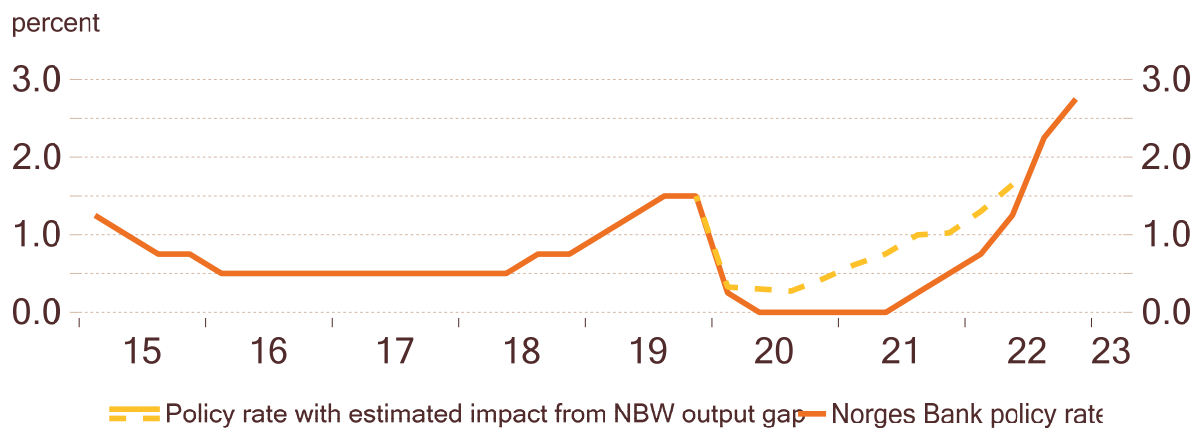
$$\text{Equation 1} \quad i_t = \pi_t + r_t^* + a_\pi(\pi_t - \pi^*) + a_y(y_t - y_t^*),$$

where  $i_t$  is the nominal policy rate at time  $t$ ,  $\pi$  is the inflation rate,  $\pi^*$  is the inflation target, and  $y_t - y_t^*$  denotes the output gap.  $r_t^*$  is the real neutral rate of interest that equilibrates the economy in the long run.  $a_\pi$  and  $a_y$  are the weights given to the inflation and output gaps, respectively. As we are only changing the output gap, the only parameter we need to have an opinion on is  $a_y$ . We have for simplicity set  $a_y = 0.5$ .

We are interested in examining the isolated effect on the policy rate from our new estimate of the output gap. We understand that this exercise is counterfactual. However, the exercise illustrates the importance of having a good estimate of the output gap for the monetary policy strategy. Indeed, during the pandemic, other considerations were important, and the uncertainty regarding both the evolution of the pandemic itself but also the longer-term effects on the economy was greater than normal. Still, based on our estimate of the output gap and given the relative weight of the output gap given in equation 1, we find that, in isolation, the policy rate should have been raised earlier, as depicted in figure 17 below. Needless to say, there is substantial uncertainty, and our estimates neither consider the endogenous effects of a less negative output gap nor a higher policy rate through the pandemic years. Additionally, it does not consider the effects of Norges Bank's model-based analysis that the policy rate should have been lowered into negative territory. This impact could exaggerate the effect of the new output gap measure. Finally, this exercise is more to illustrate the importance the output gap has on Norges Bank's monetary policy and should also only be seen as that. That being said, we recommend Norges Bank to further research the development of the output gap

during the pandemic years, as it might also have an impact on the developments further out and hence also be important for the conduct of monetary policy.

Figure 17: Norges Bank policy rate and impact from NBW output gap



Sources: Swedbank & Macrobor

## 4. Understanding inflation dynamics in the Regional Network

For more than twenty years, Norges Bank has been a flexible inflation-targeting central bank. During most of this time, inflation has been low and stable and broadly in line with Norges Bank's projections. Still, during periods of economic downturns, such as in 2015 through 2016, inflation has overshoot the inflation target owing to a weak Norwegian krone pushing up imported inflation. The same dynamics were evident after the outbreak of the pandemic in 2020 with an unprecedented weakening of the Norwegian krone, followed by higher imported inflation some quarters later.

2022 was different. There has been no trade-off between economic growth and inflation. Both strong growth in the economy and high and rising inflation have not been seen to this extent during the two decades of inflation targeting. Moreover, inflation continued to surprise Norges Bank's projections on the upside throughout the year. While it has been common to ascribe the rise in inflation to pandemic effects, such as rising prices due to high demand for goods, bottlenecks in global production and surging freight rates, and higher energy prices as an effect of the war in Ukraine, understanding the passthrough of inflation in the domestic economy will always be key for a forward-looking central bank.

To be forward-looking, Norges Bank uses a wide range of leading indicators to assess the current growth momentum in the economy and to guide on how GDP growth will develop in the near term. The set of economic indicators is provided by both public and private institutions. The most widely used are for example Statistics Norway's business survey or NIMA's purchasing manager index (PMI), an indicator that is collected and produced across a wide range of countries and could be easily compared across economies.

In 2002, Norges Bank established a regional network of Norwegian enterprises, organisations, local governments, and other public institutions. The key purpose of the network was to gather and obtain early and precise signals about current and future developments in the economy across all regions and sectors important for the overall economic activity. Moreover, the network gives information on various topics, including changes in output and production, employment, investments, capacity utilisation, labour shortage, profitability, wage growth and prices. All told, the Norges Bank's Regional Network survey is one of the most comprehensive surveys undertaken in the Norwegian economy and widely used by the central bank itself, as well as other analysts and businesses.

