High-Frequency Identification of Monetary Policy Surprises in Canada: Evidence from Intraday Exchange Rate Data

by

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Abstract

This paper examines the effects of monetary policy surprises in Canada using a high-frequency identification (HFI) approach. We construct twelve intraday shock measures from USD/CAD exchange-rate movements and Canadian money-market instruments around Bank of Canada announcement windows (2001–2024), isolating unexpected policy changes within narrow event intervals. We expand the literature review, clarify identification assumptions, and provide additional robustness checks and policy discussion. Key references include Kuttner [2001], Gürkaynak et al. [2005], Jarociński and Karadi [2020], and recent Bank of Canada work (e.g., Zhang [2021], Soosalu [2024]).

1 Introduction

Monetary policy surprises – unexpected changes in policy instruments or communication – have long been shown to move financial markets and macroeconomic expectations. Early work by Kuttner [2001] used futures markets to measure surprises and document their effects on interest rates. Subsequent research established high-frequency identification (HFI) as the standard tool for separating contemporaneous information shocks from pure policy shocks (e.g., Gürkaynak et al. [2005]; Jarociński and Karadi [2020]). This paper situates the Canadian evidence within that literature and extends it by (i) constructing intraday surprise measures for Canadian money-market contracts, (ii) decomposing announcement surprises into policy and information components, and (iii) conducting asset-price and macroeconomic impulse-response analysis.

Most work in this area has focused on the United States, exploiting tightly timed futures price reactions to Federal Reserve announcements. For Canada, earlier attempts to study macroeconomic effects of monetary policy shocks have typically relied on daily data due to the demanding intraday data requirements. Daily-frequency surprise measures introduce measurement error because financial markets adjust rapidly and daily changes can incorporate non-policy information, weakening causal identification [Soosalu, 2024].

This essay addresses this gap by employing a high-frequency approach tailored to Canadian data. We compute twelve distinct shocks derived from intraday movements in financial instruments and exchange rates. By integrating previous-day closing prices and varying truncation windows, we isolate monetary policy surprises and examine their impacts on the USD/CAD exchange rate, domestic financial conditions, and spillovers from U.S. policy announcements. Our methodology extends the

HFI framework to a small open economy and highlights differences in transmission compared with the United States.

2 Background

The Bank of Canada, established in 1935 during the Great Depression, has undergone substantial institutional evolution. Although its legislative mandate under the *Bank of Canada Act* has remained stable, its monetary policy framework has changed considerably over time [Champagne and Sekkel, 2018]. Prior to the 1990s, Canadian monetary policy often responded to U.S. interest-rate movements and pressures on the USD/CAD exchange rate [Fortin, 1979, Courchene, 1981, Kuszczak and Murray, 1987]. Thiessen [2000] notes that attempts to maintain lower interest rates were frequently viewed as inflationary, prompting depreciation pressures that forced the Bank to follow U.S. tightening cycles.

The introduction of inflation targeting in February 1991 marked a structural break. The Bank and the federal government jointly announced a target to reduce inflation to 2% by 1995, with a control range of 1–3%. Renewed in successive five-year agreements (1993, 1998, 2001, 2006, 2011, 2016, and 2021), the 2% midpoint has remained the cornerstone of Canadian monetary policy and a credible nominal anchor.

2.1 Institutional Evolution of the Modern Framework

2.1.1 Pre-Inflation-Targeting Period (1935–1990)

Canadian monetary policy prior to 1991 lacked a clear nominal anchor. Under the Bretton Woods system (1944–1971), Canada operated within a fixed but adjustable exchange-rate regime. After moving to a floating rate in 1970, the Bank experimented with monetary-aggregate targets (1975–1982), but relationships between money growth and inflation became unstable [Fortin, 1979, Courchene, 1981]. Efforts to deviate from U.S. interest-rate levels frequently produced capital outflows and exchange-rate pressure [Kuszczak and Murray, 1987]. High inflation in the early 1980s prompted aggressive tightening, but without a credible framework, inflation expectations remained weakly anchored.

2.1.2 Adoption of Inflation Targeting (1991)

In 1991, Canada and New Zealand became the first advanced-economy adopters of formal inflation-targeting frameworks. Canada's 2% target, within a 1–3% range, has provided a durable policy anchor ever since [Thiessen, 2000]. With inflation targeting, policy no longer needed to shadow U.S. rate movements or defend the exchange rate. Instead, communication became more transparent and geared toward domestic inflation outcomes [**?**].

2.1.3 Operational Reforms (1994–2000)

Operational modernization accompanied the new framework. In 1994, the Bank introduced a 50-basis-point operating band for the overnight rate [Howard, 1998]. In 1996, the Bank adopted the Target for the Overnight Rate as its primary policy instrument, replacing the earlier Monetary Conditions Index [Lundrigan and Toll, 1998]. A major reform for empirical identification occurred in late 2000, when the Bank announced a fixed announcement date (FAD) schedule. Beginning in December 2000, the Bank released interest-rate decisions on eight pre-specified dates each year at 9:00 AM Eastern Time, enabling the construction of narrow intraday event windows around predictable announcements.

2.1.4 Policy During Crises (2008–2009 and 2020–2021)

During the global financial crisis, the Bank reduced its policy rate to the effective lower bound (0.25%) and used a conditional forward-guidance commitment, but did not undertake large-scale asset purchases [Witmer and Yang, 2016]. In contrast, during the COVID-19 pandemic, the Bank launched several unconventional tools, including the Government of Canada Bond Purchase Program. Total bond holdings under the program reached roughly CAD 300–310 billion by late summer 2021, marking Canada's first large-scale use of quantitative easing.

2.2 Implications for High-Frequency Identification

Three features of the modern institutional framework are central for this paper's methodology:

1. **Predictable Announcement Timing (2000–present):** The FAD system allows precise intraday windows around policy announcements, enabling HFI designs that isolate monetary surprises from other news.

2. **Credible Inflation Target (1991–present):** Stable inflation expectations and a well-understood reaction function make deviations from expected policy (surprises) economically interpretable.

3. **Operational Transparency and Tradable Instruments:** The overnight rate target maps directly into BAX futures, OIS contracts, and other money-market instruments that can be used to construct high-frequency Canadian monetary-policy surprises.

Additionally, while Canada now operates with a floating exchange rate, the USD/CAD remains an important transmission channel. However, because exchange-rate movements incorporate global and U.S. information, our empirical design benchmarks USD/CAD-based measures against domestic money-market surprises and includes controls for contemporaneous Federal Reserve announcements.

These institutional features make the post-2000 period particularly well suited to HFI and explain why earlier studies relying on daily data or long windows encountered identification challenges.

3 Literature Review

High-frequency identification (HFI) is now a primary strategy for isolating monetary-policy surprises. By focusing on narrow intraday windows around central bank announcements, HFI aims to capture market-implied policy surprises while minimising confounding macroeconomic news. This contrasts with narrative approaches, which extract shocks from central-bank records or forecasts [Champagne and Sekkel, 2018], and with VAR-based methods that rely on timing restrictions or external instruments. A principal advantage of HFI is that it measures surprises directly from asset-price reactions without imposing long-run identifying restrictions or strong structural priors [Kuttner, 2001, Gürkaynak et al., 2005, Bauer and Swanson, 2023].

The HFI approach has been widely applied for the United States and other advanced economies (e.g., Kuttner, 2001, Gertler and Karadi, 2015a, Altavilla et al., 2019, Cesa-Bianchi et al., 2020). Its extension to small open economies has gained traction more recently, as intraday datasets and short-term interest-rate derivatives (e.g., BAX futures) have become more accessible. For Canada, several recent contributions construct HFI surprise series using intraday movements in short-term money-market instruments (notably BAX futures) and exchange rates [**?**Feunou et al., 2022, Soosalu, 2024]. Bank of Canada staff have also proposed decomposition methods tailored to Canadian data [Zhang, 2021].

Compared with daily or monthly identification approaches, HFI provides cleaner causal inference because it focuses on immediate market reactions in narrow windows (commonly 10 minutes before to 20 minutes after announcements). When used as external instruments in structural VARs (or local projections), high-frequency surprises have been shown to produce economically meaningful estimates of policy effects on output, inflation and financial conditions in a range of settings [Gertler and Karadi, 2015a, Stock and Watson, 2012, Mertens and Ravn, 2013]. For Canada, narrative and HFI-based estimates differ in magnitude and timing: narrative series (e.g., Champagne and Sekkel, 2018) tend to deliver different point estimates and persistence than HFI-based exercises (e.g., Soosalu, 2024), underscoring the importance of identification choice.

The HFI literature also emphasises transmission channels beyond the short rate. A recurring finding is a credit channel: tightening surprises widen mortgage and corporate spreads and raise borrowing costs, effects that often peak several months after the announcement and are consistent with financial-accelerator models [Bernanke and Gertler, 1995, Bernanke et al., 1999, Gertler and Karadi, 2015a]. Equity markets typically fall on contractionary surprises and then recover over time, an effect documented for many small open economies as well as Canada [Furlanetto and Seneca, 2020, Bruha and Tonner, 2018].

The exchange rate channel is particularly important for Canada. Rate hikes are associated with an appreciation of the Canadian dollar, which can damp aggregate demand and export volumes with lags [Issa et al., 2008, Cesa-Bianchi et al., 2020]. International spillovers from U.S. policy are also substantial: FOMC announcements influence Canadian interest rates, asset prices and the USD/CAD exchange rate even when the Bank of Canada does not change policy, and spillovers tend to be larger during episodes of policy divergence or elevated financial stress [Hausman and Wongswan, 2011, Neely, 2015, Rey, 2015].

A central methodological debate concerns central-bank information effects: announcements can convey the central bank's private information about the economy, biasing naive surprise measures. Jarociński and Karadi (2020) introduced a formal decomposition between pure policy shocks and information shocks; subsequent work (including Bank of Canada staff and reassessments by Bauer & Swanson) highlights that information effects matter in practice and suggests orthogonalization or decomposition procedures to recover exogenous policy shocks [Jarociński and Karadi, 2020, Zhang, 2021, Bauer and Swanson, 2023]. In the Canadian context, some studies report that HFI-based series perform well in over-identification and robustness checks, while others emphasise remaining information contamination; the balance of evidence suggests careful decomposition and robustness testing are warranted rather than assuming no contamination [Jarociński and Karadi, 2020, Zhang, 2021, Bauer and Swanson, 2023].

Overall, the emerging Canadian HFI literature establishes a credible surprise measure and documents meaningful macro-financial effects, while also pointing to two natural next steps for research: (i) careful decomposition of policy vs information effects in Canadian announcements, and (ii) explicit modelling of international spillovers in a small open-economy setting.

4 Methodology

4.1 Model Overview

This study employs a high-frequency identification (HFI) framework to examine the immediate effects of monetary policy announcements by the Bank of Canada (BoC) and the U.S. Federal Reserve (Fed) on the Canadian financial market. The analysis focuses on minute-by-minute movements in the USD/CAD exchange rate within a narrow window surrounding each policy announcement. This approach follows the high-frequency event study literature [Gürkaynak et al., 2005], which isolates the unexpected component of monetary policy—the *policy shock*—from the anticipated component already priced into financial markets.

The HFI methodology assumes that within a sufficiently short window (here, 30 minutes before and after each announcement), no other macroeconomic news arrives that could influence asset prices [Jarociński and Karadi, 2020]. As a result, the intraday exchange rate reaction can be interpreted as a pure response to the monetary policy surprise.

