Monetary Policy Analysis and its Contemporary Challenges

by

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Author's Declaration

This thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners. I understand that my thesis may be made electronically available to the public.

Statement of Contributions

Chapter 1 is written solely by myself.

Chapter 2 is co-authored with my supervisor, Professor Jean-Paul (J-P) Lam. The original idea for the second chapter was developed by myself. For this project, I contributed with the data, empirical analysis and writing, while Professor Lam provided support with the writing and guidance of the project throughout. A shorter version of this chapter was published in a 2022 edition of *Economics Letters*.

Chapter 3 is co-authored with my supervisor, J-P Lam. The original idea for the third chapter was jointly developed by Professor Lam and I. For this project, I contributed with the data, empirical analysis and writing, while Professor Lam provided support with the writing and guidance of the project throughout. A small portion of the third chapter also contains text from a solo-authored Intelligence Memo with the C.D. Howe Institute, published in 2022.

Abstract

This thesis contains three essays on the empirical analysis of monetary policy. While the subjects are diverse, they all share the goal of providing for a thorough, data-driven analysis of critical policy developments related to communications from North American central banks. The first chapter examines the effectiveness of central bank communications as a policy tool. To evaluate this otherwise qualitatively-oriented policy channel, a new dictionary of central banking sentiment is developed using natural language processing. This dictionary aims to capture the relative prevalence of positive (contractionary) versus negative (expansionary) words used in discussions of the monetary policy landscape. It is then applied to a large sample of news articles, where sentiment scores are computed and adopted in two forms of empirical analysis. The first form of analysis utilizes these sentiment scores in a high-frequency event study, which indicate that positive communication surprises lead to increased interest rates across various horizons on the yield curve, along with an appreciation of the Canadian dollar relative to other major currencies. The sentiment measure is also employed in a lower-frequency analysis, where the average score across all articles is computed on a monthly basis. VAR estimates support the findings from the high-frequency event analysis and allow exploration of other outcomes available only at a monthly frequency. The analysis suggests limited direct evidence of links between communication shocks, prices, and real measures of economic activity, except for the real estate market. In the second chapter, we profile an essential case study that emerged during COVID-related monetary stimulus, where central banks sought to dismiss concerns about rising inflation as "transitory." This chapter focuses on the United States and develops a separate tailored dictionary that is used to quantify the degree of belief (or disbelief) in the transitory inflation signal. It analyzes news articles and tracks changes in sentiment-derived signal credibility over time, revealing that overall levels of credibility declined as positive inflation surprises persisted throughout 2021. This measure is then adopted within the framework of a daily VAR model, showing that the signal credibility measure declines significantly to positive inflation surprises and that market-based inflation expectations rise even at extended horizons in response to negative shocks from the credibility measure. The final chapter explores the potential intersection

between economic inequality and monetary policy in Canada. In the first exercise, a macro panel exercise reveals a "U-shaped" effect on income sourced from labour, meaning that expansionary policy benefits the bottom and upper ends of the income distribution most significantly in percentage terms. A similar pattern is observed for non-labour income, which tend to favour the wealthiest Canadians, and particularly since the 2008-2009 Financial Crisis. Time series evidence highlights a growing connection between policy surprises and real asset prices, with a more modest impact on unemployment. Altogether, these essays address crucial issues related to monetary policy, emphasizing the importance of evidence-based analysis and objective quantitative research in evaluating the effectiveness and consequences of central bank communications and policies.

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Realistically this section could be a thesis altogether. Unfortunately, I'll have to save the printing presses for the sensational research to come.

Dedication

to everyone who supported me from *start* to *finish*

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Introduction

Introduction

It was in 1975 that Milton Friedman quipped that "One of the great mistakes is to judge policies and programs by their intentions rather than their results."[1] This timeless quote serves as a reminder of the paramount importance of properly assessing the outcomes of macroeconomic policies and programs - even those driven by good intentions - as they can sometimes fail to produce their desired effects. Consequently, policymakers are encouraged to be guided by thorough evidence-based analysis. By doing so, they can learn from the effects of their policies and make necessary adjustments, thus fostering well-informed decision-making.

The significance of this evaluation process becomes particularly more pronounced when we consider the subject of monetary policy. In the wake of the 2008-2009 Financial Crisis and the subsequent COVID recession, central banks have found themselves to be propelled even further into the public spotlight. The heightened prominence and visibility of their operations has spurred a greater need for comprehensive scrutiny, analysis and research in the field of monetary policy. Accordingly, central bank mandates and policy have come under closer examination, with questions being raised regarding their effectiveness and rel-

[1] See Friedman's December 1975 interview with PBS' *The Open Mind*.

evance in the face of evolving economic challenges. Furthermore, the growing utilization of unconventional monetary policy tools, necessitated by the unique circumstances of these recent crises, has further emphasized the need for in-depth research and analysis. These extraordinary measures, such as the use of communications for facilitating monetary policy, has raised questions surrounding their effectiveness, long-term consequences and potential risks. As a result, researchers and policymakers alike are compelled to delve into the finer nuances of these topics, seeking a deeper understanding of their implications and effects on the macroeconomy.

Enclosed in this thesis is a set of three essays in the field of monetary policy. The main purpose is to assess the effects of three highly topical issues that bear association with central bank communications. While the subject matter under investigation is diverse, all three topics are motivated by the need to have a thorough, data-driven analysis for evaluating these important policy developments. As recent years have shown the world to become more normative and polarized with respect to public policy, there is an imperative need to assess today's most pressing challenges with objective quantitative analysis.

In this thesis, I seek to assess three topical challenges related to monetary policy in Canada and the United States. First, I analyze the role of communications in facilitating monetary policy in Canada. Second, I assess the macroeconomic importance on the credibility of the infamous "transitory inflation" signal that was widely adopted by central banks in 2021. Finally, as motivated by communications from the Canadian central bank, I provide data-driven insights into the interactions between monetary policy and economic inequality in Canada.

In the first chapter, I explore the effectiveness of central bank communications as a policy tool. In the post-Financial Crisis era of low rates, central banks have increasingly adopted more unconventional policy measures - like the use of communications - to maintain price stability. The main challenge of evaluating this policy channel is that communications are qualitative in nature, and that there is no straight-forward way of relating these communications with policy outcomes of interest. Using methods from the field of natural language processing, I develop a new dictionary of central banking sentiment that is intended to capture the relative share of positive (contractionary) versus negative (expansionary) words used to discuss the monetary policy landscape. This dictionary is then applied to a large sample of approximately 23,000 news articles, therefore capturing the dynamic response of the media to information from the Canadian central bank. Sentiment scores are then computed and adopted in two forms of empirical analysis.

The first form of empirical analysis will utilize these sentiment scores in a high-frequency event style study. In this exercise, we develop a sentiment surprise indicator, which is the difference in average news article scores shortly before and after a communication event is held by the Bank of Canada. Thus, this measure accounts for shifts in media sentiment about central banking policy around a narrow window relative to a baseline average before the event was conducted. After controlling for conventional monetary surprises with a survey-based measure, we explore how sentiment surprises impact interest rates, exchange rates, and the domestic stock market. Consistent with the ambitions of the Bank of Canada, we find that positive communication surprises boost interest rates even at extended horizons on the yield curve, while also leading to an appreciation of the Canadian dollar relative to the U.S. dollar, Euro and Mexican Peso. However, the domestic stock market is not significantly impacted, with much of this variation being driven by oil prices and the U.S. stock market. Rolling window analysis shows that this effect has grown in significance into the early COVID period, remaining to be a valid instrument even when the policy rate is held at the lower bound.

Our sentiment measure can also be used at a lower frequency, where we take the average score across all articles on a monthly basis. VAR estimates corroborate our findings from the high-frequency event analysis, and also allow us to explore other outcomes that are available only at a monthly frequency. We find very little direct evidence between communications shocks, prices and real measure of economic activity, largely with the exception of the real estate market. In regions with a recent history of unprecedented price escalation, we find there to be a strong channel between positive communication shocks - as a likely indication of future contractionary policy - and a depreciation in real house prices among heated urban areas like Toronto and Vancouver. To the reverse of our main channel of analysis, we find that positive oil, housing, consumer and exchange rate prices all boost sentiment held by the Canadian central bank.

The policy-related conclusions are clear: central bank communications are an effective tool - even in a small open economy like Canada - for facilitating monetary policy. The history of events studied in Chapter 1 are supportive of this, even demonstrating that the communications channel has risen in significance and relevance when the conventional policy rate has been constrained by the zero-lower bound. In practice, a central bank can also think about how it shapes its communications, as to create a specific message that is more scientifically designed to have an intended policy effect among the general public.

A key presupposition to the effectiveness of monetary policy communications is that these signals are perceived to be credible by the stakeholders of the central bank. In 2021, a profoundly important case study developed in the aftermath of COVID-related stimulus, where central banks dismissed concerns about rising inflation as "transitory". Seeking to fortify their positions on forward guidance and with monetary stimulus more generally, central banks like the U.S. Federal Reserve doubled down on communicating this "transitory" signal as inflation persisted and soared throughout 2021. Chapter 2 provides an assessment of this crucial episode in monetary history, which saw inflation expectations become untethered for the first time in several decades.

Similar to Chapter 1, this analysis involves developing a propriety dictionary in order to quantify the degree of belief in the transitory inflation signal. I first obtain a large sample of news articles discussing the dynamic nature of inflation, which is done over the same period where this signal was publicly communicated by Federal Reserve leadership. Then, I apply this text-based data to a comprehensive dictionary containing words or phrases in support of (like "abating") or against (like "persistent") the notion of inflation as being transitory. When applied to the data, a clear downward trend is observed for the measure of credibility, where credibility is defined to be the relative share of words in support of the central bank signal.

Subsequently, this measure is then adopted within the framework of a comprehensive daily VAR model. There are two important observations of note from this exercise: (i) the signal credibility measure declines significantly to positive inflation surprises (to which there are many of magnitude throughout 2021), and (ii) market-based inflation expectations rise even at extended horizons in response to negative shocks from the credibility measure. In summary, Chapter 2 provides for a preliminary analysis on one of the most influential - and costly - monetary policy communications strategies of the contemporary era.

Finally, Chapter 3 will explore the possible intersections between economic inequality and monetary policy in Canada. Over the last several decades, there has been tremendous growth in interest among the media and general public for this relationship, which once again came to the forefront following massive expansionary policy in the aftermath of the COVID recession. Our study is particularly motivated by comments from the Canadian central bank that dismissed concerns about rising inequality. In September 2020, the governor of the Bank of Canada stated: "We're going to be there, creating the conditions for *all boats to rise*, through the full length of this recovery." (Parkin, 2020). In greater detail, he elaborated that: "You can think of monetary stimulus and the recovery like the tide coming in... when the tide comes in, it creates the conditions for all boats to rise. That's what monetary stimulus does." To the best of our ability, we put these words to the test. Do all boats rise in response to expansionary monetary policy? And better yet, is there significant heterogeneity within the income/wealth distribution, as a response to expansionary policy?

We delve into this topic with a set of three different empirical analyses. They include: (i) a distributional income analysis exploring the response of capital and labour-based sources to expansionary policy, (ii) the response of billionaire wealth to expansionary policy, and (iii) a time series analysis looking at the channels between expansionary monetary policy, real asset prices and unemployment.

In the first exercise, we draw from a large macro panel at the year-city-gender-income group level in Canada. Importantly, having data at the income group level allows us to explore the distributional impacts of monetary policy, with group sizes range from the bottom 50 percent of income earners, all the way up to the very granular top 0.1 percent. For income that is sourced from labour, we find a "U-shaped" effect, meaning that expansionary policy does lift all boats, but particularly at the bottom and upper ends of the income distribution in *percentage* terms. Once base effects are considered between the groups, the dollar value differences are staggeringly in favour of the most well-off Canadians. The asymmetric benefits from expansionary policy are further illustrated for non-labour income, which is also in favour of the most well-off, and driven especially by policy movements since the 2008-2009 Financial Crisis. A similar set of exercises using billionaire wealth shows that this channel has risen considerably in recent years, coinciding with increased concerns held by the public and in the popular media. Finally, time series evidence documents a growing channel between policy surprises and real asset prices, while only having a modest effect on unemployment. Altogether the results from these three exercises corroborate one another in the sense that the benefits of expansionary policy tend to be tailored more towards Canada's most well-off.

Therefore, while there is weak evidence in support of a "lifting of all boats", we find that the disproportionately distributed benefits from expansionary policy are more likely to amplify inequality. From the perspective of an inflation targeting central bank (like the Bank of Canada), it's not clear that they are the most appropriate institution to address economic inequality. If levels of economic inequality are determined to be abnormally high by policymakers and the general public, then the more established fiscal channels can be used for redistribution. Instead, we argue that it is important for the central bank to have an open dialogue on these concerns, and more generally to communicate a greater awareness on the externalities that arise from maintaining a given policy stance. Amid the post-COVID worries of rising inequality, it is essential for Canada's central bank to be transparent about the effects of monetary policy in order for this ever-important institution to maintain its credibility going forward.

Chapter 1

Words Hurt: A Novel Measurement and Analysis of Central Bank Communications from Canada

1.1 Introduction

1.1.1 Motivation

Central banks, once notorious for their veiled and opaque language, have become increasingly transparent - and especially so in the era of low rates. In fact, with many central banks holding their key policy rates at the zero lower bound in the post-Financial Crisis era, forward-looking policy communications remain to be one of few available tools in the hands of monetary policymakers. Therefore, central banks tend to routinely engage in forward guidance, which communicates to the public the likely future course of monetary policy either implicitly or explicitly.[1] When a central bank signals their stance, an immediate policy effect can occur if individuals and businesses credibly receive new unanticipated information. In particular, enhanced prospects about future expansionary policy tends to: suppress yields through the term structure (Lucca and Trebbi, 2011), boost stock market prices (Blinder et al., 2008), and depreciate the domestic currency (Fratzscher, 2005). Due to the unconventional and not well-defined empirical nature of central bank communications, there remains to be much to understand about such a highly influential policy tool.[2]

In this chapter, we explore the transmission of communication sentiment from Canada's central bank with a novel text-based sentiment dictionary. We construct a forward-looking, policy-oriented, news-based communication sentiment index from January 2008 to September 2020 by parsing over 23,000 articles and 17.6 million words. Sentiment scores are then applied in an event study analysis around announcement dates, and also with a lower frequency Vector Autoregressive (VAR) model. Consistent with the policy aspirations of the Bank of Canada, we find in our high-frequency analysis that positive sentiment surprises (which are indicative of positive economic growth and pivots toward contractionary monetary policy) significantly impact yields across the term structure and lead to an appreciation

[1] Respectively the implicit and explicit forms of monetary policy communication have been referred to as Delphic and Odyssean guidance.

[2] Here, we note that central bank communications are an all-encompassing definition, inclusive of forward guidance. As forward guidance can be either explicit or implicit, central bank communications in general will relate strongly with forward guidance.

of the domestic currency.[3] We find virtually no effect on the Toronto Stock Exchange (TSX), attributing much of its variation on communication dates to energy prices and developments in U.S. financial markets. Rolling window regressions illustrate that central bank communications in Canada have also become increasingly more effective in recent years, and more so as our sample stretches into the beginning of the COVID recession. We also find no evidence in the high-frequency analysis that communications are any less effective when the conventional policy rate is held at the lower bound.

In the VAR analysis, we estimate impulse response functions that represent the transmission of positive sentiment shocks from a monthly index. We find some evidence in short horizons that positive sentiment from the central bank is expansionary - namely a very modest boost in a handful of real production measures, and a decrease in the unemployment rate. However, we find other outcomes, specifically those related to real estate to be much more receptive to changes in sentiment held by the central bank. Borrowing costs, aggregate lending, sectoral real GDP, and real house prices all respond significantly in a contractionary manner, all of which persist across a longer time horizon. Collectively, this would suggest that the transmission of central bank communication sentiment is somewhat heterogeneous in nature, although the majority of the evidence we provide shows that positive movements tend to be a contractionary form of policy.

Our study adds to the literature in terms of both methodology and scope. The analysis of information, signalling, and communications in monetary economics has traditionally been represented in the literature by theoretical contributions, and less so for those of an empirical

[3]In reference to the document discussing communications as a policy tool, titled: 'Framework for Conducting Monetary Policy at Low Interest Rates'. See Bank of Canada (2015).

nature. It is troubling that communications are traditionally of a qualitative nature, and not readily available in a data format for applied practitioners. We present our novel sentiment dictionary as a solution to this problem, serving as a monetary analogue to the financial dictionary from Loughran and McDonald (2011; 2015). Furthermore, we argue that the Canadian case presents a unique perspective for studying monetary communications. In particular, the Bank of Canada is widely regarded as being in the top tier of central bank transparency for both their economic outlook and prospects for future policy (Dincer and Eichengreen, 2007; Naszodi et al., 2018).[4] Because of this perception, we hypothesize that the communication stance from the Bank of Canada should serve as an important mechanism for facilitating monetary policy.

Recent years have also provided no shortage of examples where the Bank of Canada has engaged in either explicit or implicit forward guidance. On the explicit end, in its April 2009 statement, the Bank of Canada put forth a conditional commitment to maintain its key policy rate at 25 basis points until the second quarter of 2010 - a commitment they in fact held true to. On the more implicit end of policy guidance, an overly optimistic speech by the Senior Deputy Governor Carolyn Wilkins in June 2017 foreshadowed Canada's first hike in several years at the next fixed announcement date. This signal emboldened public perception that the Bank of Canada would correctly be increasing the policy rate.[5]

We structure the rest of our chaper by first providing a brief discussion of the relevant

[4]Here we are also drawing from updated rankings on central bank transparency from Eichengreen's website for the period 1998-2015, available at: https://eml.berkeley.edu/~eichengr/data.shtml.

[5]For example see the article from Blatchford (2017). Although this is a singular article, it is reflective of the substantial amount of press generated from this speech, as is evidenced by the database discussed in greater detail in Section 2.

literature and the Canadian policy context over the course of our sample. We then describe in detail the monetary sentiment dictionary in which we develop, and how it can be applied in an empirical setting. We thereafter use our measure with the high and low-frequency methodologies, discuss the results, and conclude in the final section of the chapter.

1.1.2 Literature

The transmission channel of forward guidance (and monetary policy communications more generally) is complicated, with potentially ambiguous implications. For instance, if a central bank were to promote expectations of a low future policy rate, this would be consistent with both a negative economic stance, and one that also anticipates future expansionary policy (Campbell at al., 2012). To complicate matters further, Del Negro et al. (2015) show that standard DSGE models predict explosive macroeconomic outcomes in response to forward guidance, that was popularly dubbed the forward guidance puzzle. This finding has generated substantive debate in the literature, with many proposing solutions to this phenomenon (including: McKay et al., 2016; Gabaix, 2016; Andrade et al., 2019). If anything, the debate and sensitivity of assumptions in the theoretical literature motivate the need to better understand the real-world outcomes associated with forward guidance and central bank communications.

Empirical studies on the role of communications as a policy instrument have generally come to a greater consensus than that of the theoretical literature. Studies however tend to focus almost exclusively on the Federal Reserve, and for outcomes on the financial market, term structure and exchange rates (for example: Gürkaynak et al., 2005; Lucca and Trebbi, 2011; Carvalho et al., 2016; Nakamura and Steinsson, 2018; Jarociński and Karadi, 2020). All of the former studies in some regard adopt the use of a high-frequency methodology, where changes in an empirical communication proxy are typically utilized as a regressor on yields across the term structure, financial markets and Eurodollar pairings. There is strong evidence demonstrating that positive communication surprises from the Federal Reserve shape the term structure at extended horizons, damper financial markets, and lead to an appreciation of the U.S. dollar.

Communication sentiment measures can also be aggregated to lower frequencies. There are some limitations about collapsing the data, although doing so allows for a more expansive scope of analysis. Including communication measures in multivariate time series analysis can be done to evaluate how sentiment shocks propagate throughout other macroeconomic variables. When applied in a VAR setting, communication shocks however tend to produce results that are either weak or insignificant for outcomes that include, among others: unemployment, inflation and real production (Lucca and Trebbi, 2011; Hansen and McMahon, 2016). Jarociński and Karadi (2020) find a modest but positive and significant effect between a positive communication shock and real GDP at a short horizon, which runs consistent with the notion that a positive pivot acts in an expansionary manner. VAR evidence from Armelius et al. (2020) documents international spillovers in sentiment, with the Federal Reserve having influence over smaller monetary regions (but not vice versa), as is evidenced by linkages between sentiment measures and unemployment rates.

Campbell et al. (2019) note that extending beyond the analysis of the Federal Reserve can build a stronger understanding about the mechanisms of central bank communications, and to what extent are findings about the Federal Reserve generalizable to other central banks. In Canada, there have been a few studies that have sought to quantify the sentiment of central bank communications. Notably, Hendry and Madeley (2010) and Hendry (2012) focus primarily on text-based communications from the central bank itself in the early 2000s period.[6] Both studies found there to be an asymmetric impact on the volatility of short-term rates depending on the themes discussed by the central bank, and that sentiment surprises were comparable in magnitude to those of the policy rate for short-term yields. Theme-based measures of the documents produced results that were strongest for retrospective events in the early 2000s, including SARS, Bovine Spongiform Encephalopathy (BSE),[7] and the Northeast Blackout of 2003 being strong determinants of rate changes and volatility. Binette and Tchebotarev (2019) provide an extensive analysis on the Monetary Policy Report (MPR), a quarterly document highlighting the Bank's perspective about inflation, economic activity and potential risks to the macroeconomy. Using a novel measure of sentiment, they too find that the text analysis associates negative sentiment from the central bank with adverse economic events.

More generally, this study positions itself amid a growing use of text-based data for macroeconomic analysis. Text-based data is particularly advantageous because it is plentiful, timely, and available in wide variety of formats, which stands out strongly in contrast to traditional macroeconomic data. Central banks and researchers alike are increasingly leveraging this data to gain deeper insights into the transmission channels of monetary policy.

[6] Hendry (2012) also analyzes a smaller set of news articles in contrast with communications directly from the central bank.

[7] This is also colloquially referred to as Mad Cow Disease - which resulted in temporary economic panic in 2003, where beef exports to the U.S. and Mexico were temporarily halted.

For instance, studies that leverage text-based data sources include: news articles (Lucca and Trebbi, 2011; Kapfhammer et al., 2020), social media posts (Gorodnichenko et al., 2021; Ehrmann and Wabitsch, 2022), and communications from the central banks themselves (Carvalho et al., 2016; Ericsson, 2016; Stekler and Symington, 2016; Paloviita et al., 2020; Siklos, 2020; Byrne et al., 2021; Glas and Müller, 2021; Shapiro and Wilson, 2022). Natural language processing techniques like sentiment analysis can be applied to extract meaningful information and assess the tone and relevance of the text. Thereafter, the insights generated from text-based data can be incorporated into empirical models, where policymakers can enhance their understanding of monetary policy tools and even unconventional policies that are considered to be qualitative in nature. While this study focuses on text-based news data, other studies have since furthered this analysis to include measurement on the tone and facial expressions of central banking officials, and how these deviations impact bond and stock markets (Alexopoulos et al., 2023; Gorodnichenko et al., 2023). This evolving field of analysis holds great potential for improving the effectiveness of monetary policy decision-making in an increasingly complex and uncertainty-ridden macroeconomy.

1.1.3 Policy Context and Recent Economic History

Our scope of analysis will cover the time frame between January 2008 and September 2020 - a period where there has been no shortage of significant monetary or economic developments in the Canadian economy.[8],[9] There has been both expansionary and contractionary monetary

[8]We select our sample to be from early 2008 until the end of 2020 to balance the trade-offs between the computationally intensive limitations of working with large, unstructured text-based data, and also the need to establish a sample filled with diverse movements in monetary policy.

[9]We test the sensitivity of this window of analysis in our results section.

policy, which has also seen the adoption of unconventional tools in periods of heightened uncertainty. In this brief section, we highlight important developments in the Canadian macroeconomy as background context under the auspices of the Bank of Canada.

The first major event in our sample is the 2008-2009 Financial Crisis. As a result, Canada entered its first recessionary period since the 1990s, which generally has been thought to be less severe than the U.S. experience.[10] Domestic and global uncertainties from the crisis brought forth an unprecedented wave of monetary stimulus, including: a decrease in the key policy rate by 375 basis points from the start of 2008 through April 2009, an internationally coordinated cut in October 2008, and explicit forward guidance to commit to a low policy rate into 2010. Increasing commodity prices and economic growth then put upward pressure on inflation, where the central bank then increased its key policy rate twice in 2010, thereafter holding this position for several years.

Before the collapse in oil prices in late 2014, energy producing regions like Alberta and Saskatchewan benefited from historically high commodity price levels, and were achieving at enviable levels of economic prosperity. At the same time, the rest of the country was growing at a much more muted rate in the aftermath of the 2008-2009 Financial Crisis. From 2014 to 2016, Alberta and Saskatchewan's real GDP declined at rates of 13 and 8 percent,[11] while other large regional economies like British Columbia and Ontario grew at rates of 6 and 5 percent respectively. This disparity presented a unique set of challenges for

[10]See for example Deputy Governor of the Bank of Canada Jean Boivin's 2011 speech to the Montréal CFA Society.

[11]According to calculations by the author(s) using data from Statistics Canada Table 36-10-0222-01. Data available until the end of 2018 shows that both economies still have not recovered from the energy price shock.

monetary policymakers as the Canadian economy divided seemingly in two, leading to two expansionary cuts of the policy rate in January and July of 2015.

Another development on the radar of the central bank was the surge in housing prices present at the national level, but particularly in the hot spots of Toronto and Vancouver. Real national price levels increased by roughly 51 percent from March 2009 into March 2017, which was driven largely by Toronto and Vancouver - cities that respectively saw real appreciations of 99 and 68 percent.[12] This is a sharp contrast with the four of Canada's other six largest cities of Montréal, Ottawa, Calgary and Edmonton, which experienced appreciations of 16, 15, 7, and 3 percent over the same period. The Bank of Canada cautioned in July 2016 about Toronto and Vancouver that that 'sharply rising prices in these markets over the past year raise the possibility that prices are also being driven by *self-reinforcing expectations*, making them more sensitive to an adverse shock in housing demand.[13] Such comments were in line with the public perception of a housing crisis, adding an additional layer of caution for policymakers.[14]

As the economy began to stabilize in 2017, the inflation gap began to close, and the Bank of Canada started to increase its key policy rate well into 2018. We soon provide evidence that the central bank gradually became more optimistic following the cuts in 2015, with sentiment reaching its peak in the later parts of 2017. This stance was maintained by

[12] Author's calculations using data from the Canadian Real Estate Association (CREA). Prices are for the greater regions. Both numbers vastly exceeded the pace of inflation over the same period.

[13] Italics are added for emphasis. This observation is drawn from the July 2016 edition of the Monetary Policy Report (MPR), page 13. A copy of this document is available at: https://www.bankofcanada.ca/2016/07/mpr-2016-07-13/.

[14] In our database of news articles we come across a number of examples discussing house price escalation alongside central banking policy, even though house prices (technically speaking) beyond the purview of the Bank of Canada's singular inflation mandate.

the Bank of Canada throughout 2018, before concerns about trade policy, economic growth, and suppressed energy prices were ultimately overshadowed by the COVID recession - an event that spurred some of the most quantitatively staggering economic declines on record in Canada. When COVID became a forefront issue in March 2020, the Bank of Canada took immediate and unprecedented action. This began with a scheduled cut of the conventional policy rate of 50 basis points on March 4^{th}, followed by two emergency cuts of the same magnitude later in the month. For the first time in its history, the Bank of Canada also engaged in quantitative easing. Between March and August of 2020, the balance sheet of the Bank increased by a multiple of 4.6 times, which saw extensive purchases of provincial bonds, corporate bonds, short-term treasuries, mortgage bonds, and longer-term Government of Canada bonds (Bank of Canada, 2020).

1.2 Measuring Communication Sentiment

1.2.1 Methodology

We develop a news-oriented measure using articles from the Dow Jones Factiva worldwide news database, and for those tagged by the platform as pertaining to the Bank of Canada.[15] Drawing from a sample beginning in January 2008 and ending in September 2020, this includes a great diversity of policy decisions from the central bank, as well as two periods

[15] The Dow Jones Factiva platform provides practitioners with access to a large collection of news articles from a number of outlets around the world. Subsequently, articles obtained from this platform can be used by researchers for natural language processing, including the sentiment analysis conducted in this study.

where the bank is constrained at the lower bound. In order to ensure that the news articles are relevant to policy, we restrict the sample to include those containing any of the following words: policy, policies, rate, rates, forward, future, cut, hike, qe, easing, raise, lower, and slash. Note that this excludes any filters that are of the past tense, where words like 'slashed' and 'hiked' are omitted in an attempt to reduce the articles we analyze toward those that are forward-looking in nature. Doing so yields a sample of $23,196$ articles and $17,610,083$ words to be parsed using sentiment analysis. On average, a monthly indicator derived from this data would therefore have each observation consisting of over 150 articles and well over $110,000$ words, a sample size that we argue is comprehensive enough to construct a representative measure of communication sentiment.

Both Lucca and Trebbi (2011) and Carvalho et al. (2016) construct a measure based on the relative prevalence of the words hawkish or dovish or, on occasion, antonymies of additional words like cut and hike. Inclusive of these words, we develop a more extensive dictionary designed to better capture sentiment related to monetary policy communication. Binary combinations of either hawkish-dovish or hike-cut would inevitably mismeasure policy sentiment if words like "slowdown" or "deflation" were absent from the lexicon.[16] The dictionary was developed primarily by analyzing characteristic word selection from random subsamples of news articles across the business cycle. In doing so, we only include words that are generalizable to any aspect of the business cycle, and not those attributable to a specific event. For this reason, we add words like "crisis" to our dictionary, but not potentially

[16]Notably, in the U.S. there has been greater innovation in the scope of text processed for policy analysis, including by Aruoba and Dreschel (2022), who use Loughran and McDonald's (2011; 2015) dictionary with machine learning methods to predict changes in the policy rate in order to obtain a residual measure of monetary policy shocks. Handlan (2020) also provides for a similarly motivated approach to Aruoba and Dreschel (2022).

backward looking or period specific ones like "BSE" or "COVID". Additionally, we put in place numerous backstops for negative modifiers to account for the correct interpretation of a phrase like "not hawkish". We also exclude any republished or duplicated news articles from the Factiva search filter. Appendix 1 describes the dictionary in full, which consists of 159 words in total - 47 positive terms and 112 negative.

While it might seem like we are overvaluing negative words, this ratio is comparable to the dictionary by Loughran and McDonald (2011; 2015). Their dictionary shares some similarities to ours, although our classification picks up on several absent terms related to monetary policy and the economic outlook. Furthermore, while the Loughran-McDonald dictionary has been used in several economic studies,[17] its original usage was intended for disclosure forms from the U.S. Securities and Exchange Commission about company financial performance. Because of this, there are many terms in their dictionary that would be unsuitable for use in economics or more particularly for central bank communications. For instance, there are many words that would be better related to CEO scandals in the Loughran-McDonald dictionary, and therefore would have the potential to mismeasure sentiment if applied to monetary policy communications. Letting the counts for the set of words to be defined by q^i, each document is assigned a score of

$$s = \frac{q^{positive} - q^{negative}}{Q}, \tag{1.1}$$

where Q is the number of non-stop words in the news article.[18] This measure is simply the

[17]Among others, this includes: Binette and Tchebotarev (2019), Shapiro and Wilson (2022), and Armelius et al. (2020).

