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Economy and Their Impact on Monetary
Policy Surprises**

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Abstract

This paper studies the macroeconomic effects of global risk shocks (GRS) in a small open economy and their implications for the identification of monetary policy shocks. I construct a novel proxy for GRS based on unexpected daily innovations in the VIX and employ it as an external instrument in a proxy-SVAR for Canada. The advantage of this proxy is that, by exploiting the safe-haven role of the U.S. dollar, it identifies the effects of GRS using only domestic endogenous variables, without imposing restrictions or relying on global aggregates or narratively selected events. GRS that depreciate the Canadian dollar, tighten financial conditions, reduce asset prices, output, and prices, inducing an expansionary monetary policy response. I provide evidence that high-frequency (HF) monetary policy surprises partly reflect endogenous, risk-driven deviations between policy actions and market expectations. Ignoring GRS can lead to an overestimation of monetary policy effects obtained using HF identification.

Keywords: global risk shocks, small open economy, proxy-SVAR, monetary policy surprises

JEL Codes: E52, F41, F42, F44

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1 Introduction

Spikes in global financial risk shape macroeconomic dynamics worldwide. They tighten financial conditions, appreciate the U.S. dollar, and depress real activity through contractions in cross-border lending and rising credit spreads. Because of the safe-haven role of the U.S. dollar, investors reallocate toward dollar-denominated assets during periods of heightened global volatility, causing many small open economy (SOE) currencies to depreciate against the USD and domestic credit conditions to tighten.

While the effects of global risk shocks (GRS) have been studied extensively using panel methods, global factor models, and multi-country VARs, their identification for a specific SOE using an external-instrument proxy-SVAR remains largely unexplored. This paper fills that gap using Canadian data. Canada offers a suitable setting, as its economy is tightly integrated with U.S. financial markets yet small enough to take global risk conditions as exogenous, allowing for a clean identification of GRS transmission.

Measuring GRS in a single SOE remains empirically challenging. Existing approaches typically rely on global aggregates included directly in the VAR, impose cross-country restrictions, or identify risk and uncertainty shocks narratively using selected episodes.¹ These strategies are often less well suited for SOEs, where domestic variables may respond strongly to global risk even outside large events.

In this paper, I construct a novel proxy for GRS using unexpected high-frequency (HF) innovations in the CBOE VIX index—an options-implied, forward-looking measure of expected U.S. equity volatility that co-moves with the global financial cycle (Rey, 2015). The resulting proxy is relevant, unexpected, and orthogonal to other global shocks. Its advantage is that it allows to identify the effects of GRS in a VAR that includes only domestic endogenous variables, without imposing restrictions or relying on global aggregates or narrative selected events. I use this proxy as an external instrument in a proxy-SVAR, where

¹Moreover, existing proxy-SVAR applications focus primarily on large economies or groups of countries rather than individual SOEs (e.g., Piffer and Podstawski; Georgiadis et al., 2024).

identification exploits the safe-haven role of the U.S. dollar by targeting residuals from the CAD/USD exchange rate in the first stage. This setting allows me to study both the macroeconomic effects of GRS in a SOE and their implications for the identification of monetary policy shocks.

Contribution. This paper has two main contributions. First, it develops a novel global risk shock proxy tailored to a SOE and proposes a proxy-SVAR identification strategy that exploits residuals from exchange rate. This approach identifies GRS effects using only domestic variables, without imposing restrictions, and captures richer time variation than narrative measures, enabling more precise inference on the transmission of GRS shocks and their interaction with monetary policy surprises. Second, the paper provides evidence that HF-identified monetary policy surprises partly reflect endogenous, risk-driven deviations between central bank actions and market expectations, implying that standard HF identification may overestimate the effects of monetary policy.

Preview of results. At the daily frequency, unexpected VIX innovations predict movements in the Toronto Stock Exchange, with no evidence of reverse causality. When aggregated to the monthly frequency, these innovations also lead the CAD/USD exchange rate and remain unanticipated by other macroeconomic variables. Granger-causality and correlation tests across a wide set of domestic and global macro-financial variables indicate that the proxy is largely unexpected and orthogonal to other global shocks, supporting its interpretation as a credible measure of GRS for Canada.