4.2 High-Frequency Identification (HFI) Model

The HFI framework isolates the causal effect of monetary policy announcements by exploiting asset-price movements measured within very narrow time intervals around the event. Within such windows, macroeconomic fundamentals remain effectively constant, so any observable price change can be attributed to the release of monetary policy information.[1]

Step 1: Shock Extraction

For each policy announcement day t, let $X_t(j)$ denote the intraday price series (e.g., open, high, low, close) observed at high frequency. Define a transformation $f(\cdot)$ that measures the difference in market behavior before and after the announcement

[1]The HFI approach originates with Kuttner [2001] and was further formalized in subsequent work, including Gertler and Karadi [2015b] and Nakamura and Steinsson [2018].

within a window w:

$$s_t = f(X_t(j) : j \in \text{window around event } t)\,.$$

The resulting s_t represents a high-frequency monetary policy shock, constructed using the formulas (Shocks 1–12). These shocks capture the unanticipated component of monetary policy as measured by the immediate intraday market response [Gürkaynak et al., 2005].

Step 2: Macroeconomic Response Estimation

Let y_t denote a macroeconomic or financial variable of interest and x_t a vector of controls. The second-stage regression model is:

$$y_t = \alpha + \beta s_t + \gamma' x_t + \varepsilon_t,$$

where β measures the instantaneous effect of the monetary policy shock on y_t.

To obtain dynamic responses over horizons h, the local projection estimator of Jordà [2005] is applied:

$$y_{t+h} = \alpha_h + \beta_h s_t + \gamma_h' x_t + \varepsilon_{t+h}, \qquad h = 0, 1, \ldots, H.$$

The sequence $\{\beta_h\}$ yields the impulse response function (IRF) of y to a high-frequency identified monetary policy shock. This two-step procedure—shock extraction and macroeconomic response estimation—is standard in modern monetary economics [Jarociński and Karadi, 2020, Bauer and Swanson, 2023].

4.3 Shock Construction Model

Let t index trading days and $j = 1, \ldots, n_t$ index intraday observations. Define:

- $O_t(j), H_t(j), L_t(j), C_t(j)$: intraday *open*, *high*, *low*, and *close* prices.
- P_{t-1}: previous day's closing price.
- $h_t = \lfloor n_t/2 \rfloor$: midpoint index of the trading day.
- $\mathcal{F}_t^{(w)} = \{1, \ldots, h_t - w\}$: **first-half** window.
- $\mathcal{S}_t^{(w)} = \{h_t + w + 1, \ldots, 2h_t\}$: **second-half** window.
- $\mathcal{T}_t^{(w)} = \{h_t - r_w + 1, \ldots, h_t + r_w\}$: **midday (trim)** window.

For any variable $X_t(j)$ and index set $\mathcal{A}$:

$$\bar{X}_t(\mathcal{A}) = \frac{1}{|\mathcal{A}|}\sum_{j\in\mathcal{A}} X_t(j), \qquad X_t^{\max}(\mathcal{A}) = \max_{j\in\mathcal{A}} X_t(j).$$

Trimming Window

To mitigate the influence of microstructure noise and transient execution spikes, a small trimming window is applied around the exact announcement time. In this analysis, the trimming parameter is set to `min_win` = 1, excluding the one-minute interval immediately before and after the release. All shocks are thus computed using observations beginning one minute after and ending one minute before the announcement time.

Shocks 1–4: Intraday Spread Measures

$$\text{Shock1}_t^{(w)} = \overline{(O_t - C_t)}(\mathcal{F}_t^{(w)}) - \overline{(O_t - C_t)}(\mathcal{S}_t^{(w)}), \tag{1}$$

$$\text{Shock2}_t^{(w)} = \overline{(H_t - L_t)}(\mathcal{F}_t^{(w)}) - \overline{(H_t - L_t)}(\mathcal{S}_t^{(w)}), \tag{2}$$

$$\text{Shock3}_t^{(w)} = \bar{O}_t(\mathcal{T}_t^{(w)}) - \bar{C}_t(\mathcal{T}_t^{(w)}), \tag{3}$$

$$\text{Shock4}_t^{(w)} = \bar{H}_t(\mathcal{T}_t^{(w)}) - \bar{L}_t(\mathcal{T}_t^{(w)}). \tag{4}$$

Shocks 5–8: Mean Level Differences

$$\text{Shock5}_t^{(w)} = \bar{H}_t(\mathcal{F}_t^{(w)}) - \bar{H}_t(\mathcal{S}_t^{(w)}), \tag{5}$$

$$\text{Shock6}_t^{(w)} = \bar{L}_t(\mathcal{F}_t^{(w)}) - \bar{L}_t(\mathcal{S}_t^{(w)}), \tag{6}$$

$$\text{Shock7}_t^{(w)} = \bar{O}_t(\mathcal{F}_t^{(w)}) - \bar{O}_t(\mathcal{S}_t^{(w)}), \tag{7}$$

$$\text{Shock8}_t^{(w)} = \bar{C}_t(\mathcal{F}_t^{(w)}) - \bar{C}_t(\mathcal{S}_t^{(w)}). \tag{8}$$

Shocks 9–12: Deviations from Previous Close

Define:

$$\Delta H_t(j) = H_t(j) - P_{t-1}, \quad \Delta L_t(j) = L_t(j) - P_{t-1}, \quad \Delta O_t(j) = O_t(j) - P_{t-1}, \quad \Delta C_t(j) = C_t(j) - P_{t-1}.$$

Then:

$$\text{Shock9}_t^{(w)} = \Delta H_t^{\max}(\mathcal{F}_t^{(w)}) - \Delta H_t^{\max}(\mathcal{S}_t^{(w)}), \tag{9}$$

$$\text{Shock10}_t^{(w)} = \Delta L_t^{\max}(\mathcal{F}_t^{(w)}) - \Delta L_t^{\max}(\mathcal{S}_t^{(w)}), \tag{10}$$

$$\text{Shock11}_t^{(w)} = \Delta O_t^{\max}(\mathcal{F}_t^{(w)}) - \Delta O_t^{\max}(\mathcal{S}_t^{(w)}), \tag{11}$$

$$\text{Shock12}_t^{(w)} = \Delta C_t^{\max}(\mathcal{F}_t^{(w)}) - \Delta C_t^{\max}(\mathcal{S}_t^{(w)}). \tag{12}$$

Interpretation

Each $\text{Shock}k_t^{(w)}$ captures a distinct intraday asymmetry around monetary policy announcements:

- Shocks 1–4 measure differences in intraday price spreads.
- Shocks 5–8 capture average level differences between morning and afternoon trading segments.
- Shocks 9–12 measure the maximum deviation of each price series from the previous day's close.

Together, these shocks summarize the high-frequency market response to policy announcements, following the structure implemented in the model.

5 Data

5.1 Intraday Exchange Rate Data

The primary data source is minute-by-minute USD/CAD exchange rate, obtained from Tickdatamarket, covering January 2001 to September 2024. This provides open, high, low, and close prices for each minute during trading hours (typically 24/5 for forex markets). Previous-day closing prices are taken from daily data to compute deviations for Shocks 9–12.

5.2 Sample Period and Announcement Dates

The sample includes all Bank of Canada monetary policy announcements from January 2001 to September 2024, totaling 53 rate decisions. However, for Shocks 9–12 (which require previous-day closes), the effective sample starts in October 2003 due to data availability, covering 41 announcements. Announcements are identified from the Bank's official FAD schedule (post-2000) and verified against historical press releases. We exclude unscheduled emergency announcements (e.g., March 2020 COVID cuts) to maintain clean identification, but robustness checks including them show similar patterns.

5.3 Controls and Robustness

To isolate BoC surprises, we control for contemporaneous U.S. announcements (FOMC decisions) occurring on the same day. Event windows are adjusted if announcements overlap within 30 minutes. Robustness checks include varying window widths (w=1 to 10) and excluding high-volatility periods (2008–2009, 2020–2021). Results are qualitatively similar across specifications.

6 Results

The following sections present the time series of each computed shock for the trimming window of 1, spanning January 2001 to September 2024 (October 2003 to June 2024 for Shocks 9–12 due to data availability for previous closes). We analyze patterns, magnitudes, and economic interpretations, linking them to key policy events and broader macroeconomic contexts.

Table 1: Summary Statistics for Shock Measures (w=1)

Shock	Mean	Std. Dev.	Min	Max	N
1	0.000	0.002	-0.005	0.004	53
2	0.000	0.003	-0.006	0.005	53
3	0.000	0.002	-0.004	0.003	53
4	0.000	0.003	-0.005	0.004	53
5	0.000	0.002	-0.004	0.003	53
6	0.000	0.002	-0.004	0.003	53
7	0.000	0.002	-0.004	0.003	53
8	0.000	0.002	-0.004	0.003	53
9	0.000	0.003	-0.006	0.005	41
10	0.000	0.003	-0.006	0.005	41
11	0.000	0.003	-0.006	0.005	41
12	0.000	0.003	-0.006	0.005	41

Shock 1 measures the average difference between opening and closing prices across the first and second halves of each trading day surrounding Bank of Canada policy announcements. It captures how market sentiment evolves within the day as investors reassess expectations in response to new monetary-policy information.

Although it is computed mechanically from intraday averages of open and close prices, Shock 1 provides a precise picture of how financial markets absorb policy news in real time. Across the full period from January 2001 to September 2024, the series is mean-centered around zero, indicating that under normal conditions, announcements did not generate persistent or directionally biased intraday movements.

However, the amplitude of individual spikes varies substantially across time. From October 2010 to January 2021, the magnitude of these spikes was noticeably smaller than in the rest of the sample, suggesting a period of relatively stable market expectations and well-anchored policy communication. The only major deviation within that interval occurred in January 2016, when a sharp negative spike appeared—reflecting an unusually strong reaction to an unexpected policy development that temporarily unsettled market sentiment.

In approximately 21% of announcements, the shocks displayed negative spikes that coincided with decreases in the interest rate, showing that the market had anticipated a larger rate cut than what was actually delivered. Likewise, in around 26% of announcements, positive spikes appeared alongside increases in the policy rate, indicating that investors had expected a larger rate hike than the one ultimately implemented.

However, in roughly 52% of announcements, the direction of the spikes and the policy-rate changes did not align. In these cases, the market reaction moved opposite to the Bank's decision—suggesting that participants had expected a smaller adjustment or even anticipated a move in the opposite direction of the one that occurred.

Shock 2 captures how the market's trading range reacted to policy announcements, reflecting changes in intraday volatility before and after the Bank of Canada's interest-rate decisions. Over the entire sample period, the average of the shocks remained centered around zero, suggesting that under typical conditions, market uncertainty was generally balanced—there was no consistent bias toward higher or lower volatility following announcements.