[18]Stop words are often filtered out in text-based sentiment analysis. These include the most common

difference between the number positive and negative words, normalized by the total number of words in the text for each article.[19]

From (1.1), we can then quantify two measures suitable for use at a high and low frequency. At a higher frequency, we focus on the dates in which the central bank announces a decision on the policy rate. Unexpected changes in sentiment are defined around these dates to be

$$\Delta s_t = \bar{s}_{post} - \bar{s}_{pre}, \tag{1.2}$$

where $\bar{s}_{post}$ is the mean sentiment score for articles following the announcement on the day of, or the day following the announcement. Additionally, $\bar{s}_{pre}$ is the average sentiment score for the 50 articles that precede the announcement, a sample close enough to the event and large enough to gauge the general policy atmosphere before the decision is made.[20] This measure is very precise in identifying changes in sentiment around the policy decision because there are clearly observed dividing lines in the media following the announcement. As an example, two headlines surrounding the January 21, 2015 decision provide for a sharp contrast in communication sentiment. Separated by a matter of minutes, one headline before the announcement contained "trendsetting interest rate unlikely to move", and one immediately after the decision stated "Bank of Canada shocker: key interest rate drops to 0.75% amid oil slump threat". In this instance, a surprise movement in the policy rate coincides with the shocking news. For our empirical analysis, we can condition our findings on conventional monetary surprises, such that we will isolate directly on the communication impulse

words in the English language including the, is, and at among many others.

[19]For easier numerical interpretation, we scale this final estimate upwards by a factor of five.

[20]When we define our sample in this manner, the sample of *pre* announcement articles tends to stretch for a period of about three days, although this can vary depending on the economic situation.

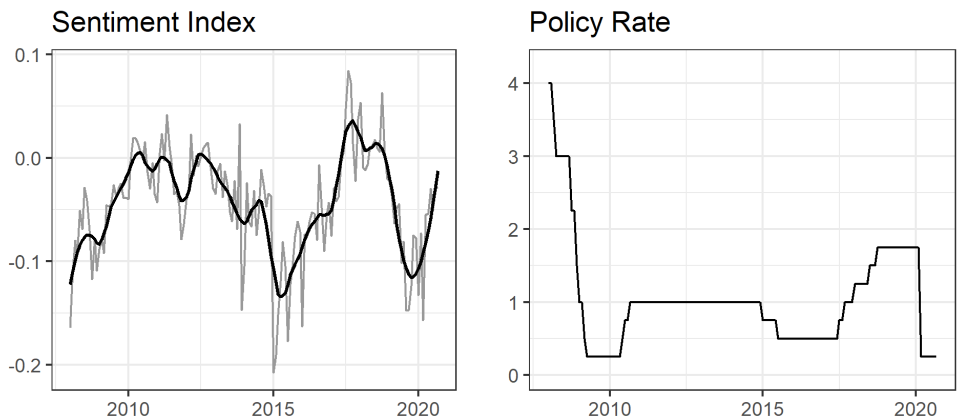


Figure 1.1: Sentiment of Central Bank Communication & Policy Rate

Notes: For the sentiment index, the thin gray line represents the raw index, while the thicker black line represents a LOESS moving trend. The policy rate is denoted by the month end value of the Bank of Canada's target for the overnight lending rate. All data is from January 2008 through September 2020.

reflected in the media. Most policy decisions tend to be in line with consensus estimates, which will therefore relegate much of the movement on policy dates to the communication measure. Should the words describing the policy landscape be similar before and after the announcement, then the measure would likely produce an estimate of Δs_t that is closer to zero. For the lower frequency VAR analysis, we take the monthly average of sentiment across all articles.

1.2.2 Data

In our sample from January 2008 through September 2020, we have a total of 104 policy communication dates. The Bank of Canada has eight scheduled policy dates throughout the year, all of which are determined at the end of the year prior. However, there are exceptions over this period for two emergency decisions that occurred during the unravelling of the coronavirus in 2020, and one during the Financial Crisis in 2008. There are many other communication events held by the Bank of Canada, including speeches and releases of survey findings, although we choose to restrict the event analysis to only formal policy decisions in order to be consistent across the events we investigate. The monthly measure will however capture other changes in central bank sentiment on a more expansive basis.

In Figure 1.1, we plot our monthly scores of communication measure s_t and the Bank of Canada's policy rate from January 2008 to September 2020. Similar to findings in the U.S. (i.e. Lucca and Trebbi, 2011; Carvalho et al., 2016), the s_t measure leads the policy rate by approximately 3-4 quarters, suggesting that the sentiment score is an informative leading indicator of monetary policy in Canada.[21] The monthly measure is somewhat volatile, although the more expansive lexicon used for this analysis produces smoother estimates than a so-called hawkish-dovish index. Each spike may even contain valuable information if a policy announcement or alternative form of communication is driving sharp changes in sentiment about the central bank. Over our sample period, we observe the sentiment measure describing: pessimism throughout 2008 and 2009, an improving but steadying level from 2010-2014, swift declines during the Oil Glut, enhanced optimism in 2017-2018, and a returning pessimism that culminated with the coronavirus recession in 2020.

We next plot the distribution of surprises, according to the equation $\Delta s_t = s_{post} - s_{pre}$ in

[21] We provide dynamic cross-correlations of the two time series, as well as using Krippner's (2013) shadow rate of monetary policy that both illustrate this point in Appendix 2. We use the conventional policy rate throughout our study, because Canada only engaged in unconventional policies in the tail end of our sample.

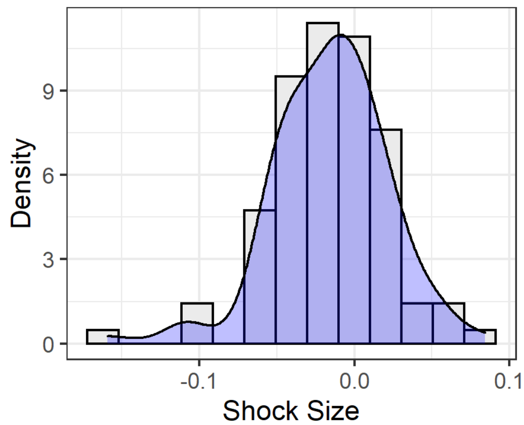


Figure 1.2: DISTRIBUTION OF SENTIMENT SURPRISES

Notes: The sample size is 104, which is the total number of communication dates in our sample from 2008 to 2020. The sentiment surprise is measured in accordance with the methodology described in Section 2, and from the formula $\Delta s_t = \bar{s}_{post} - \bar{s}_{pre}$. Properties of this distribution include: a mean of -0.015, a median of -0.012, standard deviation of 0.037, skewness of -0.546, and kurtosis of 4.817.

Figure 1.2. Communication sentiment surprises follow a quasi-normal distribution with a tail that drifts to the left. This may be driven by our sample time frame, which has seen more expansionary pressure from 2008 to 2020, with the two most severe surprises occurring in January 2015 and January 2020. The distribution of the communication sentiment surprises, as derived from news-based sourcing is consistent with our initial hypothesis. Before a typical decision, one might expect to see "Bank of Canada Expected to Hold Overnight Target Rate".[22] Often, decisions made by the central bank are in line with expectations held by the general public. Since the distribution of surprises tend to center close to zero, this would support the idea that the prior conjecture held by the public are close to the realized statement from the central bank.

[22]This is a real article headline from Thomas (2020).

Figure 1.3: Word Cloud of Documents

Notes: The word cloud describes the relative frequency of words across the over 23,000 news articles we analyze. Larger fonts indicate a greater frequency in comparison to those of a smaller font. This figure also excludes stop words - i.e. the most common in the English language, which therefore restricts the sample to be more relevant for policy analysis. The word cloud is restricted to include 100 of the most frequently used terms from the news articles.

Next in Figure 1.3, we highlight a word cloud from the corpus of text that we analyze. The cloud shows the relative frequency of words for the top 100 occurrences, where a larger scaling denotes a greater presence in the text. We note that this figure supports the intended objective of restricting the articles to be both policy-oriented and forward-looking. Most words indicate an emphasis on policy or the economic outlook, including: exports, inflation, interest, housing, GDP, cut, oil, and investment. The additional prominence of words like: outlook, expected, and forecast lead us to believe that our measure also satisfies the forward-looking objective of the methodology established in Section 2.

As a final consideration, we plot in Figure 1.4 the distributions of article sentiment by year using the full sample. From this more micro-oriented perspective, it is clear that the distributions shift to the left or right depending on which stage of the business cycle the economy is in. For instance, in 2008 the distribution skews disproportionately to the left (i.e. the pessimistic side) before gradually pivoting to the right during the post-Financial Crisis recovery. When oil prices crashed in 2014-2015, the distributions shifted back towards the contractionary side before once again shifting rightwards in the years that followed. Ultimately, in the end of our sample trade instabilities and the inevitable COVID pandemic would again see the distribution of sentiment skew further to the left, empirically verifying what was a period of enhanced doubt about the prospects for the Canadian economy.

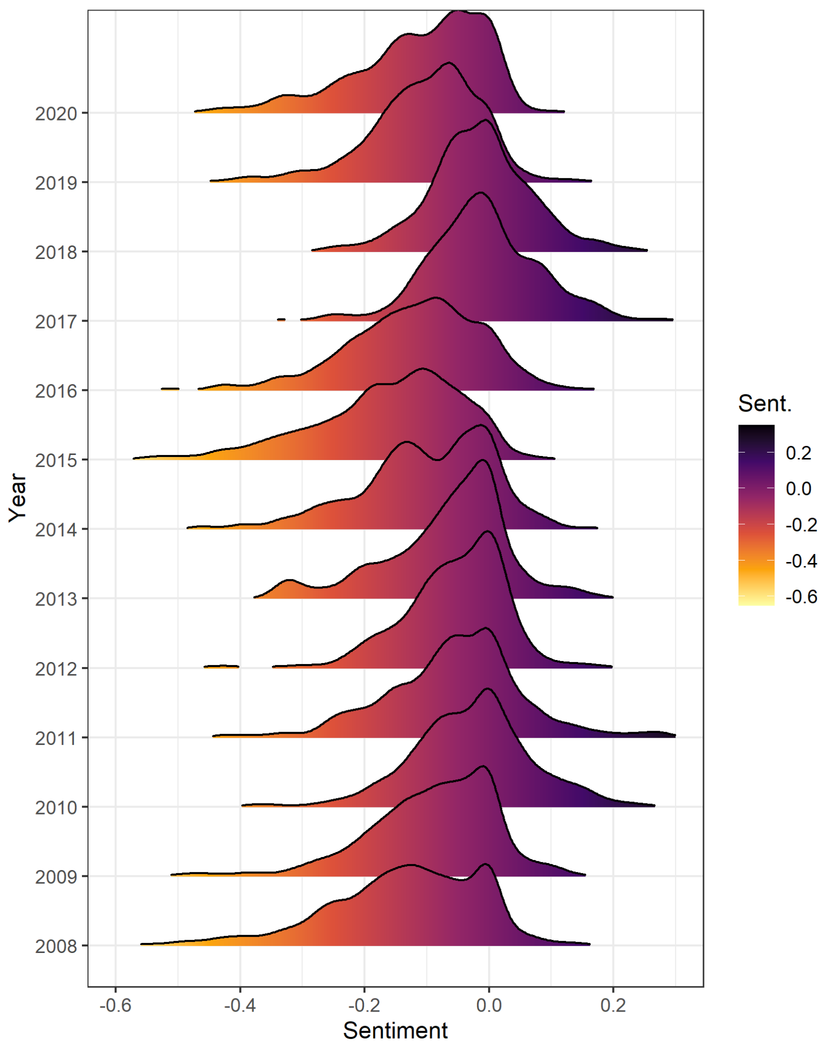


Figure 1.4: Distribution of Article Sentiment by Year

Notes: The above figure highlights kernel density plots of article sentiment by year, with a joint bandwidth of 0.02. Sample range: January 2008 through September 2020.

1.3 Event Study Analysis

1.3.1 Empirical Methodology and Data

We now describe the high-frequency identification strategy as to how, if at all, communication sentiment surprises influence a diverse set of outcomes. An unanticipated *negative* sentiment surprise from the central bank should suppress yields across the term structure, even while holding fixed surprise movements of the policy rate. Longer dated yields capture market expectations about the future path of short-term rates, which should therefore be receptive to credible developments in communications from the central bank. The same event should also share a high-frequency relationship with both exchange rates and the stock market. In summary, we are interested in the marginal impact of communication sentiment surprises on these outcomes around the narrowly defined event window using Δs.

For treasury yields, exchange rates, and financial markets, we adopt a Kuttner-like (2001) specification with the following OLS equations for the term structure

$$\Delta i_d^m = \alpha^m + \beta^m \Delta s_d + \gamma^m MS_d + \epsilon_d^m, \tag{1.3}$$

exchange rates,

$$\Delta e_d^c = \alpha^c + \beta^c \Delta s_d + \gamma^c MS_d + \phi^c \Delta oil_d + \nu_d^c, \tag{1.4}$$

and financial markets as

$$\Delta tsx_d = \alpha + \beta \Delta s_d + \gamma MS_d + \phi \Delta oil_d + \theta \Delta dow_d + \varepsilon_d. \tag{1.5}$$

In the above, the notation symbolizes the daily change in treasury yields Δi_d^m and percentage change of the noon spot exchange rate Δe_d^c for a term m, currency c and communication date d. The constructed variable Δs_d accounts for the communication surprises, the percentage change in the price of oil is denoted by Δoil_d, MS_d is a variable capturing the magnitude of unanticipated changes in the policy rate, as it is derived using the difference between a median estimate from a survey of professional forecasters and the observed policy rate,[23] Δtsx_d is the daily percentage change in the closing price of the TSX, and Δdow_d is a the same measure for the Dow Jones Industrial Average (DJIA). Finally, α denotes the constant(s) of the regression and ϵ_d are the random disturbances.

We are especially interested in the coefficients of the variable Δs_d on the term structure, exchange rates, and on the Canadian stock exchange. We consider yields at a 3-month, 6-month, 2-year, 5-year and 10-year horizon, and exchange rates for the U.S. Dollar, Mexican Peso and Euro pairings, where the Canadian dollar is always specified as the quote currency X_j/CAD. An increase in the exchange rate X_j/CAD would therefore correspond to a *depreciation* of the Canadian currency. All exchange rates are for spot values, and we do not explore futures markets since they tend to be illiquid outside of a short horizon. With the exception of the constructed sentiment index from the Dow Jones Factiva platform, all data we use are publicly available. We draw from multiple sources for this and later exercises, including the Bank of Canada, the U.S. Federal Reserve Economic Database (FRED), Yahoo Finance, Statistics Canada, OFX, the OECD, and the Canadian Real Estate Association (CREA).

[23] Specifically, this is the Trading Economics Consensus estimate, which comes from a survey of professional forecasters, including banks, research firms and others about expected movements in monetary policy.

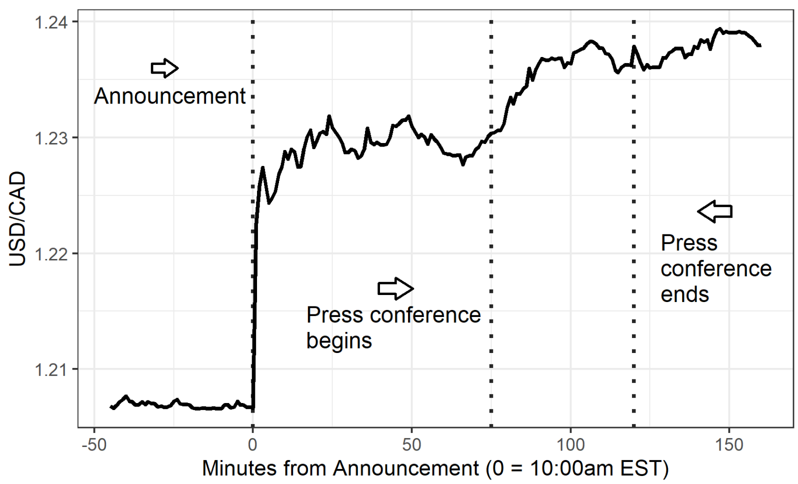


Figure 1.5: Detailed Event Analysis: USD/CAD January 21, 2015

Notes: This figure presents the minute-level open price of the exchange rate USD/CAD on January 21, 2015 from 45 minutes before the announcement of the change in the policy rate (a cut of 25 basis points) at 10:00am EST, to 160 minutes following the initial release at 12:30pm that same day.

To better illustrate how an announcement propagates new information into markets, we plot minute-level data of the U.S. exchange rate USD/CAD in Figure 1.5 for the event date of January 21, 2015. In this particular event, the Canadian central bank shocked many by cutting its key policy rate by 25 basis points amid the unravelling commodities glut. Instantly, the Canadian exchange rate depreciated by about 1.7 percent - a movement that is relatively unprecedented by historical standards. In fact, when considering 15 minute intervals of this exchange rate pair over the period from 2000 through 2020, this event differential was at a magnitude of over 28 standard deviations from the mean. From a policy perspective, this event had its intended effect, where the surprise lowered the relative cost of domestic goods immediately. Moreover, there is also an additional depreciation coinciding with the press conference by about 0.7 percent. As central bankers relayed their concerned messaging about the state of the economy, markets responded further to the formal policy movement that preceded the conference only minutes earlier. With our empirical specification, it is our intention to disentangle and quantify these effects.

1.3.2 Results

We first explore in Table 1.1 the response of yields throughout the term structure to sentiment surprises from Δs_d. Owing to its text-based and constructed nature, our measure of sentiment does not have a straightforward interpretation in comparison to the other variables of this exercise. In our sample, more momentous sentiment surprises have tended to be negative, and at a size of about four standard deviations. While one might expect there to be a multicollinearity issue from including the two surprise variables, this is not necessarily the case. Monetary surprises occur at a much more scarce frequency, where changes in communication sentiment are much more continuous in nature, even though the mean and median are roughly null. While this is argued conceptually, it is also worth mentioning that the raw correlation between communication and monetary surprises is only 0.08.

The results show that communication surprises significantly augment yields throughout the term structure, where conventional monetary surprises burn out over a shorter horizon. This is consistent with the idea that central banks can shape long-term expectations about the future path of rates with their words (Bank of Canada, 2015). Significance is seen as far out as the 5-year Government of Canada bond, before fading in the long-run. Point estimates on Δs_d are also shown to be highly similar between the 3-month treasury and the longer 5-year bond, showing that a one standard deviation movement in the communication

	Treasury Yields				
	3-month	6-month	2-year	5-year	10-year
Δs_d	0.543***	0.520**	0.551**	0.402**	0.150
	(0.207)	(0.254)	(0.251)	(0.201)	(0.152)
MS_d	0.436***	0.310***	0.186***	0.045	-0.029
	(0.122)	(0.067)	(0.061)	(0.077)	(0.089)
$\bar{R}^2$	0.544	0.375	0.177	0.048	-0.006

Table 1.1: Impact of Communication Surprises on Treasuries

Notes: Regression estimates are between the daily change in a given treasury yield, the communication surprise around the policy announcement Δs_d and a variable for monetary surprise MS. *** denotes significance at the 1% level, ** at the 5% level and * at the 10% level. Bootstrapped standard errors are reported in parenthesis from 499 repetitions. The sample size is 104 - the number of communication dates on the policy rate from March 2008 to September 2020.

surprise variable (about 0.04 units of Δs_d) moves these yields by greater than two basis points. While this might seem low, it is important to mention that daily movements in treasuries are inherently non-volatile, as a one standard deviation movement in the 3-month treasury bill rounding out at approximately 3 basis points.[24] In contrast to these findings is the influence of MS_d, which dissipates across the term structure more quickly.

Next, in Table 1.2 we present the event analysis results for selected exchange rate pairings and the TSX. Across all three exchange rates, we find that positive sentiment surprises from the central bank lead to an appreciation of the domestic currency. The magnitude on the coefficients is similar for the three exchange rate pairs, and signify that a negative sentiment surprise the size of one standard deviation would lead to an expected depreciation

[24] According to calculations from the author and using data from the beginning of the Bank of Canada's fixed announcement date system in December 2000, until May of 2023.

of the Canadian dollar by roughly 0.2 percent. Considering that exchange rates are typically not that volatile, this would represent a sizeable amount of variation attributed here to communications surprises. Such a movement would ultimately then serve to support exports in the transmission channel of monetary policy. Interestingly, while the coefficient in the stock market equation is negative, it is not statistically insignificant. We find that the variation on event dates is driven largely by U.S. financial markets and commodity prices. This would suggest that small open economies do not have the ability to move financial markets in the same way that the Federal Reserve is able to in the United States, and similarly the ECB in the Euro area (Jarociński and Karadi, 2020; Jouvanceau and Mikaliunaite, 2021).

One unexpected finding in Table 1.2 is that the coefficients for the monetary surprise variable MS_d are now statistically insignificant. While this does seem puzzling, it is consistent with recent Euro area evidence from Gürkaynak et al. (2021). Like their analysis, these coefficients are of the right sign, but fail to meet the threshold for being significant. Instead, the authors found that a path surprise (an orthogonalized change in a one-year treasury yield around the event date) explained much of the variation in exchange rates around ECB announcement dates. The parallel with our analysis is that communication surprises appear to be capturing the channel that relays the prospects about future policy to foreign exchange markets. Similar to Gürkaynak et al. (2021), this is significant and negative, where the conventional monetary surprise channel fails to exhibit the same level of prominence.

Finally, we estimate a set of rolling regressions to explore the dynamic effects of communication sentiment across our sample. A rolling window regression estimates the parameters on a short subsample or fixed window of the data, then is shifted forward across the time

	Exchange Rates			Stock Exchange
	MXN	USD	EUR	TSX
Δs_d	-0.061***	-0.060***	-0.058**	-0.025
	(0.019)	(0.022)	(0.025)	(0.023)
MS_d	-0.000	-0.002	-0.011	-0.025
	(0.010)	(0.010)	(0.011)	(0.017)
Δoil_d	0.022	-0.141***	-0.067**	0.124***
	(0.035)	(0.034)	(0.028)	(0.036)
Δdow_d	-	-	-	0.751***
				(0.114)
$\bar{R}^2$	0.069	0.226	0.127	0.751

Table 1.2: Impact of Communication Surprises on Exchange Rates & Stock Market

Notes: Estimates are a regression between the daily change in a given exchange rate: MSX Mexican Peso, USD U.S. Dollar or, EUR the Euro, the communication surprise around the policy announcement Δs_d and a variable for monetary surprise MS_d. *** denotes significance at the 1% level, ** at the 5% level and * at the 10% level. Bootstrapped standard errors are reported in parenthesis with 499 repetitions. The sample size is 100 - the number of communication dates on the policy rate from March 2008 to September 2020 that are not conflicted by either U.S. holidays or the death of George H.W. Bush.

dimension one observation at a time. The benefit of doing so allows us to evaluate the effectiveness of monetary communication surprises in a more dynamic manner. For each of the outcomes, we roll the window over intervals of 48 observations, accounting for roughly six years of policy decisions at a time. Then, we draw the coefficient and bootstrapped standard errors from each estimation. The coefficients as they vary across time are presented in Figure 1.6.

Our results from this exercise indicate that in the era of low rates, monetary communications from the Bank of Canada are increasing in their effectiveness. This is evidenced in the various yields, which tend to be increasing in the size of the coefficients, and also in terms of statistical significance over time. Even the 10-year bond begins to shift upwards when the rolling samples begin to incorporate decisions that include the COVID recession. More generally, this upward bump towards the end of the rolling sample is present in all yields, although this is most prominent further out in the term structure.

The same observation holds true for exchange rates. The currency pairing with Canada's largest trading partner, the United States, has produced estimates that are negative and significant throughout. For the Euro and Mexican Peso pairings, the results show a time varying relationship that also reflects an increasingly effective use of communications as a policy instrument. The marginal effects between the communication surprise variable and these two pairs grow from insignificant to significant, and remain on a downward trend across the rolling window sample. A similar finding can be described for the TSX. This coefficient was insignificant in Table 1.2 by a fair margin, but the rolling window estimates show that this may be attributable to the initial portion of our sample. Over the rolling window period

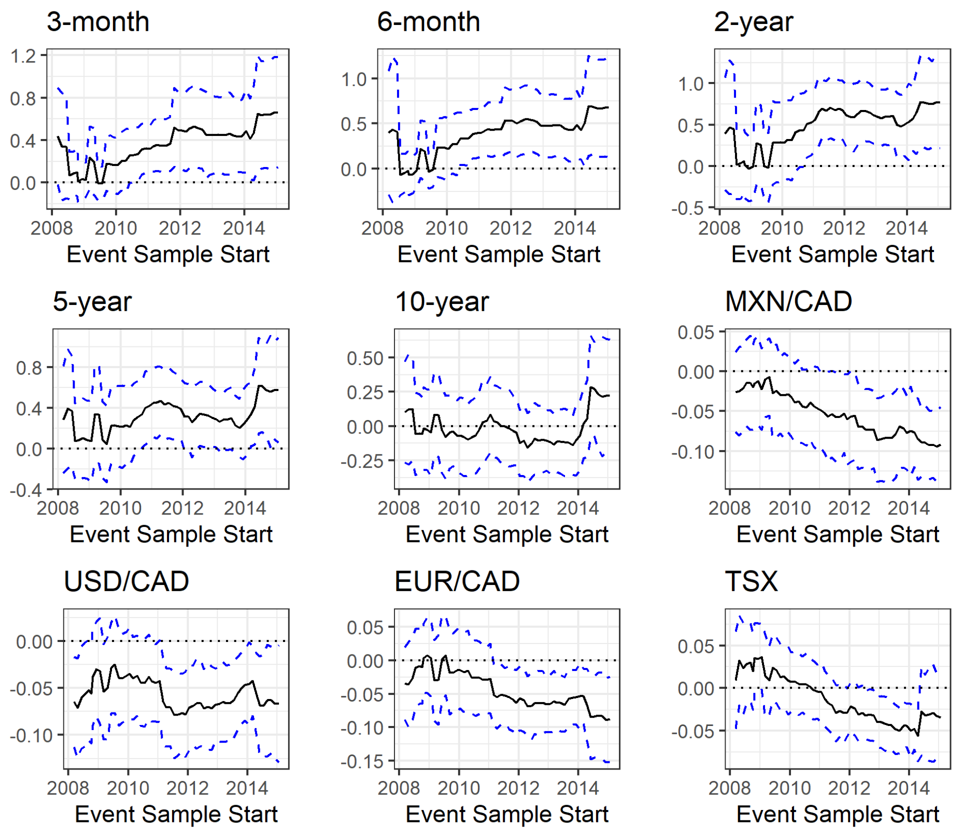


Figure 1.6: Rolling Window Parameters for Communication Surprises

Notes: Estimates plot the coefficients on Δs_d from each rolling regression over a sample of 48 observations. Confidence bands are bootstrapped at a 90 percent interval using 299 repetitions. Event sample start denotes when each rolling window sample begins, the end date of the sample is roughly six years following what is highlighted on the x-axis. For example, the final rolling sample observation begins January 2015 and ends September 2020. All regressions include the same additional covariates that are described in Tables 1.1 and 1.2.

that corresponds to 2014-2019, these results become statistically significant and negative. Should this hold true in future analysis, then the Canadian results would support U.S. findings of a positive stance leading to a reduction in stock price indices, despite Canada being a small economy with less influence than the U.S.. In our main regressions, we also test the parameter estimates using an interaction for when the policy rate is at the lower bound. We find no significant results that communication surprises are less effective when decisions are being announced in this period.[25]

There could be a number of reasons as to why we find the magnitude of these coefficients to be increasing in size over our sample period. Firstly, after the 2008-2009 Financial Crisis, central banks realized the importance of clear and effective communication with the public and financial markets, leading to greater transparency in their policy intentions. Moreover, over much of this period the Bank of Canada was not engaging in active conventional monetary policy, and was further periodically constrained by the zero lower bound. With no conventional policy levers at play, central bank communications played a vital role in guiding the expectations of the general public, possibly explaining the increase in their effectiveness over the sample period. As an additional consideration, this sample period also reflected a changing technological environment, where social media became prominent. Central banks adapted their communication strategies to reach a wider audience, and had more channels to communicate with the general public at their disposal. Finally, economic research and analysis has grown substantially in recent years, where central banks have had a better understanding and measurement of communication outcomes. Accordingly, this can lead to revised strategies that may seek to more optimally communicate to have an intended policy

[25]We provide these tables in Appendix 2.

effect.[26]

1.4 VAR Analysis

1.4.1 Methods

With the lower frequency data we seek to estimate a set of VARs - a methodology that endogenously models a set of time series with one another. We consider five-variable VARs consisting of the variables $Y_t^j = [y_t, p_t, s_t, r_t, X_t^j]'$ for the set of models:

$$AY_t^j = c + \Phi_1 Y_{t-1}^j + \Phi_2 Y_{t-2}^j + \cdots + \Phi_p Y_{t-p}^j + \epsilon_t^j. \tag{1.6}$$

For each j model, we include real GDP y_t, the consumer price index (CPI) including energy and food prices p_t, monthly average sentiment s_t, and the Bank of Canada's key policy rate r_t. A rotated set of variables $j \in \{$ 3-month, 6-month, 2-year, 5-year, 10-year, USDCAD, MXNCAD, EURCAD $\}$ is used to reduce the overparameterization of the VARs, and comprises nearly the same set as used in the event study analysis.[27] We should therefore expect to see a corroborating set of results between the VAR method and the event study regressions

[26]It is worth mentioning that in this period, the inflation rate in Canada was never far from its mandated target. Future research should serve to explore whether or not communications diminish in terms of their desired policy effect when inflation is substantially away from the target level (such as in the eventual aftermath of COVID).

[27]We estimate all VARs using 3 lags. Using BIC information criterion, the optimal leg length was estimated to be 2. To assuage concerns about errant serial correlation, we include an additional lag to our benchmark length of p=3. Other information criterion suggested lag lengths of between 2 and 6 lags. When we extend our analysis to these alternative lag structures, the sign and significance of our results remained to be largely the same.

exemplified in the previous section. Elsewhere in the model, A is the matrix of contemporaneous restrictions on Y^j, Φ are matrices of coefficients, c is a vector of constants, and ϵ_t^j is a vector of presumed serially uncorrelated residuals. We specify the A matrix in accordance with a standard recursiveness assumption also adopted by Lucca and Trebbi (2011), meaning that A is set to be a lower triangular matrix of coefficients. Thus, the leading variable y_t has a contemporaneous impact on all of the others in the system of equations, while the final variable X_t^j does not have a contemporaneous impact on any variables in the system, and only at a lagged horizon. The core of the variable selection in our VAR is related to many others in the literature, including Bernanke and Mihov (1998) and Christiano et al. (1999, 2005).

To conduct inference on (1.6), we present an impulse response analysis, which will document how a one standard deviation structural shock from one variable to another within the system of equations is transmitted until a horizon of 24 months. Our primary interest is in how unanticipated changes in sentiment from the central bank propagate onto the term structure and in exchange rate markets. If these lower-frequency findings corroborate our event study analysis, then the suitability of the VAR model can be applied to other covariates. Consequently, we would also like to consider the role that sentiment shocks play downstream in the transmission channels of monetary policy. As such, in our extended analysis we take the j set of rotated variables to include a host of other macroeconomic variables. Namely, this includes: real production from energy, construction, manufacturing, retail, and real estate, in addition to consumer confidence, the unemployment rate, the 5 year fixed mortgage rate, real aggregate residential mortgage credit, net exports - denoted by the monthly ratio between exports and imports, the TSX, real national house prices, and the same for prices in Toronto, Montréal, and Vancouver. All variables are seasonally adjusted when necessary, and expressed in natural logs with the exception of the unemployment rate, net exports, the sentiment index, the policy rate, mortgage rates, and yields from the term structure.

1.4.2 Results from Core Models

We now document the core findings from the VAR analysis, which denote a one standard deviation unanticipated positive increase in the sentiment index in Figure 1.7 to the list of outcomes, and also from a contractionary one standard deviation shock from the policy rate in Figure 1.8. Consistently we find a one standard deviation communication sentiment shock to be in the neighbourhood of 0.035 - roughly the same magnitude described earlier in the event study section. The shock size of the policy rate is about 15 basis points. Providing both sets of results will allow for a comparison between the two policy forms, as to how unanticipated changes in the variables influence the outcomes of interest. The VAR is an appealing methodology to use for contrasting the two policy forms, as each estimate is conditional on having both metrics included in the system of equations.