GRS generate economically meaningful effects: they simultaneously depreciate the Canadian dollar respect to the USD, tighten financial conditions, reduce asset prices, output, and the price level, and elicit an expansionary monetary policy response. The GRS proxy is also correlated with Canadian HF-identified monetary policy surprises (MPS). Given that Canada is a SOE, it is unlikely that Canadian monetary policy affects global risk. Instead, global risk conditions may influence domestic MPS. Consequently, I remove the GRS compo-

ment from HF-identified MPS. Once this component is removed, estimated monetary policy effects on real variables are smaller and more consistent with standard SOE predictions: responses of risk-sensitive financial variables are attenuated, while exchange-rate transmission strengthens and becomes significant. I provide additional evidence suggesting that GRS load onto HF-identified MPS, as market participants overestimate the monetary policy reaction to high risk episodes.

Related literature. The first related strand of the literature studies the macro-financial effects of global risk and uncertainty shocks. Christiano et al. (2014), Leduc and Liu (2016), and Georgiadis et al. (2024) show that increases in global risk tighten financial conditions and depress real activity. Georgiadis et al. (2024) further document an appreciation of the U.S. dollar—consistent with its safe-haven role—and a contraction in cross-border bank lending. Complementing this evidence, Bruno and Shin (2015), Kekre and Lenel (2021), and Jiang et al. (2024) emphasize the role of global liquidity, intermediary balance sheets, and international lending flows in amplifying the transmission of risk shocks across countries. Mendicino and Zhang (2018) show in a Canada-calibrated DSGE model that risk shocks lower output, widen risk premia, and call for an expansionary monetary policy response.

Within this literature, the VIX is a widely used benchmark for global financial risk and volatility expectations (Bloom, 2009; Whaley, 2000; Bekaert and Hoerova, 2014). Caballero and Kamber (2019) identify global risk-off episodes using large deviations in an HP-filtered weekly VIX series as a GRS proxy, an approach designed to study risk shocks for the U.S. economy and other large economies or economic aggregates. Although informative, this identification assumes that only large VIX deviations are exogenous and does not formally assess the predictability or orthogonality of the proxy with respect to other structural disturbances.

The present paper contributes to this literature by providing new empirical evidence on the transmission of GRS to the Canadian economy, which is closely integrated with a safe-haven country. To do this, using Canada as a case study, I construct a global risk proxy from unexpected daily innovations in the VIX that is explicitly designed for identification in

a SOE setting. Unlike event-based approaches that focus on large realizations, the proposed proxy captures systematic variation in global risk relevant for a SOE.

A second strand of the literature develops identification strategies based on external instruments and proxy-SVARs. Narrative approaches have been applied to tax shocks (Mertens and Ravn, 2014), while HF-identification of monetary policy shocks has been pioneered by Gertler and Karadi (2015). Känzig (2021) extends this framework to oil-supply news shocks, and Sekkel and Champagne (2018), as well as Soosalu (2024), apply similar methods to Canadian monetary policy. Georgiadis et al. (2024) use a HF-narrative-based proxy to identify GRS effects by separating the U.S. from an aggregated group of other economies. Existing GRS proxies used in proxy-SVARs—such as in Piffer and Podstawski (2018)—are designed to target global volatility measures directly. When the objective is to study a specific SOE, applying these proxies requires either including global variables in the VAR—leading to high-dimensional systems with usually cross-country exclusion restrictions—or relying on domestic variables while targeting domestic residuals with the proxy. I assess these approaches using their narrative HF-proxy and show that the resulting impulse responses are imprecise and economically uninformative (see *Figures 15*, *16* and *17* in *Appendix B*).

The global risk shock proxy developed in this paper resolves these limitations by allowing identification to be conducted using only domestic variables while providing a continuous monthly measure of global risk that captures richer variation than proxies based on large deviations or narratively selected events. At the same time, the proxy remains strongly correlated with a theoretically appropriate and empirically powerful target—the exchange-rate residual—reflecting the safe-haven role of the U.S. dollar. As a result, this identification yields statistically precise impulse response functions that align closely with theoretical predictions, offering a coherent characterization of global risk transmission in Canada.