Another important element of the network survey is combining quantitative information from the aggregated survey results with qualitative assessments from interviewed enterprises. This extra dimension gives rise to a key feature of the survey which is an assessment of risks surrounding the outlook and an understanding of important dynamics in the economy currently taking place. These qualitative assessments are often summarised and outlined in the quarterly reports published together with updated survey results from Norges Bank. In addition, Norges Bank includes *special topics*, a stand-alone sub-survey where they explore important

economic topics currently under-analysed or not fully captured in the main survey. For example, in the Regional Network survey 2/2022, published in June 2022, Norges Bank had a *special topic* covering “Cost pressures, capacity constraints and the war in Ukraine”, where the surveyed enterprises responded to questions on how costs and supply of goods were affected and to what extent they experienced side-effects after the outbreak of the war. These *special topics* provide timely, relevant, and useful information on the current challenges facing the economy.

Looking across the most used leading indicators for the Norwegian economy, it is our experience that most surveys are designed to capture developments in economic activity, being either GDP growth or employment. Some surveys, such as NIMA’s PMI, also have indices concerning businesses’ changes in output prices. Still, we do not know any surveys being constructed to explain the development of the consumer price index directly, aside from Norges Bank’s *Expectation survey*, conducted by Ipsos. Given that maintaining annual consumer price inflation close to 2% over time is a primary objective of Norges Bank’s monetary policy, we see this as a shortcoming for understanding inflation dynamics from leading indicator surveys.

The results of the Regional Network have been evaluated several times over the twenty years the survey has been active. In 2014, Martinsen, Ravazzolo and Wulfsberg (2014) constructed factor models based on the disaggregate survey data from the Regional Network to forecast national aggregate macroeconomic variables. The study showed that the Regional Network was most useful in forecasting GDP growth, but less for the unemployment rate and core inflation (CPI-ATE). Brander, Brekke, Eger and Naug (2017) did not evaluate the price components of the Regional Network but found that the network supplied better leading information about mainland GDP growth in the current and the next quarter than house prices, equity prices and indicators from other business surveys. Moreover, the network’s forecasts of gross fixed capital formation over the next year had been relatively precise since 2012. In addition, its forecasts of wage and employment growth had been roughly as good as those in Ipsos’ Expectations survey. Lastly, Brekke and Halvorsen (2009) include measures of businesses’ selling prices in their evaluation of the network data. However, they highlight that among the network’s series for selling prices, only the series for prices in the domestic manufacturing and construction series are comparable to other official statistics. They also conclude that there is occasionally a weak correlation between the network data and official data for producer prices for domestic manufacturing and construction.

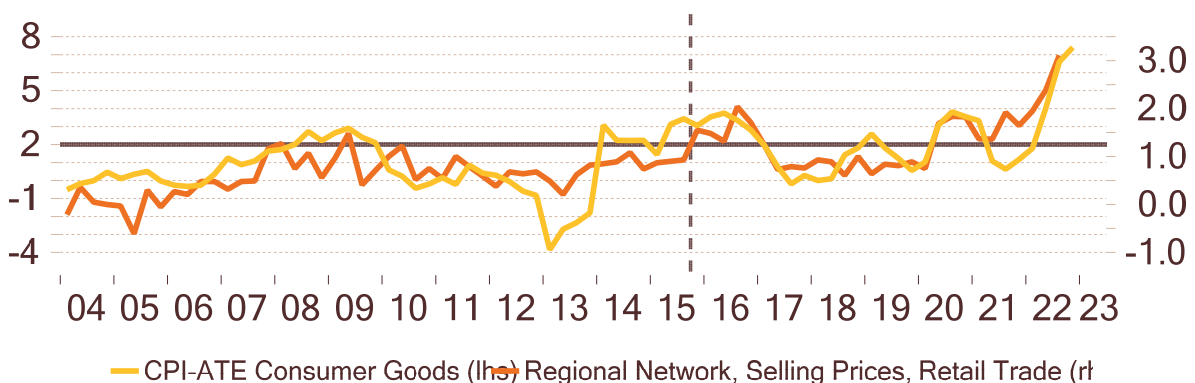
Our interest is to examine whether the Regional Network survey for selling prices could give any good assessment of current and future development in consumer price inflation. If that were to be the case, also qualitative information regarding price dynamics could add to the understanding of inflation risks going forward and potentially improve Norges Bank’s inflation projections. In the network survey, enterprises are asked two questions on selling prices. One is more backward-looking, regarding price changes over the past twelve months, while another is forward-looking, where enterprises state their price change intentions over the coming twelve months. The backward-looking question is scored on an index from -5 to +5, while the forward-looking component is constructed as a diffusion index.

Statistics Norway publishes consumer price data based on the delivery sector. While there was a break in the data series in 2015, it is possible to construct the price series back to 2003 for consumer goods and services. We have additionally taken out the rent component from the services data, to better reflect the surveyed enterprises servicing households in the Regional Network. Moreover, we use the CPI-ATE data to better capture underlying inflation developments, as it is the favourable inflation measure of Norges Bank. Together, consumer goods and services excluding rent make up nearly 80% of the CPI-ATE basket and should henceforth be adequate for understanding most underlying inflation variations.

However, looking at figures 18 and 19 below, the correlation between the household-related Regional Network data and consumer goods and services excluding rents inflation is not as high as one could have hoped. The correlation between the network and actual inflation is between 0.5 and 0.7 over the whole sample. Additionally, looking at the forward-looking components, we find little quantitative information in the series to improve predictions of future inflation. In that way, our findings remain that the Regional Network is a better survey to understand the real activity side of the economy and not inflation dynamics to the same extent. These findings are in line with for example Martinsen, Ravazzolo and Wulfsberg's (2014) conclusions.