Based on the impulses response functions in Figure 1.7, we find there to be strong similarities between the high-frequency and low-frequency analysis. Yields across the term structure rise to positive sentiment shocks, demonstrating a similar magnitude and trajectory over a two-year horizon. Interestingly, the hump-shaped response reflects that the positive communication shock peaks at about 2-6 months, indicating further leading behavior of our communication surprise measure. In the event study analysis, we did not find evidence that sentiment augmented yields out to the ten-year horizon, but do here modestly with the VAR.

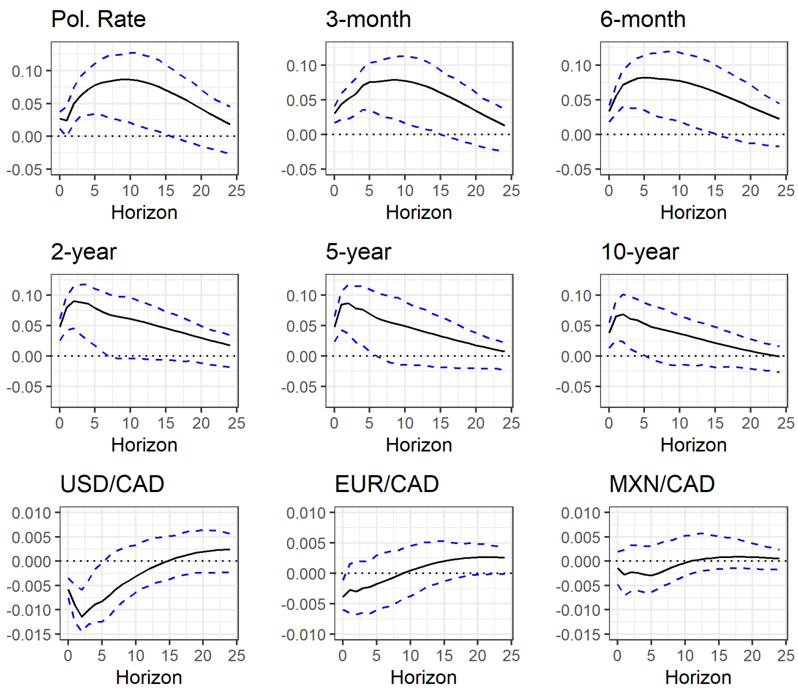


Figure 1.7: Positive Shock from Central Bank Sentiment

Notes: Impulses denote a positive one standard deviation shock from the communication sentiment index to the listed variables. Each model is estimated with three lags (as determined via AIC), and 90% bootstrapped confidence bands are shown with 299 repetitions. Moreover, each VAR consists of five variables: real GDP, CPI, the communication sentiment index, the key policy rate, and the final variable is rotated in the fifth in final slot.

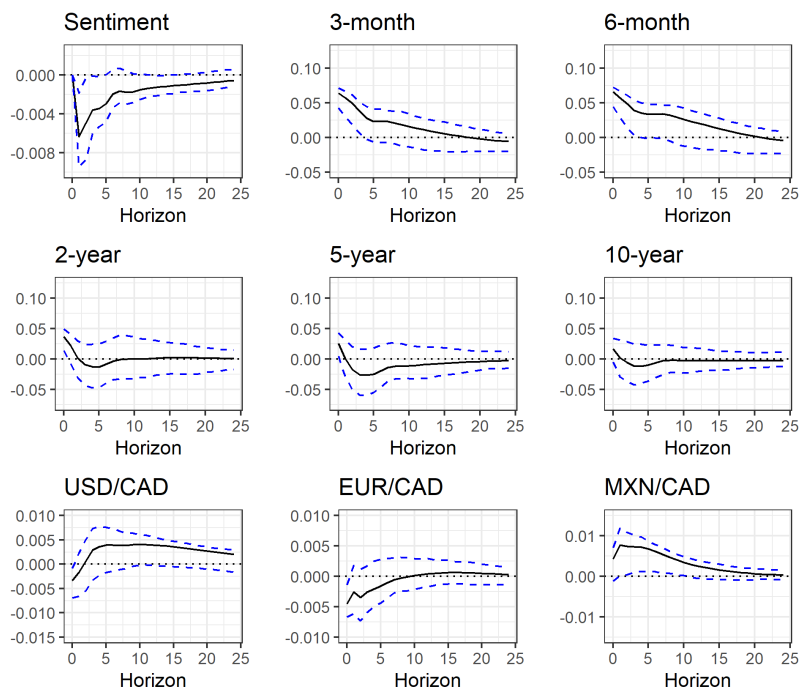


Figure 1.8: Positive Shock from the Policy Rate

Notes: Impulses denote a contractionary one standard deviation shock from the Bank of Canada's key policy rate (roughly 15 basis points) to the listed variables. Each model is estimated with three lags, and 90% bootstrapped confidence bands are shown with 299 repetitions. Further, each VAR consists of five variables: real GDP, CPI, the communication sentiment index, the key policy rate, and the final variable is rotated in the fifth in final slot.

All exchange rate pairings dip at least slightly in response to the shock, again verifying that positive sentiment shocks lead to an appreciation of the Canadian currency (or a decline in X/CAD).

In contrast to the findings illustrating communication sentiment shocks, we document how shocks from the policy rate impact the same set of outcomes in Figure 1.8. Much like the high-frequency analysis, traditional monetary shocks influence shorter-term treasuries, before burning out across longer-term yields. A contractionary policy shock is also associated with a shallow but significant softening of the central bank sentiment measure. Notably, shocks from the policy rate produce impulses that are of a consistently weaker magnitude than those from the communication sentiment index. Such a result also holds true for the exchange rate pairs, except for the Mexican peso, which produces a puzzling result that is of the opposite sign.[28] Overall, these results suggest that the discussion of policy may be just as important for shaping markets than the realized actions undertaken by the central bank, and might also reflect the credibility of the central bank.[29] Since these results largely support the event study analysis, we argue that the VAR methodology is both robust and convincing to further extend our set of outcomes to include a more comprehensive list of covariates.

[28]This result may be a consequence of data aggregation into a monthly frequency. Recall that in the high-frequency results from Table 2, none of the monetary surprise coefficients exhibited any statistical significance, while the communication surprise variable was strongly significant.

[29]As a central bank with zero credibility should not be able to alter outcomes to any degree of statistical significance.

1.4.3 Results from Extended Models

We now provide a discussion of the extended set of models, which seek to explore the relationship shared between the communication sentiment of the central bank and an extended set of macroeconomic outcomes. Themes range from real house prices, to financial markets, labour, trade, credit, real GDP in various industries, and consumer confidence. Again, this involves the transmission of a positive one standard deviation shock from the sentiment index onto a given outcome, as it is shown in Figure 1.9. In total, we explore an additional 16 variables in this exercise.

We are especially interested in the outcomes that are downstream in the transmission channel of monetary policy, namely for those that involve asset prices (like real estate), and commercial interest rates. We would hypothesize from our initial findings that positive communications, as a likely indication of future contractionary policy should dampen asset prices, and negative communications should have the opposite, expansionary impact on asset prices. Declines in asset prices would decrease household wealth, which may then in turn dissuade consumers from borrowing and spending. Our results thus far would support the notion of positive communication pivots as being a contractionary form of policy, although a positive stance still may exhibit a contrarian result for some outcomes in the expanded set of analysis.

There are several important findings from the impulses response functions, the most notable of which is how the real estate sector responds to positive communication shocks. This result is broad-based, and applies to real GDP in the sector, financing costs, and real house prices. Real estate markets were well on the monetary policy radar for our sample

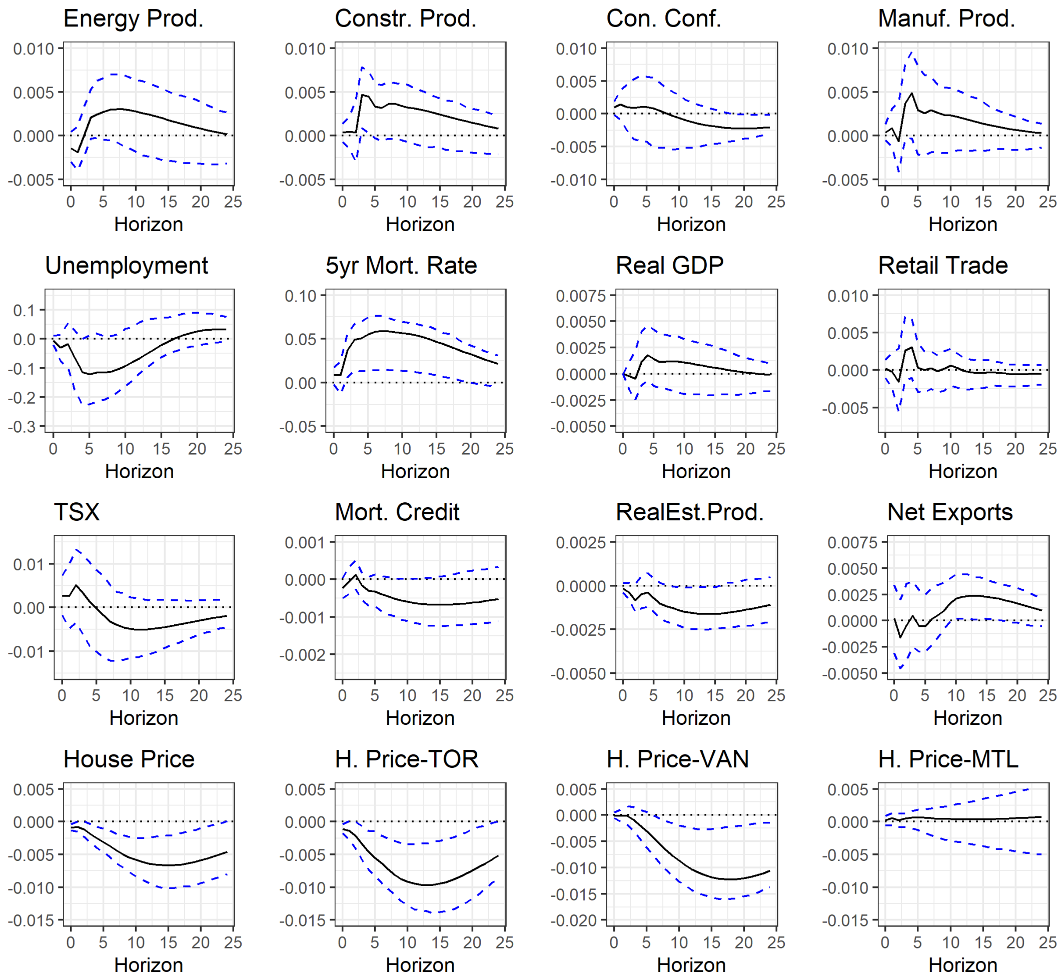


Figure 1.9: Shocks from Sentiment to Extended Outcomes

Notes: Impulses denote a one standard deviation shock from the central bank sentiment score to the listed variables. Each model is estimated with three lags, and 90 percent confidence bands surround the impulse response functions. They are bootstrapped with 299 repetitions. Additionally, each VAR consists of five variables: real GDP, CPI, the communication sentiment index, the key policy rate, and the final variable is rotated in the fifth in final slot. Energy Prod.: Real GDP from Energy, Constr. Prod.: Real GDP from Construction, Con. Conf.: Consumer Confidence, unemployment: unemployment rate, 5yr Mort. Rate: 5-year fixed mortgage rate, retail trade: Real GDP from retail sector, Mort. Credit: real aggregate mortgage lending, RealEst.Prod: real GDP from the real estate sector, H.Price: real house prices for Toronto (TOR), Vancouver (VAN), and Montréal (MTL).

period, where there was particular concern about the sensitivity of prices in Toronto and Vancouver. First, we make note of the channel between communication sentiment and commercial interest rates, as represented by the five-year fixed mortgage rate. Mortgage rates rise significantly by about 6 basis points - a finding that is prominent given that the range of mortgage rates over the vast majority of our sample period is within a tight range of 100 basis points. This likely also has a direct impact on output from the real estate sector, which declines significantly by about 0.20 percent in response to the positive sentiment shock. Aggregate lending for residential mortgages does fall into negative territory, although this result is at best modest and weakly significant.

Real housing prices produce the most interesting set of results for this impulse response exercise. Sharp and significant declines are seen at the national level, and especially so in the hot spots of Toronto and Vancouver. Respectively, the observed declines to a positive sentiment shock are roughly 0.75 percent nationally, 1.00 percent in Toronto, and 1.30 percent in Vancouver. For additional context regarding the margnitude of this estimate, September 2021 single-family detached house prices in Vancouver were at slightly over 1.8 million Canadian dollars.[30] A shock from the central bank would therefore have the potential to augment the real net worth of many Canadian households by a considerable margin, simply from a pivot in sentiment. Montréal, another major city that was not burdened with the same inflated reputations as Toronto and Vancouver, does not experience any significant declines. This finding leads us to believe that housing markets with a history of more momentous price movements are more susceptible to policy fallout from monetary communications. A similar conclusion is reached from contractionary shocks of the policy rate, although the

[30] According to publicly available data from the CREA.

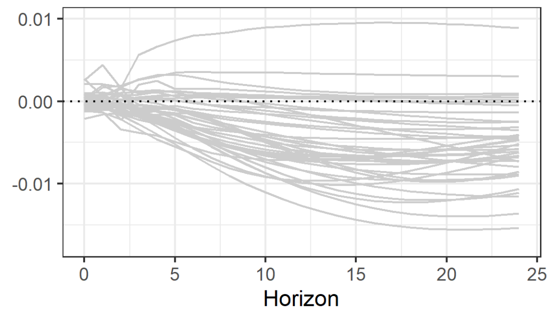


Figure 1.10: Shocks from Sentiment to Regional House Prices

Notes: Impulses denote a one standard deviation shock from the central bank sentiment score to the natural log of each real housing price index. Each model is estimated with three lags, and each individual gray line corresponds to a regional housing market.

magnitude of the impulses is again much larger coming from the communication index than from conventional policy shocks.

As an extension to this intriguing finding, we run the same impulse response exercise using 37 additional regional real estate markets in Canada for a total of 40 altogether.[31] These impulses are plotted in Figure 1.10, where each gray line denotes an individual real estate market price response to the sentiment shock. An overall negative response is robust to these markets, with a clear majority of the estimates falling below zero across the 24-month horizon. Other markets that face similarly sharp price declines to positive sentiment shocks are often in close proximity to the hot spots of Toronto and Vancouver. Housing markets in Québec, the Prairies, and Atlantic region tend to be less receptive to these shocks.

[31] Including: Victoria, Vancouver Island (elsewhere), Lower B.C. Mainland, Okanagan Valley, Calgary, Edmonton, Regina, Saskatoon, Winnipeg, Bancroft, Barrie, Brantford, Cambridge, Owen Sound, Guelph, Hamilton-Burlington, Huron-Perth, Kawartha Lakes, the Muskokas, London, Mississauga, Niagara, North Bay, Northumberland County, Oakville, Peterborough, Quinte, Simcoe, South Georgian Bay, Tillsonburg, Montréal, Québec City, Moncton and St. Johns.

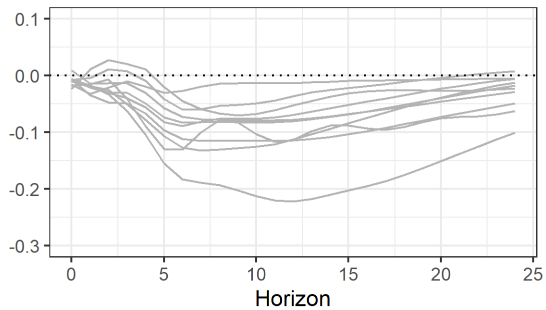


Figure 1.11: Shocks from Sentiment to Provincial Unemployment Rates

Notes: Impulses denote a one standard deviation shock from the central bank sentiment score to the unemployment rate for a given province. Each model is estimated with three lags, and each gray line corresponds to an individual province.

Aside from outcomes specific to the housing market, other impulses from this exercise point to a more heterogeneous impact from sentiment shocks. In fact, many of the other variables in Figure 1.8 respond in an *expansionary* manner to the positive shocks, although these estimates are modest when significant. In all cases, the boost from a positive sentiment shock is seen at short-term horizons of 1-5 months. For example, the unemployment rate falls by 0.10 percentage points, and some sectors of real GDP rise by about 0.25 to 0.45 percent. Total real GDP rises, but is weakly insignificant for this confidence interval. One explanation for the expansionary outcomes could be that an optimistic central bank might resonate onto consumers and industry about the future outlook, who then take this information into account when making economic decisions. For example, firms and consumers can invest and spend before the cost of borrowing increases.

This finding has been demonstrated recently by Armelius et al. (2020), who construct a quarterly measure with central bank documents and the Loughran-McDonald dictionary.

They similarly document a connection between positive sentiment shocks and decreases in the unemployment rate among a cross-section of countries. To further test this result, we rotate in the VAR the 10 provincial unemployment rates instead of the national equivalent, and plot the impulses in Figure 1.11. A declining unemployment rate in response to the shock is common to all regions, with the average impulse being of a similar magnitude to the national estimate from Figure 1.9. Alberta, which experienced a sizeable variation in its unemployment rate over our sample period falls by the largest amount in Figure 1.11, followed by British Columbia and the other provinces thereafter. This finding confirms that labour markets synchronously react in an expansionary manner to the positive sentiment shock from the central bank, albeit even if the magnitude of these estimates is modest at best.

One might also be concerned with the inclusion of the COVID recession toward the end of our sample, as this period has generated some staggering peaks and troughs in many time series. This is especially evident in data pertaining to the labour market and production beginning in March 2020. Lenza and Primiceri (2020) discuss trade-offs of the VAR methodology between parameter estimation and forecasting suitability in light of the COVID pandemic. They suggest that excluding this period from the sample can be beneficial for inference, but counter that the period should be included for forecasting analysis as a result of the rich information contained in the spikes. For our purpose, we also estimate our results excluding five observations at the end of the sample where this might be an issue. Our main conclusions remain to be the same after the fact, although they become lesser in magnitude for outcomes on the labour market and industry production. It is our preference to include the coronavirus recession also because it is a period of momentous movement in monetary policy - conventional and unconventional.

1.5 Conclusion

In this paper, we presented a new text-based sentiment scoring method that evaluates central bank related information on monetary policy - a method that is both flexible and suitable for use in a high and low-frequency empirical analysis. This measure builds on existing methods by establishing a new objective and intuitive dictionary of sentiment, which could be in turn applied in a number of different settings. We found this measure to contain very valuable information that documents how important words from and about the central bank are for a variety of policy outcomes. On fixed announcement dates, positive sentiment surprises significantly influence yields of both short and longer term dates, all while holding fixed for traditional monetary surprises. We also find that positive sentiment surprises lead to an appreciation of the domestic currency - a relationship that is growing stronger into the later 2010s and early 2020s. VAR analysis on positive sentiment shocks corroborates findings from the event study, while also illustrating broad-based contractions in the real estate sector.

Future work could expand upon our methodology, and apply it in a number of different settings. One potential use could even contrast the sentiment espoused by central bank communications with those from the public to see what, if any consequences may arise from miscommunications or a misunderstood signal from the central bank. Additionally, the coronavirus recession and subsequent recovery should lead to further analysis, where communications from the central bank may become more important than ever. The Bank of

Canada announced in October 2020 that the policy rate would be held effectively at zero until 2023 (Evans, 2020).[32] Should this hold true, there will be a considerable increase of lower bound announcements in Canada, and likely in many other countries, that communications from the central bank may become of an increasing importance to markets. While our sample does capture some of these events, more analysis will be needed to see if communications maintain the same level of effect in a period of extended turbulence.

[32] Amid rising inflation well above its target level, the Bank of Canada reneged and raised rates early in 2022. The growing mistrust and perceived lack of credibility among central banks during this period presents further opportunity to use text-based measures for understanding the channel of central bank communications, as has been demonstrated by Baker and Lam (2022).

Chapter 2

Assessing the Credibility of Central Bank Signals: The Case of Transitory Inflation

2.1 Introduction

2.1.1 Overview

On January 27, 2021, Federal Reserve Chair Jerome Powell was questioned about the potential for a post-COVID rise in U.S. inflation. In response, he stated: "...we would see that as something likely to be *transient* and not to be very large" (Powell, 2021a). Not long after this press conference, central bankers around the world began to characterize rising inflation as *transitory*. This description would go on to generate substantial media attention and intense public debate throughout 2021. Central bankers utilized this signal not only to assuage concerns about rising inflation but also to justify the need for continued monetary stimulus in the aftermath of the COVID recession. Throughout 2021, U.S. CPI inflation continued on an upward trend, rising from 1.4 to 6.2 percent between January and November of that year. Increasing concerns about the persistence of inflation eventually prompted the Federal Reserve Chair to renege and call for the retirement of the word transitory in his November 2021 congressional testimony.

The transitory inflation case study presents itself as a unique opportunity to evaluate the credibility of central bank communications. This is an issue of tremendous importance, as communications shape public expectations about future monetary policy while also being one of few tools available to policymakers when the federal funds rate is at the zero lower bound. The study of credibility and central banking is challenging for several reasons. Most importantly, the definition of credibility can be subjective in nature, and as a further consequence, that also implies there is no straight-forward way to evaluate the policy implications of changes in the perceived credibility of a central bank (or indeed their signals). Some initiatives that seek to quantify the credibility of these institutions as a whole include: how closely policy outcomes are to their target levels (Bordo and Siklos, 2015) and how anchored inflation expectations are relative to a target level (Demertzis and Viegi, 2016).

The implications of central bank credibility are however best described conceptually within the literature. For example, the importance of credibility was noted by Blinder

(2000) who argued that greater credibility makes disinflation less costly and raises support for central bank independence. Erceg and Levin (2003) make reference to the costs associated with a lack of credibility, namely through a decreased ability for central banks to facilitate monetary stabilization policy. In periods of heightened economic uncertainty, credibility becomes ever more important. This is not necessarily about specific policies that are implemented by central banks, but are instead more broadly about the confidence that the public has in the ability of policymakers to manage uncertainty (Drazen and Masson, 1994; Demertzis and Viegi, 2010; Posen 2010). The post-COVID recovery was a period characterized by tremendous uncertainty, making the transitory inflation case study all the more interesting to analyze the subject of credibility.

For the purpose of our study, we emphasize that our objective is to quantify the credibility of this specific signal, as opposed to the roles of these institutions more generally. Here we define "credibility" as the relative share of belief (or disbelief) in the transitory inflation signal as this position was communicated by the Federal Reserve to the general public. We propose a novel text-based news measure of signal credibility, which utilizes articles on the subject of transitory inflation, and develop a daily measure documenting the relative share of support in favour of the signal. We incorporate this daily measure within a Vector Autoregressive (VAR) model alongside inflation surprises, expectations data, and other macroeconomic variables. Our measure documents the declining credibility of the signal throughout 2021, all while expectations about future inflation rose dramatically. VAR estimates show that credibility diminishes following positive inflation surprises, and that negative credibility shocks increase inflation expectations over both short and long-run horizons.

2.1.2 Timeline of Events

Amid the heightened economic uncertainty brought forth from the COVID pandemic, central banks around the world undertook significant unprecedented actions to mitigate the economic fallout resulting from the global health and economic crisis. Between April and December of 2020, U.S. headline CPI inflation gradually rose from 0.3 to 1.4 percent year-over-year. With this context in mind, we below highlight key events that are relevant to shaping up the timeline of this policy signal throughout 2021.

- JANUARY 27, 2021 - Fed Chair Jerome Powell (2021a) responds to a journalist's question on the potential for a post-COVID rise in inflation, claiming: "...we would see that as something likely to be *transient* and not to be very large".
- FEBRUARY 10, 2021 - January headline CPI inflation is released. $\pi_t = 1.4$. Surprise=-0.1.[1]
- FEBRUARY 24, 2021 - Fed Governor Lael Brainard warns that: "we could see transitory inflationary pressures" (Federal Reserve, 2021).
- MARCH 10, 2021 - February headline CPI inflation is released. $\pi_t = 1.7$. Surprise=0.
- MARCH 17, 2021 - Fed Chair Powell indicates at a press conference that the central bank has no plans to scale back its unprecedented monetary stimulus, referring to inflation many times as transitory (Powell, 2021b).

[1] Data on CPI inflation is obtained from the U.S. Federal Reserve, and the "Surprise" is the Trading Economics Consensus estimate deviation from observed year-over-year inflation value.

- MARCH 25, 2021 - In a speech at the 2021 Institute of International Finance Washington Policy Summit, Fed Vice Chair Richard Clarida discussed his position on U.S. inflation: "I expect most of this increase to be transitory and for inflation to return to or perhaps run somewhat above our 2 percent longer-run goal in 2022 and 2023." (Federal Reserve, 2021).

- APRIL 13, 2021 - March headline CPI inflation is released, exceeding the target rate for the first time. $\pi_t = 2.6$. Surprise=+0.1.

- APRIL 28, 2021 - In his April FOMC press conference, Fed Chair Powell re-iterates that: "one-time increases in prices are likely to have only transitory effects on inflation."

- MAY 2, 2021 - Treasury Secretary Janet Yellen said she did not believe increases in inflation would be an issue, and referred to such inflation as transitory (Reuters, 2021).

- MAY 11, 2021 - Governor Brainard in a speech stated: "an increase in inflation associated with reopening that is largely transitory." (Federal Reserve, 2021).

- MAY 12, 2021 - April headline CPI inflation is released. $\pi_t = 4.2$. Surprise=+0.6.

- MAY 12, 2021 - Vice Chair Clarida re-iterates his March comments to state there are: "transitory effects on underlying inflation, and I expect inflation to return to—or perhaps run somewhat above—our 2 percent longer-run goal in 2022 and 2023." (Federal Reserve, 2021).

- JUNE 10, 2021 - May headline CPI inflation is released. $\pi_t = 5.0$. Surprise=+0.3.

- June 16, 2021 - With inflation now at 300 basis points above the target rate, Fed Chair Powell continues to express confidence in his inflation forecasts, expressing that: “As these transitory supply effects abate, inflation is expected to drop back toward our longer-run goal” (Powell, 2021d). With inflation intensifying, the public debate around the dynamic nature of inflation continues to become more contentious in the popular press.

- July 13, 2021 - June headline CPI inflation is released. $\pi_t = 5.4$. Surprise=+0.5.

- July 28, 2021 - In the July FOMC press conference, Fed Chair Powell again refers to inflation as transitory, but acknowledges that increases in inflation have been larger than expected. In defense of their continued policy stimulus, Powell stated: “Indicators of long-term inflation expectations appear broadly consistent with our longer run inflation goal of 2 percent. If we saw signs that the path of inflation or longer-term inflation expectations were moving materially and persistently beyond levels consistent with our goal, we’d be prepared to adjust the stance of policy” (Powell, 2021e).

- August 11, 2021 - July headline CPI inflation is released. $\pi_t = 5.4$. Surprise=+0.1.

- August 27, 2021 - In a Jackson Hole speech, Chair Powell refers to state of inflation as: “likely to prove transitory” (Federal Reserve, 2021).

- September 14, 2021 - August headline CPI inflation is released. $\pi_t = 5.3$. Surprise=-0.1.

- September 22, 2021 - In contrast with his previous FOMC press conference appearances, Fed Chair Powell refrains from using the word transitory in his opening statements (Powell, 2021f).

- October 12, 2021 - Fed Atlanta Governor Bostic says in a speech that he has banned his staff from using the word "transitory" to describe the current state of inflation (Bostic, 2021).[2]

- October 13, 2021 - September headline CPI inflation is released. $\pi_t = 5.4$. Surprise=+0.1.

- November 3, 2021 - In the November 2021 FOMC press conference, Fed Chair Powell said that they are "walking back" specifically on the use of the word transitory but defends this position by stating that "it will not leave behind it permanently or very persistently higher inflation" (Powell, 2021g).

- November 10, 2021 - October headline CPI inflation is released. $\pi_t = 6.8$. Surprise=+0.4.

- November 30, 2021 - In his congressional testimony, Fed Chair Powell calls for the retirement of the word transitory (Cheung, 2021). Treasury Secretary Yellen would publicly express the same sentiments three days later (Rappeport and Ngo, 2021).

- March 2022 - With headline inflation now sitting at 650 basis points above the target rate, the Fed increases its key policy rate and ends its quantitative easing program.[3]

In what follows, we direct the scope of our analysis to the perceived credibility of the

[2]In March of the same year, Bostic made note that the Fed expected to be roughly 2.4 percent for 2021, but expressed concern about how responsive demand might be to pandemic-related stimulus measures (Derby, 2021).

[3]For the Federal Reserve, this story is more complicated because of the nature of its dual mandate - which is for both price stability and maximum employment. Over this period unemployment was well above its pre-pandemic levels considerably, but closed in to be nearly 4 percent when the Federal Reserve began scaling back its policy in March of 2022. Because of this, the transitory inflation signalling strategy could reflect an informal re-weighting of its policy function entirely away from its price stability mandate in favor of maximum employment.

transitory inflation signal, and the implications that negative credibility shocks may have for inflation expectations.

2.2 Data and Measuring Credibility

We adopt a text-based measure using a sample of 8,362 news articles from January 22, 2021 through to January 31, 2022, totalling 13,603,441 words. We obtain our news articles from the Dow Jones Factiva platform and use filters for articles containing the words: “transitory”, “inflation” and “federal reserve”, such that our sample is focused on both transitory inflation and U.S. central banking. After retrieving these news articles, we apply a standard cleaning procedure that removes Unicode characters, punctuation, white space and capitalization.[4]

Due to the precise language surrounding the transitory inflation debate, there is not an existing sentiment dictionary that is adequately suited to assess polarity. To that end, we develop a dictionary of words and phrases by manually reviewing a 25 percent random subset of news articles from across our sample period, then recording words or phrases in favour of or against the notion of inflation as being transitory. Some of our examples supporting inflation being transitory include: “abating”, “will prove transitory” and “expected to settle”. In contrast, some examples against this notion include: “persistent”, “out of control” and “not likely to be transitory”.[5] This exercise yields a total of 191 positive and 330 negative elements. While it may seem like we are being overly negative, this ratio between positive and

[4]For the processing of the text in this study, the authors benefited greatly from the R package (Feinerer, 2008).

[5]We also associate policy-related words like “hawkish” with negative credibility, as they indicate an opposing view to the Fed’s policy stance over this period and words like “dovish” with positive credibility.

negative words and phrases is more modest than other popularly used sentiment dictionaries (including Loughran and McDonald, 2011). It is our intention that the dictionary-based measure will provide for an objective and intuitive scoring procedure on the credibility of the signal, allowing for the empirical analysis of an otherwise qualitative subject. In the interest of being concise, the dictionary is described in full in Appendix A.

For a given news article i on day t, we compute the normalized sentiment score between positive words and phrases in support of the transitory inflation signal $\omega(p)_{it}$, and their negative counterparts $\omega(n)_{it}$ relative to the total word count of the article W_{it} as:

$$s_{it} = \frac{\omega(p)_{it} - \omega(n)_{it}}{W_{it}}. \tag{2.1}$$

To get a broader sense of the polarity surrounding transitory inflation on a given day, we take the average for each period t, defining the daily indicator as s_t. Our text-based measure (2.1) is a departure from other empirical measures of central banking credibility, which tend to evaluate relative dispersions of inflation from the mandated target rate (Bordo and Siklos, 2017) or alternatively draw from survey-based measures (Blinder, 2000; Ehrmann et al., 2023). As the two words "transitory" and "inflation" so concisely convey the message of the signal, we argue that our measure provides a unique opportunity to analyze the dynamics of belief - as captured by the relative share of positive versus negative elements - in the now infamous policy position. Figure 2.1 plots the ten-day moving average of s_t over the sample period from January 22, 2021, through January 31, 2022. The measure documents declining faith in the signal, which drops continuously throughout 2021. After the signal was officially abandoned in November 2021, the credibility measure declines further before stabilizing into

Figure 2.1: Signal Credibility Measure

Notes: This data presents a ten-day trailing moving average of the signal credibility measure s_t. Time span: January 22, 2021 - January 31, 2022.