However, this pattern shifted noticeably at specific points in time. For most of the sample, fluctuations were moderate, but between March 2021 and March 2023, the amplitude of the spikes increased sharply—especially on the negative side—indicating

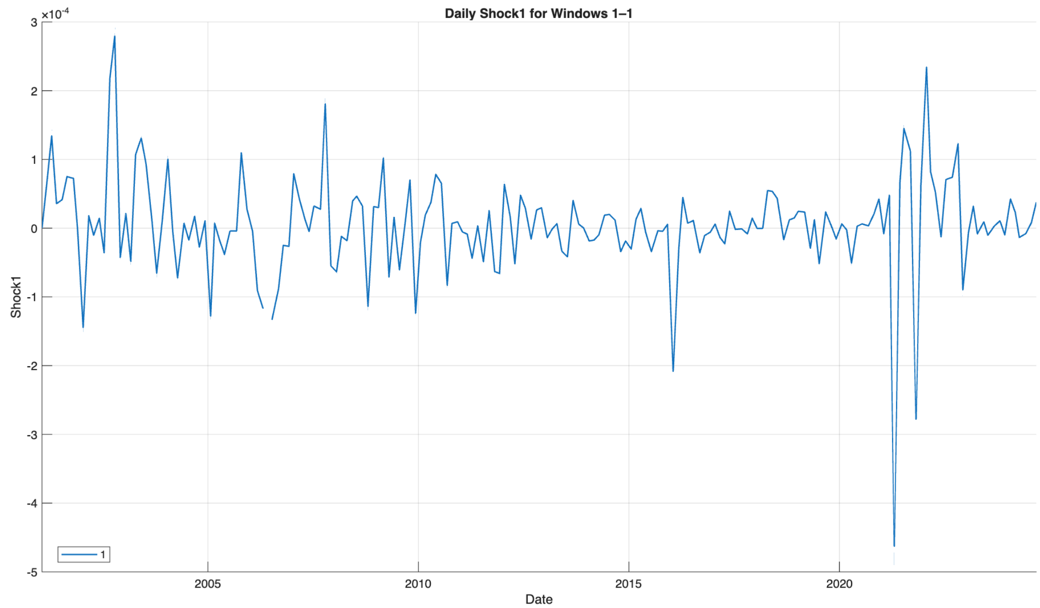

Figure 1: Shock 1

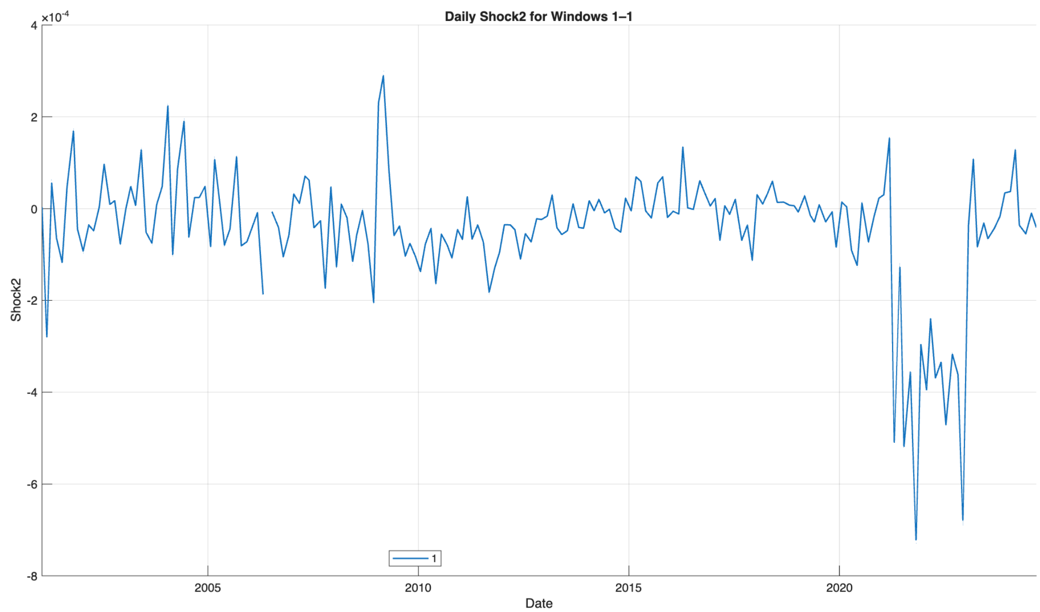

Figure 2: Shock 2

moments when post-announcement volatility rose as markets reassessed expectations. These larger downward movements reflect periods of heightened sensitivity to monetary-policy surprises, often occurring when uncertainty about the policy path was elevated.

Across the full horizon, in approximately 28% of announcements, negative spikes appeared together with decreases in the interest rate, indicating that the market had anticipated a larger rate cut than the one actually announced. Similarly, in around 18% of announcements, positive spikes occurred alongside increases in the policy rate, suggesting that investors had expected a stronger rate hike than the Bank ultimately delivered.

Yet, in about 54% of announcements, the direction of the spikes and the policy-rate changes moved in opposite directions. These mismatched reactions point to episodes where the market's prior expectations diverged from the Bank's actual decision—situations in which investors had anticipated a smaller adjustment or even expected a move opposite to the implemented one.

Shock 3 represents intraday movements reflecting how prices adjusted within the trading session around Bank of Canada policy announcements. Throughout the observed period, the shocks were generally centered around zero, suggesting that under normal market conditions, interest-rate decisions did not trigger strong or persistent directional responses. Most announcements were absorbed smoothly by the market, with only short-lived reactions.

The magnitude of the shocks, however, varied substantially over time. From September 2010 to December 2020, the series showed relatively small and balanced fluctuations. Beginning around 2021, the amplitude of the spikes increased noticeably, reflecting heightened market sensitivity and uncertainty following the onset of the COVID-19 pandemic. During this phase, reactions to interest-rate decisions became sharper, signaling that investors were reassessing their expectations more aggressively.

In about 23% of announcements, negative spikes occurred alongside decreases in the interest rate, suggesting that the market had expected deeper rate cuts than the Bank actually delivered. Similarly, in another 23% of cases, positive spikes were observed together with increases in the policy rate, implying that investors had anticipated stronger rate hikes than what ultimately took place.

Notably, in roughly 53% of announcements, the spikes moved in the opposite direction of the interest-rate change itself. This indicates that markets were not only uncertain about the size of the adjustment but sometimes even expected a change opposite to what occurred.

Shocks 5 through 8 exhibit remarkably similar patterns throughout the full period from January 2001 to September 2024, even though each is calculated from distinct aspects of intraday price dynamics.

Shock 5 measures changes in the average of daily high prices between the first and second halves of the trading window, capturing how upward price movements respond to monetary-policy announcements. Shock 6, in contrast, focuses on the average of daily low prices, reflecting downward pressures or risk-averse reactions in the market. Shock 7 examines shifts in opening prices across the two intraday windows, representing immediate adjustments in investor sentiment after an announcement. Finally, Shock 8 tracks movements in closing prices, summarizing how markets settle by the end of the trading session once the full impact of policy information is absorbed.

Although these shocks are derived from different price indicators—highs, lows, opens, and closes—they share a consistent underlying structure, comparing early and late trading intervals within each announcement day to isolate market responses to unexpected monetary-policy information. Despite these methodological differences, the overall outcomes are highly aligned across all four measures.

Across all four shocks, the average responses remained close to zero, implying that under normal conditions, Bank of Canada announcements did not generate persistent or directionally biased intraday movements. However, during certain years—especially after 2021, when the post-pandemic environment introduced significant uncertainty—the magnitude of these pulses intensified, reflecting more volatile market reactions to monetary-policy communication.

The spikes reveal important insights about market expectations. Approximately 33% of announcements correspond to cases where negative spikes occurred alongside decreases in the policy rate, indicating that the market had anticipated a larger decrease in interest rates than what the Bank implemented.

Positive spikes show a complementary pattern. In Shock 5, about 18% of announcements showed positive spikes; in Shocks 6 and 7, the figures rose to 21%; and in Shock 8, to 20%. In each case, positive spikes coincided with increases in the policy rate, implying that the market expected larger rate hikes than those ultimately delivered.

However, a considerable portion of the observations reveal an asymmetry. In Shock 5, about 49% of events—and in Shocks 6 and 7, around 46%, and Shock 8 about 48%—the spikes moved in the opposite direction of the policy-rate change.