Figure 18: CPI-ATE Consumer goods and Regional Network Selling prices

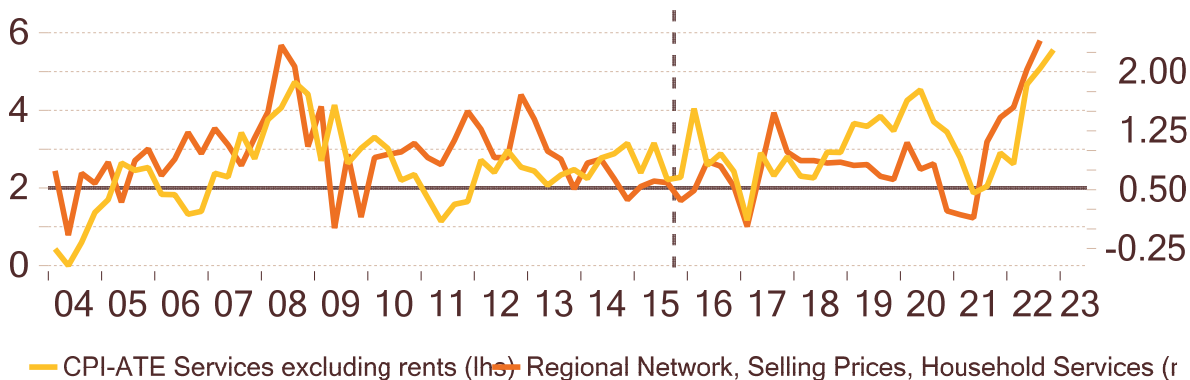
y/y percent (lhs), index (rhs). Dashed line indicates break in CPI-ATE series



Sources: Swedbank & Macrobor

Figure 19: CPI-ATE Services prices and Regional Network Selling prices

y/y percent (lhs), index (rhs). Dashed line indicates break in CPI-ATE series



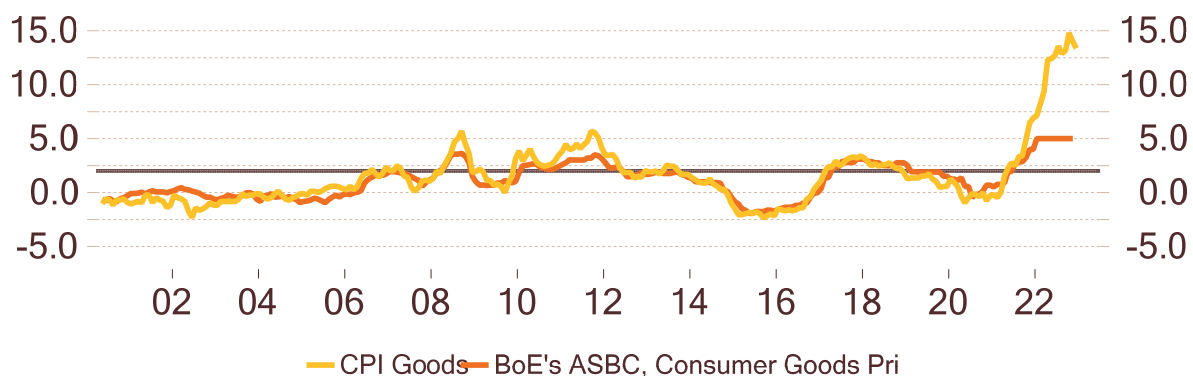
Sources: Swedbank &amp; Macrobond

It remains unclear exactly how the selling price indices are constructed in the Regional Network. Based on available documentation on the Regional Network, there is no distinction between producer prices and consumer prices. If so, this could be a shortcoming of the network that Norges Bank should strive to change going forward. A clearer difference between producer and consumer prices could increase the understanding of both PPI and CPI developments and improve the forecast ability of the network for price data. One such change could also increase the information in the forward-looking element of the selling prices question.

Bank of England has had their survey on Agents' Summary of Business Conditions since 2000 and in many ways paved way for Norges Bank's Regional Network. In their survey, the Bank of England distinguishes more on what type of prices the agents are talking about. More precisely, the price categories are divided into four; manufacturers' domestic prices, consumer goods prices, consumer services prices, and business-to-business services prices. It should be noted that there are some shortcomings in the Bank of England survey as well. One example is that the index is truncated at +5 points and hence does not fully capture the sharp increase in the goods inflation during 2022, see figure 20 below. However, the correlation between the survey and actual data for goods and services inflation is markedly and visibly higher than for the Regional Network. The Agents' survey has a correlation of nearly 0.90 with CPI goods inflation. Excluding the last year, where the index has been truncated at +5 point, the correlation is 0.93. The correlation between the Agents' survey and service inflation is also higher than for the Norwegian counterpart, at nearly 0.70. Notwithstanding the first years of the survey, where the correlation between the survey and service inflation was negative (most likely related to high rent inflation in the CPI data), the correlation has been 0.80 since 2005 and through 2022. Lastly, the annual change in the series for manufacturers' domestic prices has a correlation coefficient of 0.86 against the Producer Price Index for manufactured products for the domestic market, underscoring the possibility of differentiating the survey results between consumer and producer prices. We have not been able to find a relevant price index to compare the survey results of business-to-business services prices.