2022. In order to ensure that our empirical analysis is related to policy, we focus on the period where the signal was used by the Fed, as indicated by the vertical lines in Figure 2.1.

We also draw from data on inflation news surprises and break-even inflation rates. Inflation surprises are survey-based consensus estimates from Trading Economics, which occur only on dates of CPI inflation releases from the U.S. Bureau of Labor Statistics. On days with no data releases, observations of this variable are defined to be zero. Break-even inflation rates are obtained from the Wall Street Journal and the U.S. Federal Reserve Economic Database, which denote the difference between nominal and real government bond yields at varying term lengths from one to ten years. Both sets of data are exhibited in Figure 2.2. Not surprisingly, inflation surprises are biased to the positive side, and inflation expectations rise across the term structure, but at an especially pronounced rate for short to mid-term expectations as 2021 progressed.

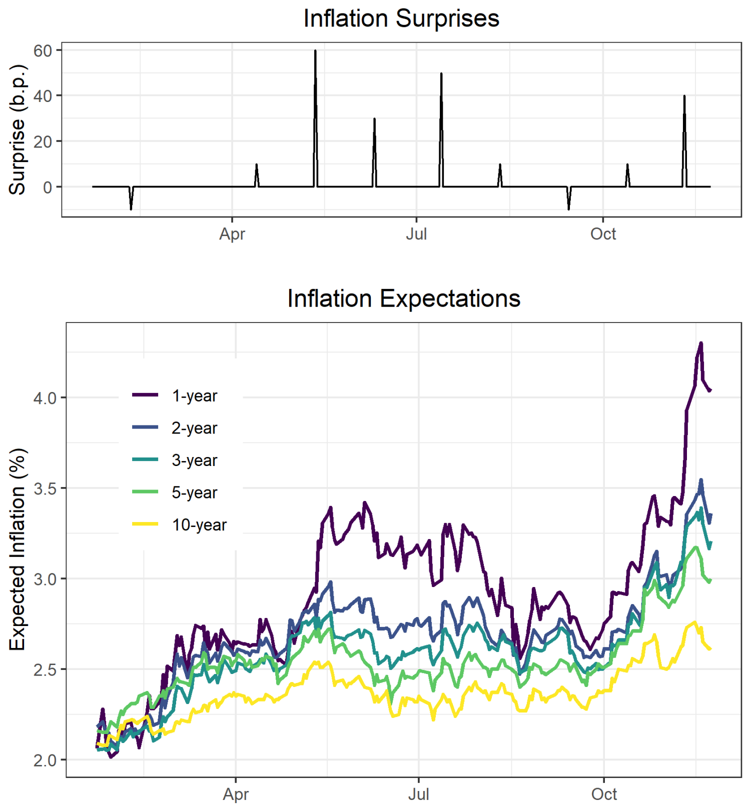


Figure 2.2: Inflation Surprises and Expectations

Notes: This data presents inflation surprises π_t^s and break-even inflation expectations of horizon j, $\mathbb{E}[\pi_t]^j$ over the period in which this signal was utilized by the U.S. Federal Reserve. Time span: January 27, 2021 - November 30, 2021.

2.3 Methods

We estimate the set of j external instrument VARs using the system of equations:

$$Y_t^j = \begin{bmatrix} \pi_t^s \\ f_t \\ s_t \\ \mathbb{E}[\pi_t]^j \end{bmatrix} = \begin{bmatrix} 0 \\ c_2 \\ c_3 \\ c_4 \end{bmatrix} + \sum_{p=1}^{P} \begin{bmatrix} 0 & 0 & 0 & 0 \\ \Phi_{21}^p & \Phi_{22}^p & \Phi_{23}^p & \Phi_{24}^p \\ \Phi_{31}^p & \Phi_{32}^p & \Phi_{33}^p & \Phi_{34}^p \\ \Phi_{41}^p & \Phi_{42}^p & \Phi_{43}^p & \Phi_{44}^p \end{bmatrix} \begin{bmatrix} \pi_{t-p}^s \\ f_{t-p} \\ s_{t-p} \\ \mathbb{E}[\pi_{t-p}]^j \end{bmatrix} + \begin{bmatrix} \nu_{1t} \\ \nu_{2t} \\ \nu_{3t} \\ \nu_{4t} \end{bmatrix}, \qquad (2.2)$$

where each j iteration involves swapping out the final variable for a different break-even inflation rate at terms of one, two, three, five and ten years. Elsewhere in the above system, c represent the constants of each equation, Φ are the parameters on prior lags of variables within the system of equations, and ν_t are the presumably serially uncorrelated residual terms. For this exercise, we insert the ten-day trailing moving average of the daily s_t measure, such that we capture the broader moving trend without incorporating any forward-looking information. Other controls include inflation surprises π_t^s, and macro-financial variables for log oil prices, the log of the VIX and a daily job vacancy index as a real measure of economic activity in f_t.[6]

A key presumption about our specification is that π_t^s is defined to be an external instrument, meaning that the first equation is treated as purely exogenous such that $\pi_t^s = \nu_{1t}$. This identification strategy is motivated by the unanticipated nature of inflation surprises, which therefore serve as an adequate proxy for ν_{1t}.[7] The other equations for s_t, f_t and $\mathbb{E}[\pi_t]^j$ are

[6] We use the VIX index as a measure of broad market risk premia, and the daily Indeed job vacancy index from the U.S. Federal Reserve Economic Database.

[7] For influential studies on the external instrument methodology, see Stock and Watson (2018) and Olea

analogous to a standard P order VAR. From the Wold representation of (2.2), our results can be interpreted using impulse response functions. This exercise aims to describe the dynamic evolution of the model's variables in response to a shock from one or more of the variables within the system, i.e. $\partial Y_{it}^{j}/\partial \nu_{it}$. More specifically, we will focus on how the credibility measure responds to inflation surprises and how the inflation expectations term structure responds to negative credibility shocks. We adopt a standard recursive decomposition for the VAR and estimate each model using three lags.[8]

2.4 Results

Consider first the response of break-even inflation expectations to inflation surprise shocks in Figure 2.3. Contemporaneous news releases of U.S. CPI inflation surprises boost both short and long-term expectations across the term structure. This effect is most pronounced in the short-term and burns out over a longer horizon. The 20 basis point positive shock, which is approximately the average magnitude of inflation surprises in our sample, produces a peak estimate of 15 basis points on the one-year expected inflation rate. All impulses exhibit positive significance at the horizon $t = 0$, with the one, two, three and five year expected inflation rates maintaining at least some level of significance throughout.[9] The observed burning out across the term structure is consistent with differently motivated empirical studies of central banking sentiment that analyze the effects of communication pivots on

et al. (2021).

[8]The recursiveness assumption means that inflation surprises contemporaneously impact all variables in the system, but not vice versa in the sequential ordering.

[9]This is not a surprising finding. As it was shown earlier in Figure 2.2, longer-run break-even expectations tend to be much less volatile than those in the short-run.

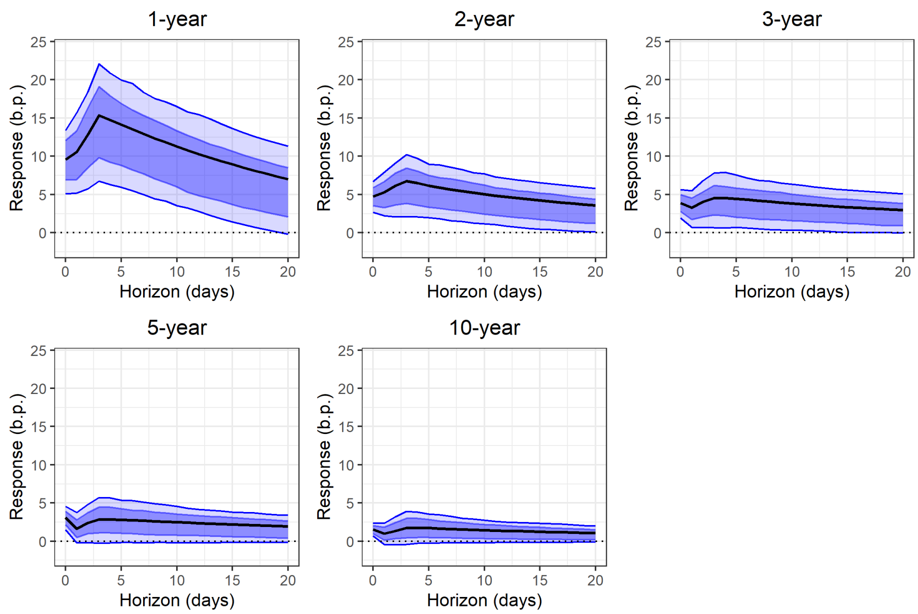


Figure 2.3: Response of Break-even Inflation to Positive Inflation Surprise

Notes: Shock size: +20 b.p. Confidence bands: bootstrapped at 68 percent and 90 percent intervals with 299 repetitions. This plot documents the response of the respective break-even inflation rates $\mathbb{E}[\pi_t]^j$ to a 20 basis point shock from the inflation surprise variable using estimates of (2.2).

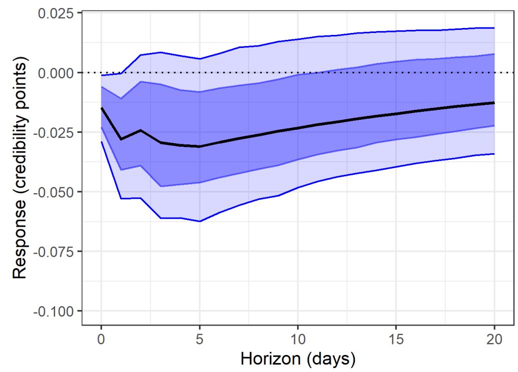


Figure 2.4: Response of Credibility to Positive Inflation Surprise

Notes: Shock size: +20 b.p. Confidence bands: bootstrapped at 68 percent and 90 percent intervals with 299 repetitions. This plot documents the response of our credibility measure s_t to a 20 basis point shock from the inflation surprise variable using estimates of (2.2).

nominal yields (see: Lucca and Trebbi (2009); Carvalho et al. (2016)). Altogether, this exposition lends preliminary credibility to the empirical methodology, with the effects of the inflation surprise producing a set of impulses that are of the right sign, at a plausible magnitude, and with the correct interpretation of "burning out" over the break-even inflation expectations term structure.

We next direct our findings to an impulse response function documenting the response of the credibility measure to a 20 basis point inflation surprise shock in Figure 2.3. Interestingly, we find that the positive inflation surprise negatively influences the belief in the transitory inflation narrative - a result that is statistically significant at a shorter horizon within the 90 percent confidence bands, and for an extended horizon within 68 percent confidence bands. Over the course of 2021, inflation surprises tended to be positive and of a relatively high magnitude, two facts that would be consistent with a declining trend in signal credibility that was shown previously in Figure 2.1. We find that this result is intuitive given the nature of the transitory inflation signal that was conveyed by the Fed. Under the guise of this signal, agents should expect to see either no, or negative surprises from inflation news. Instead, our surprise measure π_t^s is biased to the positive side, and produces an impulse response function runs consistent with the expectations of diminished credibility in the signal.[10]

Turning next to Figure 2.5, we explore the role of signal credibility on the inflation expectations term structure. Specifically, this plot documents the response of the respective break-even inflation rates to a *negative* one standard deviation shock from the credibility measure using estimates from (2.2). The first part of this story has so far illustrated that (i) positive inflation surprises diminish the credibility measure of the transitory inflation signal, but perhaps more importantly it should be asked that (ii) do shocks from diminished credibility influence break-even inflation in the short and long-run? We find that negative credibility shocks surrounding the transitory signal boost inflation expectations across all horizons with consistent statistical significance for all term lengths at the 90 percent confidence level. Or, in the inverse case of this exhibit, an increase in the credibility of the signal would in fact reduce future expectations about inflation in both the short and long-run. Similar to Figure 2.3, we again see a burning out effect where impulse response estimates decline across the term structure.

[10]Note that the inflation surprise measure π_t^s can be biased in the VAR to its true magnitude of surprise because of the external instrument specification. Otherwise, in a standard Choleski VAR model the central limit theorem would impose undue normality on the shock term ν_{1t}.

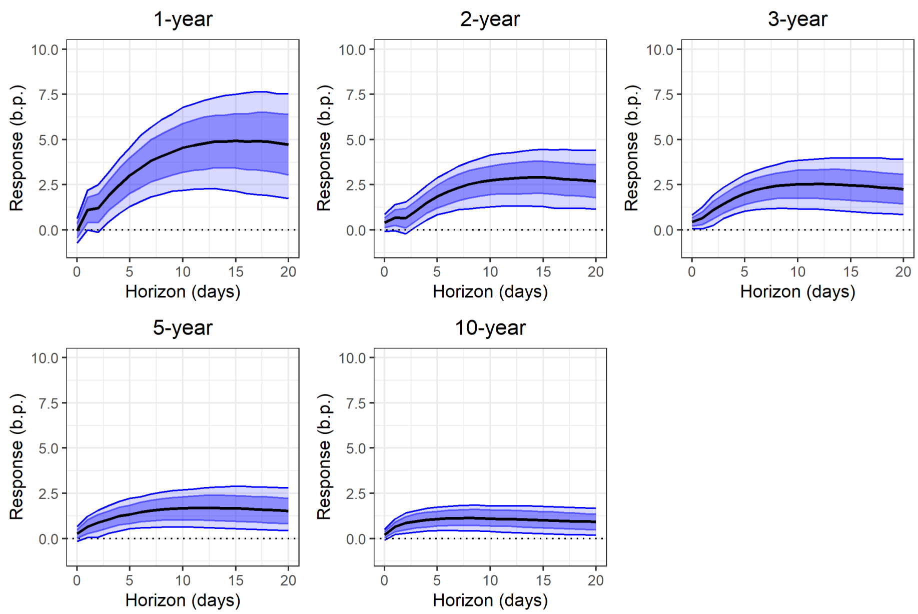


Figure 2.5: Response of Break-even Inflation to Negative Credibility Shock

Notes: Shock size: -1 s.d. Confidence bands: bootstrapped at 68 percent and 90 percent intervals with 299 repetitions. This plot documents the response of the respective break-even inflation rates $\mathbb{E}[\pi_t]^j$ to a negative one standard deviation shock from the credibility measure using estimates from (2.2).

2.5 Conclusion

Throughout 2021, central bankers expressed with confidence that rising inflation in the aftermath of COVID was transitory. However, subsequent data releases consistently contradicted this narrative, revealing a persistent rise in inflation that was well outside of the target range held by many central banks. Despite the mounting evidence of increasing inflation, central banks including the Federal Reserve maintained their extensive monetary stimulus measures, which likely contributed to further inflationary pressures. In this study, we have presented a novel and objective measure used to assess the credibility of central bank signals through the transitory inflation case study. Throughout 2021, we find that doubts about the transitory nature of inflation grew until the point at which the U.S. Federal Reserve abandoned use of the word transitory. Our evidence illustrates that negative credibility shocks positively influenced inflation expectations over both the short and long-run, and serves as a foundational study for such a profoundly important period in monetary history.[11]

The most forefront concern from this story is the potential erosion of public trust in the signals provided by central banks. The public's loss of confidence in the accuracy and reliability of central bank communications may importantly have far-reaching policy consequences. It could hinder future attempts by central banks to effectively convey their monetary policy decisions and objectives, should stakeholders not have confidence in the information that they are receiving from the central bank. In turn, it could be possible that central banks will have to operate with a reduced ability to influence the expectations of policy stakeholders.

[11] In addition to Baker and Lam (2022), some other topical contributions include Arnott and Shakernia (2022), Gharehgozli and Lee (2022) and Tokic (2022).

Consequently, future studies should assess the efficacy of monetary policy communications in light of this episode, to determine if there will be adverse long-term implications when compared to the period preceding the transitory inflation case study.

Chapter 3

Does a Rising Tide Lift all Boats?: Monetary Policy and Inequality in Canada

3.1 Introduction

3.1.1 Motivation

In the post-COVID era, central banks have become increasingly more cognizant about economic inequality and the possible intersection that disparities in wealth and income may have with monetary policy. This is especially evident in recent communications from the

Bank of Canada, which, in the aftermath of implementing COVID-related stimulus, governor Tiff Macklem stated: "We're going to be there, creating the conditions for *all boats to rise*, through the full length of this recovery."[1] In greater detail, Macklem emphasized that its policy stance was perhaps agnostic towards economic inequality, remarking further that: "You can think of monetary stimulus and the recovery like the tide coming in... when the tide comes in, it creates the conditions for all boats to rise. That's what monetary stimulus does." On the contrary, these statements were made as the Canadian central bank itself voiced concerns about the potential that its quantitative easing (QE) program was propagating inequality amid what was referred to as "the sharpest and most unequal economic cycle of our lifetime."[2] The notion of lifting all boats while also engaging in large-scale expansionary policy may sound conflicting because of the role played by asset prices in the transmission channel of monetary stimulus, though the channels between monetary policy and economic inequality remain to be not well defined in Canada and abroad, despite growing interest among policymakers and the general public.

Aside from these specific comments, there has been considerable growth in the share of international central bank speeches discussing economic inequality (Bank of International Settlements, 2021). This upward trend in interest is also well-documented in the press. Figure 3.1 plots the percent of central banking news articles containing the distributional keywords of: "inequality", "inequalities", "unequal", "GINI", "uneven" and "distributional"

[1] Emphasis added by the authors. This refers to a comment from the the Bank of Canada Governor Tiff Macklem on September 10, 2020 to reports at a video conference for the Canadian Chamber of Commerce. A discussion of this passage is available from an article by Parkinson (2020) titled: "BoC's Macklem warns rising inequality in jobs and income poses the biggest threat to economic recovery."

[2] See the full context in a news article quoting a speech from the Governor of the Bank of Canada by Gordon and Ljunggren (2020).

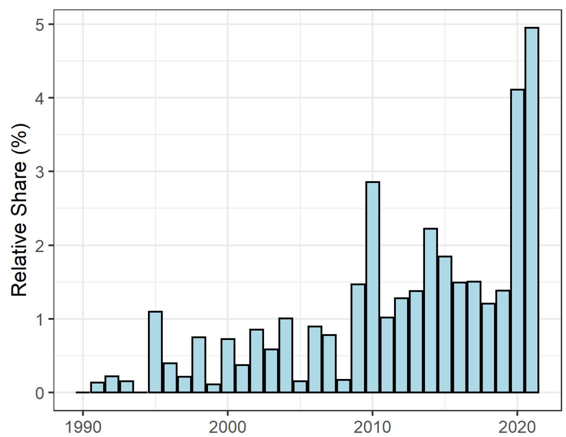


Figure 3.1: Percent of Central Banking News Articles Containing Distributional Keywords

Notes: This chart plots the relative frequency of articles with distributional keywords from English language news articles on the Dow Jones Factiva platform for: the Federal Reserve, the Bank of Canada, the Reserve Bank of Australia, the Reserve Bank of New Zealand, and the European Central Bank. Keywords include: inequality, inequalities, unequal, GINI, uneven, and distributional. Date range: 1990-2021, although the year 2021 only includes data until end-of-month July. Total news articles sampled: 1,118,220.

from the Dow Jones Factiva Network over time. Two distinctive upward shifts are observed in this figure. This first occurs immediately after the 2008-2009 Financial Crisis, and second during the COVID pandemic - two periods that are synonymous with substantial monetary stimulus. This plot demonstrates a growing concern about the possible intersection between monetary policy and inequality, which may in fact be justified if the nature of monetary policy has evolved over time. But how should monetary policy impact inequality? Even this simple question can be met with conflicting hypotheses. For example, expansionary policy would likely better serve those at the lower-end of the income distribution through employment channels,[3] while at the same time increasing the price of assets, which should disproportionately benefit the wealthy.[4]

With respect to the asset channel, expansionary monetary policy has a significant impact on wealth through its influence on asset prices and financial markets. Expansionary policy can consist of both lower interest rates and increased liquidity, which encourages investors to seek higher returns in riskier assets, thus driving up the prices of financial assets including stocks. A second observation is that lower interest rates can lead to an increased demand for real estate, boosting house prices and benefiting homeowners and real estate investors. Since the wealthy tend to disproportionately hold these assets in the first place, this can further amplify wealth inequality.

At the opposite end of the distribution, expansionary monetary policy can positively impact low-income households through employment channels. When the central bank lowers

[3]See Gali (2010) for a discussion on the channel between monetary policy and unemployment.

[4]Among the many studies that explore the relationship between monetary policy shocks and asset prices, Paul (2020) provides for a take on the time varying relationship between the two in the United States.

interest rates, businesses are encouraged to expand and invest, leading to more hiring. This benefits low-income individuals who tend to face higher unemployment rates in recessionary periods. Moreover, expansionary monetary policy can support small businesses - where many low-income individuals work - by reducing the cost of credit and promoting business expansion. Increased competition among firms for workers can lead to wage growth, improving the standard of living for low-income workers and their families. However, these two trade-off effects must be considered with respect to base effects, as a three percent increase for a large asset holder is not comparable to a three percent wage increase for an individual who is already considered to be low-income.

In this study, we are primarily interested in the short to medium-run implications of monetary policy on economic inequality in Canada. Motivated by recent communications from central banks around the globe, and in particular the "lifting of all boats", we seek to investigate this very relationship. We provide estimations from three different empirical perspectives, including: i) a distributional income panel analysis at the income group-Census Metropolitan Area (CMA)-gender-year level, ii) a wealth-oriented panel analysis at the billionaire-year level, and iii) an external-instrument Vector Autoregressive (VAR) model exploring the relationship between monetary policy surprises, unemployment and real asset prices from both a static and time-varying parameter point-of-view.

Evidence from the distributional income panel shows that all income groups benefit from expansionary policy in percentage terms (before considering steep differences in base effects). Non-labour income gains are however reserved for Canada's most well-off individuals - a result that is driven especially by policy movements after the 2008-2009 Financial Crisis.

From our billionaires sample, we find there to be real wealth increases that have grown in magnitude following the financial crisis and into the COVID pandemic. Our VAR evidence shows that expansionary policy surprises inflate real housing and stock prices, the source of which wealth and indirect forms of income are often dependent upon, while having a more modest effect on reducing unemployment. Further analysis with a time-varying parameter VAR also highlights that the effect of expansionary monetary policy on real asset prices has grown in its magnitude since the early 2000s.

In what follows, we provide for a brief review of the literature, then a discussion of our monetary policy identification strategy in Section 2. Then in Section 3 we present the data, methodology and results from our panel datasets for distributional income and Canadian billionaires. In Section 4, we discuss the VAR methods and results. Finally, we provide for a comprehensive discussion of policy and conclude in Section 5.

3.1.2 Previous Studies

The evaluation of the potentially unequal effects of monetary policy is a relatively new phenomenon in the literature, the likes of which has grown tremendously in the aftermath of the 2008-2009 Financial Crisis. Even with growing interest among the general public and central banks themselves, the literature can be described as having mixed conclusions. For instance, Coibion et al. (2017) found that contractionary U.S. policy increased inequality across various sources of income and consumption. A similar conclusion was also reached by Mumtaz and Theophilopoulou (2017) and Ferceri et al. (2018), who find that inequality rises with a tightening policy stance in the U.K. and also across a larger cross-section of nations. Contrast this with other studies, including Ampudia et al. (2018) who find that Euro-area expansionary policy "lifts all boats". Notably, the authors found that the indirect effects of lower unemployment benefited the lower end of the household income distribution.

At the upper end of the income distribution, there are additional concerns that asset inflation from expansionary policy will disproportionately benefit the wealthy (O'Farrell and Rawdanowicz, 2017; Amaral, 2017). For instance, administrative evidence from Denmark (Andersen et al., 2021) and Sweden (Amberg et al., 2021) both show that expansionary shocks disparately increase incomes in the right tail of the income distribution - which is especially evident when the income is sourced from capital gains. Both studies also document that the lower end of the income distribution does benefit from greater increases in wages and salaries relative to other income groups, suggesting that gains are experienced through the labour channel of monetary policy. Seemingly absent are the middle percentiles of the income distribution, which appear to be more agnostic in real terms to policy shocks (see Amberg et al., 2021).

Aside from conventional monetary policy shocks, there are additional studies that explore the relationship between QE and economic inequality. Japan has engaged in QE longer than any other nation, to which Saiki and Frost (2014) show with VAR evidence that post-2008-2009 expansions widened inequality, and particularly through sources of income derived from assets. In a later study, Saiki and Frost (2020) note that the unique demographic landscape of Japan may result in the asset channel outweighing the labour channel of expansionary policy.[5] While Canada does have a large baby boomer cohort, its demographics remain to be

[5]Taghizadeh-Hesary et al. (2020) come to a similar conclusion as Saiki and Frost (2014) on the link between QE and income inequality in Japan.

markedly different from Japan. Further to this point, Lenza and Slacalek (2019) found that Euro-area QE did not increase income inequality. In a more theoretical analysis, Hohberger et al. (2020) find that both conventional policy and unconventional expansionary shocks tend to mitigate income and wealth inequality between two representative groups - further adding to the conflicting relationship exhibited between monetary policy and inequality in the literature.

In Canada, recent analysis from Kronick and Villarreal (2020) uses monthly Labour Force Survey (LFS) to estimate GINI coefficients from hourly wage data.[6] Subsequently, impulse response functions mapping policy shocks to the GINI measure finds that expansionary policy increases hourly wage inequality. In a later exercise, the authors estimate a wage to gross operating surplus gap - the difference between wages and capital income derived from production, finding that an expansionary shock reduced the gap (as a proxy for inequality from capital rents) at extended horizons, thus implying an increase in the inequality of household income.[7] There is a great incentive to study the topic of monetary policy and inequality in Canada from a similar motivation to the studies in the U.S. and Europe. While hourly wages are one important dimension of income, an emphasis must also be directed towards income that is derived from wealth and other indirect sources. As the Bank of Canada will continuously reevaluates its policy mandate, more research is needed to better understand the channels of a growing set of potential frameworks (Murray, 2021). This includes not only how movements in monetary policy impact historically less-emphasized

[6] It is not stated whether the authors use the public-use or confidential versions of the LFS. Should the public-use version be used, then censoring in the right tail of wages has the potential to understate inequality among those surveyed.

[7] The authors similarly did not find a significant impact from a contractionary shock to the wage–gross operating surplus gap.

outcomes like economic inequality, but also to have a constructive dialogue surrounding the suitability of a central bank for addressing many of today's forefront policy challenges.

3.2 Monetary Surprise Identification

Before we begin exploring the implications for inequality, we must first discuss how we identify exogenous movements in monetary policy. In the most traditional time series identification strategies, a VAR model is used to estimate changes in a monetary policy instrument that are not explained by covariates in the VAR, which are subsequently interpreted as exogenous policy shocks. This form of identification has been challenged by Evans and Kuttner (1998), who highlight model specification, linearities, and data aggregation as reasons to be skeptical about this approach. As a consequence, this strategy has a tendency to misidentify unanticipated pivots in policy, and has fallen out of favour for newer methods in identifying monetary policy shocks (Nakamura and Steinsson, 2018). For instance, Kuttner (2001) and Gürkaynak et al. (2004) were, among others, highly influential in adopting a high-frequency event-style analysis surrounding monetary policy announcements. This approach can involve taking the difference in a relevant treasury rate with a short timeframe around the policy decision.[8] After incorporating this indicator with lower-frequency macroeconomic data, one could then conduct inference by using the variable as an external policy instrument.[9]

Our strategy is to first gather event dates from the Bank of Canada over the period from

[8]Or alternatively an orthogonalized difference in a treasury yield around the event date.

[9]This general form of identification was introduced to the literature by Stock and Watson (2012) and Mertens and Ravn (2013), and has been adopted for use in the context of monetary policy transmission by Gertler and Karadi (2015), Paul (2020), and Jarociński and Karadi (2020) among others.

March 1996 through January 2022. The sample start date corresponds to the first full month that the Bank of Canada moved from a float to a fixed rate policy.[10] From December 2000 onward, the central bank moved to a fixed announcement date system, where eight annual pre-arranged dates have since been used to communicate monetary policy decisions. While this is now the formal way of communicating policy movements, emergency decisions can, and have been made by the central bank. Examples include the globally coordinated cut by several central banks during the 2008-2009 Financial Crisis, and stimulus enacted at the onset of the COVID pandemic.

After drawing these dates, we then take the daily change in the one-year treasury yield around the event date, defined as

$$m_t = m_{post} - m_{pre}. \tag{3.1}$$

This metric measures the unanticipated change in the policy stance, as it deviates from the level m_{pre} the day prior to the announcement from the central bank. As noted by Gertler and Karadi (2015), this instrument is also valid at the zero-lower bound because the one-year is able to incorporate the effects of forward guidance if any surprising information is relayed following the announcement. A visualization of this identification strategy is exemplified in Figure 3.2, using two event dates that occurred in January 2015 and January 2016. In the first of the two events, the Canadian central bank surprised many by cutting its key policy

[10] Note that in the Bank of Canada's float rate monetary policy the central bank allowed interest rates to be determined by market forces (set at 25 basis points above the average yield on a 3-month treasury bill). To the contrary, the Bank of Canada then adopted a fixed rate policy in 1996, where it has since set a specific target rate in a pre-determined on unannounced manner at least eight times per year. Float rate policies offer greater flexibility in response to market conditions, while fixed rate policies provide stability with the pre-determined policy rate being maintained by the Bank of Canada.

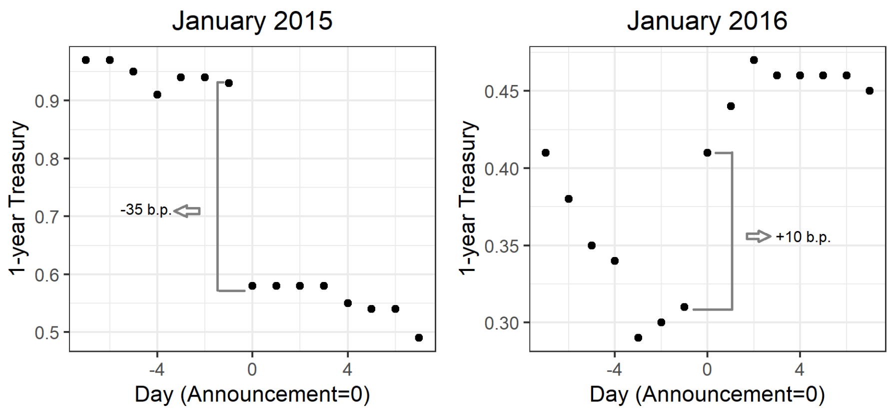


Figure 3.2: Example Event Analysis

Notes: The above figure includes two plots denoting monetary policy announcements from the Canadian central bank in January 2015 and January 2016. The left pane is indicative of a strong downward movement around the event date, where the central bank surprised many by cutting its key rate 25 basis points. The right pane highlights a softer increase in the one-year treasury when the Canadian central bank *did not* move its key rate, but instead voiced its opinion about the prospects for future monetary policy.

rate by 25 basis points. Amid the worsening decline in energy prices, the one-year treasury yield fell by 35 basis points around the event date. One year later in 2016, the Bank of Canada did not change its policy rate, although a more optimistic stance coincided with an increase in the one-year treasury of 10 basis points.