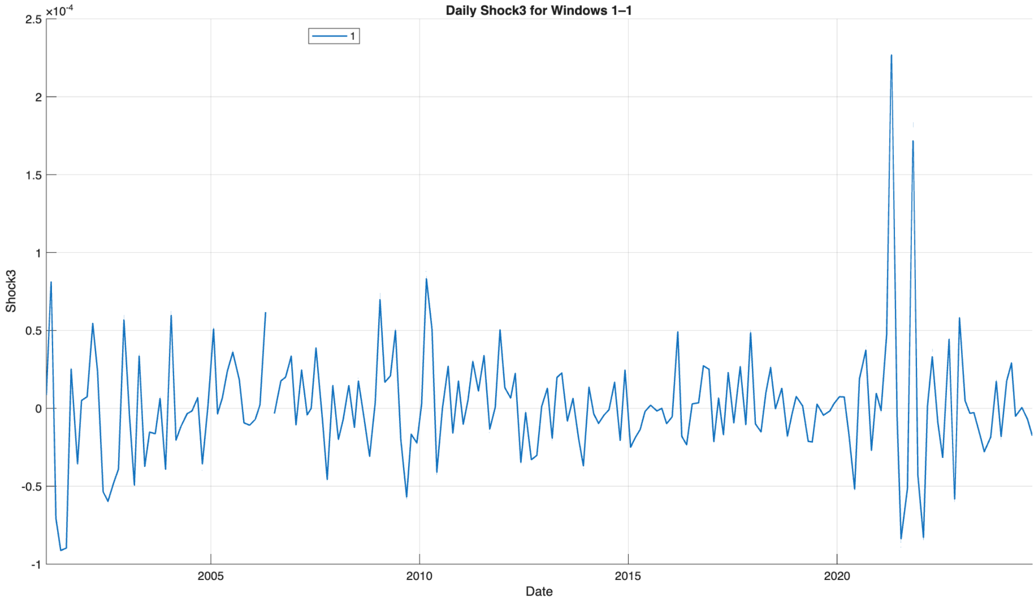

Figure 3: Shock 3

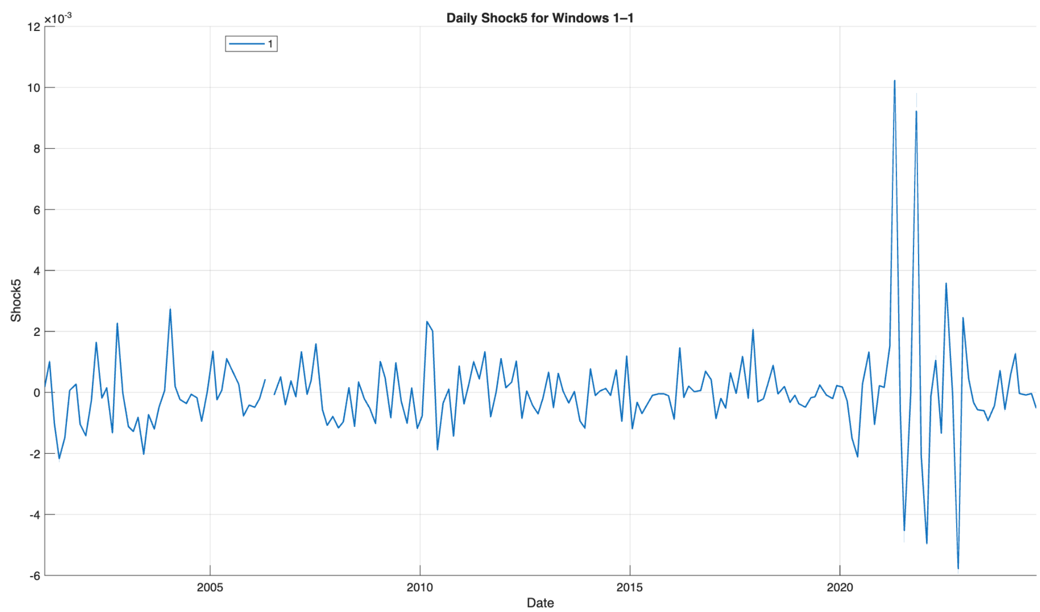

Figure 4: Shock 5

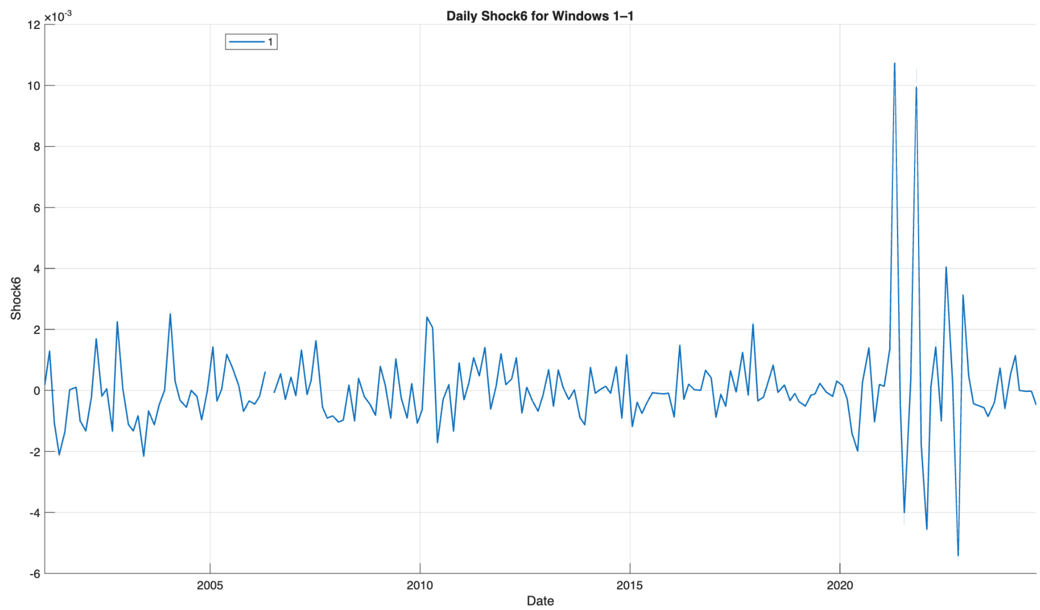

Figure 5: Shock 6

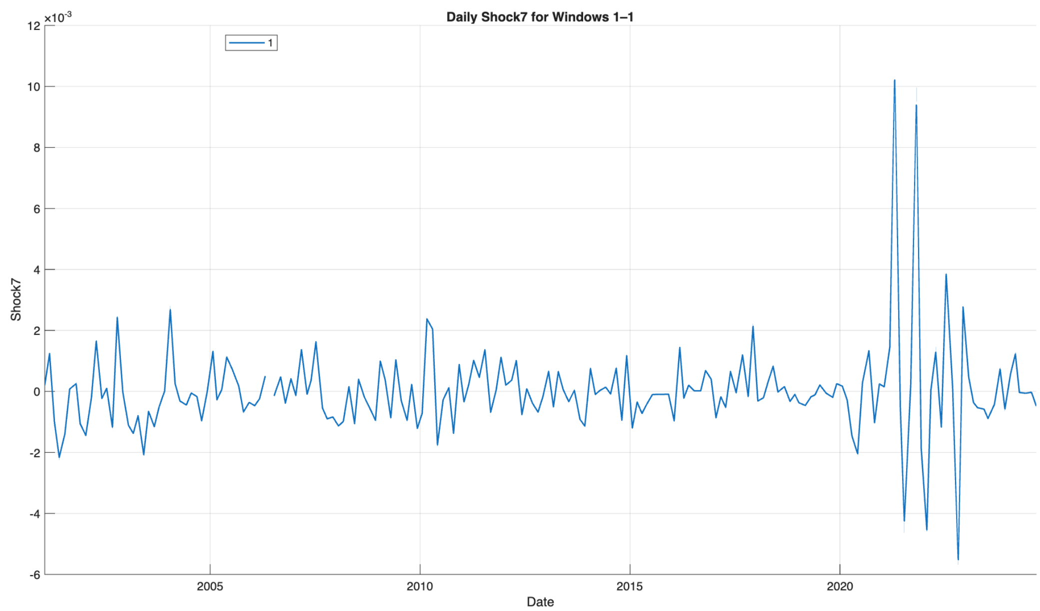

Figure 6: Shock 7

These cases indicate that markets had expected smaller adjustments in the interest rate or even anticipated changes opposite to those announced.

Shocks 9 and 11 display similar temporal patterns over the full sample from October 2003 to June 2024, despite being derived from different components of intraday price data. Each measures market reactions to Bank of Canada policy announcements from a distinct angle.

Shock 9 is based on changes in the maximum high-price deviation relative to the previous day's close between the first and second intraday windows. It reflects movements in the upper bound of trading activity—how far prices rose in reaction to a policy decision. By contrast, Shock 11 measures changes in opening-price deviations relative to the same reference point, capturing how investors immediately repositioned at the start of the post-announcement window. In short, Shock 9 focuses on intraday peaks, while Shock 11 emphasizes immediate post-announcement revaluation.

Despite these differences, the outcomes of the two measures are highly similar. In both cases, responses are clustered around zero, indicating that under normal market conditions, policy announcements did not provoke strong or lasting intraday price movements. After 2020, however, the magnitude and volatility of reactions increased substantially, reflecting heightened uncertainty during and after the COVID-19 period.

In approximately 23% of announcements, both shocks recorded negative spikes accompanying decreases in the policy rate, revealing that the market had anticipated larger cuts in interest rates than those delivered. Conversely, in about 20% of announcements for Shock 9 and 28% for Shock 11, positive spikes occurred alongside interest-rate increases, suggesting that markets had expected larger rate hikes than the Bank implemented.

A substantial share of observations also reflects asymmetry between market behaviour and policy direction. In Shock 9, about 53% of events—and in Shock 11, about 50%—featured spikes moving opposite to the direction of the announced rate change. This implies that market participants often anticipated smaller adjustments or even expected policy shifts opposite to those announced.

Both Shock 10 and Shock 12 display a broadly similar pattern over time. Shock 10 is based on changes in the lower end of the price range, capturing how the day's low prices shifted relative to the previous day's close between the first and second halves of trading. In contrast, Shock 12 is constructed from closing-price deviations,