Figure 20: BoE's Agents' Summary of Business Conditions and CPI

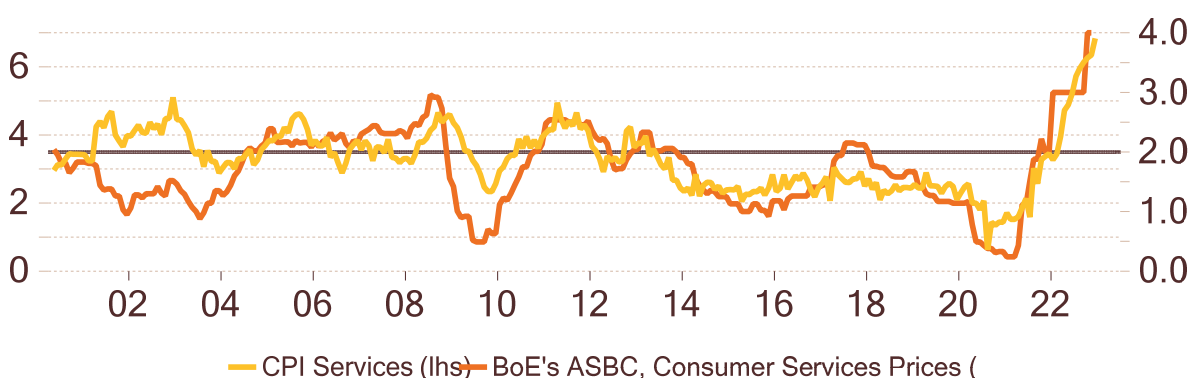
y/y percent (CPI), index (BoE)



Sources: Swedbank &amp; Macrobor

Figure 21: BoE's Agents' Summary of Business Conditions and CPI

y/y percent (lhs), index (rhs)



Sources: Swedbank &amp; Macrobor

On 8 February 2023, Norges Bank announced several changes to the Regional Network. One of these changes was discontinuing and removing the questions covering price developments. Norges Bank argued that the Expectation survey historically has contributed to a far greater extent to inflation projections. We find this discontinuation of the inflation questions in the Regional Network to be unfortunate. Not only has the last year proven that understanding the passthrough of inflation in the economy is of instrumental significance for monetary policy, but there is also a great limitation to surveys that capture inflation dynamics in Norway. Removing one of the flagship surveys on this topic could further increase the risk of misunderstanding inflation dynamics. Instead, we have shown that the Bank of England survey indeed captures the UK inflation dynamics in a timely and consistent manner. Optimally, Norges Bank should, rather than removing the questions on inflation, have adjusted the questions to make the questions more relevant for CPI and PPI inflation.

## 5. Monetary trade-offs in times of high inflation

*This chapter uses a structural model to convey three main points on what matters for how monetary policy should respond to high inflation. Our findings suggest that, first, understanding the source of inflation (demand vs. cost-push) is key to determining how monetary policy should respond. Second, if inflation is not demand-driven, the sign of the optimal interest rate response is ambiguous and depends on which monetary transmission channels operate. Third, the optimal monetary policy response depends on what we deem to be the marginal cost of inflation, that is, how important it is to reduce inflation quickly.*

Last year saw an unprecedented rise in inflation. In December 2021, annual price growth, as measured by the CPI-ATE, was 1.78%, close to the inflation target. In December 2022, it was 5.80%, almost three times as high as the inflation target.

This chapter presents a framework to analyze how monetary policy should respond to such large price movements. The framework is based on the standard sticky-wage model (Erceg et al., 2000) adjusted to include two types of households: capitalists and workers, in the spirit of Bilbiie (2008). The separation allows us to include nominal monetary transmission channels to match recent empirical evidence for Norway (Holm et al., 2021) while retaining the standard New Keynesian model as a special case of parameter combinations. The central bank is assumed to conduct optimal discretionary monetary policy by minimizing a loss function, a simplified version of the framework used by Norges Bank.

Our findings result in three main messages. First, understanding the source of price growth is key to understanding how the central bank should respond to monetary policy. If price growth is demand-driven, there are no trade-offs between reducing demand and inflation in our standard framework. Norges Bank should raise the interest rate to reduce demand, immediately eliminating the source of price growth. The main complication is that how much the rate must increase depends on the strength of various transmission channels.

Second, if high price growth instead is due to a cost-push shock (a stand-in for an energy or import price shock in our closed economy model), even the sign of the optimal interest rate response is ambiguous and depends on the relative importance of monetary transmission channels. If monetary policy primarily transmits via real interest rates, as in standard monetary policy models such as NEMO, the nominal interest rate must increase in response to cost-push inflation. If nominal monetary transmission channels instead are important, where households respond to changes in disposable income, the sign of the optimal nominal interest rate response is ambiguous. The main intuition is that when households respond to changes in disposable income, higher prices cause a recession. It is then unclear whether the central bank should deepen or dampen the recession.

Third, the optimal monetary policy response depends on the marginal cost of inflation. Standard monetary policy models include a quadratic loss function. This quadratic loss function can be derived theoretically by taking a second-order Taylor approximation of the planner

problem in a standard New Keynesian model. However, the quadratic loss function may be problematic today because it hinges on a local approximation and specific frictions. A quadratic loss function implies a very large marginal cost of inflation when inflation is high. The optimal monetary policy response is therefore to engineer a deep recession even when the price increase is short-lived, and the recession only marginally impacts inflation. However, small deviations from a quadratic loss function significantly affect the optimal monetary policy response. There should therefore be an informed discussion about the marginal benefits of reducing inflation today.

### 5.1 The Model

Our model is a two-agent closed economy New Keynesian model. The model is based on the sticky wage model in Erceg et al (2000) but adjusted to include two types of households: workers and capitalists, inspired by Bilbiie (2008). Workers are impatient, hold debt, and supply labor inelastically. Capitalists own firms, supply labor, and own the debt of the workers.