Outline. Section 2 presents the identification strategy and the construction of the GRS proxy. Section 3 provides an empirical validation of the proxy, assessing its relevance, unexpectedness, and exogeneity. Section 4 examines the interaction between GRS and MPS,

including their implications for the identification of monetary policy effects and the channel through which global risk interferes with it. Section 5 concludes.

2 Identification of structural global risk shock

The identification goal of this paper is to isolate and estimate the causal effects of global risk shocks (GRS)—unexpected, exogenous changes in global volatility expectations—on the Canadian exchange rate, financial conditions, and the broader economy.

The main identification challenge is to construct a proxy for GRS that is both relevant and exogenous for Canada. Relevance requires the proxy to be systematically correlated with the underlying structural GRS. Exogeneity requires the proxy to be orthogonal to other structural shocks and not anticipated.

To address these challenges, the paper exploits two established empirical regularities. (i) During global financial stress episodes, the U.S. dollar acts as a safe-haven currency, appreciating against most others; thus, higher global risk is associated with Canadian dollar depreciation and tighter financial conditions. (ii) The VIX index, which reflects expectations of future stock-market volatility, offers a natural indicator of global financial risk. Although it is not identical to global risk itself, it provides a high-frequency, market-based measure of shifts in global risk appetite (Rey, 2015). Unexpected innovations in the VIX—residuals from an autoregressive model—are treated as an instrument (proxy) for GRS, since a SOE like Canada cannot systematically influence them.

These VIX innovations, which lead exchange rate and equity market movements rather than follow them, are interpreted as unanticipated changes in global financial expectations. They are used as an external instrument for the unobserved GRS in a proxy-SVAR framework. Canadian and U.S. financial and macroeconomic variables do not predict these innovations, underscoring their orthogonality to domestic conditions and confirming that they represent unanticipated changes in global risk sentiment.

The following section introduces the proxy-SVAR framework and describes the construction of the novel instrument used to identify GRS.

2.1 Empirical framework: proxy-SVAR

The identification strategy follows the proxy-SVAR methodology of Stock and Watson (2012) and Mertens and Ravn (2013), which I use to trace the dynamic responses of the Canadian economy to global risk shocks. Consider the reduced-form VAR of order p :

$$y_t = b + B_1 y_{t-1} + \dots + B_p y_{t-p} + u_t, \quad (1)$$

where y_t is an $n \times 1$ vector of endogenous variables ($n = 8$), including the exchange rate, the one-year Treasury bill rate, the consumer price index, output, domestic uncertainty, the mortgage spread, the corporate spread, and the Toronto Stock Exchange index. The vector u_t collects reduced-form innovations with covariance matrix $\Sigma = \text{Var}(u_t)$.

I assume that reduced-form residuals are related to structural shocks through a linear mapping, $u_t = S\varepsilon_t$, where S is a nonsingular $n \times n$ structural impact matrix and ε_t is a vector of mutually uncorrelated structural shocks, $\text{Var}(\varepsilon_t) = \Omega$, with Ω diagonal. It follows that $\Sigma = S\Omega S'$. Let the first structural shock correspond to a GRS, denoted ε_t^{GR} . Writing s^1 for the first column of S and s^y for the remaining columns, the reduced-form residuals can be expressed as $u_t = s^1 \varepsilon_t^{GR} + s^y \varepsilon_t^y$, where ε_t^y collects the remaining structural disturbances. To identify s^1 , we employ an external instrument Z_t , which satisfies the standard conditions:

$$\mathbb{E}[Z_t \varepsilon_t^{GR}] = c \neq 0 \quad (\text{relevance}), \quad (2)$$

$$\mathbb{E}[Z_t \varepsilon_t^j] = 0 \quad \forall j \neq GR \quad (\text{exogeneity}). \quad (3)$$

These conditions ensure that the instrument is correlated with the global risk shock and orthogonal to all other structural shocks.