The daily metric m_t can then be converted into a monthly frequency, which will later be evaluated alongside other macroeconomic covariates. In months where no announcements are held, we impute the values of m_t to be zero. Using this strategy, we plot the monetary surprise time series in Figure 3.3. For one, it is observed that monetary policy was much more active in the period preceding the 2008-2009 Financial Crisis. This is best characterized by the apparent change in the variation of the surprise series before and after 2010, as well as

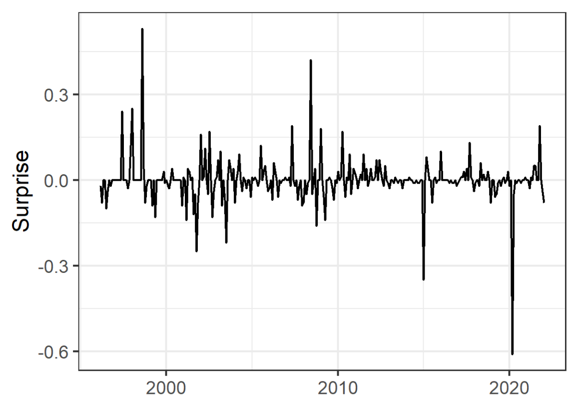


Figure 3.3: Policy Surprise Series

Notes: Sample period: 1996:3-2022:1. The monetary surprise series is calculated using the values derived from (3.1) via daily changes in the one-year treasury yield surrounding event dates held by the Bank of Canada. In months where policy decisions where not held or made, the value of the time series is imputed to be zero. Furthermore, in months where more than one decision was made (typically in the case of emergency decisions, including COVID in 2020:3), we take the sum of total surprises.

what corresponds with the persistent decline in the level of the policy rate over this period. All monthly observations are surpassed in magnitude by COVID-related stimulus, which accumulated to a total surprise of 61 basis points in March 2020.

Related to Figure 3.3, one could point to the fact that some shocks are positive, some are negative, and over the course of the full business cycle, the two competing expansionary and contractionary elements may balance out to eradicate unequal impacts on income over the long-run. Ultimately, it depends on the perspective or the time frame of analysis from estimates of (3.1). When the data is extended to the beginning of the post-float policy rate era (i.e., March 1996 onward), the cumulative sum of m_t across time is shown to approximately net out positive and negative surprises. This is in part due to larger contractionary swings before the fixed announcement date system was implemented in December of 2000. When considering only the fixed announcement date era, this accumulates to a net effect of -70 basis points by early 2022, indicating bias towards expansionary surprises, though this measure is influenced somewhat by the COVID pandemic occurring near the end of the sample.[11]

One caveat for our study of inequality is that distributional income and billionaire wealth data is at best available at an annual frequency.[12] Therefore, for our income and billionaire panel analyses we must collapse the data by taking the annual sum of monetary surprises from Figure 3.3 - a process also adopted by others in the literature (Amberg et al., 2021; Andersen et al., 2021). This process gathers the net effect over the course of a 12-month

[11] Analysis on data through until May 2023 verifies the same, with post fixed announcement data surprises accumulating to a stimulative -70 basis points.

[12] Setting aside recent innovations in real-time estimates of billionaire wealth, the annual estimates are available over a longer time period.

period, to which we illustrate in Appendix 1. In the later time series analysis, we use the monthly data with the VAR methodology.

Altogether, the measure of m_t is premised to serve as an external instrument for our empirical analysis. There are three conditions needed to satisfy the use of m_t as an external instrument: (i) Relevance: $\mathrm{E}[m_t \epsilon_{m;t}] = \alpha \neq 0$, meaning that the monetary surprise instrument is a correlated representative of the target policy shock $\epsilon_{m;t}$, (ii) Contemporaneous exogeneity: $\mathrm{E}[m_t \epsilon_{j;t}] = 0$, for $j \neq m$, meaning that the instrument is uncorrelated with other shocks in the model at time t, and (iii) Lag-lead exogeneity: $\mathrm{E}[m_t \epsilon_{j;t+k}] = 0$, for $j \neq m$ and for $k \neq 0$, meaning that the dynamic nature of the identification strategy also satisfies the standard exogeneity condition across the time dimension with respect to $\epsilon_{j;t+k}$ (Stock and Watson, 2018). In this analysis we are treating the monetary communication dates as exogenous sources of variation that are relevant in proxying for unanticipated movements in the policy stance held by the central bank.

3.3 Distributional Effects of Monetary Policy

3.3.1 Data

Distributional Trends in Canadian Income

Our income macrodata originates from Canada's Longitudinal Administrative Databank (LAD). The LAD is a 20 percent sample of the individual T1 files submitted to the Canada

Revenue Agency, which includes a comprehensive summary of income in a given year. We draw from the aggregate records at the CMA level, while treating the Atlantic provinces and the Territories as independent cross sections in the panel over the period from 1996-2019.[13] Our panel will contain income from wages and salaries, non-labour income sources,[14] total income, and total income after taxes. As we are interested in the distributional effects of monetary policy, we segment the data for income groups inclusive of: the bottom 50 percent, the median, the top 50 percent, the top ten percent, the top 5 percent, the top one percent and the top 0.1 percent, where income averages are used within each group. Finally, we separate income data by gender, such that the final panel is at the region-year-gender-income group level.[15]

We provide a plot of historical trends in real national after-tax income from all sources in Figure 3.4. This is demonstrated with the aforementioned emphasis on the right tail of the income distribution, where income groups are shown to be increasingly more granular until the final sorting at the top 0.01 percent. Income levels are normalized such that values in 1982 are fixed to 100, and represent the average income within each group.

By a considerable degree, real after-tax income growth has been concentrated well in the upper-end of the income distribution. This is especially true for those in the top 0.1 and 0.01

[13] The full list of regions include: Calgary, Edmonton, Sudbury, Hamilton, Kitchener-Cambridge-Waterloo, London, Montréal, New Brunswick, Newfoundland and Labrador, Nova Scotia, Oshawa, Ottawa, Gatineau, Prince Edward Island, Québec City, Regina, Saguenay, Saskatoon, Sherbrooke, St. Catherines-Niagara, the Territories, Thunder Bay, Toronto, Trois-Rivières, Vancouver, Victoria, Windsor and Winnipeg.

[14] Which is determined by taking the difference between total income and income from wages and salaries. It would therefore be left to represent alternative forms of income, including the disposition of capital.

[15] In some instances we are limited by data suppression from Statistics Canada. This is most common in the top 0.1 percent, when the underlying smaller sample sizes may violate publication requirements in the Canadian Statistics Act.

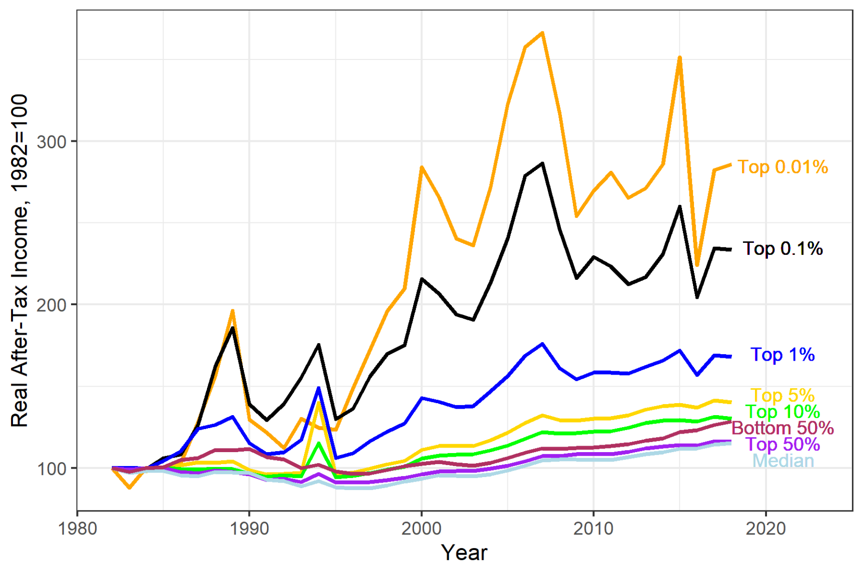


Figure 3.4: National Trends in Real Income Growth by Income Grouping

Notes: Data is sourced from Statistics Canada Table 11-10-0055-01 via the LAD. Values are deflated using annual CPI data to 2002 dollars, then normalized to a value of 100 in 1982. Income in this figure is defined to be total income after taxes at the national level by income group.

percent, which both see increases respectively of 2.34 and 2.86 times 1982 levels by 2018. These two levels also appear to be strongly procyclical in nature, as real income consistently drops during economic downturns. This pattern however diminishes for the most part at the opposite end of the income distribution. Altogether, there has been comparatively very modest real growth for the top 50 percent, and also the median income across all tax filers. Interestingly, both of the former groups are surpassed in growth by the bottom 50 percent, who experienced a real increase over this period by a multiple of 1.28 times through 2018, most of which has been achieved in the years following the 2008-2009 Financial Crisis. Over time, there have been considerable differences in the level and trajectory of income by region. Some regions, like Newfoundland and Labrador and Saskatoon have experienced noticeable levels of real income growth, while others, including Windsor and the Niagara region have been significantly more stagnant. By 2019, regions with the highest levels of income tend to coincide with either a strong public or energy sector. Related to this observation, Calgary, Edmonton, Ottawa and Regina all stand out as regions that are more pronounced in terms of income levels relative to other jurisdictions in Canada.[16] Collectively, the disparate growth inc real income among Canada's most well-off points to rising inequality over the last several decades. While it is worth mentioning that national after-tax GINI coefficients have been more stable from 1976-2020,[17] the within distribution trends shown in Figure 3.4 demonstrate that there is much more to the story of Canadian income inequality.

[16] Plots of regional time trends are available in Appendix 1.

[17] According to calculations by the authors from Statistics Canada Table 11-10-0134-01.

Billionaire Wealth

In studying the linkages between economic inequality and monetary policy, wealth is undoubtedly the preferred outcome of interest. Unfortunately for researchers and policymakers, data on wealth tends to be scarce, and also of poor quality. This is especially true in Canada, where the leading survey on wealth is compiled at an irregular frequency, often spanning several years between survey years. To get around this issue, we use data from Forbes' Worlds Billionaires List - a ranking system that estimates the net worth of the richest persons in the world at an annual frequency. Forbes deploys a number of reporters to draw this information first from surveying the billionaires or their representatives. As this process can often under or over-state wealth, estimates are then also used to verify the accuracy of the data if provided. Next, the assets of billionaires, including equity positions in publicly traded companies, stakes in private companies, cars, yachts, real estate and art are used to develop an estimate of wealth less any known debts held by the individual.[18] In 2022, this global index totalled over $2,750$ billionaires - a noteworthy increase of over 32% from the year prior. Moreover, substantial post-COVID global wealth accumulation is exemplified by the fact that 86% of billionaires experienced an increase in net worth from the year prior (Kerry and Peterson-Withorn, 2022).

In Figure 3.5, we highlight two time series documenting the immense growth in wealth among Canada's most well-off. The left pane plots real aggregate wealth of Canada's billion-

[18]For those who derive their wealth from privately held corporations estimates of revenues are used in consortium with price to revenue ratios from comparable public companies. In, the real-time edition of the billionaires index, when individuals derive more than 20% of their wealth from a private company, an industry-region index is used to proxy for changes in net worth. Our description of the Forbes methodology is drawn from Kerry (2012).

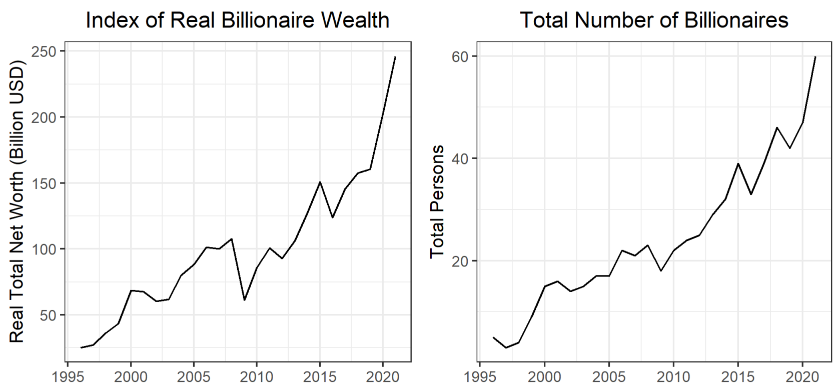


Figure 3.5: Trends in Billionaire Wealth and Counts

Notes: The left pane documents the real aggregate wealth of Canada's billionaires (in USD, 2021=100), while the right pane illustrates the total number of listed billionaires over the period from 1996 through 2021.

aires, while the right pane illustrates the total number of listed billionaires over the period from 1996 through 2021. Over time, we observe the total number on Forbes' list as rising twelve-fold from five to 60, all while real wealth increased nearly ten-fold from 25 billion to 246 billion USD. Following the onset of the pandemic in March of 2020, Forbes' real-time billionaires index demonstrates that total real wealth declined by about 16%, although this dip was short-lived (as this coincides with the precipitous drop seen in financial markets as well). After only a mere three more months, wealth among billionaires in Canada fully recovered along with rising equity prices and the unprecedented global fiscal and monetary policy.

We argue that the billionaires index provides for a compelling perspective on the dynamic nature of wealth in Canada. For one, the relative share of wealth among Canada's billionaires is not to be dismissed. Despite only consisting of 60 billionaires in the year 2021, this relatively small number of individuals held as much wealth as the bottom 40% of Canadian households.[19] Since those at the lower end of the wealth distribution are less likely to hold significant quantities of assets, the billionaires index will allow for a new approach to examining how monetary policy surprises influence inequality through the lens of Canada's most well-off individuals. In total, our data provides for an unbalanced panel over the years from 1996-2021, containing 101 individuals who appeared at least once on the list over time.[20]

3.3.2 Methodology

Distributional Income Analysis

For our core analysis, we will seek to map out the relationship between monetary policy surprises and real income within differing subsets of the income distribution. The outcome variable of interest will capture changes in income from a source type $Y_{gik;t}$ relative to *ex-ante* baseline levels $\bar{Y}_{gik;<t}$, which is set to be a three year average before time t in order to reduce the influence of transitory shocks on our baseline levels of income (Andersen et al., 2021). Of particular interest is how changes in m_t are interacted with the income groups. In considering this objective, we explore the results from the model:

$$Y_{gik;t} - \bar{Y}_{gik;<t} = \sum_{k=1}^{K} 1[g, i \in k][\alpha^k + \sum_{h=0}^{1} \psi_h^k(-\Delta m_{t-h}) + \gamma^k \Delta X_t] + \epsilon_{gikt}. \tag{3.2}$$

[19]See Statistics Canada Table 11-10-0049-01. Real total wealth at its maximum in 2019 Canadian dollars is about 312 billion, which is contrasted with data from the 2019 Survey of Financial Security that estimates the aggregate net worth of the bottom 40% of households to be 299 billion.

[20]There is entry and exit from the panel across time. Entry is always determined when an individual's net worth rises above the threshold of one billion USD, while exit can occur as a result of mortality, or having a net worth falling below the threshold of one billion USD.

In the above, $Y_{gik;t}$ denotes the natural log of average real income from either wages and salaries or non-labour income in the k income group of: the bottom 50 percent, the total median, top 50 percent, top ten percent, top five percent, top one percent and top 0.1 percent. Furthermore, income data is indexed by gender grouping $g \in \{male, female\}$, region i, and time period t. As the left-hand side of the equation will take log differences, the outcome variable is then approximately the percentage change in real income.

Real income growth is expressed as a function of the monetary surprise variable Δm_t, a set of macro controls ΔX_t, and income group specific fixed effects α^k.[21] For the monetary surprise variable, we allow for contemporaneous and one-period lagged horizons of $h = 0$ and $h = 1$. We argue that the choice h is well-suited for identifying the short to medium-term relationship between monetary surprises and real income. Collectively, the two-year effect of relays up to 24 months of previous monetary activity, which is suffice to cover the full transmission length of policy movements by the Bank of Canada, the likes of which are estimated to take as long as 18-24 months (Ragan, 2010).

Importantly, the indicator $1[g, i \in k]$ defines that the parameters will be estimated for each k income group when the gender and region correspond to the respective percentile of the overall distribution. This is the main objective of the first empirical exercise - to explore what patterns exist among the estimates of ψ_h^k. We have also inverted the sign of the monetary surprise variable, such that the interpretation would denote an unanticipated *expansionary* movement in our policy measure. Of course, we would hypothesize that a

[21] Time fixed effects are not included because there would be inevitable collinearities with Δm_t, which is common to all groups.

softening of the policy stance would lead to an increase in real income, or that $\psi_h^k > 0$.[22] Given the wide-ranging and somewhat ambiguous findings demonstrated in the literature, we reserve hypothesizing about any asymmetries in ψ_h^k across the income gradient.

Our framework also allows for heterogeneity in terms of the macroeconomic controls. Namely, for this exercise we include province-specific unemployment rates and housing starts at the regional level. With respect to the Canadian case, this setup is crucial for controlling for strong diverging regional trends in income during our sample period. After the 2008-2009 Financial Crisis, the well-populated provinces of Ontario and Québec experienced a less-than expeditious economic recovery, while Canada's energy producing provinces experienced a period of enhanced prosperity. When energy prices declined substantially in 2014 and 2015, there was a marked reversal of fortunes between these regions that persisted for several years. In total, this model is estimated over the period from 1996 through 2019, and we report clustered standard errors at the region-year-income group level.

Billionaire Wealth Analysis

Next, we consider a second set of analyses using the billionaires data sample. Motivated by a similar empirical strategy to (3.2), the main equation of interest is defined to be:

$$W_{i;t} - \bar{W}_{i;<t} = \alpha + \sum_{h=0}^{1} \psi_h(-\Delta m_{t-h}) + \gamma \Delta X_t + \epsilon_{it}. \tag{3.3}$$

[22]For other studies that have found real heterogeneous policy impacts in income, see Carlino and DeFina (1998) and Leahy and Thapar (2019).

The main difference is for the outcome $W_{i;t}$, which represents the real natural log of wealth for billionaire i in year t as it deviates away from the baseline level of $\bar{W}_{i;<t}$, which is the natural log of the three-year average real wealth in the years before t.[23] In this case there is only one ($k = 1$) wealth grouping for billionaires, meaning that the need for interactions is no longer warranted for this model. Our main empirical relationship of interest is again the same, in that we are testing for the statistical significance in expansionary monetary surprises through ψ_0 and ψ_1. Once more, the set of macro variables in X_t will include the national unemployment rate and the natural log of housing starts common to all of the i billionaires. In supplemental Appendix 2 we also provide estimates exploring the impact of monetary surprises on entry into Forbes' Canadian billionaires index. We cluster our standard errors in (3.3) on the billionaire.

3.3.3 Results

Distributional Income Analysis

We begin by plotting coefficient estimates of (3.2) in Figure 3.6, which first explore the channel between policy surprises and real income from wages and salaries. Estimates are normalized to reflect a one standard deviation expansionary movement of the policy rate. The coefficients are plotted in order of descending income group and lag horizons of $h = 0$ (contemporaneous) and $h = 1$ (one-year lag).

Altogether, these estimates follow a near inverted U-shaped pattern, where the contem-

[23] Like the previous exercise, this is to smooth out transitory shocks to real wealth in the years prior to t.

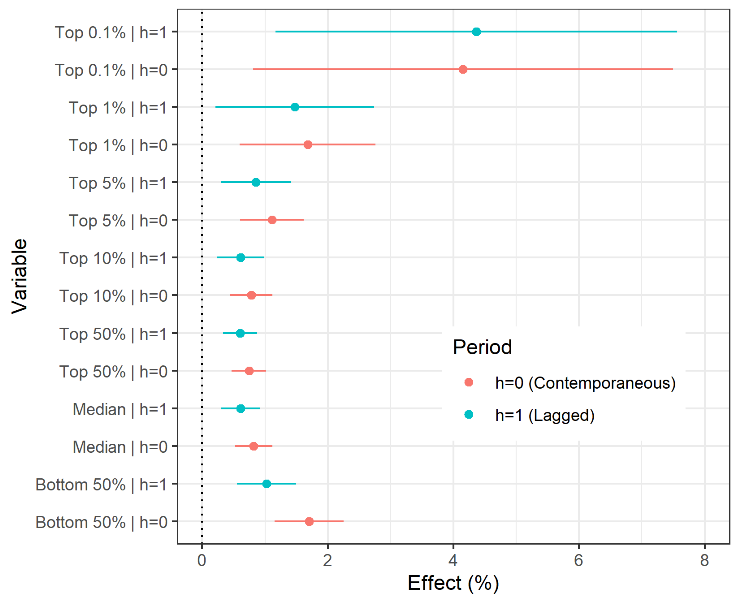


Figure 3.6: Expansionary Impact on Wages

Notes: Income from wages and salaries is defined as being in real terms (2002=100). This figure plots coefficient estimates from (3.2), where the surprise series Δm_t was normalized to reflect a one standard deviation expansion. The bars on the coefficient plots represent 90 percent confidence bands as derived from clustered standards errors at the year-region-income group level. Sample period: 1996-2019. $R^2 = 0.111$ and $N = 7846$.

poraneous impact (in percent) is nearly the same for those in the top one percent and those in the bottom 50 percent. Roughly speaking, this is close to a two percent increase in real wages for both groups. Importantly, all coefficients are of the right sign - meaning that monetary expansions lead to real wage increases and all are statistically significant. These results are consistent with Amberg et al. (2021), who found there to be a U-shaped transmission from policy shocks on income across all decile groupings.

Depending on how one interprets these results, this would provide preliminary evidence that all boats are lifted as a result of monetary stimulus. As this outcome is for real annual income from wages, it is entirely possible that the positive estimates are a result of both employment and income effects.[24] In spite of this, it is also essential to consider how base effects would play into the interpretation of our findings. After all, a two percent increase for a millionaire is markedly different than a two percent increase for an individual who is working at minimum wage. For additional context on this point, the average 2019 income from wages in the top 0.1 percent was \$1.77 million Canadian dollars. This is sharply contrasted with the \$18,400 earned on average by those in the bottom 50 percent of the income distribution. So while it might be true that all boats rise in response to the expansionary surprise, it would be misleading to suggest that these effects are proportionately the same for rich and poor Canadians.

One shortcoming from analyzing wages is the inability to distinguish between wage and employments effects from the policy expansion. Motivated by this observation, we turn next

[24] Ampudia et al. (2018) found that the indirect effects of lower unemployment in the Euro-area as benefiting those in the lower-end of the income distribution.

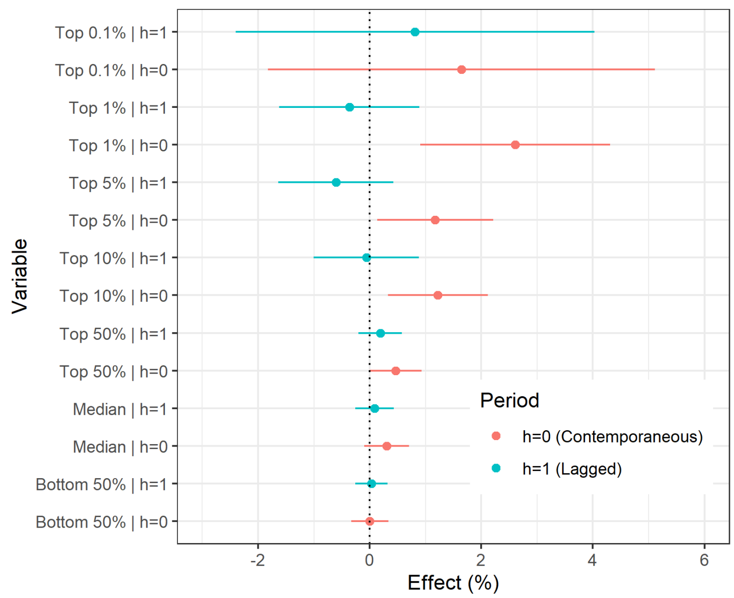


Figure 3.7: EXPANSIONARY IMPACT ON NON-LABOUR INCOME

Notes: Non-labour income is defined as being in real terms (2002=100). This figure plots coefficient estimates from (3.2), where the surprise series Δm_t was normalized to reflect a one standard deviation expansion. The bars on the coefficient plots represent 90 percent confidence bands as derived from clustered standards errors at the year-region-income group level. Sample period: 1996-2019. $R^2 = 0.040$ and $N = 7846$.

to the impact of surprise movements on income from all non-labour sources in Figure 3.7.[25] This perspective is important because of the tendency of expansionary monetary policy to boost asset prices (Paul, 2020). Higher values of assets can then be leveraged by owners into income through capital gains. Not surprisingly, Scandinavian microdata studies have supported the notion that asset-reliant income gains are most prominent in the right tail of the income distribution (Andersen et al., 2021; Amberg et al., 2021).[26] Compared to our results from wages, non-labour income is shown to be weakly receptive to policy surprises across the income gradient. Point estimates for the bottom 50 percent are effectively null, while contemporaneous policy effects tend to rise modestly with income. The largest estimate from this exercise shows that the top one percent benefits contemporaneously by about two percent following the one standard deviation monetary expansion. At best, this shows there to be modest heterogeneity among the income groups, which would run inconsistent with the overarching theme of lifting all boats as the percentage effect is more strongly concentrated among the top one percent.

As Figure 3.1 demonstrated earlier, media interest in the intersection between monetary policy and economic inequality rose sharply following the 2008-2009 Financial Crisis. Amid growing scrutiny more generally about the influence that central banks have in society, it is important to explore the possibility of our parameters as being sensitive to time-varying heterogeneity. Perhaps the growing concern expressed in the public press would be justified if the nature of monetary policy has deviated over the income gradient across time. In line with this suspicion, Coulombe (2021) finds that the channel between monetary policy shocks and

[25]This is a residual calculation we take by differencing total income from all sources with wage income.

[26]This has also been well-described conceptually by O'Farrell and Rawdanowicz (2017) and Amaral (2017).

CPI inflation in Canada has risen in magnitude immediately following the financial crisis. We first approach this parsimoniously by treating the financial crisis as a break in the time dimension of the panel. Sample periods are defined to include the years: (a): 1996-2007 and (b): 2007-2019. We first repeat our exercise estimating (3.2) on the two subsamples for wages in Figure 3.8.

Speculation about the changing nature between monetary policy and economic inequality would be justified according to the results from Figure 3.8. In the sample period from 1996 through 2007, many of the estimates are statistically significant and follow a similar extended U-shaped pattern to our full-sample results. Despite the occasional significance, this sample stands out for having coefficient estimates that are all shallow in magnitude and close to null. For the post-financial crisis period, income from real wages becomes noticeably more responsive to the policy surprise variable. These effects are more prominent at time t, but remain to be persistent at $t-1$ as well. All boats do rise comparatively more in contrast with the 1996-2007 sample, although the one standard deviation expansion is most disparate for those in the top 0.1 percent, with contemporaneous and lagged estimates falling just short of 15 percent. For every other income grouping, the expansionary effects are less than five percent on real wages. Yet, these estimates stand out relative to the 1996-2007 sample, and would appear to be behind much of the variation from our full-sample analysis in Figure 3.6.

A similar but more staggering pattern is observed for non-labour income sources, to which we illustrate with a similar exercise in Figure 3.9. In both sample periods, real gains in non-labour income for the bottom 50 percent are shown to be close to null. This is likely a consequence of those in the lower-end of the income distribution as being less-

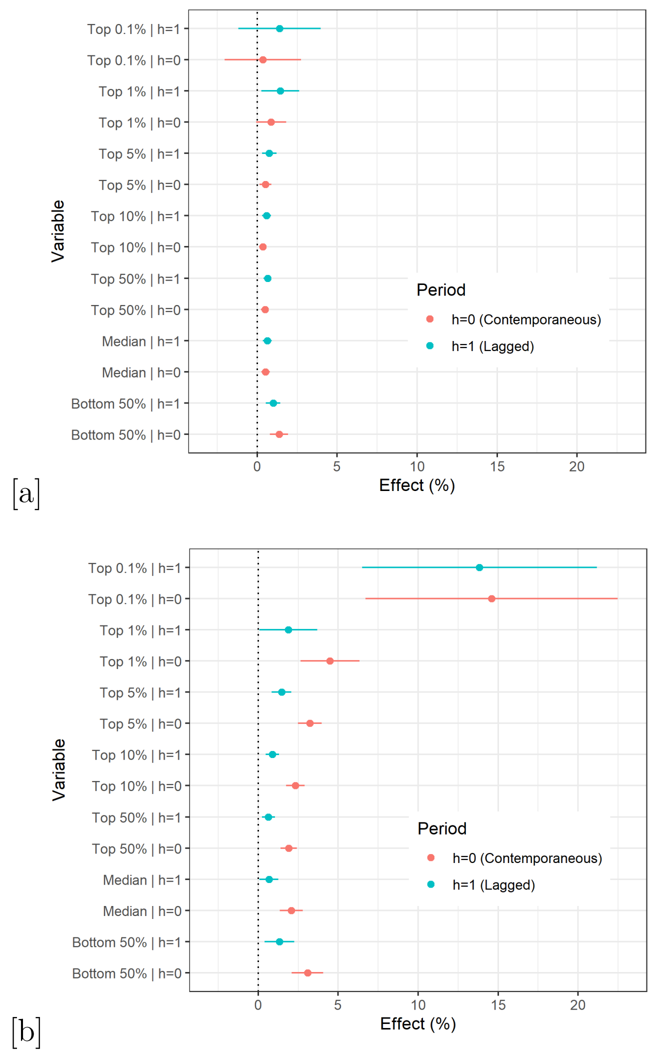


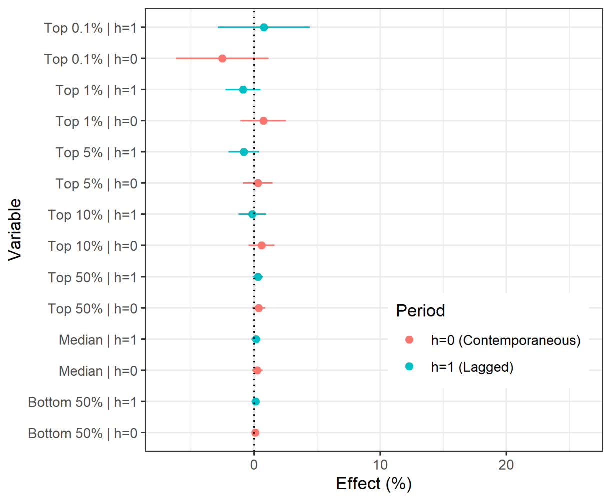
Figure 3.8: (a) Impact on Wages ('96-'07) | (b) Impact on Wages ('07-'19)

Notes: Wage income is defined as being in real terms (2002=100). This figure plots coefficient estimates from (3.2), where the surprise series Δm_t was normalized to reflect a one standard deviation expansion. The bars on the coefficient plots represent 90 percent confidence bands as derived from clustered standards errors at the year-region-income group level. Sample period (a): 1996-2007. Sample period (b): 2007-2019. $R_a^2 = 0.266$, $R_b^2 = 0.148$, $N_a = 3538$ and $N_b = 3954$. A common scaling on the x-axis is used for ease of comparison.

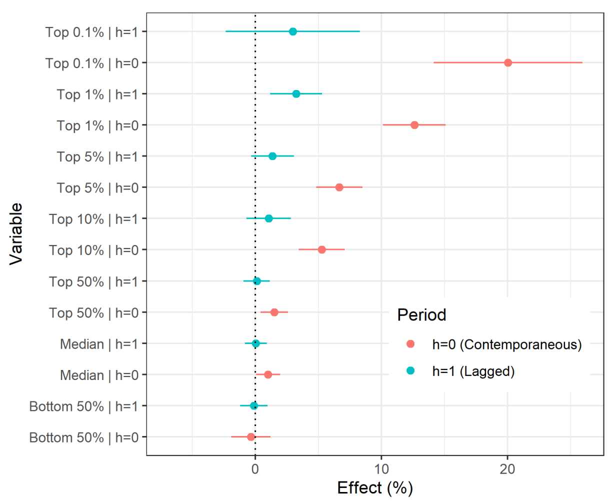
likely to own assets, which can ultimately be leveraged into non-labour income. On the other side of the distribution, those in top 0.1 percent earn 56.8 percent of their income from wages and salaries, leaving much of the remaining amount to be attributed to the disposition of capital and other market sources.[27] In pre-financial crisis period, a near-null or statistically insignificant estimate is commonly observed for contemporaneous and lagged policy surprises. Once post-financial crisis data is incorporated, we find the policy effect to increase dramatically over the income gradient. These results rise particularly for Canada's most well-off individuals, with the contemporaneous estimate for the top 0.1 percent being as high as 20 percent following the expansion. As the estimate for the top 50 percent is much closer to zero, our results suggest that the post-crisis movements in monetary policy have benefited a select few in Canada, and particularly when income is derived from non-labour sources. Setting aside the larges differences in base effects between income groups, these results alone run counter to the notion that monetary stimulus lifts all boats.