**Capitalists.** The economy consists of a  $(1 - \lambda)$  share of capitalists who work, own all firms, and solve the following consumption-saving problem

$$\max_{\{C_t^k\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \left( \frac{(C_t^k)^{1-\frac{1}{\eta}}}{1-\frac{1}{\eta}} - \frac{(N_t^k)^{1+\phi}}{1+\phi} \right)$$

subject to

$$P_t C_t^k + B_{t+1} \leq W_t N_t^k + (1 + i_t) B_t + P_t D_t$$

where  $\beta$  is the discount factor,  $\eta$  is the elasticity of intertemporal substitution,  $\phi$  is the inverse of the Frisch elasticity,  $C^k$  is the capitalists' consumption,  $N^k$  is the capitalists' labor supply,  $B$  is a nominal bond,  $i$  is the nominal interest rate, and  $D$  is the profit flow from firm ownership.

The linearized Euler equation for capitalists is

$$c_t^k = E_t c_{t+1}^k - \eta(i_t - E_t \pi_{t+1}) + g_t$$

where  $g_t = \rho_g g_{t-1} + \varepsilon_t^g$  is a stochastic process for a demand shock (or discount rate shock if you wish).

**Workers.** There exists a  $\lambda$  share of workers in the economy solving the following problem

$$\max_{\{C_t^w\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} (\beta^w)^t \log C_t^w$$

subject to

$$P_t C_t^w + B_{t+1} \leq W_t N^w + (1 + i_t) B_t$$

$$B_{t+1} \geq -DTI \cdot W N^w$$

where  $DTI$  is the debt-to-income constraint and variables without subscript are steady state variables. We assume that  $\beta^w$  is sufficiently low such that the workers are always at their borrowing constraint. The log-linearized consumption function (around  $i = 0$ ) is

$$c_t^w = \omega_t - i_t DTI$$

where  $\omega_t$  is the real wage. We note that the way the borrowing constraint is defined is problematic because it would imply that real debt declines permanently in response to an inflation episode. This may hold in the short run but not for longer horizons. The model results should therefore be interpreted as a short-run exercise.

**Firms and unions.** Firms and unions behave as in Erceg et al (2000), giving rise to the following equation system

$$\pi_t = \beta E_t \pi_{t+1} + \kappa_p y_t + \lambda_p \omega_t + u_t$$

$$\pi_t^w = \beta E_t \pi_t^w + \kappa_w y_t - \lambda_w \omega_t$$

$$\omega_t = \omega_{t-1} + \pi_t^w - \pi_t$$

$$u_t = \rho_u u_{t-1} + \varepsilon_t^u$$

where  $\pi$  is price inflation,  $\pi_w$  is nominal wage inflation,  $u$  is the cost-push process, and  $\varepsilon_t^u$  is a cost-push shock.<sup>2</sup>

**Monetary policy.** The monetary authority sets the nominal interest rate by minimizing the following loss function under discretion.

$$L_t = \sum_{k=0}^{\infty} \beta^k (\pi_{t+k}^2 + \gamma y_{t+k}^2)$$

where  $y_t = (1 - \lambda)c_t^k + \lambda c_t^w$ . Because we solve the model under discretion, discounting is irrelevant.

**Calibration.** We consider four calibrations. The first calibration is a representative agent model (RANK), like NEMO. The second calibration is a standard two-agent model. The third calibration is two-agent model with debt such that it includes a cash-flow channel of monetary policy. And the fourth calibration is a two-agent model with debt, but where we also reduce the

<sup>2</sup> We abstract from the exchange rate channel of monetary policy in the current analysis. One can include a reduced-form version of uncovered interest rate parity by including a term in the price Phillips curve that depends on the interest rate relative to the foreign interest rate. While it would strengthen the total effect of interest rate changes on inflation, and thus the optimal monetary policy trade-off, it does not materially affect the theoretical points we are making in this chapter.

elasticity of intertemporal substitution to illustrate the effect when we reduce the role of real interest rate changes in monetary transmission. Table 2 lists the calibrations used in all simulations. The calibrations considered here are not meant to match any specific economy, but rather serve to highlight theoretical points about what is important for the optimal interest rate responses.

**Table 2. Calibration**

| Parameter   | Description                            | RANK | TANK | TANK w.<br>debt | TANK w.<br>debt and<br>low EIS |
|-------------|----------------------------------------|------|------|-----------------|--------------------------------|
| $\beta$     | Discount rate                          | 0.99 |      |                 |                                |
| $\phi$      | Inverse Frisch                         | 0.50 |      |                 |                                |
| $\gamma$    | Output weight in loss function         | 0.30 |      |                 |                                |
| $\rho_u$    | Persistence of cost-push shock         | 0.50 |      |                 |                                |
| $\rho_g$    | Persistence of demand shock            | 0.50 |      |                 |                                |
| $\kappa_p$  | Slope of price Phillips curve          | 0.10 |      |                 |                                |
| $\kappa_w$  | Slope of wage Phillips curve           | 0.05 |      |                 |                                |
| $\lambda_p$ | Effect of real wage on price inflation | 0.01 |      |                 |                                |
| $\lambda_w$ | Effect on real wage on wage inflation  | 0.05 |      |                 |                                |
| $\lambda$   | Share of workers in the economy        | 0.00 | 0.50 |                 |                                |
| DTI         | Debt-to-income among workers           | 0.00 |      | 2.50            |                                |
| $\eta$      | EIS                                    | 1.00 |      |                 | 0.10                           |