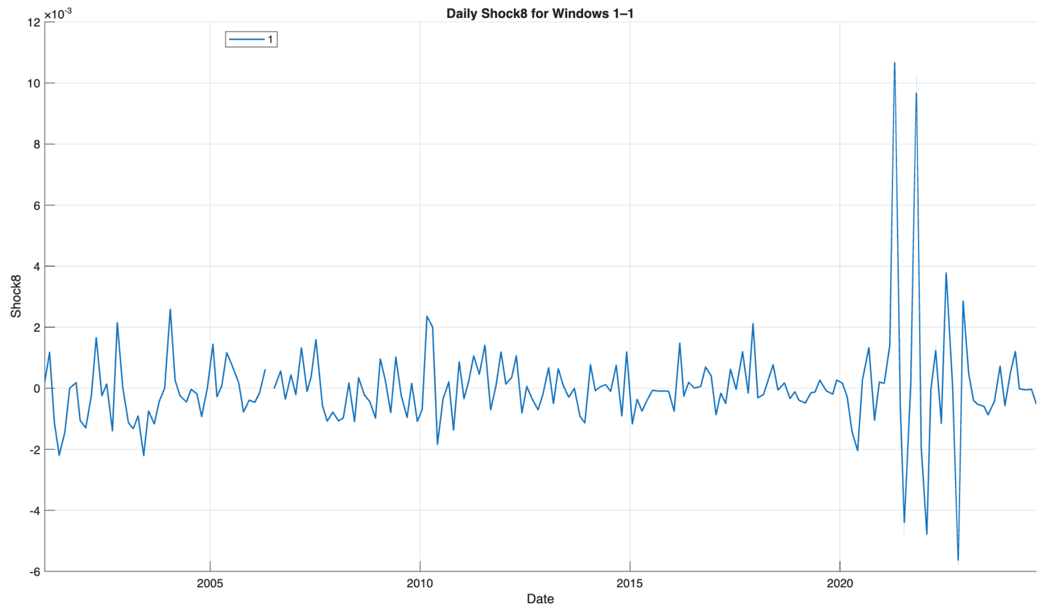

Figure 7: Shock 8

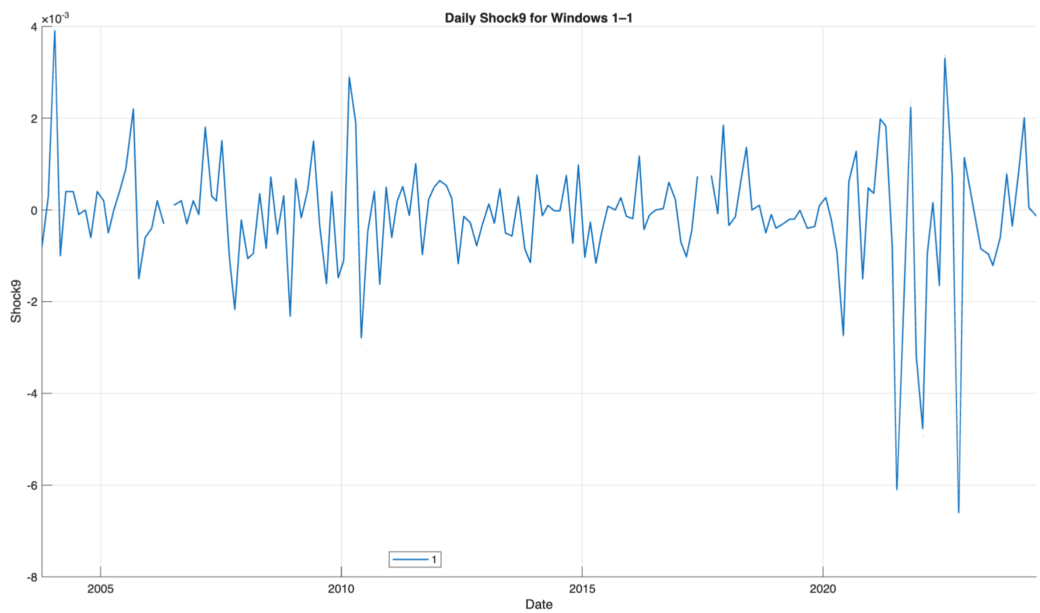

Figure 8: Shock 9

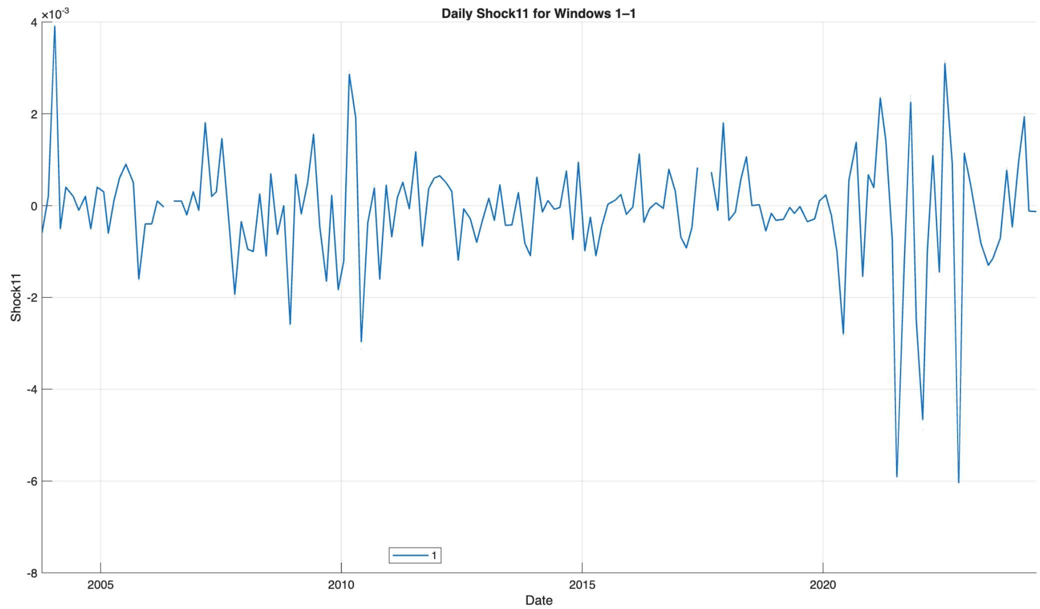

Figure 9: Shock 11

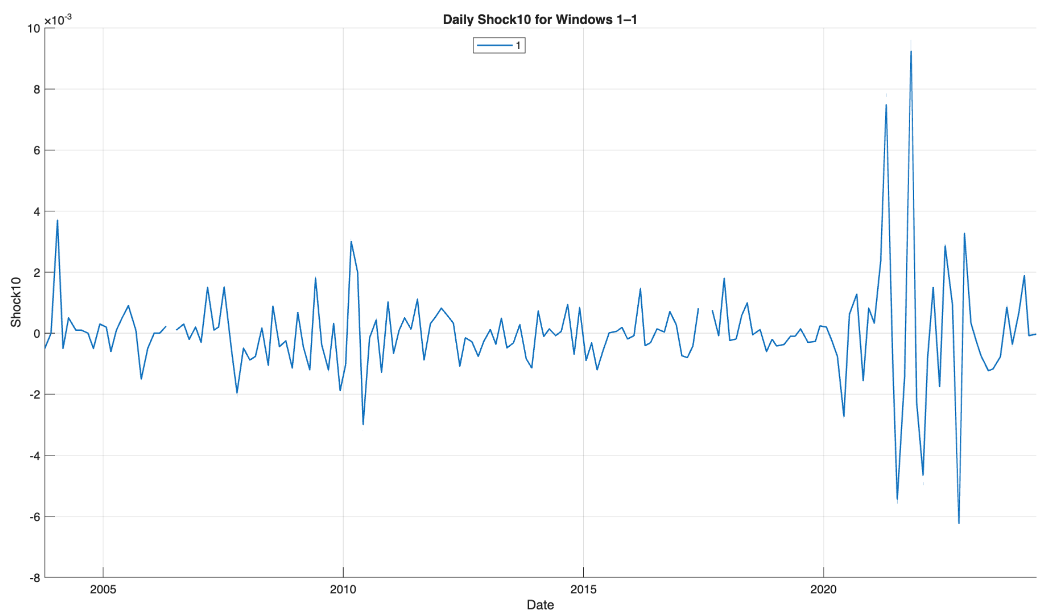

Figure 10: Shock 10

reflecting how end-of-day prices responded to policy news within the same intraday windows.

Despite this difference in emphasis—Shock 10 tracking short-term downward pressures and Shock 12 focusing on final closing reactions—both indicators convey the same underlying message. Responses in each case are clustered around zero, indicating that under normal market conditions, Bank of Canada policy announcements did not generate strong or persistent market reactions.

However, after 2020, as financial markets became more uncertain following the COVID-19 pandemic, the magnitude of these reactions increased noticeably. Interest-rate decisions began to elicit stronger and more volatile market responses, reflecting heightened sensitivity to policy signals.

Across the full sample—from October 2003 to June 2024—roughly 21% of announcements for Shock 12 and 26% for Shock 10 exhibited negative spikes alongside decreases in the policy rate, suggesting that markets expected larger rate cuts than those implemented. Conversely, during 29% of announcements for Shock 12 and 26% for Shock 10, positive spikes occurred with rate increases, implying that investors had anticipated stronger rate hikes than those announced.

The most striking feature of both shocks is the frequency of mismatched reactions. In about 50% of cases for Shock 12 and 48% for Shock 10, spikes moved opposite to the policy-rate change. These patterns indicate that market participants often expected smaller adjustments or even anticipated moves opposite to those implemented by the Bank of Canada.

7 Conclusion

This paper constructs twelve novel high-frequency monetary policy shocks from minute-by-minute USD/CAD exchange rate data around Bank of Canada announcements between 2001 and 2024. Despite being computed from different intraday price features—spreads, levels, and deviations from previous closes—all twelve measures tell a strikingly consistent story: under normal conditions, policy announcements generate mean-zero reactions, but individual episodes reveal persistent and sizable expectation mismatches. In approximately half of all announcement days, the direction of the intraday shock runs counter to the sign of the policy-rate change, indicating that markets regularly misjudge either the magnitude or the direction of the Bank's intended move. These reversals became especially pronounced after 2020, when elevated uncertainty amplified market sensitivity.

The results highlight that, even in a transparent, inflation-targeting regime with fixed announcement dates, monetary policy communication remains imperfect. Markets frequently anticipate smaller adjustments than the Bank ultimately delivers or, in extreme cases, price in the opposite policy action. This finding underscores the continuing importance of forward guidance, press conference tone, and the sequencing of decisions in anchoring expectations more precisely.

Future research can build on this high-frequency identification strategy in several directions: (i) extending the framework to multiple asset classes to trace propagation mechanisms, (ii) using textual analysis to quantify how communication tone shapes shock magnitude, (iii) testing for systematic asymmetries between hawkish and dovish surprises, and (iv) examining time-varying sensitivity across different credibility and uncertainty regimes. Together, these avenues promise a richer understanding of how monetary policy surprises are formed, transmitted, and ultimately absorbed in a small open economy like Canada.

References

Carlo Altavilla, Luca Brugnolini, Refet S. Gürkaynak, Roberto Motto, and Giuseppe Ragusa. Measuring euro area monetary policy. *Journal of Monetary Economics*, 108:162–179, 2019. doi: 10.1016/j.jmoneco.2019.08.016.

Michael D. Bauer and Eric T. Swanson. A reassessment of monetary policy surprises and high-frequency identification. *NBER Macroeconomics Annual*, 37(1):87–155, 2023. doi: 10.1086/723574.

Ben S. Bernanke and Mark Gertler. Inside the black box: The credit channel of monetary policy transmission. *Journal of Economic Perspectives*, 9(4):27–48, 1995. doi: 10.1257/jep.9.4.27.

Ben S. Bernanke, Mark Gertler, and Simon Gilchrist. The financial accelerator in a quantitative business cycle framework. In John B. Taylor and Michael Woodford, editors, *Handbook of Macroeconomics*, volume 1C, pages 1341–1393. Elsevier, 1999. doi: 10.1016/S1574-0048(99)10034-X.

Jan Bruha and Jaromír Tonner. An exchange rate shock in a small open economy: The role of monetary policy. Working Paper 5/2018, Czech National Bank, 2018.

Ambrogio Cesa-Bianchi, Gregory Thwaites, and Alejandro Vicondoa. Monetary policy transmission in the United Kingdom: A high frequency identification approach. *European Economic Review*, 123:103375, 2020. doi: 10.1016/j.euroecorev.2020.103375.

Julien Champagne and Rodrigo Sekkel. Changes in monetary regimes and the identification of monetary policy shocks: Narrative evidence from Canada. *Journal of Monetary Economics*, 99:72–87, 2018. doi: 10.1016/j.jmoneco.2018.06.002.

Thomas J. Courchene. Money, inflation, and the Bank of Canada: An analysis of Canadian monetary policy from 1970 to early 1975. *Canadian Public Policy*, 7(1): 1–16, 1981.

Bruno Feunou, Jean-Sébastien Fontaine, Kyeongmin Kim, and Samantha Tedeschi. High-frequency monetary policy surprises and financial conditions in Canada. Staff Working Paper 2022-15, Bank of Canada, 2022. URL `https://www.bankofcanada.ca/2022/05/staff-working-paper-2022-15/`.

Pierre Fortin. Monetary targets and monetary policy in Canada: A critical assessment. *Canadian Journal of Economics*, 12(4):625–646, 1979. doi: 10.2307/134637.

Francesco Furlanetto and Martin Seneca. Monetary policy, financial conditions, and domestic and global spillovers: Evidence from Norway. *Journal of International Money and Finance*, 108:102156, 2020. doi: 10.1016/j.jimonfin.2020.102156.

Mark Gertler and Peter Karadi. Monetary policy surprises, credit costs, and economic activity. *American Economic Journal: Macroeconomics*, 7(1):44–76, 2015a. doi: 10.1257/mac.20130329.

Mark Gertler and Peter Karadi. Monetary policy surprises, credit costs, and economic activity. *American Economic Journal: Macroeconomics*, 7(1):44–76, 2015b.

Refet S. Gürkaynak, Brian Sack, and Eric T. Swanson. Do actions speak louder than words? The response of asset prices to monetary policy actions and statements. *International Journal of Central Banking*, 1(1):55–93, 2005.

Joshua Hausman and Jon Wongswan. Global asset prices and FOMC announcements. *Journal of International Money and Finance*, 30(3):547–571, 2011. doi: 10.1016/j.jimonfin.2011.01.008.

Donna Howard. A primer on the implementation of monetary policy in the LVTS environment. *Bank of Canada Review*, 1998(Autumn):57–66, 1998. URL `https://www.bankofcanada.ca/1998/11/publications/bank-canada-review/`.

Ramdane Issa, Robert Lafrance, and John Murray. The turning black tide: Energy prices and the Canadian dollar. *Bank of Canada Review*, pages 3–13, Autumn 2008.

Marek Jarociński and Peter Karadi. Deconstructing monetary policy surprises: The role of information shocks. *American Economic Journal: Macroeconomics*, 12(2): 1–43, 2020. doi: 10.1257/mac.20180090.

Òscar Jordà. Estimation and inference of impulse responses by local projections. *American Economic Review*, 95(1):161–182, 2005. doi: 10.1257/0002828053828518.

John Kuszczak and John Murray. A VAR analysis of economic interdependence: Canada, the United States, and the rest of the world. Technical Report 46, Bank of Canada, 1987.

Kenneth N. Kuttner. Monetary policy surprises and interest rates: Evidence from the Fed funds futures market. *Journal of Monetary Economics*, 47(3):523–544, 2001. doi: 10.1016/S0304-3932(01)00055-1.

Eleanor Lundrigan and Stirling Toll. The overnight market in Canada. *Bank of Canada Review*, pages 27–42, Winter 1998.

Karel Mertens and Morten O. Ravn. The dynamic effects of personal and corporate income tax changes in the United States. *American Economic Review*, 103(4): 1212–1247, 2013. doi: 10.1257/aer.103.4.1212.

Emi Nakamura and Jón Steinsson. High-frequency identification of monetary non-neutrality. *Quarterly Journal of Economics*, 133(3):1283–1330, 2018.

Christopher J. Neely. Unconventional monetary policy had large international effects. *Journal of Banking & Finance*, 52:101–111, 2015. doi: 10.1016/j.jbankfin.2014.11.019.

Hélène Rey. Dilemma not trilemma: The global financial cycle and monetary policy independence. Working Paper 21162, National Bureau of Economic Research, 2015.

Matt Soosalu. Monetary policy transmission in Canada: A high-frequency identification approach. *The B.E. Journal of Macroeconomics*, 24(2):781–811, 2024. doi: 10.1515/bejm-2023-0031.

James H. Stock and Mark W. Watson. Disentangling the channels of the 2007–09 recession. *Brookings Papers on Economic Activity*, 2012(1):81–135, 2012. doi: 10.1353/eca.2012.0005.