Our results demonstrated in this section are also robust to a series of alterations. In Appendix 2, we also plot estimates of our main regression analysis using total income and total income after taxes. However, our results remained to be largely similar to those seen in the text (or akin to the sum of). Even after considering all sources of income after taxes, our results continued to show disparities between the bottom 50 percent and the upper income groupings. Further, as an extension to the sample-splitting parameter time variation explored in this section, we also run a set of rolling window panel analyses in Appendix 2. This exercise involves taking the first twelve years of the sample, estimating

[27] According to calculations by the authors using 2019 tax data for the top 0.1 percent of income earners from Statistics Canada Table 11-10-0055-01.



[a]



[b]

Figure 3.9: (a) Impact on Non-Labour Income ('96-'07) | (b) Impact on Non-Labour Income ('07-'19)

Notes: Non-labour income is defined as being in real terms (2002=100). This figure plots coefficient estimates from (3.2), where the surprise series Δm_t was normalized to reflect a one standard deviation expansion. The bars on the coefficient plots represent 90 percent confidence bands as derived from clustered standard errors at the year-region-income group level. Sample period (a): 1996-2007. Sample period (b): 2007-2019. $R_a^2 = 0.055$, $R_b^2 = 0.164$, $N_a = 3538$ and $N_b = 3954$.

the parameters from (3.2), obtaining the coefficients and their standard errors, then shifting the sample forward one year at a time until all observations in T are exhausted. Doing so will allow for a more dynamic estimate of the policy effect beyond the sample-splitting around the financial crisis. For those in the bottom 50 percent, the contemporaneous policy effect has been relatively stable across time for wages and non-labour income. Wages respond positively to the expansion, while non-labour income never responds with any significance, with estimates being roughly zero across time. For those in the top one percent, there is much more time-variation of note. The response of wages is mostly positive, shifting upwards to a contemporaneous effect of about five percent over time. For non-labour income, there is also a sharp upwards pivot in the expansionary effect, which rises especially after the 2002-2013 window of analysis. Finally, our results were robust to many different forms of standard error estimates. This included analytical errors, robust standard errors, bootstrapped standard errors, and clustered standard errors at the region-year level and region-year-gender level. We observed no concerning differences in terms of statistical significance for our findings.

In summary, these findings highlight the noitceable changes in the relationship shared between expansionary monetary policy and the macroeconomy in the aftermath of the 2008-2009 Financial Crisis. While concerns have arisen about the impact of prolonged low interest rates on risk-taking behavior, the literature has only recently started to emphasize the potential amplification of economic inequality. By examining different time periods in Figure 3.9, our estimates reveal that the era of low rates has led to expansionary monetary policy surprises disproportionately inflating the non-labor income of the wealthiest Canadians. These findings shed light on the evolving effects of monetary policy on the income distribution and raise important considerations regarding inequality dynamics in the post-crisis economic landscape.[28]

Billionaire Wealth Analysis

Next, we turn to our results using the billionaire wealth sample data derived from Forbes' Billionaires List. The methods behind these estimates are comparable with the income panel data analysis, although the equation (3.3) will map annual policy surprises onto wealth instead of income, and will only involve one wealth group for billionaires. But given that this relatively small group of individuals holds a substantial portion of the nation's overall wealth, this exercise will prove insightful beyond our preliminary income-oriented analysis. To our benefit, our billionaires sample also has data that extends into 2021. Therefore, we can examine how (if at all) policy surprises from the unprecedented COVID expansionary period have influenced real wealth for Canada's most well-off individuals. Much like the time-varying heterogeneity we observed after the 2008-2009 Financial Crisis, Figure 3.1 suggests that public scrutiny about the nature of monetary policy and inequality has again shifted upwards following COVID-related monetary stimulus. Whether or not this is justified, we can explore the time-varying dimension further with the empirical analysis in Table 3.1.

In order to get a full understanding of how monetary policy surprises have behaved from 1996 through 2021, we split our sample in five different directions, including: 1996-2007, 1996-2019, 1996-2021, 2007-2019, and 2007-2021. Our strategy with the sample splitting is to first of all correspond with the samples used for the income panel analysis (i.e. 1996-2007,

[28]Here, it is worth additionally emphasizing that surprises from the 2008-2009 Financial Crisis through to the most recently available data (July 2023) are biased towards expansionary policy. With our measure, this is estimated to be at a magnitude of 36 basis points.

	$\mathrm{W}_{i;t} - \bar{W}_{i;<t}$				
Sample	1996-2007	1996-2019	1996-2021	2007-2019	2007-2021
Δm_t	-2.903	1.431	7.914***	8.710***	14.874***
	(1.909)	(1.710)	(2.068)	(2.744)	(3.102)
Δm_{t-1}	-0.278	2.744	3.738*	6.005**	8.312***
	(2.346)	(1.869)	(1.949)	(2.794)	(2.943)
Controls	Y	Y	Y	Y	Y
N	90	363	438	255	330
R^2	0.057	0.148	0.063	0.214	0.129
Clusters	20	54	59	48	53
F-stat	1.66	12.36	7.19	13.08	15.29

Table 3.1: Expansionary Impact on Billionaire Wealth

Notes: Regressions are for the equation (3.3), where the dependent variable is the percentage deviation of real billionaire wealth from the baseline level. *** denotes significance at the 1% level, ** at the 5% level and * at the 10% level. Coefficients and standard errors are normalized to represent a one standard deviation expansionary movement in the monetary surprise variable. Robust clustered standard errors at the billionaire level are reported. Controls in all regressions include housing starts and the national unemployment rate.

2007-2019 and 1996-2019), while also incorporating newer data from the COVID-era (i.e. 1996-2021 and 2007-2021). It is noted that earlier in the sample, there is a relatively smaller total number of Canadian billionaires, hence the smaller sample sizes and number of clusters in earlier periods like from 1996 through 2007.

Interestingly, we find that the impact of a monetary softening on billionaire wealth to increase by a considerable degree over time. An upward shift in the coefficients occurs after monetary stimulus during the financial crisis, then subsequently again during the COVID era. Across the full sample from 1996 through 2021, the two period effect from a one standard deviation policy expansion is estimated to be greater than a ten percent movement in real billionaire wealth. Focusing closer on the more recent policy dynamics in billionaire wealth, the 2007-2019 period has a two-period effect of 15 percent, before expanding considerably to over 23 percent once the COVID data is included. Both findings would in fact justify growing public concern that the intersection between wealth, inequality and monetary policy has been exacerbated in recent years. Despite consisting of only a handful of individuals, the sheer size of aggregate wealth held by Canada's billionaires is an important perspective to consider relative to the bottom 50 percent of Canadians who tend to be much less asset-endowed. In Appendix 2 we also provide a table exploring entry into the billionaires index with a simple linear probability model, and find that monetary expansions increase the likelihood of entrance into the index, which too has grown in its influence across time. Finally, Appendix 2 includes twelve-year rolling window estimates of (3.3) that provide for a more dynamic analysis on the changing nature of monetary policy and real billionaire wealth across time. Similar to the findings for income, these estimates show that the expansionary channel has risen considerably over time.

3.4 Vector Autoregressive Analysis

Our preliminary findings suggest that the unequal effects of monetary stimulus are both concentrated among a small minority of those earning the highest levels of income in Canada, and particularly when income is from non-labour sources. To expand upon our initial findings, we next turn to the VAR analysis, which will explore at a monthly, shorter-run frequency how monetary policy shocks can be transmitted to real asset prices at the macro-level. Higher asset prices not only have an impact on income derived from capital sources, but more importantly for wealth, to which most Canadians derive from real estate and financial assets.

3.4.1 Methods

In a traditional VAR model, a set of time series determined to be endogenous are included in the kx1 vector Y_t. The set of variables Y_t is modelled in the general structural form of

$$A_0 Y_t = c + A_1 Y_{t-1} + A_2 Y_{t-2} + ... + A_p Y_{t-p} + \epsilon_t. \tag{3.4}$$

Where ϵ_t is a kx1 vector of structural shocks determined to be zero mean white noise processes, and $A_i \, \forall \, i \geq 1$ are kxk coefficient matrices. Additionally, c is a kx1 vector of constants. With respect to the matrix A_0, the most common specification is the Choleski form, where the lower triangular of the matrix allows for contemporaneous relationships in decreasing order through the VAR. Multiplying both sides by A_0^{-1} produces the reduced-form version of the VAR as

$$Y_t = \tilde{c} + B_1 Y_{t-1} + B_2 Y_{t-2} + ... + B_p Y_{t-p} + \nu_t. \tag{3.5}$$

Now, $\tilde{c} = A_0^{-1} c$, $B_i = A_0^{-1} A_i \; \forall \; i \geq 1$ and the reduced-form innovations are represented by $\nu_t = A_0^{-1} \epsilon_t$. One can then take the Wold representation of (3.5) for Y_t in terms of the innovations ν_t as

$$Y_t = \mu + \nu_t + \Psi_1 \nu_{t-1} + \Psi_2 \nu_{t-2} + ..., \tag{3.6}$$

which is obtained through recursive substitution. From here, we will investigate the typical form of inference on the system through an impulse response analysis. This exercise maps the response of a particular variable from innovations of another variable within the system across a given horizon. The impulse responses of Y_t to shocks from $\nu_{j,t}$ are therefore

$$\frac{\partial y_{i,t+s}}{\partial \nu_{j,t}} = \psi_{ij}^s, i, j = 1, ..., k; s > 0. \tag{3.7}$$

Here, each $\psi_{i,j}^s$ is the (i,j)'th element of Ψ_s. Plotting estimates of $\psi_{i,j}^s$ against the horizon s yields the orthogonal impulse response function of a given variable in the system y_i to a shock from ν_j.

We next define the variables that characterize the endogenous vector Y_t. This involves the following setup:

$$Y_t = \begin{bmatrix} x_t \\ m_t \\ f_t \end{bmatrix} = \begin{bmatrix} c_x \\ 0 \\ c_f \end{bmatrix} + \sum_{p=1}^{P} \begin{bmatrix} B_{xx}^p & B_{xm}^p & B_{xf}^p \\ 0 & 0 & 0 \\ B_{fx}^p & B_{fm}^p & B_{ff}^p \end{bmatrix} \begin{bmatrix} x_{t-p} \\ m_{t-p} \\ f_{t-p} \end{bmatrix} + \begin{bmatrix} \nu_{x,t} \\ \nu_{m,t} \\ \nu_{f,t} \end{bmatrix}, \tag{3.8}$$

where the data vector consists of measures of economic activity and prices in x_t, the monetary surprise variable m_t and macro-financial variables f_t. In x_t we use in order: the unemployment rate, real GDP, the consumer price index, the producer price index, and the house price index, while in f_t we use the real Toronto Stock Exchange and the yield slope between a 10-year bond and the policy rate.[29] As such, the model represents a potentially complete macroeconomy, with both supply and demand side influences. All variables with the exception of m_t, the yield slope, and the unemployment rate are denoted in natural logs. For our core analysis, we also take the first difference of all variables excluding the external instrument m_t and the yield slope in order to ensure that the VAR is stationary.

Note that the constant and the coefficients in the equation m_t are all restricted to be zero.[30] That means that m_t is estimated to be purely stochastic in the system, while all other variables are modelled in a manner similar to a classical reduced-form VAR. Furthermore, since we order m_t before f_t in the system, this means that the Choleski identification will allow for a contemporaneous impact from the monetary surprise series on the stock market and yield slope variables. While there are multiple ways to estimate the parameters in (3.8), we choose to adopt both a static and time-varying parameter kernel-based approach (Robinson, 1989; Casas et al., 2019). The static parameter VAR estimates can be obtained through standard equation-by-equation OLS, while the time-varying coefficients are obtained using a hybrid of equation-by-equation OLS and a local-level kernel regression of the Naradaya-Watson origin. Specifically, we follow Li et al. (2017) to approximate $B_i^p(z) \approx B_i^p(z_0)$ for z

[29] We obtain these data from Statistics Canada, Yahoo Finance, the U.S. Federal Reserve Economic Database (FRED), and from the Teranet-National Bank House Price Index.

[30] See Jarociński and Karadi (2020) for a similar use of this methodology.

in the neighbourhood of $z_0 \in (0,1)$ to be

$$\hat{B}_i^p(z_0) = [\sum_{t=1}^{T} Y_{t-p}Y'_{t-p}K(\frac{t-Tz_0}{Th})]^{-1}[\sum_{t=1}^{T} Y_{t-p}Y_tK(\frac{t-Tz_0}{Th})] \tag{3.9}$$

for each lag length p in the system, a given bandwidth h, and a designated kernel function K(·). Roughly speaking, the estimator fits a weighted set of local regressions where the window size is determined via the bandwidth h. The bandwidth describes how much information on the time dimension to incorporate, where larger choices of h would allow for less time variation in the parameters and smaller values of h would allow for greater flexibility in the time-varying parameters. The choice of the bandwidth will therefore have to balance trade-offs between distinguishing the time-varying nature of the parameters and incorporating enough data to provide stability for the impulse response analysis. We set the joint bandwidth of the system to be 0.6 - a number that roughly mimics the movements of a rolling window VAR model over a ten-year window.[31] Our determination from the sensitivity analysis showed, albeit with some subjectivity, that this specification balanced the trade-offs between time-varying influence and parameter stability.[32]

The impulses are calculated in roughly the same manner as the static VAR, except now the impulse response functions have the potential to be changing across time. These are computed in a manner similar to (3.7), although there is now a parameter matrix estimate for each $t = 1, 2, ...T$. From here, we can then estimate the impulse response functions for each fixed point in time from $t = 1$ to $t = T$. In mapping each impulse across time, we

[31]We provide a more detailed discussion of this methodology, as well as a sensitivity analysis surrounding the kernel bandwidth in Appendix 2.

[32]Although similar, the benefit from using a kernel method relative to a rolling window model is that data is never truly excluded, and parameters can be estimated at fixed points in time for the full sample.

can get a better understanding of how shocks from m_t of the same magnitude may have heterogeneous impacts across time.[33]

3.4.2 Results

Static Parameter VAR

Consider first in the static case impulse response functions mapping the response of core variables within our system to shocks from m_t. We normalize the impulses to reflect a 61 basis point expansion of m_t - an amount that is equal to the sum of COVID stimulus in March of 2020. Relative to the full sample, a 61 basis point expansion is quite large. We argue that this scaling is relevant in light of recent policy developments. The impulses are cumulative from the stationary VAR, and estimated from a model using 4 monthly lags.[34] They are shown collectively in Figure 3.10.

Expansionary policy of this magnitude is shown to have a widespread impact on these economic measures. In support of our methodology and identification strategy, we first discuss the responses of unemployment, real GDP and the consumer price index. All three exhibit the signs and significance that are consistent with economic theory, including cumulative changes of: a reduction in the unemployment rate in excess of one percentage point, a rise in consumer prices of nearly one percent, and a rise in real GDP of three percent. This

[33] It is worth noting that other methodologies exist to compute time-varying parameter models, including via Bayesian methods.

[34] Lag structure tests using AIC suggested two lags, however, we extend this to four lags in order to assuage concerns about errant serial correlation. The sign and significance of our findings are robust to alternative lag lengths.

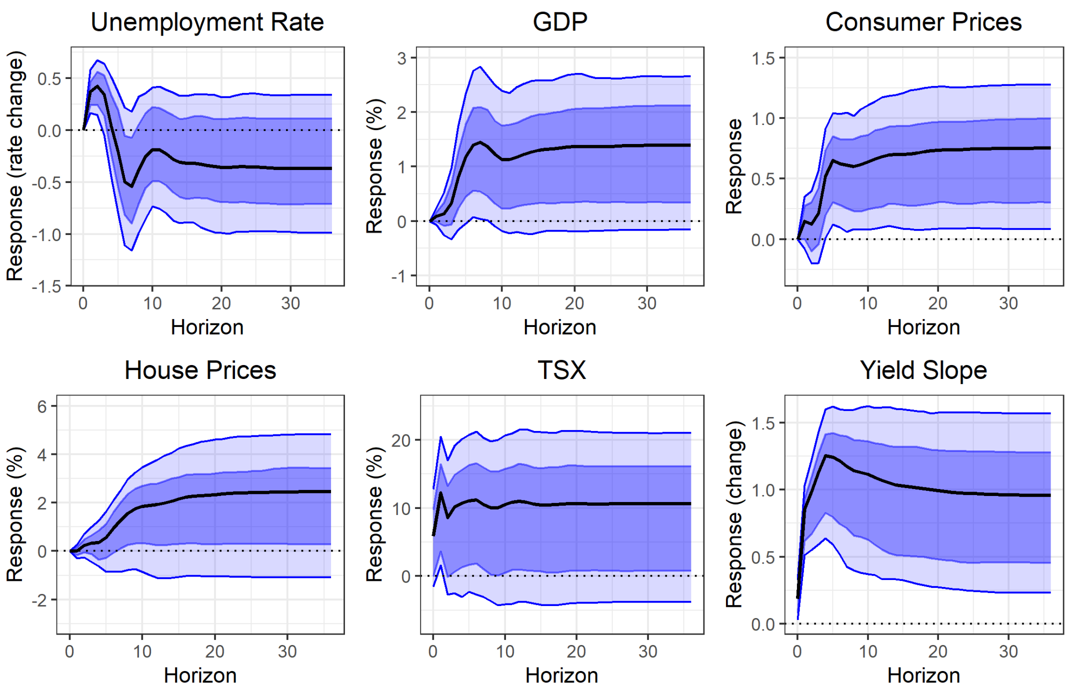


Figure 3.10: Response of Variables to Shocks From Policy Expansion

Notes: Sample period: 1996:3-2021:5. Lag length: 4. The darker blue bands denote a 68 percent set of confidence bands, while the lighter blue dotted bands denote a 90 percent set of confidence intervals. The policy expansion is normalized to 61 basis points - the magnitude of COVID policy response in March 2020. GDP, the TSX and house prices are all expressed in real terms. Impulses are cumulative, and derived from the stationary VAR.

evidence supports the labour market channel through a decrease in the unemployment rate, which is more likely to benefit those in the lower end of the income distribution (Ampudia et al., 2018).

However, we are primarily interested in how this transmission impacts real sources of wealth and capital income. It is shown that real estate rises by about four percent to the shock, accumulating to this plateau gradually over time. Stock markets are comparatively much more quick in synthesizing new sources of information. This is evident for the response of the TSX to the policy expansion, which rises immediately by roughly 10 percent. The accumulated effect does not vary much outside of this initial impact. In Appendix 2 we also provide a sample splitting exercise by running the static parameter VAR models from 1996:3-2007:12 and from 2007:1-2021:5. These figures reveal that most outcome variables respond with the same sign in both periods. However, the magnitude and significance of these estimates rise prominently in the post-financial crisis period, much like the findings from our panel analysis.

There is a direct parallel to be made here with our earlier panel findings that documented that the most well-off benefit disproportionately from expansionary monetary policy. For example, as those in top 0.1 percent of the income distribution have less than half of their income from wages and salaries, much of the remaining amount is therefore attributed to the disposition of capital and other market sources. Moreover, the prominent increases in house prices and the stock market are also more likely to disproportionately benefit the *wealth* of the most well-off. Those at the lower-end of the income distribution are much less likely to own real estate or financial assets, and are therefore as a result less likely to benefit from the real asset price gains from expansionary monetary policy.[35]

Time-Varying Parameter VAR

As a supplement to the static impulses in Figure 3.10, we also consider that the impact of monetary surprises on real asset prices may be heterogeneous across time. Accordingly, we allow for greater flexibility in the parameters of the VAR model to test how consistent the impact of a 61 basis point expansion is throughout our sample. We present these impulse response functions in Figure 3.11, which now map the response of the TSX and house prices across time. The bar above the plots in Figure 3.11 document individual impulses drawn from each period in accordance to the shading scale, which do indicate sizeable variation across time. Since the shock sizes for all impulses are fixed to be of the same magnitude, this therefore illustrates that the empirical channel between monetary policy and real assets has grown in recent years - and especially so in the aftermath of the COVID pandemic. Dating back to the early 2000s, the channel to real house prices was comparatively much more moderate, only rising by one to two percent at longer horizons. Over time, this has shifted upwards by a considerable degree. This progresses throughout the 2008-2009 Financial Crisis and peaks at close to nine percent at the end of the sample. At this point, the kernel bandwidth draws more heavily from data that is defined by the commodities glut and the COVID-era - two periods that are biased towards large expansionary movements by the Canadian central bank.

[35]Data from the 2019 Survey of Financial Security supports this line of reasoning, to which we draw insights from Statistics Canada Table 11-10-0078-01.

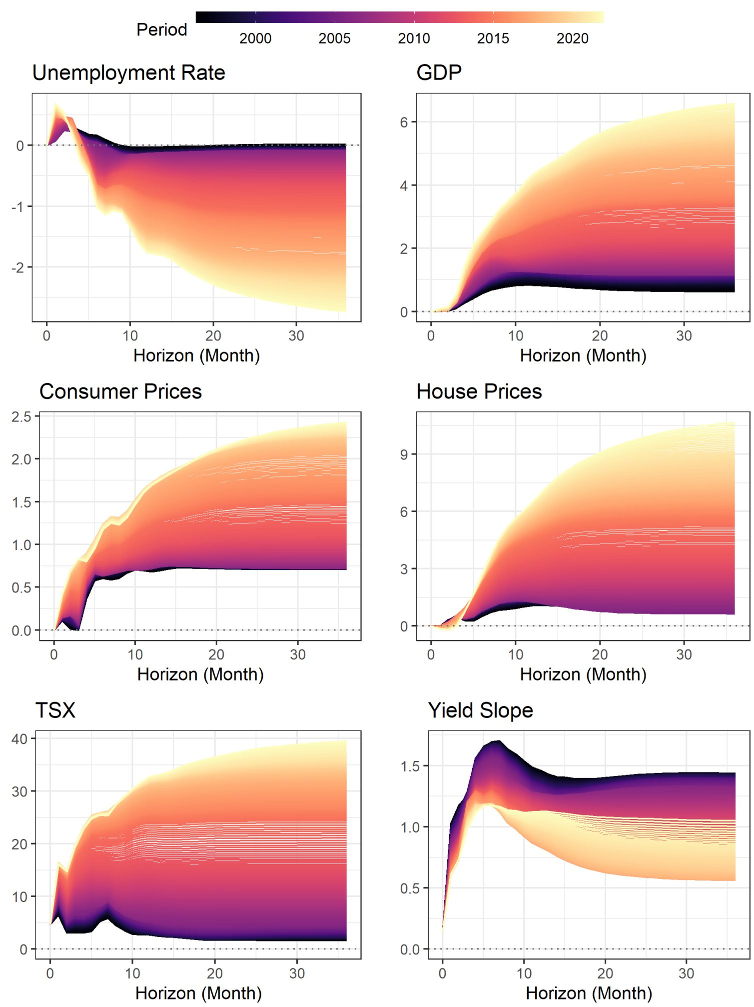


Figure 3.11: TIME VARYING RESPONSE OF VARIABLES TO SHOCKS FROM POLICY EXPANSION

Notes: Sample period: 1996:3-2021:5. Lag length: 4. Joint kernel bandwidth of the system of equations: 0.6. The shaded bar above the plots denotes the impulse response functions drawn from a parameter estimate at a given time t. The policy expansion is normalized to 61 basis points - the magnitude of COVID policy response in March 2020. Impulses are cumulative, and derived from the stationary VAR.

A similar pattern emerges for stock prices. An expansionary shock of 61 basis points was once associated with an increase in real prices by less than ten percent, which towards the end of the sample more than triples to over 30 percent.[36] Like the earlier static analysis, the effect of the policy shock is nearly fully materialized contemporaneously, where the cumulative response remains stable across an extended horizon. To an individual with substantial wealth in real estate and equities, a 61 basis point expansion stands to inflate one's net worth in real terms, much of which is realized over a very short-term horizon.

But what would explain this time-varying heterogeneity? We find that since the 2008-2009 Financial Crisis, the impact of expansionary monetary policy surprises has grown stronger, and has been particularly acute once data from the COVID-era has been incorporated into the model. In an effort to combat the severe economic downturn, the Canadian central bank for the first time adopted additional unconventional policy including quantitative easing, but also adopted explicit forward guidance and sustained low interest rates to stimulate an uncertain economy. These measures resulted in a substantial increase in overall liquidity in financial markets, leading to a real pronounced effect on the stock market and house prices. With respect to real estate prices, Canada's inelastic housing supply may also in part help amplify this time-varying heterogeneity. When COVID-era expansionary monetary policy lowered interest rates and rapidly increased the quantity of money, it helped foster an increased demand for housing in Canada. However, as housing supply in Canada is constrained and (in the aggregate) does not respond quickly to changes in demand, property prices can be extra susceptible to unprecedented monetary stimulus. Altogether, the fact that policy initiatives tended to be more isolated and coupled with additional stimulus

[36] In Appendix 2, we provide surface plots of the response of real asset prices from this model.

measures may be behind the observed changes in the time-varying parameter model, which become especially pronounced in the COVID-era.

3.5 Policy Discussion

One must however think carefully about what, if any policy conclusions should be considered by the central bank. Regardless of how the central bank approaches its mission, having a general awareness about policy externalities is important for maintaining trust and confidence among their stakeholders. At the very least, recent communications and research interests reflect a drive by the Bank of Canada to expand their horizons beyond traditional means.[37] As the world will no doubt experience unprecedented challenges in the years to come, monetary policymakers must be prepared to adapt to whatever uncertainties that may arise.

Following unprecedented COVID-induced monetary stimulus, central banks have received greater scrutiny about economic inequality and the possible intersection that disparities in wealth (especially concerning the post-stimulus effect on boosting asset prices) and income may have with expansionary monetary policy. On the one hand, COVID-related stimulus has played a role in stabilizing the tremendous labour market peril that came at the onset of the pandemic. Assuaging frictions in the labour market will inevitably benefit those in the lower-end of the income distribution, as this group was much more likely to be negatively

[37] See for example: the central bank's perspective on climate change (Beaudry, 2020), to economic inequality (Parkinson, 2020; Gordon and Ljunggren, 2020; Baker, 2022), to becoming a participating member of an international central banking consortium on indigenous issues (Bank of Canada, 2021).

influenced from the fallout of the COVID recession to begin with.

To the contrary, one must also consider the fact that expansionary monetary policy boosts asset prices, which are disproportionately held by Canada's most well-off households. From the March 2020 lows through to December 2021, the Toronto Stock Exchange rose 58.6%, while house prices have risen by 40.6% at the national level. In contrast with developments on the labour side, real wages *declined* by 1.2%, and the unemployment rate fell by 7.2 percentage points.[38] Despite positive improvements in employment numbers, these statistics suggest that wealthier individuals have benefited more greatly from the recovery. This is also compounded by the fact that white-collar workers were far less likely to lose their employment in the first place during the pandemic, or to be negatively affected by public health measures that followed thereafter. While the asset-endowed Canadians saved and invested over this period, those from the working class faced tremendous uncertainty from their labour income.

But of course, not all of the appreciation in asset prices can be attributed to loose monetary policy, although it is worth acknowledging that it is at the very least a contributing factor. Take for example the case of house prices. Communications from the central bank often emphasize a lack of supply and "extrapolative expectations" as the reasons driving imbalances in the housing market.[39] While these are undoubtedly contributors, one must also acknowledge the friendly lending environment that has fueled unprecedented demand from investors and repeat-home buyers relative to first-time buyers (Khan and Xu, 2022).

[38]These observations derived by the Authors from Statistics Canada Tables 10-10-0125-01, 18-10-0004-01, 14-10-0320-01, the Canadian Real Estate Association (CREA) and U.S. FRED Table LRUNTTTTCAM156S. The TSX and house price quotes are in nominal terms.

[39]See for example speeches from the Bank of Canada Governor to the Calgary and Edmonton Chambers of Commerce on February 23, 2021 and to CTV News on November 7, 2021 (among others).

One might interject that between contractionary and expansionary policy, any long-run influence on inequality will simply net-out over time - but this has not been the case historically - as it has been demonstrated in this study. Since the beginning of the Bank of Canada's fixed announcement date system, both the level and surprise component of the policy rate have been biased towards expansionary policy.[40] Aside from all of these considerations, if economic inequality is determined to be abnormally high by policymakers and the general public, it's not clear that monetary policy is the best tool to address these frictions, as fiscal channels are already well-established on this front. Instead, it is important for the central bank to have an open dialogue on these concerns, and more generally to communicate a greater awareness on the externalities that arise from maintaining a given policy stance. Amid the post-COVID worries of rising inequality, it is essential for Canada's central bank to be transparent about the effects of monetary policy in order for this ever-important institution to maintain its credibility going forward. Central banks, despite growing interest from many sides in the general public, cannot provide solutions to all of society's problems. A concise, and well-defined mandate, we argue, is the most proper avenue forward for Canada's central bank.

3.6 Conclusion

Let us now revisit the catchy euphemism that inspired this study - whether or not expansionary monetary policy lifts all boats. In light of the evidence we have seen, this notion

[40] A further analysis on the contractionary policy that followed COVID stimulus in 2022-2023 shows that our monetary surprise measure remains to be biased in favour of expansionary policy during the Bank of Canada's fixed announcement date policy era.

would be best described as misleading. Beginning with our distributional income panel analysis, we demonstrate that all income groups benefit from expansionary policy in percentage terms (before considering steep differences in base effects). Non-labour income gains are however concentrated among Canada's highest earning individuals, and time-varying parameter heterogeneity reveals that this is driven especially by policy movements after the 2008-2009 Financial Crisis. In a similarly motivated analysis with our billionaires sample, we find there to be real wealth increases that have grown in magnitude following the financial crisis and COVID pandemic. Finally, our time series VAR evidence shows that expansionary policy movements inflate real housing and stock prices, the source of which wealth and indirect forms of income are dependent upon, while only having a modest effect on reducing unemployment. A time-varying parameter VAR analysis also highlights that the effect of expansionary monetary policy on real asset prices has grown by a considerable degree since the early 2000s.

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APPENDICES

Appendix A

Words Hurt: A Novel Measurement and Analysis of Central Bank Communications from Canada

Appendix 1: Dictionary of Sentiment

Positive: hawkish, tighten, hike, hiking, raise, raising, raises, hikes, taper, boost, increase, increases, increased, rebound, positive, bolster, bolstered, confident, optimistic, advance, advances, attain, attains, attaining, boom, booming, benefit, benefits, breakthrough, favourable, favorable, gain, gains, gaining, impressive, impresses, improve, improving, improvement, outperform, outperforms, outperforming, strong, stronger, succeed, expansion, upbeat.

Negative: dovish, ease, easing, eases, qe, cut, slashes, deflation, deflationary, cutting, slash, unconventional, bleak, sluggish, alarm, alarming, plunge, plunges, woe, woes, panic, gloom, gloomy, downside, collapse, vulnerable vulnerability, vulnerabilities, slowest, downgrade, instability, subdue, subdued, crash, crashes, drag, drags, rout, delinquent, delinquency, delinquencies, grim, worse, worsening, erode, wary, concern, concerning, depression, rough, disappoint, disappointing, disappointment, pessimistic, riskier, worrisome, emergency, stimulus, relief, plunge, turbulence, ugly, negative, downward, glut, difficult, meltdown, crisis, bankruptcy, bankruptcies, roil, halt, damage, slump, down, fear, fears, uncharted, weaker, weak, weakened, low, lows, recession, downturn, dropoff, risks, risk, slowdown, lower, burden, calamity, calamitous, break, broken, catastrophe, catastrophic, collapse, collapses, collapsing, correction, default, dampening, damage, declines, decline, declining, devastate, devastating, foreclose, foreclosures, panic, panics, poor, recessionary, shutdown, severe, sluggish, stagnate, stagnates, stagnation, turmoil, damper, fearful, downbeat.