## 5.2 Demand Shocks

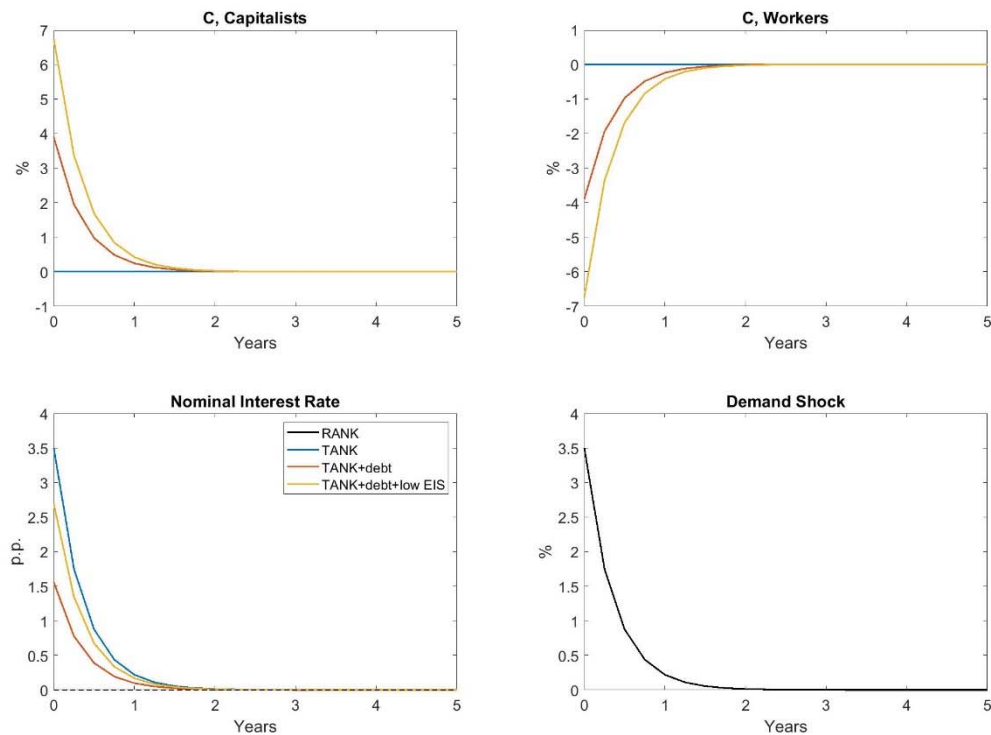
In our first set of results, we simulate how the economy responds to a demand shock. Figure 22 displays the impulse responses to the demand shock for the four calibrations in table 2. In all cases, a demand shock affects the economy by raising output. The divine coincidence holds in all models and the central bank responds by raising the interest rate such that neither output nor inflation moves. The only visible effects of a demand shock are that the nominal interest rate is higher and that there is some redistribution between workers and capitalists.

The nominal interest rate response is the main result in this section. Irrespective of the underlying model, if inflation is caused by an increase in aggregate demand, the optimal monetary policy response is to raise the interest rate sharply. The presence of nominal monetary transmission channels or the relevance of real interest rate channels does not affect this result.

However, changes in the underlying model do affect the strength of the interest rate response. What matters for this result is the effect monetary policy has on aggregate demand. If monetary policy has a strong effect on aggregate demand, as in the TANK model with debt (but not low

EIS), the interest rate response is smaller. If monetary policy has a weak effect on output, as in the standard TANK model, the interest rate response is larger.<sup>3</sup>

**Figure 22: Impulse responses to a demand shock**



### 5.3 Cost-push shocks

Our next focus is on optimal monetary policy responses to a cost-push shock. In the monetary policy literature, cost-push shocks are interesting because trade-offs are involved. Whenever inflation increases due to cost-push shocks, the monetary authority must induce a recession to reduce inflation. The (marginal) benefit of reducing inflation therefore must be evaluated against the (marginal) cost of inducing a recession.

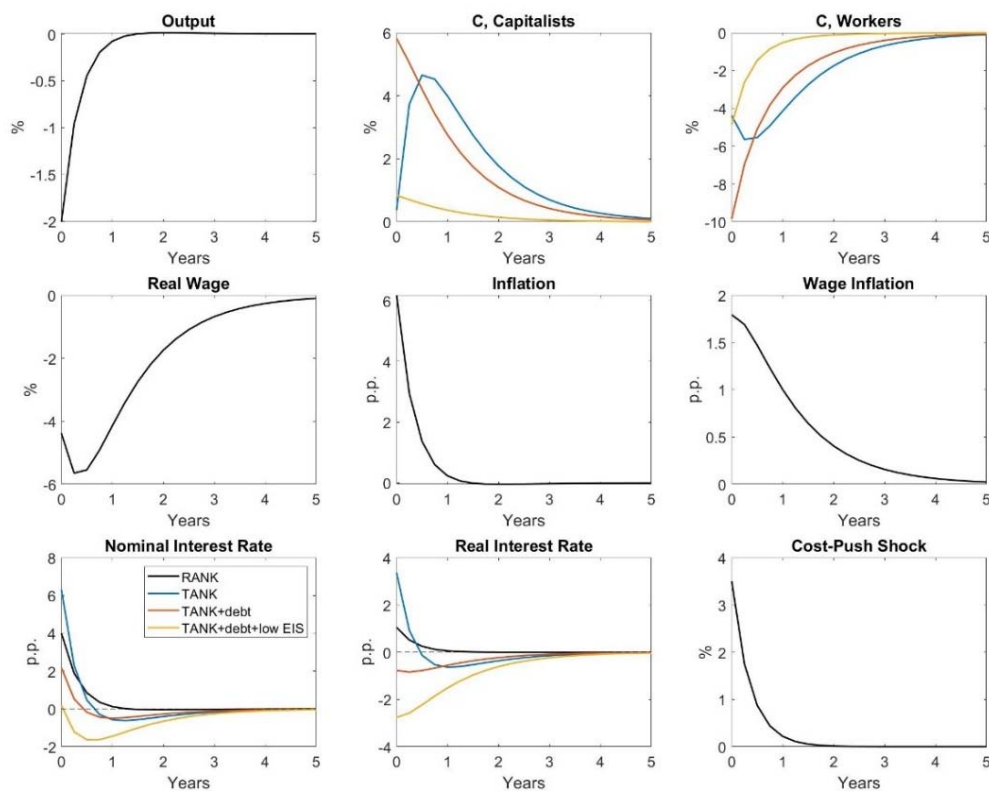
<sup>3</sup> Once one introduces household heterogeneity in a model, monetary policy has redistributive effects. Specifically, when households hold debt, a higher interest rate redistributes disposable income from workers (debtors) to capitalists (creditors). We do not consider inequality concerns here.