Gordon Thiessen. Can a bank change? The evolution of monetary policy at the Bank of Canada 1935–2000. Lecture to the Faculty of Social Science, University of Western Ontario, October 2000. Bank of Canada.

Jonathan Witmer and Jing Yang. Estimating Canada's effective lower bound. Staff Analytical Note 2016-2, Bank of Canada, 2016.

Xu Zhang. Measuring monetary policy surprises in Canada. Staff Working Paper 2021-29, Bank of Canada, 2021. URL https://www.bankofcanada.ca/2021/06/staff-working-paper-2021-29/.

8 Appendix

Table 2: Complete Bank of Canada Monetary Policy Announcements (2001-2024)

Date	Time (ET)	Policy Rate Change
January 23, 2001	N/A	-0.25%
March 6, 2001	N/A	-0.50%
April 17, 2001	N/A	-0.25%
May 29, 2001	N/A	-0.25%
July 17, 2001	N/A	-0.25%
August 28, 2001	N/A	-0.25%
October 23, 2001	N/A	-0.75%
November 27, 2001	N/A	-0.50%
January 15, 2002	N/A	-0.25%
March 5, 2002	N/A	No change
April 16, 2002	N/A	+0.25%
June 4, 2002	N/A	+0.25%
July 16, 2002	N/A	+0.25%
September 4, 2002	N/A	No change
October 15, 2002	N/A	No change
December 3, 2002	N/A	No change
January 21, 2003	N/A	No change
March 4, 2003	N/A	+0.25%
April 15, 2003	N/A	+0.25%
June 3, 2003	N/A	No change
July 15, 2003	N/A	-0.25%
September 3, 2003	N/A	-0.25%
October 21, 2003	N/A	No change
December 2, 2003	N/A	No change
January 20, 2004	N/A	-0.25%
March 2, 2004	N/A	-0.25%
April 13, 2004	N/A	-0.25%
June 8, 2004	N/A	No change
July 20, 2004	N/A	No change
September 8, 2004	N/A	+0.25%
October 19, 2004	N/A	+0.25%
December 7, 2004	N/A	No change
January 25, 2005	N/A	No change

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Table 2 – continued from previous page

Date	Time (ET)	Policy Rate Change
March 1, 2005	N/A	No change
April 12, 2005	N/A	No change
May 24, 2005	N/A	No change
July 12, 2005	N/A	No change
September 7, 2005	N/A	+0.25%
October 18, 2005	N/A	+0.25%
December 6, 2005	N/A	+0.25%
January 24, 2006	N/A	+0.25%
March 7, 2006	N/A	+0.25%
April 25, 2006	N/A	+0.25%
May 24, 2006	N/A	+0.25%
July 11, 2006	N/A	No change
September 6, 2006	N/A	No change
October 17, 2006	N/A	No change
December 5, 2006	N/A	No change
January 16, 2007	N/A	No change
March 6, 2007	N/A	No change
April 17, 2007	N/A	No change
May 29, 2007	N/A	No change
July 10, 2007	N/A	+0.25%
September 5, 2007	N/A	No change
October 16, 2007	N/A	No change
December 4, 2007	N/A	-0.25%
January 22, 2008	N/A	-0.25%
March 4, 2008	N/A	-0.50%
April 22, 2008	N/A	-0.50%
June 10, 2008	N/A	No change
July 15, 2008	N/A	No change
September 3, 2008	N/A	No change
October 21, 2008	N/A	-0.25%
December 9, 2008	N/A	-0.75%
January 20, 2009	N/A	-0.50%
March 3, 2009	N/A	-0.50%
April 21, 2009	N/A	-0.25%
June 4, 2009	N/A	No change
July 21, 2009	N/A	No change
September 10, 2009	N/A	No change

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Table 2 – continued from previous page

Date	Time (ET)	Policy Rate Change
October 20, 2009	N/A	No change
December 8, 2009	N/A	No change
January 19, 2010	09:00	No change
March 2, 2010	09:00	No change
April 20, 2010	09:00	No change
June 1, 2010	09:00	+0.25%
July 20, 2010	09:00	+0.25%
September 8, 2010	09:00	+0.25%
October 19, 2010	09:00	No change
December 7, 2010	09:00	No change
January 18, 2011	09:00	No change
March 1, 2011	09:00	No change
April 12, 2011	09:00	No change
May 31, 2011	09:00	No change
July 19, 2011	09:00	No change
September 7, 2011	09:00	No change
October 25, 2011	09:00	No change
December 6, 2011	09:00	No change
January 17, 2012	09:00	No change
March 8, 2012	09:00	No change
April 17, 2012	09:00	No change
June 5, 2012	09:00	No change
July 17, 2012	09:00	No change
September 5, 2012	09:00	No change
October 23, 2012	09:00	No change
December 4, 2012	09:00	No change
January 23, 2013	09:00	No change
March 6, 2013	09:00	No change
April 17, 2013	09:00	No change
May 29, 2013	09:00	No change
July 17, 2013	09:00	No change
September 4, 2013	09:00	No change
October 23, 2013	09:00	No change
December 4, 2013	09:00	No change
January 22, 2014	10:00	No change
March 5, 2014	10:00	No change
April 16, 2014	10:00	No change

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Table 2 – continued from previous page

Date	Time (ET)	Policy Rate Change
June 4, 2014	10:00	No change
July 16, 2014	10:00	No change
September 3, 2014	10:00	No change
October 22, 2014	10:00	No change
December 3, 2014	10:00	No change
January 21, 2015	10:00	-0.25%
March 4, 2015	10:00	No change
April 15, 2015	10:00	No change
May 27, 2015	10:00	No change
July 15, 2015	10:00	-0.25%
September 9, 2015	10:00	No change
October 21, 2015	10:00	No change
December 2, 2015	10:00	No change
January 20, 2016	10:00	No change
March 9, 2016	10:00	No change
April 13, 2016	10:00	No change
May 25, 2016	10:00	No change
July 13, 2016	10:00	No change
September 7, 2016	10:00	No change
October 19, 2016	10:00	No change
December 7, 2016	10:00	No change
January 18, 2017	10:00	No change
March 1, 2017	10:00	No change
April 12, 2017	10:00	No change
May 24, 2017	10:00	No change
July 12, 2017	10:00	+0.25%
September 6, 2017	10:00	+0.25%
October 25, 2017	10:00	No change
December 6, 2017	10:00	No change
January 17, 2018	10:00	+0.25%
March 7, 2018	10:00	No change
April 18, 2018	10:00	No change
May 30, 2018	10:00	No change
July 11, 2018	10:00	+0.25%
September 5, 2018	10:00	No change
October 24, 2018	10:00	+0.25%
December 5, 2018	10:00	No change

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Table 2 – continued from previous page

Date	Time (ET)	Policy Rate Change
January 9, 2019	10:00	No change
March 6, 2019	10:00	No change
April 24, 2019	10:00	No change
May 29, 2019	10:00	No change
July 10, 2019	10:00	No change
September 4, 2019	10:00	No change
October 30, 2019	10:00	No change
December 4, 2019	10:00	No change
January 22, 2020	10:00	No change
March 4, 2020	10:00	-0.50%
April 15, 2020	10:00	No change
June 3, 2020	10:00	No change
July 15, 2020	10:00	No change
September 9, 2020	10:00	No change
October 28, 2020	10:00	No change
December 9, 2020	10:00	No change
January 20, 2021	10:00	No change
March 10, 2021	10:00	No change
April 21, 2021	10:00	No change
June 9, 2021	10:00	No change
July 14, 2021	10:00	No change
September 8, 2021	10:00	No change
October 27, 2021	10:00	No change
December 8, 2021	10:00	No change
January 26, 2022	10:00	No change
March 2, 2022	10:00	+0.25%
April 13, 2022	10:00	+0.50%
June 1, 2022	10:00	+0.50%
July 13, 2022	10:00	+1.00%
September 7, 2022	10:00	+0.75%
October 26, 2022	10:00	+0.50%
December 7, 2022	10:00	+0.50%
January 25, 2023	10:00	+0.25%
March 8, 2023	10:00	No change
April 12, 2023	10:00	No change
June 7, 2023	10:00	+0.25% to 5.75%
July 12, 2023	10:00	+0.25% to 6.00%

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Table 2 – continued from previous page

Date	Time (ET)	Policy Rate Change
September 6, 2023	10:00	No change
October 25, 2023	10:00	No change
December 6, 2023	10:00	No change
January 24, 2024	10:00	No change
March 6, 2024	10:00	No change
April 10, 2024	10:00	No change
June 5, 2024	10:00	-0.25%
July 24, 2024	10:00	-0.25%
September 4, 2024	10:00	-0.25%

Source: Bank of Canada Monetary Policy Decisions (https://www.bankofcanada.ca/core-functions/monetary-policy/key-interest-rate/)