Notes: This does not include any negative modifiers, such as “not hawkish”, which expands upon this set considerably.

Appendix 2: Robustness and Empirical Extensions

Policy Cross-Correlation Functions

In the first supplementary exposition, we highlight cross-correlation functions between our communication sentiment measure and two forms of central banking policy measurment - the conventional overnight lending rate set by the Bank of Canada and Krippner's (2013) shadow short rate. The shadow rate is an empiricial measure which takes into account the effect of unconventional policy (like QE) when rates are held at the effective lower bound. Cross-correlation functions plot the correlation (on the y-axis) between the policy measure and lags/leads of our communication sentiment index (on the x-axis). These are shown in Figure B.1.

Both measures show that our communication index leads the actual policy rate by roughly a year - a result that would suggest that changing attitudes about the central bank in the public sphere eventually correspond to realized movements in conventional (or unconventional in the case of the shadow rate) monetary policy.

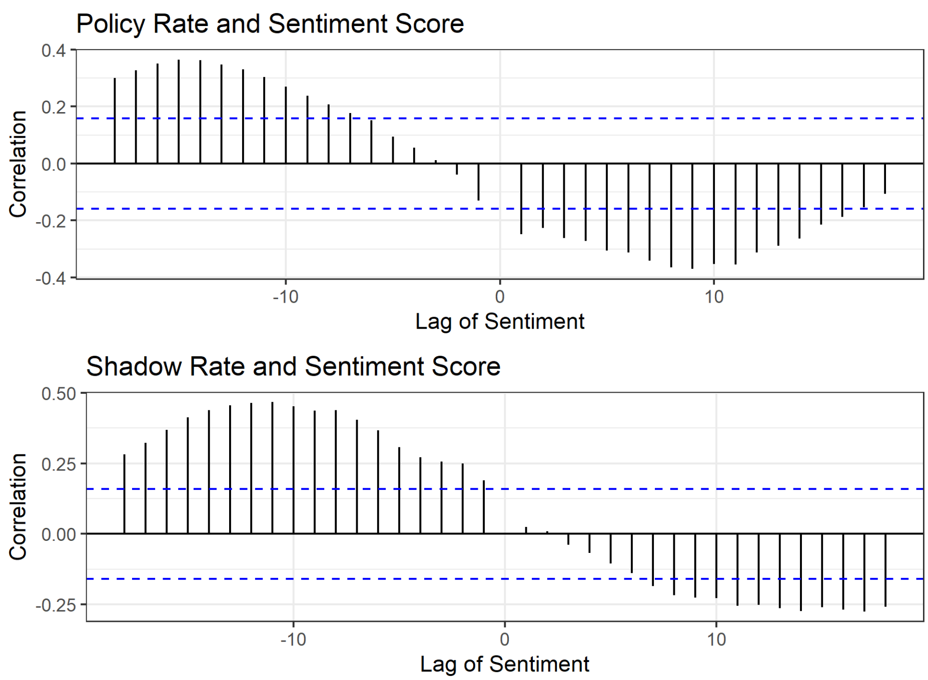


Figure A.1: Policy Cross-Correlation Functions

Notes: Data is from 2008:1-2020:9. The cross-correlation functions document the dynamic relationship shared between the communication sentiment index and the policy or shadow rates. Krippner's (2013) estimates for the shadow rate are obtained from https://www.ljkmfa.com/.

Text Regressions

One potential caveat with our sentiment analysis is that the dictionary is constructed by manually reading news articles, then classifying relevant words to be interpreted as either positive or negative. In the following alternative form of analysis, we consider a raw text regression using a penalized LASSO approach.

The process works by taking each of the i articles that occur on event date d. Then, each article is scrubbed to produce a large data matrix consisting of the 28,711 words that were used on at least one occasion, from one article in our sample. It is entirely possible that a vast dimension of singular text words could produce spurious correlations on our outcomes of interest (i.e. interest rates, exchange rates and the stock market). Therefore, we restrict the sample to include words that occur in at least five percent of the total sample, reducing the dimension of the data matrix then to 1,156 words.

The general LASSO estimator (see Hastie et al., 2009) is defined to be the loss minimization problem of:

$$\hat{\beta} = \underset{\beta}{\operatorname{argmin}}\{\sum_{i=1}^{N}(y_i - \beta_0 - \sum_{j=1}^{p} x_{ij}\beta_j)^2 + \lambda \sum_{j=1}^{p} |\beta_j|\}. \tag{A.1}$$

The main benefit from this methodology is that the LASSO shrinks the regression coefficients by imposing a penalty on the sum of their size in absolute value. That is to say, for some shrinkage penalty $\lambda \geq 0$, larger values of λ will correspond to a greater amount of shrinkage and subsequently a (likely) smaller number of covariates used to achieve the optimal estimator of $\hat{\beta}$. This methodology will allow us to alter λ in order to find out which specific words in the media are associated with changes in interest rates, exchange rates and the stock market on fixed announcement dates from the Canadian central bank. While it is often the case that λ is determined through cross-validation, we instead set λ to reduce the number of selected variables to be 10, such that our results are directly comparable across different outcomes.[1]

[1] This is because cross-validated estimates often chose several hundred words in the optimal scenario. Choosing a larger value of λ will allow for greater shrinkage to reduce the severe dimensionality problem we face.

Outcome	Variables (sign)
3-month treasury ($\lambda = 0.0058$)	barrel (-), benefit (-), coronavirus (+), move (-), oil (-), plunge (-), risks (-), upside (-), MS (+)
6-month treasury ($\lambda = 0.0050$)	barrel (-), benefit (-), conditions (+), lending (+), oil (-), plunge (-), shock (-), temporary (+), MS (+)
2-year yield ($\lambda = 0.0066$)	barrel (-), benefit (-), hike (+), oil (-), outside (-), plunge (-), seven (+), weaker (-), MS (+)
5-year yield ($\lambda = 0.0064$)	barrel (-), cut (-), hike (+), momentum (+), oil (-), outside (-), suggesting (+), weaker (-), MS (+)
10-year yield ($\lambda = 0.0050$)	committee (+), cut (-), half (-), hike (+), momentum (+), slowdown (-), suggesting (+), weaker (-), MS (+)
USD/CAD ($\lambda = 0.00093$)	benefit (+), cut (-), modestly (+), recession (+), reduction (+), seven (-), weaker (+), MS (-), Δoil (-)
EUR/CAD ($\lambda = 0.00099$)	energy (+), hike (-), modestly (+), mortgages (-), oil (-), raised (-), seven (-), weaker (+), MS (-),
MXN/CAD ($\lambda = 0.00085$)	benefit (+), cautious (+), downside (+), find (-), friday (-), hawkish (-), hours (+), wildfires (-), Δoil (+)
TSX ($\lambda = 0.00095$)	coronavirus (-), emergency (-), england (+), oil (+), reduced (+), stability (+), Δdow (+), MS (-), Δoil (+)

Table A.1: Text Regressions Summary

Notes: Words are not italicized in the second column of results. Total number of articles analyzed: 2883. Each LASSO regression is developed by setting the value of λ equal to the amount which restricts the total number of covariates plus the intercept to a total of 10 terms.

In Table A.1. we present regressions documenting our core findings from Section 1.3.1 with the addition of frequency columns for each word in the domain of the data. This table lists both the words and conventional macroeconomic variables selected by the optimal LASSO routine that restricts the total number of variables (including the intercept) to 10 terms/. In parenthesis, the sign of the coefficient is also plotted.

In support of this approach, many of the listed variables seem to be both relevant and also of the right sign. Even though this is a data-driven process, examples of success can be seen where: “hike” and “momentum” positively influence several yields, “weaker” and “plunge” negatively influence several yields, “coronavirus” leads to declines in the TSX and “recession” leads to a depreciation of the Canadian dollar in the USD/CAD pairing. However, this approach does appear to have several shortfalls as well. Take for instance the a-theoretical sign of “cut” in the USD/CAD equation, and “wildfires” leading to an appreciation of the Canadian dollar in the MXN/CAD equation. More to this point, many words either lack context or are directly unrelated to monetary policy, leading us to believe that the LASSO procedure has filtered out some spurious results. This includes, but is not limited to the presence of: “benefit”, “suggesting”, “friday”, “seven” and “england”.

	Treasury Yields				
	3-month	6-month	2-year	5-year	10-year
Δs_d	0.572**	0.560**	0.606**	0.449**	0.185
	(0.208)	(0.257)	(0.246)	(0.201)	(0.154)
$\Delta s_d * ZLB$	-0.783	-1.121	-1.530	-1.310	-0.962
	(0.596)	(0.822)	(1.120)	(1.020)	(0.960)
$\bar{R}^2$	0.550	0.388	0.201	0.067	0.007

Table A.2: Impact of Communication Surprises on Treasuries: Lower Bound Regressions (Part 1)

Notes: ZLB is a dummy variable for when the policy rate is held at the lower bound. Estimates are a regression between the daily change in a given treasury yield, the communication shock around the policy announcement Δs_d and a variable for monetary surprise MS_d (not shown but included). *** denotes significance at the 1% level, ** at the 5% level and * at the 10% level. Bootstrapped standard errors are reported in parenthesis from 499 repetitions. The sample size is 104 - the number of communication dates on the policy rate from March 2008 to September 2020.

Lower Bound Interactions

Next, we re-create our event-study findings allowing for an interaction effect of the communication surprise variable Δs_d with a dummy variable for when the conventional policy rate is held at the zero lower bound (or ZLB for short). These findings are shown respectively in Tables A.2 and A.3.

It is noted that while the interaction terms with the dummy ZLB are negative, they are also insignificant. In this case, we would be concerned if these coefficients exhibited statistical significance, as it would demonstrate that pivots in communication surprises would be weaker when the central bank is constrained with its policy toolkit. Therefore, we do not have enough evidence to suggest that the influence of central banking communication is any less effective at the zero lower bound.

	Exchange Rates			Financial Market
	MXN	USD	EUR	TSX
Δs_d	-0.065***	-0.064***	-0.062**	-0.025
	(0.018)	(0.022)	(0.024)	(0.023)
$\Delta s_d * ZLB$	0.182	0.170	0.201	0.007
	(0.213)	(0.210)	(0.212)	(0.126)
$\bar{R}^2$	0.082	0.235	0.143	0.750

Table A.3: Impact of Communication Shocks on Exchange Rates and Financial Market: Lower Bound Regressions (Part 2)

Notes: ZLB is a dummy variable for when the policy rate is held at the lower bound. Estimates are a regression between the daily change in a given exchange rate: MSX Mexican Peso, USD U.S. Dollar or, EUR the Euro, the communication shock around the policy announcement Δs_d and the same controls as Table 2 in the manuscript. *** denotes significance at the 1% level, ** at the 5% level and * at the 10% level. Bootstrapped standard errors are reported in parenthesis with 499 repetitions. The sample size is 100 - the number of communication dates on the policy rate from March 2008 to September 2020 that are not conflicted by either U.S. holidays or the death of George H.W. Bush.

Sensitivity of Rolling Window Regressions

In the main body of our results, we look at the time-varying behavior of sentiment surprises on interest rates, exchange rates and the stock market by applying a rolling window regression analysis. We set the rolling window length R to be 48 rolling event dates, which approximates to about six years worth of events for each parameter estimation. While this is done with some subjectivity, the window of $R = 48$ was established to balance off the inevitable trade-offs between allowing for greater time-variation in the parameter plots and have a large enough sample size to conduct statistical inference. In this exercise, we test the sensitivity of this rolling window threshold to lengths of $R = 40$ and $R = 56$, which correspond to subtracting and adding an additional year of event dates to each window of analysis. We provide plots of this analysis in Figures A.2 and A.3.

The trade-offs between greater time-variation in the parameter plots and having a larger sample size are well illustrated in these figures. When the rolling window sample is reduced to 40, there is more volatility in the rolling parameter estimates, which also has an impact on the confidence bands relative to the baseline findings. Overall the sign and significance remain the same, though there appears to be a diminishing effect on shorter term treasuries from a positive communication surprise towards the end of the sample. Next, turning to the extended rolling analysis of $R = 56$, the parameters are conversely much more smooth than the baseline analysis and the reduced window. It would appear that the post-Financial Crisis era has been the most influential for the term structure, as estimates point upward with greater significance and stability. This is particularly evident in the short-term treasury equations do not point downwards, where they do when $R = 40$. The same is not true, however for exchange rate pairings and the stock market. From the beginning of our sample until the end, parameter estimates on the communication surprise variable progressively point downward (meaning an enhanced appreciation of the domestic currency following a positive communication surprise, and a decline in the Toronto Stock Exchange) and further away from zero with increased confidence over time.

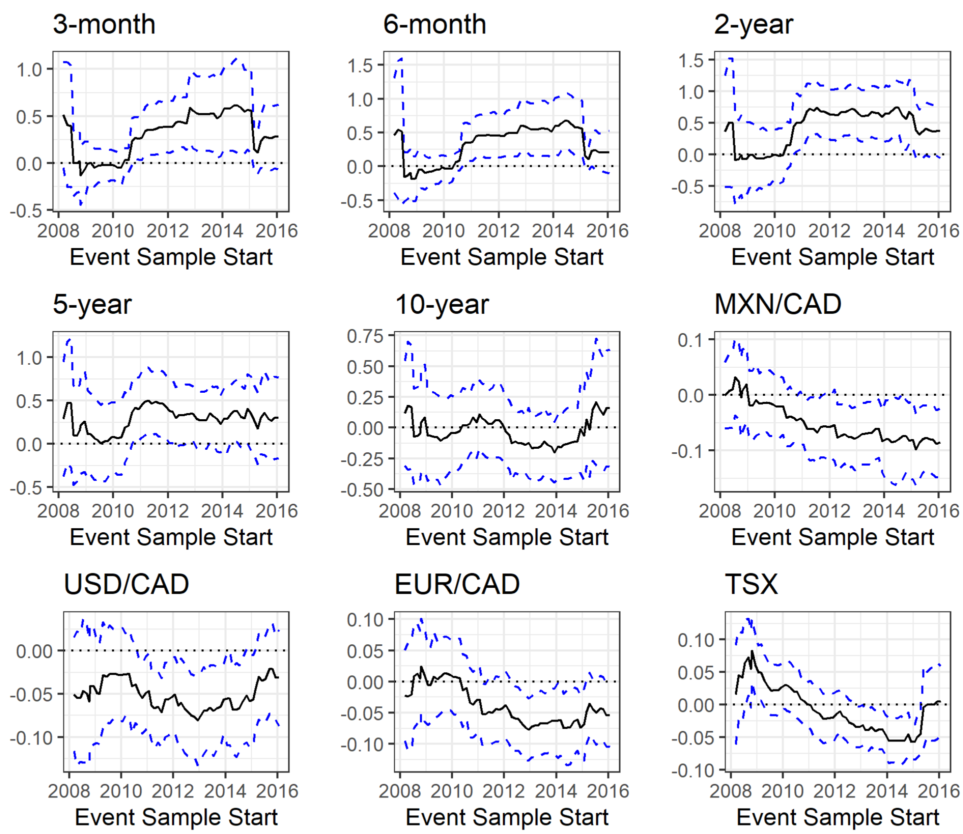


Figure A.2: Rolling Window Parameters for Communication Surprises (R=40)

Notes: Estimates plot the coefficients on Δs_d from each rolling regression over a sample of **40** observations. Confidence bands are bootstrapped at a 90 percent interval using 299 repetitions. Event sample start denotes when each rolling window sample begins, the end date of the sample is roughly six years following what is highlighted on the x-axis. For example, the final rolling sample observation begins January 2015 and ends September 2020. All regressions include the same additional covariates that are described in Tables 1 and 2.

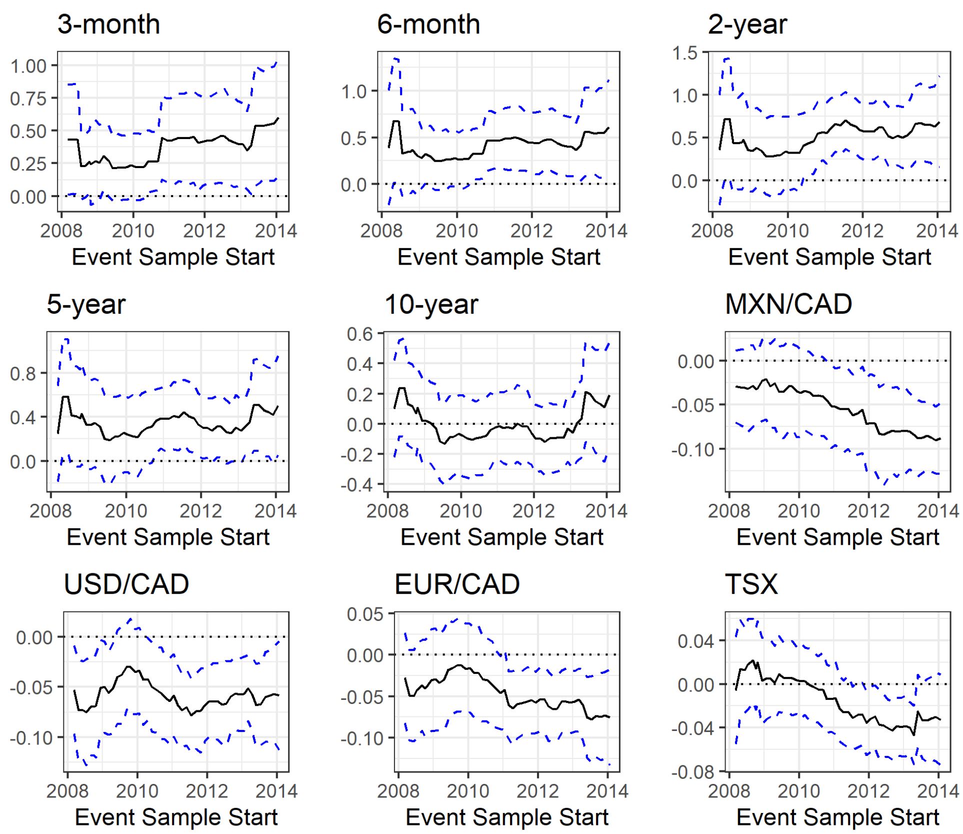


Figure A.3: Rolling Window Parameters for Communication Surprises (R=56)

Notes: Estimates plot the coefficients on Δs_d from each rolling regression over a sample of **56** observations. Confidence bands are bootstrapped at a 90 percent interval using 299 repetitions. Event sample start denotes when each rolling window sample begins, the end date of the sample is roughly six years following what is highlighted on the x-axis. For example, the final rolling sample observation begins January 2015 and ends September 2020. All regressions include the same additional covariates that are described in Tables 1 and 2.

Variance Decompositions

As a secondary form of analysis to the impulse response functions, the coefficient matrices Ψ can also be used to estimate forecast error variance decompositions (FEVD), which account for the fraction of the variance of the forecast error of each variable attributable to all shocks at all horizons. The FEVD is derived from the matrix Ψ, where the element-wise squared impulse responses are divided by the variance of the forecast error variance at a given horizon.

Now we turn our attention to the variance decompositions of the different VAR specifications, as to how sentiment shocks impact the variance of the forecast error of an outcome over an extended horizon. In Table B.4 we present the decompositions, which account for the percent that sentiment or policy rate shocks contribute to the h-step forecast error variance of the variables listed in the table. We highlight the decompostitons at horizons of 3, 6, 12, and 24 months.

These findings again support the effectiveness of communications as a policy instrument. At the 24 month horizon, communication shocks explain more than a third of the forecast error variation in short-term treasury yields, and sizeable amounts even at longer-term yields. Shocks from the policy rate also shown in Table 5, symbolize that communication sentiment shocks are more important in generating movements across the yield curve and with exchange rates. In fact, the policy rate only explains more of the forecast error variance for short-term treasuries at a short horizons, and only for one currency pair. The policy rate has almost no influence over longer-term yields, and the two metrics jointly contribute as much as 47 percent of the variation in the forecast errors of shorter-term treasuries, where communications explain usually 1.5 to 2 times the forecast errors than the policy rate, and more often at longer horizons.

Table A.4: Variance Decomposition of Policy Variables

Sentiment

Hor.	Policy Rate	3-month	6-month	2-year	5-year
3	10	15	15	17	15
6	22	26	24	19	16
12	35	37	32	19	15
24	39	40	34	19	14

Hor.	10-year	USD/CAD	EUR/CAD	MXN/CAD
3	13	16	3	2
6	14	15	3	2
12	14	14	2	2
24	12	12	4	2

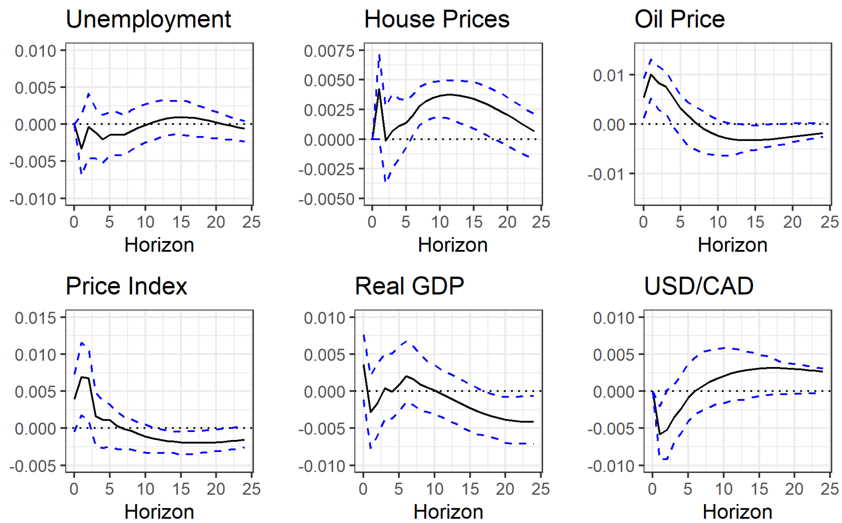
Policy Rate

Hor.	Sentiment	3-month	6-month	2-year	5-year
3	2	20	18	4	1
6	3	11	14	3	1
12	4	8	11	2	1
24	4	7	10	2	1

Hor.	10-year	USD/CAD	EUR/CAD	MXN/CAD
3	2	2	4	8
6	1	1	2	11
12	1	3	2	13
24	1	4	3	12

Notes: Each cell is indicative of how much percent of the forecast error variance is explained by exogenous shocks to the other variables in the system. Estimates are rounded to the nearest integer.

Figure A.4: Shocks from Outcomes to Sentiment Index



Notes: Impulses denote a one standard deviation shock from a given variable to the sentiment index. Each model is estimated with three lags, and 90 percent confidence bands surround the impulse response functions. They are bootstrapped with 299 repetitions.

Impulses: Shock from Listed Variable to Sentiment

In the core analysis of the manuscript, we discuss the one-way channel between communication surprises/shocks and the term structure, exchange rates, and stock market (among others). With respect to the VAR methodology, we could also consider the reverse scenario - i.e., how do shocks from our outcomes of interest influence the sentiment espoused about the central bank? In Figure A.4, we provide a demonstration of how shocks from: the unemployment rate, house prices, oil prices, the CPI, real GDP and the exchange rate impact central bank sentiment. Among the impulses that we analyze in Figure A.4, we show that the sentiment surrounding the Canadian central bank is boosted by a positive shock from house prices, oil prices, CPI and the USD/CAD exchange rate. The same is not observed for real measures of economic activity.

Appendix B

Assessing the Credibility of Central Bank Signals: The Case of Transitory Inflation

Appendix 1: Dictionary of Signal Sentiment

Positive: abate, abated, abating, are credible, attributed to catching up, base effect, base effects, benefits of inflation, calm reigns, calm the markets, cocksure, consider the trend a transitory phenomenon, contained inflation, cooling, cut, cuts, cutting, dampening price pressures, debate still unresolved, decelerate, dismiss inflation concerns, dissipate, dissipating, do not expect inflation to persist, doesnt need policy action, dont care about inflation, dont freak out, dont worry, dove, doves, dovish, downward pressure, downward revision, driven largely by temporary factors, ease, eased, easing, easing fears, easing inflation, expected to settle, fading, faith in the fed, faith in the feds, fear mongering, fears cool, fears ease, fed in control, fed seems in control, going away, goldilocks fed, gone soon, good news, has peaked, hasnt lost control, have confidence in the fed, have peaked, ignore the inflation, inflation bear, inflation bears, inflation could quickly decline, inflation diagnosis is correct, inflation diagnosis is right, inflation doesnt matter, inflation dove, inflation doves, inflation easing, inflation has peaked, inflation is temporary, inflation may be easing, inflation slowing, inflation slows, inflation temporary, inflation will be transient, inflation wont last, irrelevant inflation, is a temporary phenomenon, is a transitory phenomenon, is credible, is in charge, is short lived, is waning, isnt a big deal, isnt losing control, isnt that bad, isnt worse, krugman, less sticky than in the 1970s, less sticky today, lies about stagflation, likely temporary, likely to be temporary, loose, loosening, minor problem, moderate inflation, modest, no doubt, no doubts, no fear, no fears, no hyperinflation, no risk, no stagflation, no surge, no threat, non threatening, not a major concern, not a problem, not a threat, not behind the curve, not getting worse, not hawkish, not hike, not hiking, not jimmy carter, not permanent, not persist, not persistent, not persistently, not prolonged, not raise, not raising, not scorching, not surge, not surging, not the 1970s, not threatening, not tighten, not to be fearful, not to worry, not venezeula, not worrisome, not zimbabwe, nothing to fear, over hyped, price slack, proved right, qe infinity, relatively narrow, reliable, reversing the trend, rise is temporary, see inflation as transitory, sees inflation as transitory, short bout, should also prove transitory, should be temporary, should be transient, should be transitory, slack in prices, slacking inflation, slash, slashes, slowing down, soft inflation, softer inflation, soon cooling, soon settling, stay the course, subside, subsiding, sure of it, surge is transitory, tantrum over inflation, temporary factors, temporary inflation, temporary phenomenon, this is transitory, transitory in nature, transitory respite, trust in the fed, trusted as credible, unfazed, vanish, vanishing, vindicate feds bet, waiting for inflation, will be brief, will be short lived, will fade, will fall short, will have a temporary effect, will have a transitory effect, will prove temporary, will prove to be temporary, will prove to be transitory, will prove transitory, will subside, will ultimately prove transitory, will wane, wont get worse, wont lose control, wont need policy action, wont spiral.

Negative: 1970s, 70s, accelerated, achieved goal, act sooner, afraid of inflation, anxiety, bad news, ballooning, be here for a long time, become a common gripe, behind the curve, boiling inflation, bolster, bolstered, boom, boost, broadening of inflationary pressures, bulwark against inflation, burst of inflation, cant be dismissed, carter, cause problems, central bank failed in forecasting, cheap money, concerns about inflation, confident, continue to mount, continue to rise, continues unabated, continuing inflation, contractionary, conundrum, credibility, danger of rising prices, deal with it, difficult to characterize as transitory, dilemma, dire situation, disconnect, does not look all that transitory, doesnt believe, doesnt seem to be going away, dont believe, dont trust, doubt, doubts, downplaying risks, eagerness, easy money, elevated, endure, enduring, entrenched, eroding confidence, escaping fig leaf, ever faster, expansion, expected inflation to spike, extreme inflation, falsely signalled, far from cooling, fateful signal, fear for inflation, fear inflation, fear of inflation, fears of inflation, fed sweats, froth, frustrating inflation, get used to, get worse, getting worse, gone the way of disco, hard to fathom, harm middle class, haunt, haunting, haunts, have not seen, hawk, hawkish, hawks, heart attack, here forever, here to stay, high levels of inflation, higher than expected, higher than previously thought, hike, hikes, hiking, hyperinflation, ignore inflation, ignores inflation, ignoring inflation, inaction, increase, increased, increases, indefinite, indefinitely, inevitable, inflation alarm, inflation bets perk up, inflation bites, inflation bull, inflation bulls, inflation concern, inflation concerns, inflation continues, inflation could derail economic recovery, inflation crisis, inflation diagnosis is wrong, inflation earthquake, inflation fears, inflation hangover, inflation hawk, inflation hawks, inflation hell, inflation is here to stay, inflation lies, inflation linked fund inflows, inflation overshoot, inflation risk, inflation risks, inflation scare, inflation set to spike, inflation still lies ahead, inflation storm, inflation tax, inflation terror, inflation threat, inflation to rise, inflation warning, inflation will last, inflation woes, inflation worries, inflationary flood, intensified inflation pressures, into 2022, into 2023, into 2024, is spreading, isnt stable, isnt temporary, isnt transitory, jimmy carter, lack of confidence, last for a long time, last into the future, last longer, less convincing, less sanguine, less sure of how transitory, lie about inflation, lie about transitory, linger, lingering, little sign of moderating, long time, losing control, lost all control, lost control, major problem, make matters worse, making a mistake, may no longer be transitory, might not be as transitory, misunderstanding, misunderstandings, more pain, more permanent, more than a transitory gust, more than transitory, more than transitory gust, need to act, new regime, nightmare, nightmarish, no confidence, no definition, no signs of abating, no signs of easing, not abate, not abating, not an accident, not be as transitory, not be temporary, not comfortable, not cooling, not credible, not cut, not cutting, not dovish, not ease, not easing, not going away, not likely to be temporary, not likely to be transitory, not loosen, not loosening, not short lived, not slash, not slashing, not slowing, not subside, not subsiding, not temporary, not transitory, not wane, not waning, on the loose, optimistic, out of control, outsize inflation, overheating, panic button, peak everything, permanent, permanent shift, permeate, persist, persistence, persistent, persistently, peter schiff, playing down the risk, policy error, policy mistake, pose real challenges, positive, pour gasoline, prediction fails, pressure on the fed, price pressures, prices to climb, prolong, prolonged, proper upward shift, questionable, raise, raise the alarm over inflation, raises, raising, raising the alarm, real problems, reassess inflation, reassessment of inflation, rebound, reckless, reckless policy, red flag, red hot, remain elevated, removing the word transitory, respond to inflation, rethink strategy, risk is real, risk of inflation, risk of overheating, run hot, runaway inflation, running hot, scary inflation, scary prospect, scorching, self fulfilling, sending chills, serious problem, skyrocket, skyrocketing, skyrockets, so called temporary, so called transitory, so high, soaring, stagflation, stays above target, stickier, sticky, stoke inflation, structural inflation, stubborn, successive years, self fulfilling, summers, supposed to be temporary, supposed to be transitory, surge, sustained, sustained inflation, sustained price hike, take seriously, taper, tapering, term transitory should be eliminated, tighten, tightening, tightens, too high, top concern, top priority, transitory lie, unchecked inflation, under pressure, unlikely temporary, unlikely transitory, unrelenting, unreliable, unusual strength, upgrade to their inflation outlook, upward pressure, upward revision, urgent action, urgent issue, venezuela, venezuelan, violently high, weimar, why should we believe the fed, will not be brief, will stick around, wiped away by inflation, wont cut, wont leave, worried about central banks, worrisome, worrisome trend, zimbabwe, zimbabwean.

Appendix 2: Placebo Analysis

In this appendix, we present our placebo empirical analysis. Using a sample of 7880 news articles from the New York Times (via the Dow Jones Factiva Network), we apply our dictionary sentiment analysis to 19 different topics that are irrelevant to transitory inflation. These categories include: climate change, natural disasters, hate crimes, gang-related crime, Broadway, patents, the Opioid Crisis, big tech, unionization, the culture wars, obesity, national parks, campaign finance, yoga, Serbia, globalization, charter schools, foreign aid and electric cars.

The main motivation behind this exercise is that unrelated news categories should not share any empirical similarities with our tailored sentiment dictionary for news inspired by the notorious central banking signal of "transitory inflation." Thus, if we apply the sentiment scoring measure to the unrelated news topics and re-run our core empirical analysis, our findings should differ significantly from the placebo news indices. With 20 total time series to test (the transitory inflation index plus the 19 placebos), our main impulses falling in the tails of the distribution would indicate a significance level of five percent.