Formally, this trade-off and the respective marginal benefits and costs are operationalized in the central bank's loss function. The first-order condition of the central bank when minimizing the loss function subject to the price Phillips curve is

$$\gamma y_t = -(\kappa_p + \lambda_p \partial \omega_t / \partial y_t) \pi_t$$

where the left-hand side is the marginal cost of a recession, and the right-hand side is the marginal benefit of reducing inflation. Because  $\gamma$ ,  $\kappa_p$ ,  $\lambda_p$ , and  $\partial \omega_t / \partial y_t$  are the same across all models, the trade-off is the same. Hence, in all cases in figure 23, the movements in output and inflation are the same.

**Figure 23: Impulse responses to a cost-push shock**



The main difference between the four cases is what is required to engineer the optimal recession. In a RANK model, the initial inflation shock is expansionary because it implies lower expected inflation and thus a lower real rate. The central bank raises the nominal rate sufficiently to increase the real rate, often described as the Taylor principle. A similar pattern happens in the standard TANK model. The central bank even increases the nominal interest rate more because a given real rate change only affects capitalists, who now are a smaller share of the population.

Things are different once the model includes debt. When the workers hold debt, the cash-flow channel comes into play. When the central bank increases the nominal interest rate, workers' disposable income decreases, and workers reduce consumption. Hence, when the model includes debt, the nominal interest rate response is weaker because a given interest rate change now more potently affect the economy. Hence, rather than raising the interest rate by 4 percentage points, the optimal response is to increase the interest rate by 2 percentage points.

The model contains a natural measure of the relative importance of real interest rates in monetary transmission. For a given level of debt, a reduction in the elasticity of intertemporal substitution (EIS) reduces the importance of real interest rate channels. One can think of changes in the EIS as a test of ideas, e.g., what if the real interest rate/intertemporal substitution channel is less important. However, one can also view variation in the EIS as representing the possibility of substitution in the goods for which prices are currently increasing. Some goods are easier to substitute than others across time. Necessities are goods that are hard to substitute across time. For example, even if I knew bread would be expensive a year from now, there's a limit to how much bread I can consume today to take advantage of the (relatively) cheap current bread. A low EIS may therefore also represent the observation that a large part of the price increases in 2022 are in necessities (energy, food) that are hard to intertemporally substitute.

In any case, a reduction in the elasticity of intertemporal substitution raises the relative importance of the cash-flow channel. The TANK model with debt and a low EIS therefore illustrates the effect of reducing the importance of intertemporal substitution in monetary transmission. When the EIS is lower, the optimal interest rate response is smaller. With a low EIS, households do not respond much to real interest rate changes. Hence, an increase in (future) inflation is less expansionary. Instead, higher prices are primarily contractionary because they result in lower disposable income for workers. Higher inflation today thus induces a recession by itself. The question is then, should the central bank deepen or dampen that recession? In the calibration in Figure 23, it should dampen the recession – and thus reduce the nominal interest rate – in response to a cost-push shock.

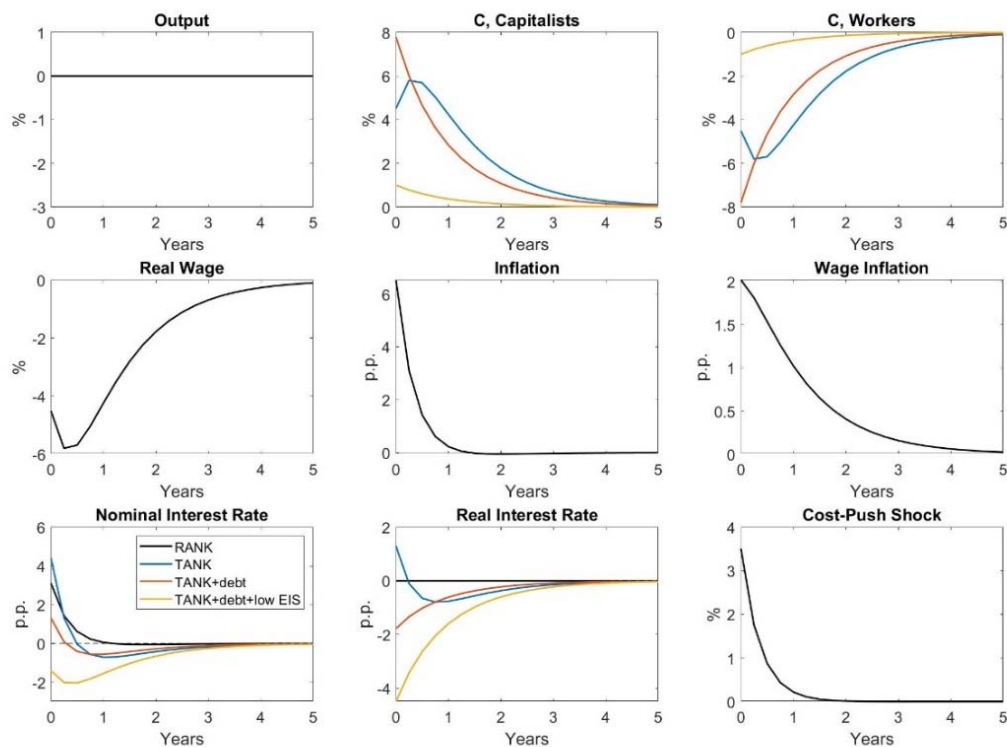
The more general message is that the optimal monetary policy response to a cost-push shock depends on the model, or more specifically, the assumptions about the monetary transmission channels that operate. With nominal transmission channels, the Taylor principle no longer holds and the optimal monetary policy response to a cost-push shock may be to reduce the real rate, or even reduce the nominal interest rate.