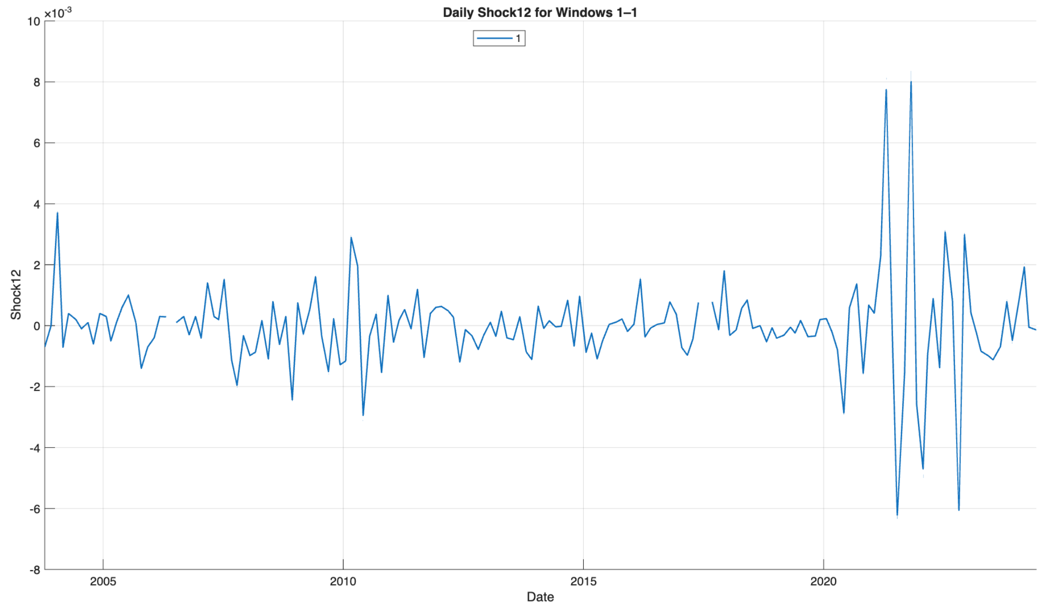

Figure 11: Shock 12

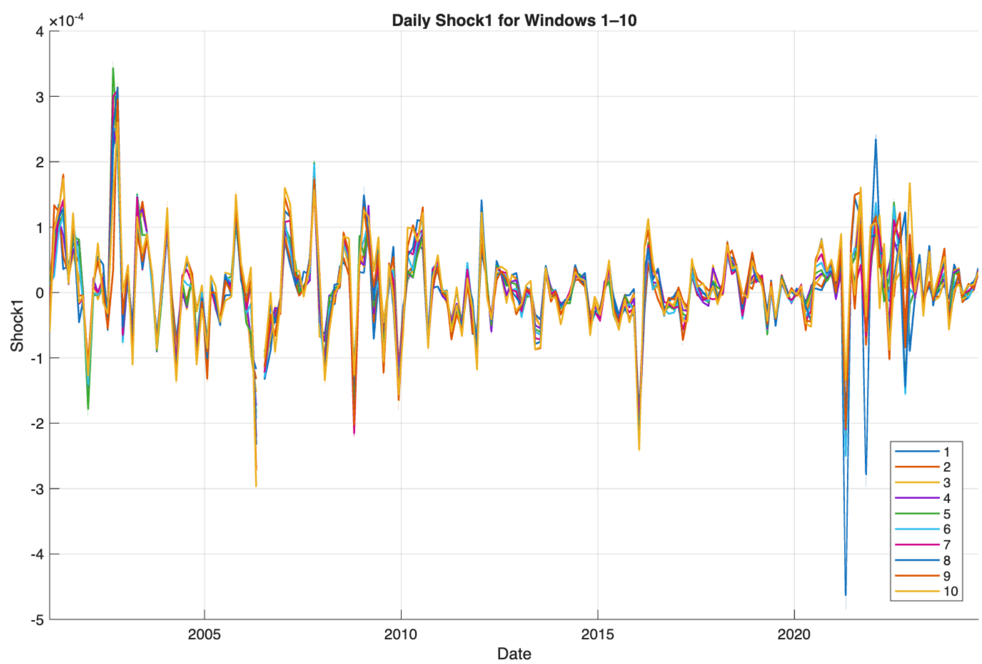

Figure 12: Shock 1- Trim 1-10

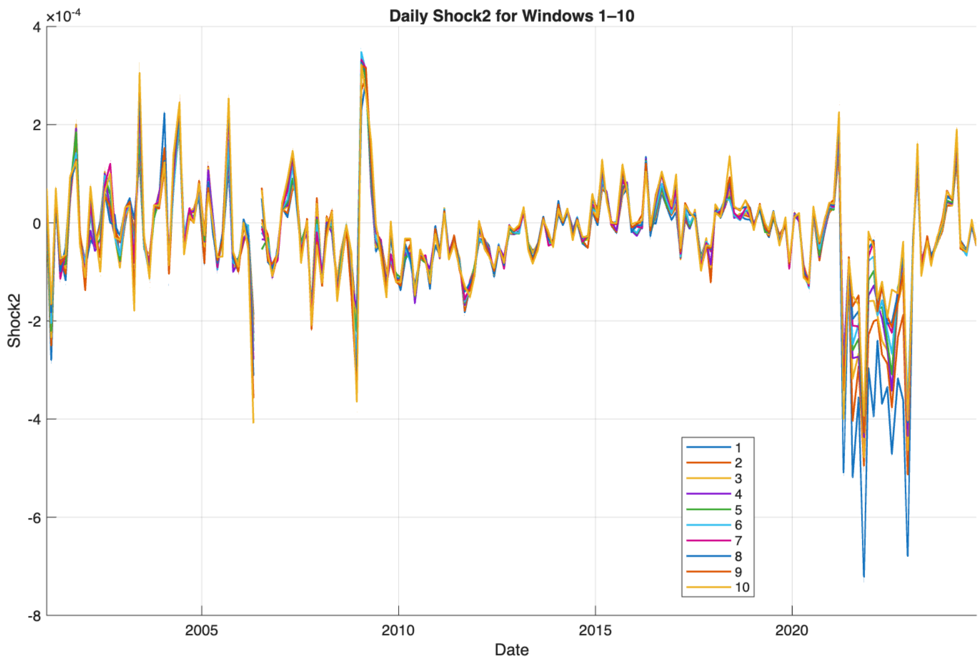

Figure 13: Shock 2- Trim 1-10

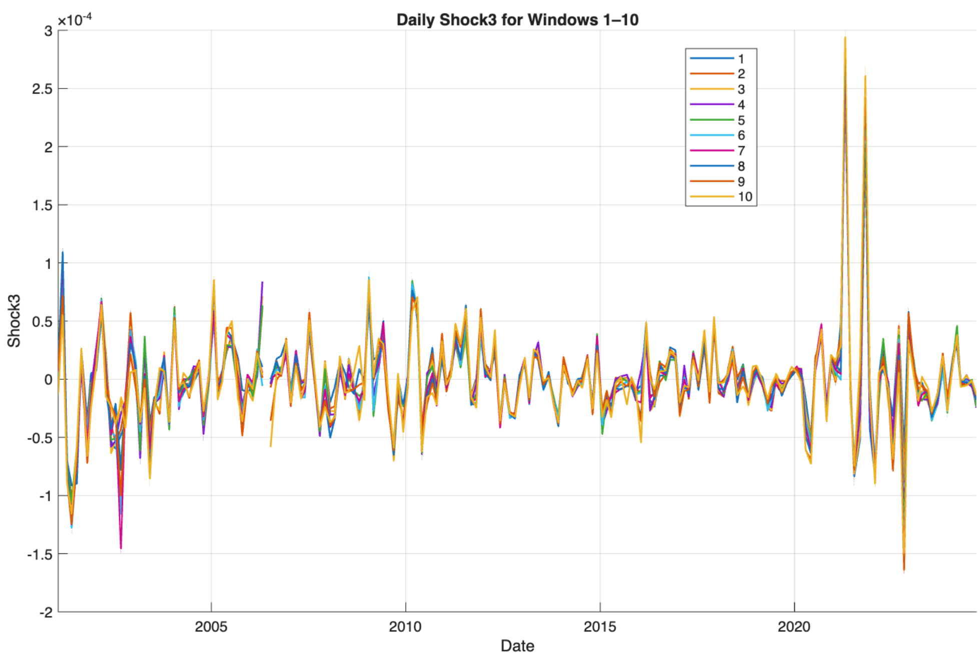

Figure 14: Shock 3- Trim 1-10

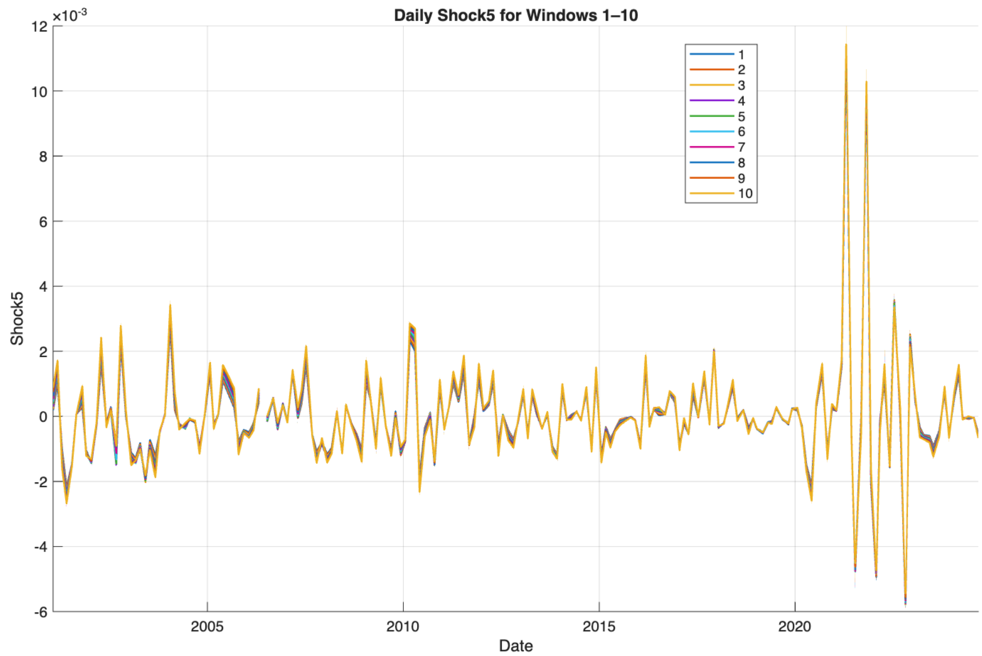

Figure 15: Shock 5- Trim 1-10

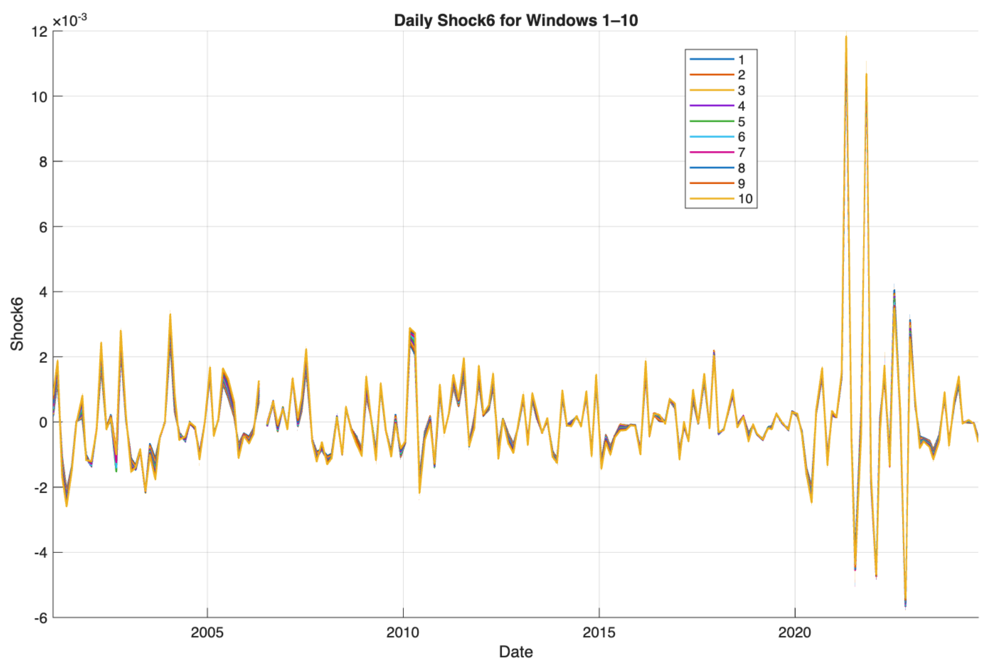

Figure 16: Shock 6- Trim 1-10