In Figure B.1, we plot the ten-day moving average of our sentiment measure s_t alongside ten-day moving averages of the 19 placebo sentiment indices. The downward trending credibility measure reflects rising inflation and doubt in the signal over the course of 2021, while the gray placebo indices pivot around zero and are stationary in the sample. Next, if we repeat the estimations for each placebo using the VAR method of (2.2), we can contrast our core impulse response findings with those of the placebos. Figure B.2 plots the response of the 1-year break-even inflation rate to a negative one standard deviation shock from the news sentiment indices, and Figure B.3 documents the response of the news sentiment measures to a positive 20 basis point shock from the inflation surprise variable. Both impulses are in the furthest tail of the distribution of response functions (as consistent with the sign of our hypotheses), indicating significance at the five percent level relative to the placebo pool.

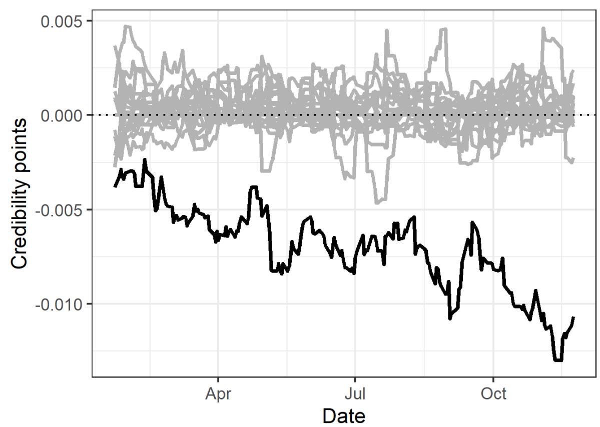


Figure B.1: Signal Credibility Measure vs. Placebos

Notes: This data presents a ten-day trailing moving average of the signal credibility measure s_t in black. Ten-day moving averages of the placebo news sentiment time series are shown with each gray line. Time span: January 22, 2021 - November 30, 2021.

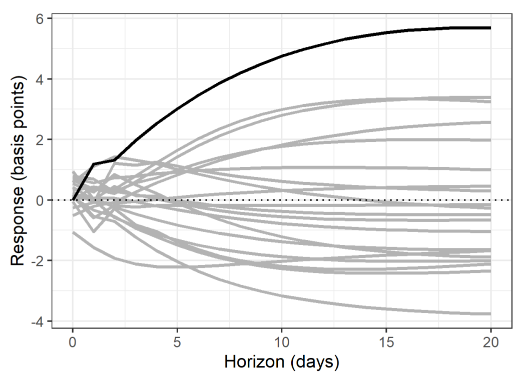


Figure B.2: Response of 1-Year Breakeven Inflation to Negative Credibility Shock

Notes: This plot highlights the response of the 1-year breakeven inflation rate to a negative one standard deviation shock from the news sentiment indices. In this placebo analysis, each gray line denotes an impulse response function generated by rotating the placebo news sentiment series in (3.8). The black line represents the impulse response function from our main analysis with the transitory inflation credibility measure s_t.

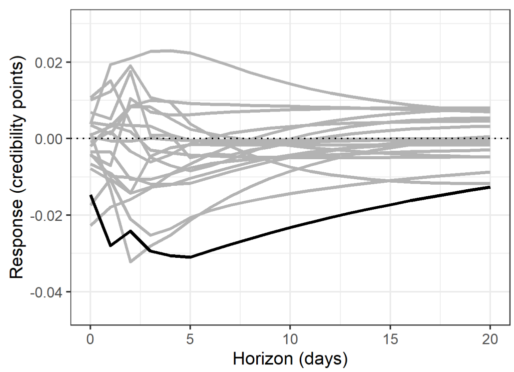


Figure B.3: Response of Credibility to Positive Inflation Surprise

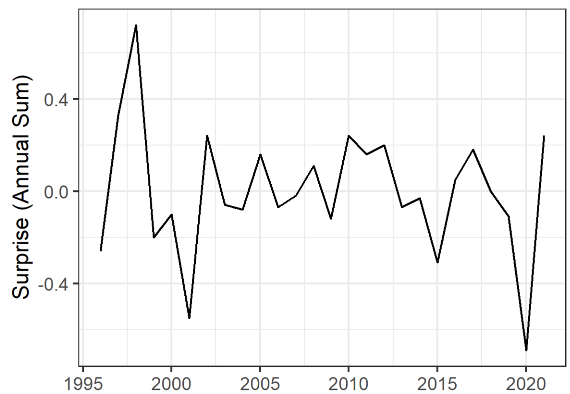
Notes: This plot highlights the response of the news sentiment measures to a positive 20 basis point shock from the inflation surprise variable. In this placebo analysis, each gray line denotes an impulse response function generated by rotating the placebo news sentiment series in (3.8). The black line represents the impulse response function from our main analysis with the transitory inflation credibility measure s_t.

Appendix C

Does a Rising Tide Lift all Boats?: Monetary Policy and Inequality in Canada

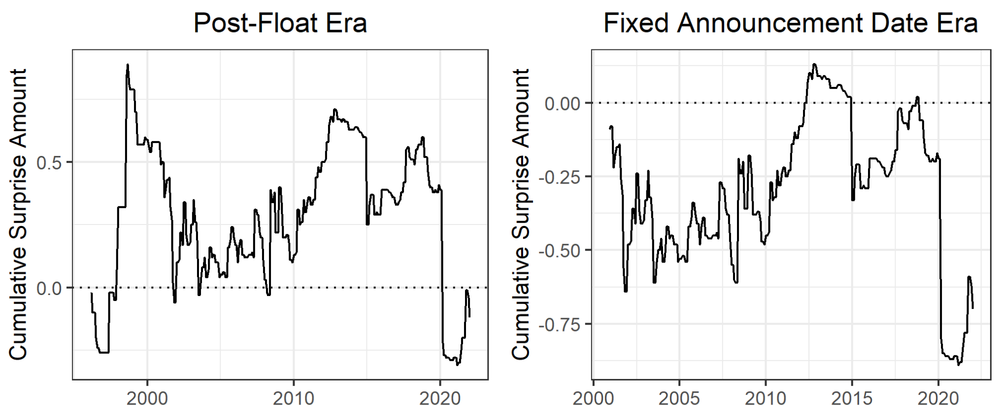
Appendix 1: Additional Data Expositions

Annual Monetary Surprises



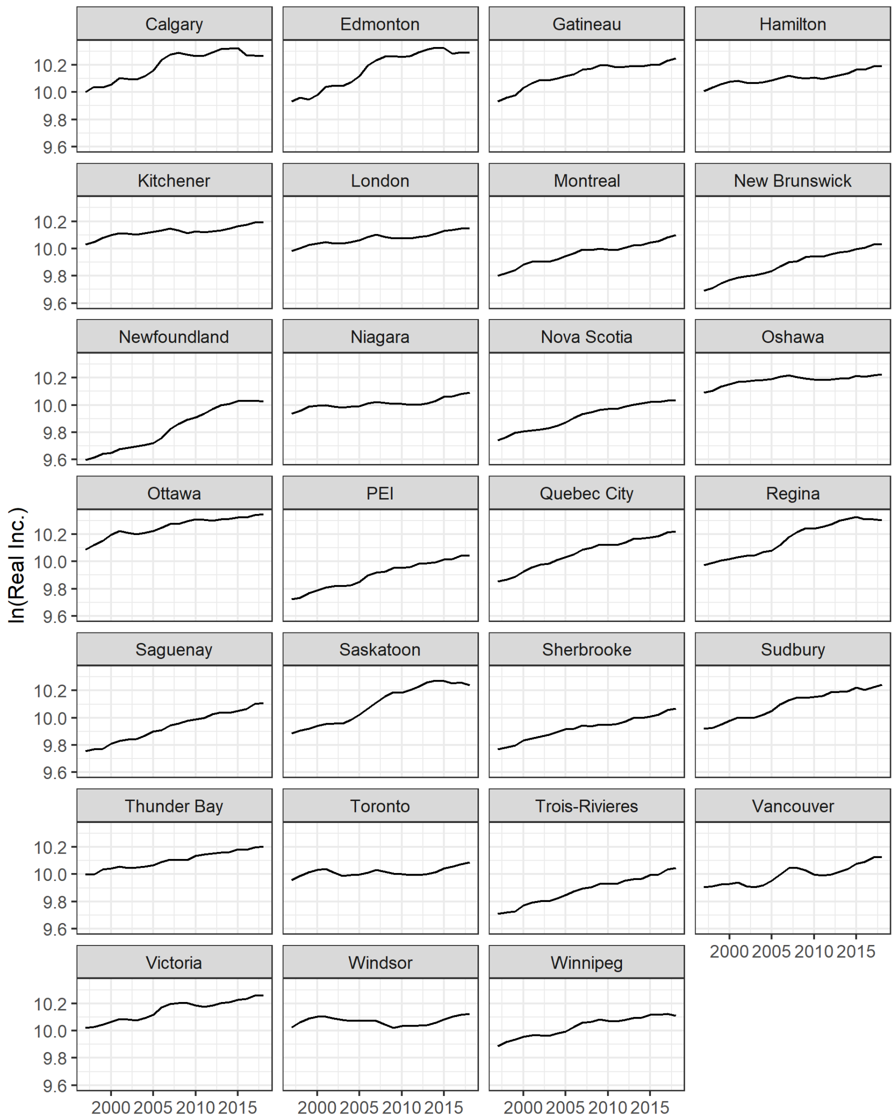
Notes: This series is developed by taking the annual sum of the monetary surprise series shown in Figure 3. Sample period: 1996:3-2021:12. The monetary surprise series is calculated using the values derived from (3.1) using daily changes in the one-year treasury yield surrounding event dates held by the Bank of Canada. In months where policy decisions where not held or made, the value of the time series is imputed to be zero. Furthermore, in months where more than one decision was made (typically in the case of emergency decisions, including COVID in 2020:3), we take the sum of total surprises.

Cumulative Sum of Surprises Across Time



Notes: This series is developed by taking the moving cumulative sum of the monetary surprise series shown in Figure 3. Sample period for post-float era: 1996:3-2022:1. Sample period for the fixed announcement date era: 2000:12-2022:1. Positive values show a surprise bias towards contractionary policy, while negative values show a bias towards expansionary policy. The monetary surprise series is calculated using the values derived from (3.1) using daily changes in the one-year treasury yield surrounding event dates held by the Bank of Canada. In months where policy decisions where not held or made, the value of the time series is imputed to be zero. Furthermore, in months where more than one decision was made (typically in the case of emergency decisions, including COVID in 2020:3), we take the sum of total surprises.

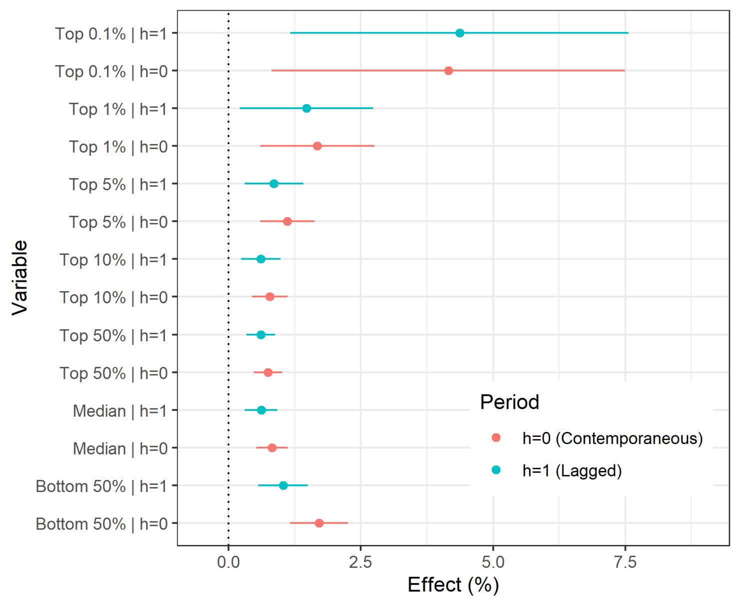
Trends in Real Median Canadian Income



Notes: Sample period: 1995-2019. Data is sourced from Statistics Canada Table 11-10-0055-01.

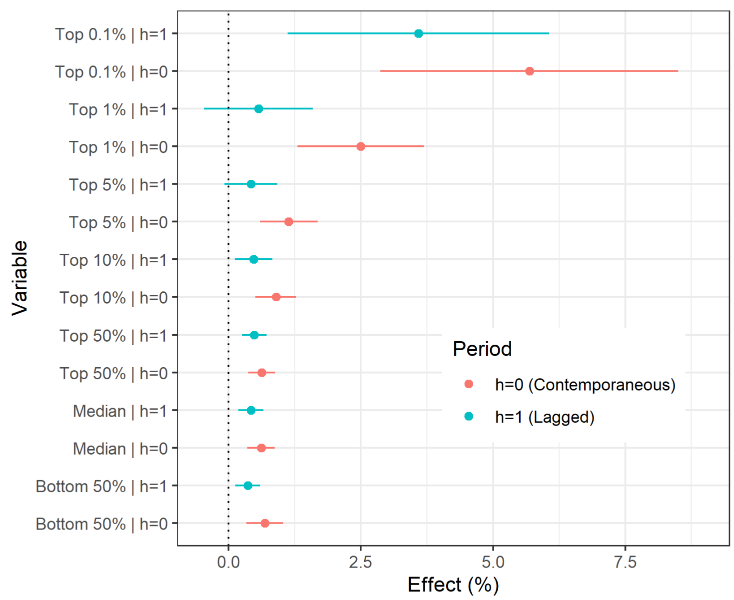
Appendix 2: Robustness Exercises

Impact on Total Income Before Taxes



Notes: Total income is defined as being in real terms (2002=100). This figure plots coefficient estimates from (3.2), where the surprise series Δm_t was normalized to reflect a one standard deviation expansion. The bars on the coefficient plots represent 90 percent confidence bands as derived from clustered standards errors at the year-region-income group level. Sample period: 1996-2019. $R^2 = 0.161$ and $N = 7846$. This figure explores total income, thus combining the wages and non-labour income variables that were explored independently in the body of the text. When combining both, we still see a quasi-U-shaped pattern over the income gradient.

Impact on Total Income After Taxes



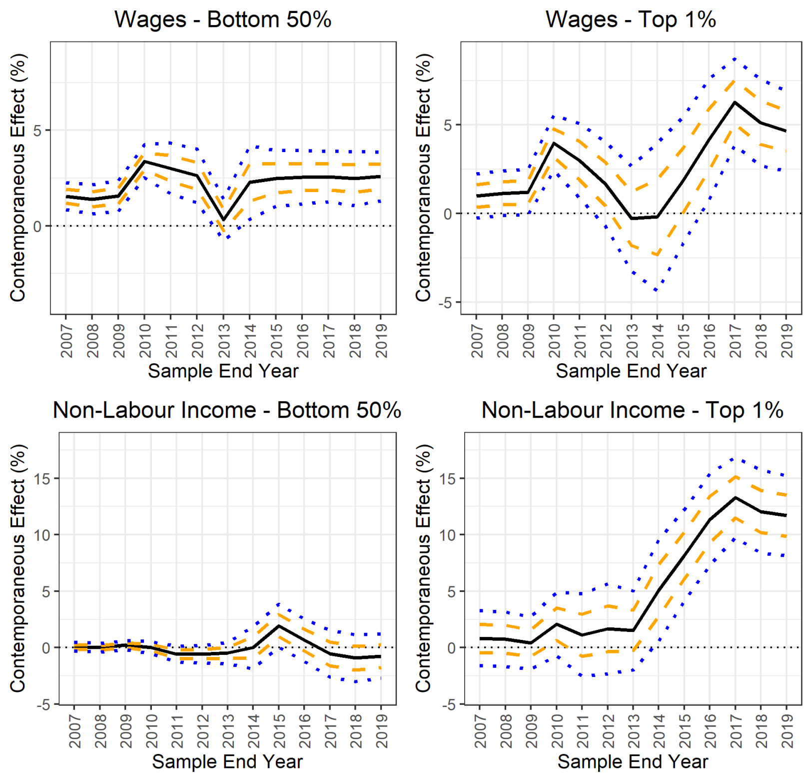
Notes: Total after-tax income is defined as being in real terms (2002=100). This figure plots coefficient estimates from (3.2), where the surprise series Δm_t was normalized to reflect a one standard deviation expansion. The bars on the coefficient plots represent 90 percent confidence bands as derived from clustered standards errors at the year-region-income group level. Sample period: 1996-2019. $R^2 = 0.162$ and $N = 7908$. This figure explores total after-tax income, thus combining the wages and non-labour income variables that were explored independently in the body of the text, while also considering the role that taxation might play on our findings. When combining both *and* considering taxes, we see that the expansionary coefficient estimates rise somewhat over the income gradient.

Impact on Billionaire Index Entry

	Pr[Enter=1]				
Sample	1996-2007	1996-2019	1996-2021	2007-2019	2007-2021
Δm_t	0.011**	0.020***	0.016***	0.068***	0.020
	(0.004)	(0.005)	(0.005)	(0.022)	(0.013)
Δm_{t-1}	0.002	0.002	0.009*	-0.007	0.029**
	(0.006)	(0.005)	(0.005)	(0.012)	(0.013)
Controls	Y	Y	Y	Y	Y
N	1020	2224	2448	1122	1326
R^2	0.033	0.016	0.017	0.023	0.020
Clusters	102	102	102	102	102
F-stat	7.51	19.99	23.30	19.91	24.07

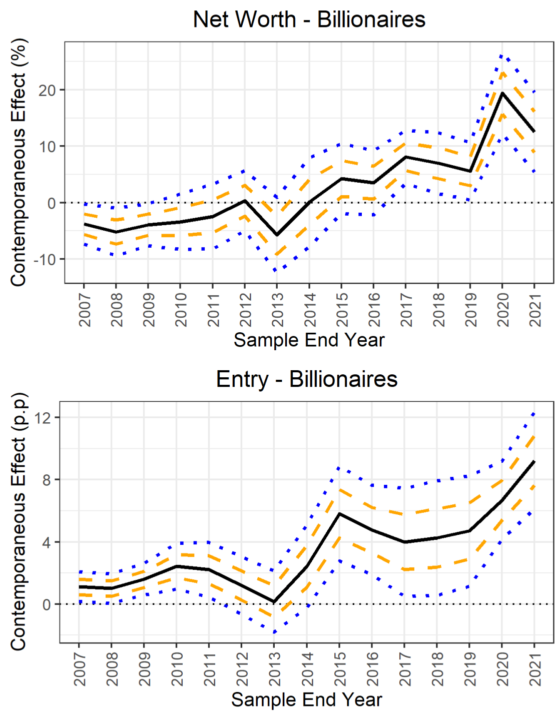
Notes: Regressions are linear probability estimates for the equation (3.3), where the dependent variable is set to one if the individual enters the billionaire index and zero otherwise. *** denotes significance at the 1% level, ** at the 5% level and * at the 10% level. Coefficients and standard errors are normalized to represent a one standard deviation expansionary movement in the monetary surprise variable. Robust clustered standard errors at the billionaire level are reported. Controls in all regressions include housing starts and the national unemployment rate.

Rolling Window Analysis - Income Panel



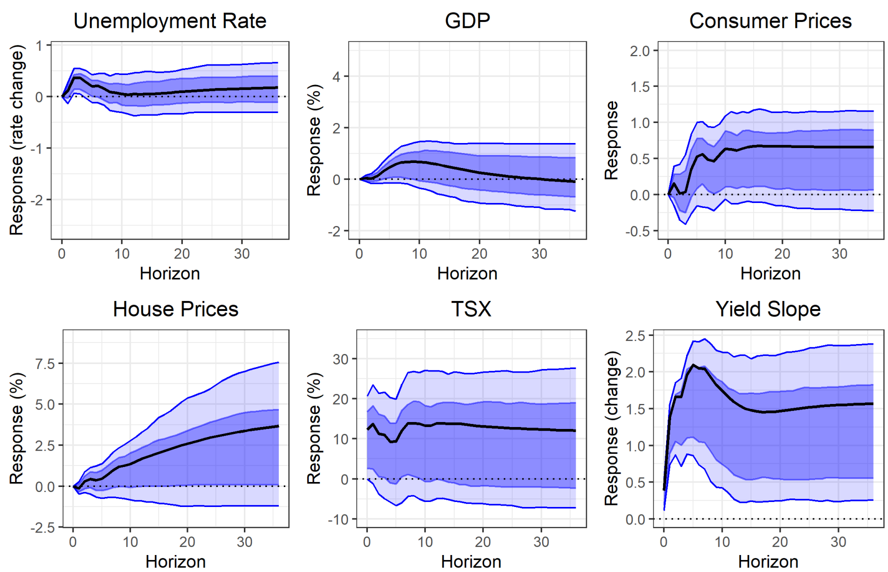
Notes: Wages and non-labour income are defined as being in real terms (2002=100). This figure plots coefficient estimates from (3.2), where the surprise series Δm_t was normalized to reflect a one standard deviation expansion. The blue dots on the coefficient plots represent 95 percent confidence bands as derived from clustered standards errors at the year-region-income group level. Orange dashed lines denote one standard error bands. Sample period: 1996-2019.

Rolling Window Analysis - Billionaire Panel



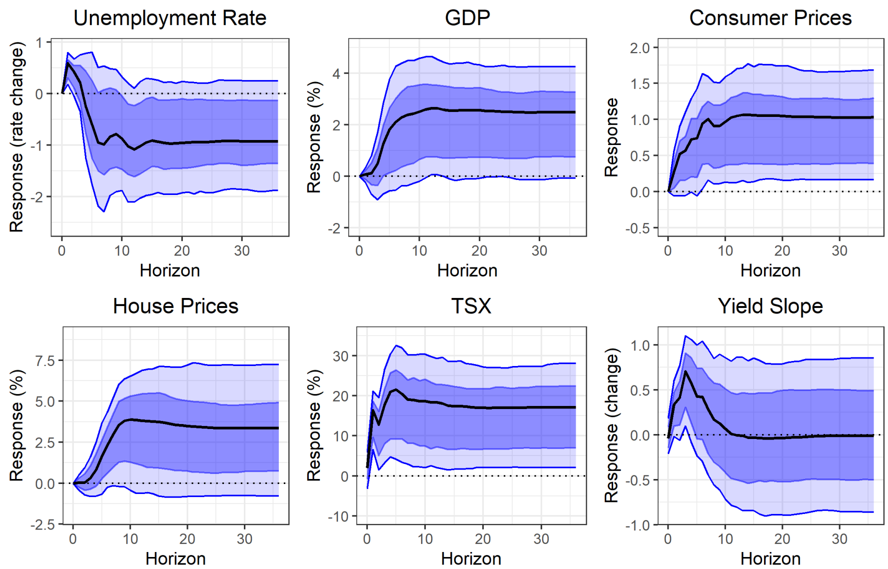
Notes: Billionaire wealth is defined as being in real terms (2002=100). This figure plots coefficient estimates from (3.3), where the surprise series Δm_t was normalized to reflect a one standard deviation expansion. The bars on the coefficient plots represent confidence bands as derived from clustered standards errors at the billionaire level. (blue dots) are 95 percent confidence bands and (orange dashed lines) are one standard error bands respectively. Sample period: 1996-2019.

Sample-Splitting VAR Analysis - Sample Period: 1996:3-2007:12



Notes: Sample period: 1996:3-2007:12. Lag length: 4. The shaded bar beneath the two plots denotes the impulses response functions drawn from a parameter estimate at a given time t. The policy expansion is normalized to 61 basis points - the magnitude of COVID policy response in March 2020. TSX and house prices are both expressed in real terms. Impulses are cumulative, and derived from the stationary VAR.

Sample-Splitting VAR Analysis - Sample Period: 2007:1-2021:5

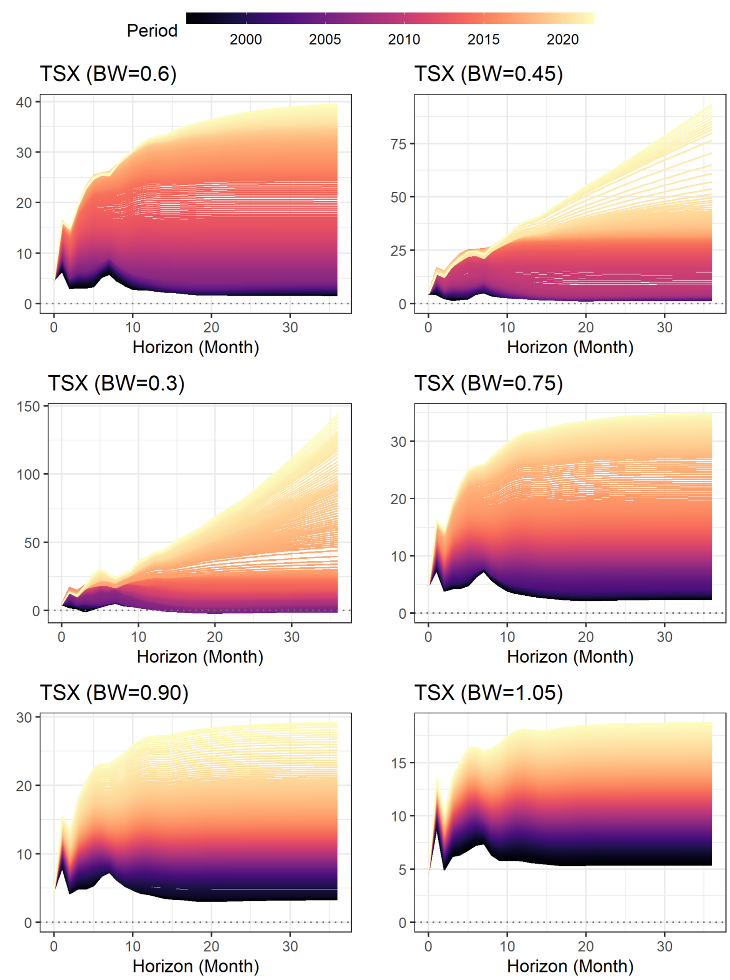


Notes: Sample period: 2007:1-2021:5. Lag length: 4. The shaded bar beneath the two plots denotes the impulses response functions drawn from a parameter estimate at a given time t. The policy expansion is normalized to 61 basis points - the magnitude of COVID policy response in March 2020. TSX and house prices are both expressed in real terms. Impulses are cumulative, and derived from the stationary VAR.

Kernel Bandwidth Sensitivity

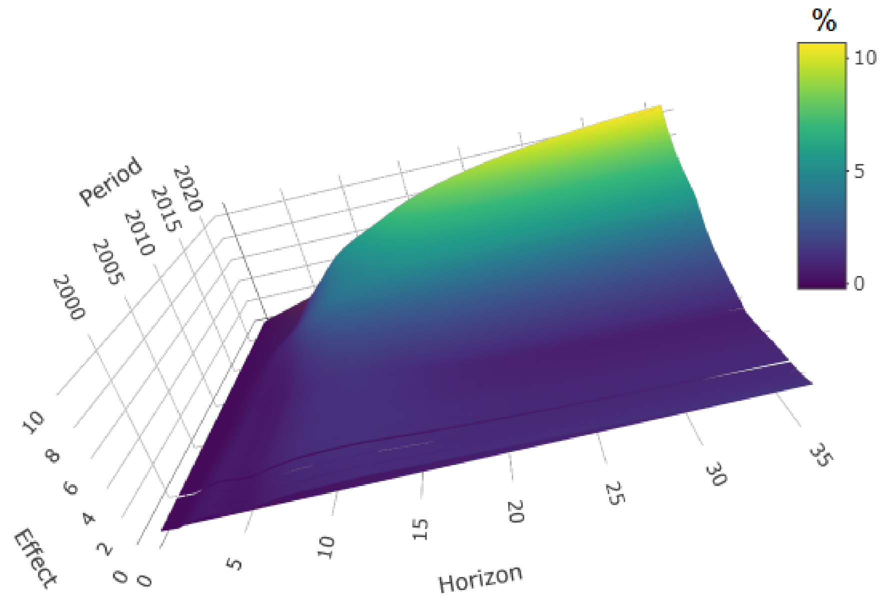
In Section 4 of the paper, we present a time-varying VAR analysis that is contingent upon the kernel bandwidth selection used to estimate the time-varying parameters. Our bandwidth selection in our core analysis of 0.6 is the product of a balancing act: a bandwidth selection that is too low produces impulse response functions that are too wild, drawing from only a limited amount of data, while a bandwidth too high incorporates too much data, and therefore will not allow for much time variation in the parameters. In an effort to assuage this trade-off, we illustrate our time-varying VAR results at different bandwidths in the below figure.

While we tested a continuum of different bandwidths, we illustrate different estimates using a kernel bandwidth of 0.60, 0.45, 0.75, 0.9, and 1.05. It is clear that our choice of 0.60 strikes a balance between slightly smaller bandwidths (0.45) and slightly higher bandwidths (0.75). Doing so allows us to conduct inference on the time-varying relationship between monetary policy and real asset prices, where the window of analysis is defined to be neither too broad or too narrow. At the other end, one can also observe that a higher bandwidth of 1.05 allows much less variation on the time dimension. In fact, when the bandwidth is set to be greater than 2, the impulse response functions effectively have no variation and look analogous to the full sample static model. Yet, on the other end, a bandwidth less than approximately 0.4 sources from too little data on the time dimension, which would ultimately produce explosive impulses when the data is biased too heavily on the large quantitative swings seen in the COVID-era.



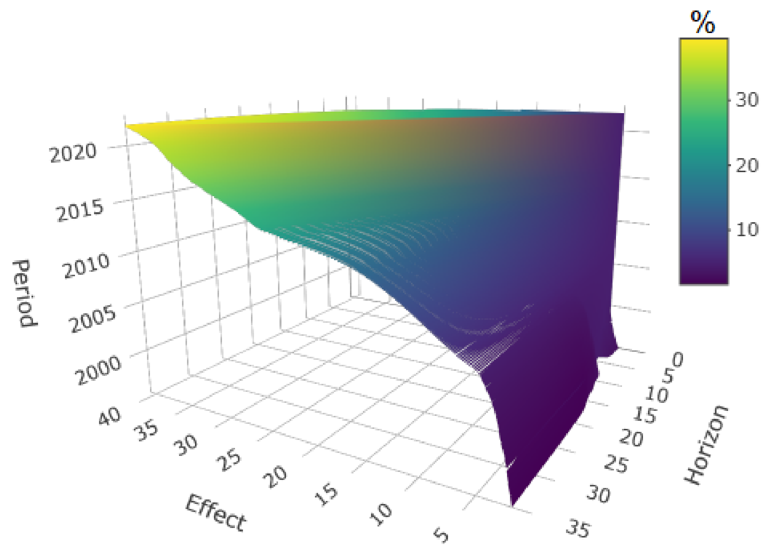
Notes: Sample period: 1996:3-2021:5. Lag length: 4. The shaded bar beneath the two plots denotes the impulses response functions drawn from a parameter estimate at a given time t. The policy expansion is normalized to 61 basis points - the magnitude of COVID policy response in March 2020. The TSX variable is expressed in real terms. Impulses are cumulative, and derived from the stationary VAR.

Three-Dimensional Impulses for Asset Prices - House Prices



Notes: Sample period: 1996:3-2021:5. Lag length: 4. The shaded bar beneath the two plots denotes the impulses response functions drawn from a parameter estimate at a given time t. The policy expansion is normalized to 61 basis points - the magnitude of COVID policy response in March 2020. House prices are expressed in real terms. Impulses are cumulative, and derived from the stationary VAR.

Three-Dimensional Impulses for Asset Prices - Stock Prices



Notes: Sample period: 1996:3-2021:5. Lag length: 4. The shaded bar beneath the two plots denotes the impulses response functions drawn from a parameter estimate at a given time t. The policy expansion is normalized to 61 basis points - the magnitude of COVID policy response in March 2020. Stock prices are expressed in real terms. Impulses are cumulative, and derived from the stationary VAR.