#### *5.4 The marginal cost of inflation*

In the optimal monetary policy framework, we weigh the marginal cost of recession against the marginal benefit of reducing inflation. The way this is formalized in standard monetary policy models is through a quadratic loss function. In this section, we will discuss how deviations from a quadratic loss function affect optimal monetary policy.

There are at least two reasons why the quadratic loss function may be problematic. The first problem with a quadratic loss function is that it stems from a specific model of price stickiness. With sticky prices, inflation is costly because it will result in the misallocation of resources between firms. And the cost of inflation is typically convex because misallocation increases more than one-for-one with inflation. This cost is large in models but relatively small in practice (e.g., Nakamura, Steinsson, Sun, and Villar, 2018). If the main cost of inflation is not misallocation, the marginal cost of inflation may be very different. The second problem is that the quadratic loss function comes from a second-order approximation of the households' welfare. These approximations hold locally for small deviations of inflation from the target but may not be as relevant when inflation is higher.

**Figure 24. Impulse responses to a cost-push shock if the central bank only cares about output ( $\gamma \rightarrow \infty$ ).**



Regardless of what one believes about the correct loss function, the current loss function implies the following behavior. Assume that a transitory cost-push shock affects the economy. The central bank knows that the shock will be short-lived and disappear by itself. Nevertheless, it will engineer a deep but short-lived recession to marginally reduce inflation because the loss function implies that the marginal benefit of reducing inflation is large. Hence, even if the shock is short-lived and the effect of the recession on inflation is small, the central bank engineers a 2 percent fall in output in the previous section. That seems suboptimal in many realistic situations.

Figure 24 illustrates an extreme case where we set the marginal cost of inflation to zero. In this case, the central bank fully stabilizes output. Hence, depending on whether the cost-push shock is expansionary (RANK, TANK) or contractionary (TANK+debt+low EIS), the central bank either raises or reduces the nominal interest rate.

The broader point is that optimal monetary policy may be anything between figures 23 and 24, depending on what the central bank deems to be the marginal benefit of reducing inflation. The marginal cost of inflation is thus a key component in determining how we should respond to a cost-push shock. If we think the marginal cost is low, we should engineer a smaller recession, or even no recession. If we believe the marginal cost of inflation is high, we should engineer a deep recession.

### *5.5 Conclusions*

In this chapter, we have used a structural model to investigate how the central bank responds to high inflation when it solves an optimal monetary policy problem under discretion. There are three main results. First, understanding the source of inflation is key to determine how the central bank should respond. If high inflation is caused by high demand, the central bank should unambiguously raise the interest rate. How much the central bank should raise the interest rate depends on the underlying model.

Second, if inflation is not due to demand (i.e., cost-push), the sign of the optimal interest rate response is ambiguous and depends on which monetary transmission channels are important. When nominal monetary transmission channels are important (e.g., cash-flow effects), the optimal interest rate response may even be to reduce the interest rate in response to higher inflation.

Third, the optimal monetary policy response depends on what the central bank perceives as the marginal cost of inflation. If the marginal benefit of reducing inflation is perceived to be smaller, the central bank increases the interest rate by less. Understanding what the marginal benefit of reducing inflation is therefore key to determine the optimal interest rate response.

Considering these three findings, three questions are important for how Norges Bank should respond to the current inflation episode. First, they should be concerned with decomposing and understanding the causes of inflation. Second, they should be concerned with how they believe the economy responds to this inflation episode and how monetary policy transmits to the economy. Third, they should consider what the marginal cost of reducing inflation today is.

Norges Bank seems very concerned with how they believe the economy responds to inflation and how monetary policy transmits to the economy. In Monetary Policy Report 2/2022, there was a long discussion about cash-flow effects, a transmission channel that is not prominent in standard monetary policy models. Moreover, there is ongoing work in Norges Bank on building models of household heterogeneity along the lines presented here.

Norges Bank, however, is less clear about how it perceives the underlying causes of the current inflation episode. An analysis that may be useful for this purpose is to use the input-output matrix between sectors in the national accounts to compute upper bounds to the effects of foreign input prices (energy, import prices) on prices. For example, Dhyne et al. (2021) find that most “firms use a lot of foreign inputs, but only a small number of firms show that dependence through direct imports.” And Gaarder (2019) finds that VAT changes are fully passed through to consumer prices. It is thus likely that firms in Norway are more reliant on foreign inputs than suggested by the official statistical definition and that the firms are likely to pass-through a large share of cost changes to their buyers.

Norges Bank is also less clear about how it evaluates the marginal costs of inflation. At the CME speech in November 2022, Governor Ida Wolden Bache presented several reasons why inflation is costly. Our analysis suggests that the reason is important and may shape how the central bank should respond to price changes. However, we can understand that it wants to be less clear here given the potential role of expectations and credibility in monetary transmission. Nevertheless, we highlight that the perception about the marginal cost of inflation is of first-order importance for the interest rate response. Blindly following the loss function presented in the Norges Bank’s Monetary Policy Handbook may in some cases be very problematic.

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