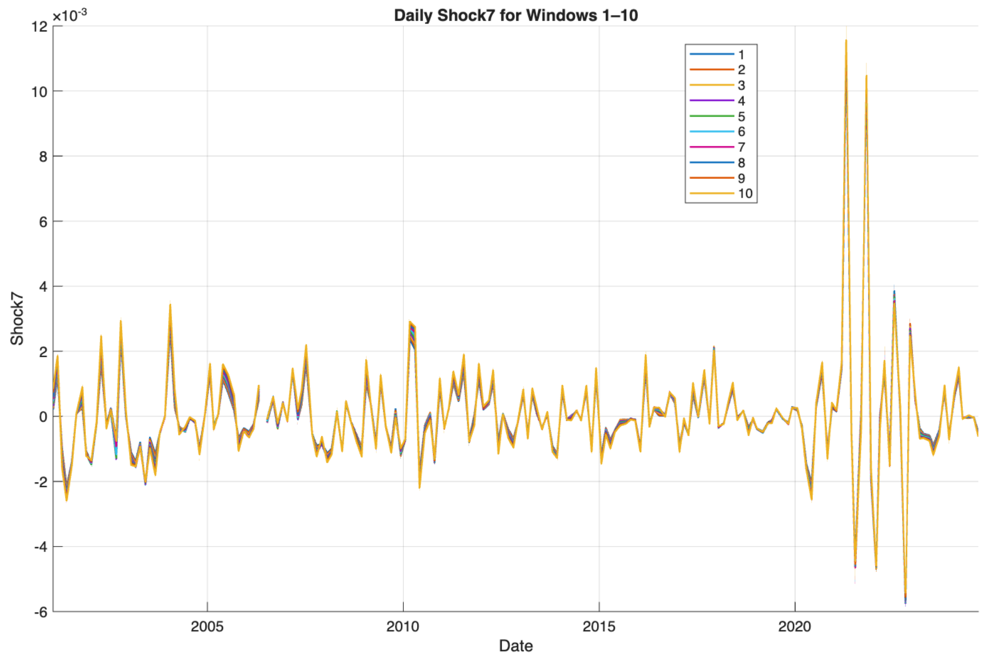

Figure 17: Shock 7- Trim 1-10

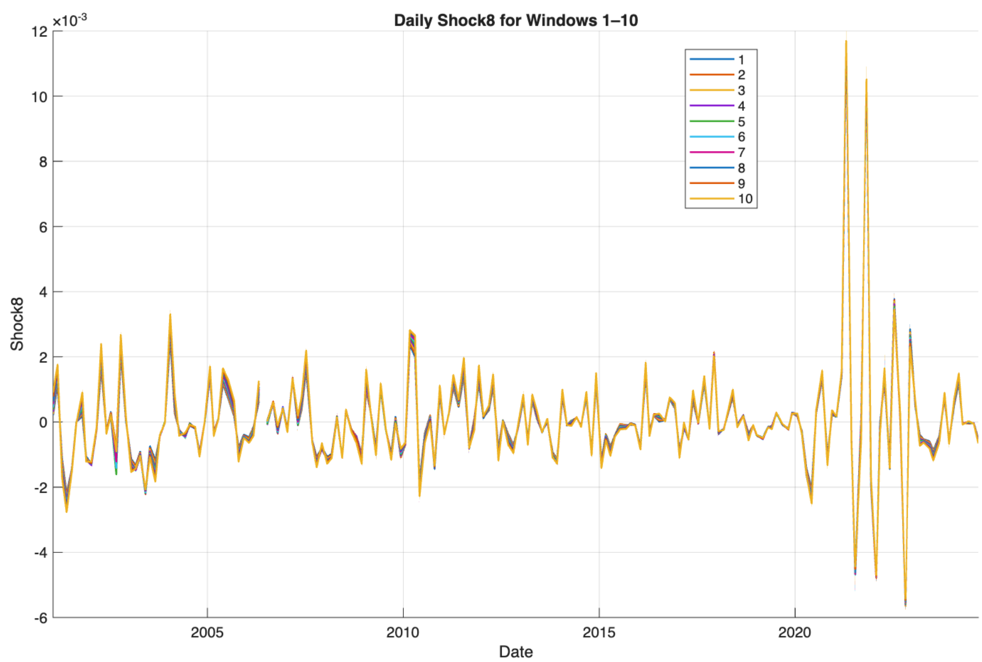

Figure 18: Shock 8- Trim 1-10

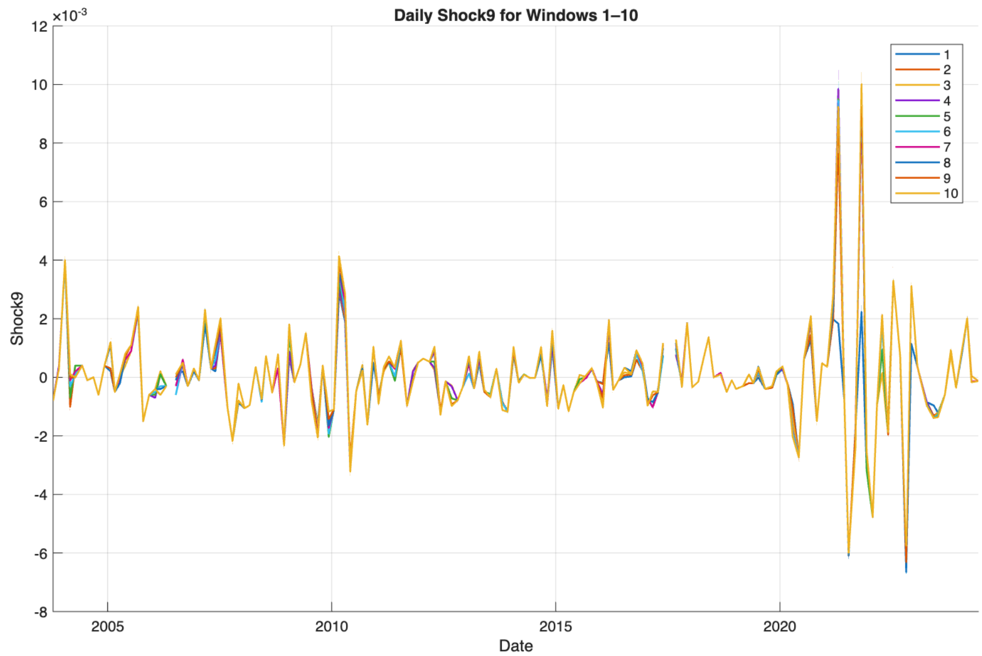

Figure 19: Shock 9- Trim 1-10

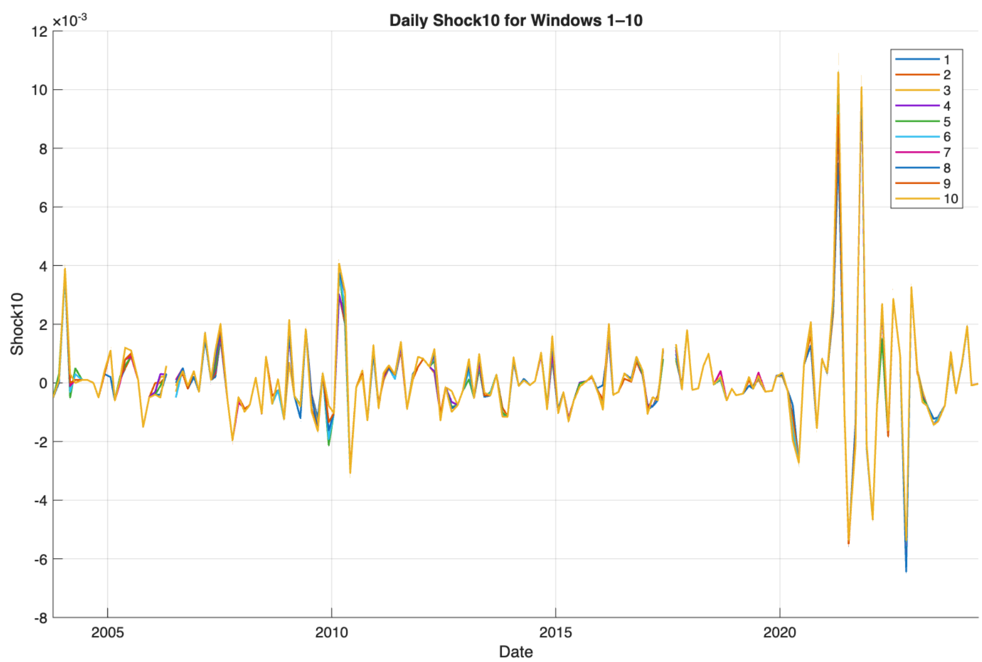

Figure 20: Shock 10- Trim 1-10

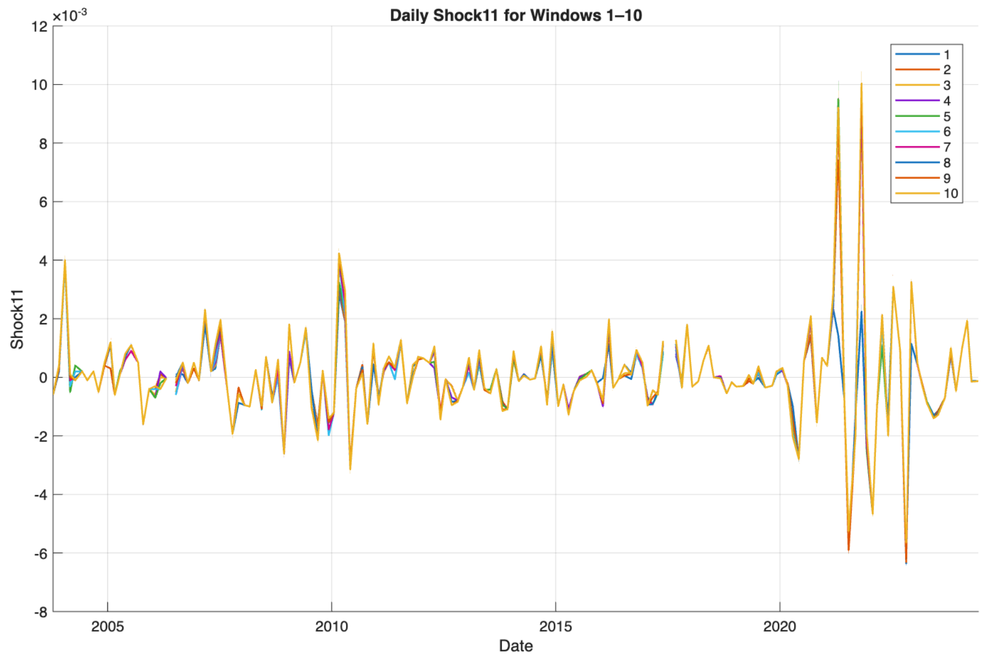

Figure 21: Shock 11- Trim 1-10

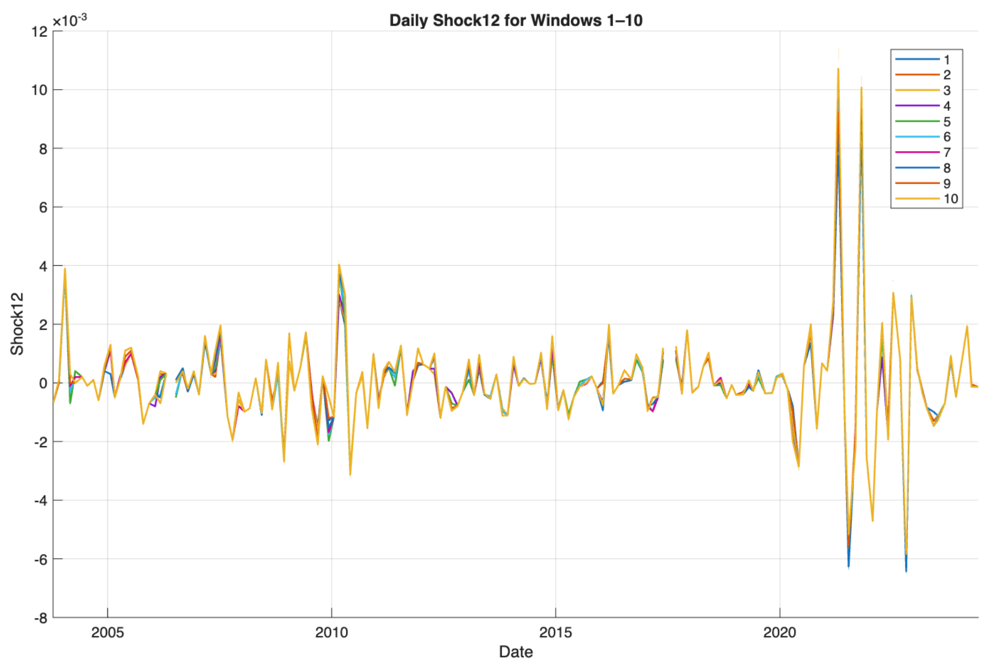

Figure 22: Shock 12- Trim 1-10