First stage. The exchange-rate (ER) residual, denoted u_{1t} , is used as the target variable. Estimating the regression $u_{1t} = \hat{\beta}Z_t + \xi_{1t}$, leads to $\hat{\beta} = \frac{\text{Cov}(u_{1t}, Z_t)}{\text{Var}(Z_t)} = \frac{s_{11}c}{\text{Var}(Z_t)}$, where ξ_{1t} denotes a mean-zero error term, s_{11} is the contemporaneous impact of the global risk shock on the ER, and $c \equiv \text{Cov}(\varepsilon_t^{GR}, Z_t)$. Thus, the first stage identifies the ER response to the global risk shock up to a scale factor on impact.

Second stage. For each variable $i \neq 1$, I estimate $u_{it} = \gamma_i \widehat{u}_{1t} + \xi_{it}$. Under the relevance and exogeneity conditions, the OLS estimate $\widehat{\gamma}_i$ identifies the ratio of contemporaneous responses,

$$\widehat{\gamma}_i = \frac{s_{i1}}{s_{11}}, \quad (4)$$

that is, the response of variable i to the GRS relative to the ER response. Normalizing the contemporaneous effect of the GRS on the ER to unity, $s_{11} = 1$, identifies the column of the structural impact matrix associated with ε_t^{GR} . Under this normalization, the full vector of contemporaneous responses of all endogenous variables to GRS can be recovered.

2.2 Construction of a global risk shock proxy

As discussed above, the VIX is a widely used measure of global risk aversion and financial conditions. Moreover, Cormun and De Leo (2020) show that the dominant external shock driving exchange-rate fluctuations is strongly correlated with innovations in an autoregressive (AR) process for the VIX. Motivated by this insight, I construct a proxy for GRS using innovations from an AR specification of the daily VIX, isolating the unpredictable component of global risk sentiment. This approach is designed for identification in a SOE setting, where domestic shocks cannot systematically influence global financial conditions, allowing unexpected innovations in the VIX to be interpreted as exogenous global risk variation from the domestic perspective.

Using daily data from January 1, 2002, to December 31, 2019, I estimate an AR(14) model for the daily logarithmic change in the VIX, as selected by the Akaike Information Criterion.

The resulting one-step-ahead forecast errors, denoted u_d^{VIX} , are interpreted as unexpected innovations in global risk sentiment and form the basis of the GRS proxy. Specifically, the estimated model is given by

$$\Delta \ln(\text{VIX}_d) = \alpha + \sum_{i=1}^{14} \beta_i \Delta \ln(\text{VIX}_{d-i}) + u_d^{\text{VIX}}, \quad (5)$$

where u_d^{VIX} represents the deviation of the observed daily change in the VIX from its conditional expectation given information available up to day $d - 1$.

Monthly aggregation. I next map this HF series into a monthly instrument suitable for use in the proxy-SVAR. Aggregating HF surprises to the frequency of macroeconomic data is standard practice in the HF identification literature. Monthly proxy variables are commonly constructed by summing daily HF surprises over the course of a month (Gertler and Karadi, 2015; Kilian, 2023). More generally, high-frequency (HF) innovations are often aggregated using simple sums, smoothed series, or moving-average schemes and then used as proxies for unobserved structural shocks in VAR models. This aggregation helps mitigate timing distortions that arise when shocks occur near the end of the month. Some studies instead construct weighted averages that depend on the timing of observations within the month. Given that our data are available at the daily frequency, we rely on a moving-average specification. Accordingly, I first compute a daily moving average of the VIX forecast errors,

$$\tilde{u}_d^{\text{VIX}} = \frac{1}{K} \sum_{j=0}^{K-1} u_{d-j}^{\text{VIX}}, \quad (6)$$

where K denotes the average number of trading days in a month and u_d^{VIX} is the one-step-ahead forecast error from the AR(14) model. The monthly proxy for global risk shocks, $Z_t^{\text{G.Risk}}$, is then constructed by summing the smoothed daily forecast errors within each calendar month:

$$Z_t^{\text{G.Risk}} = \sum_{d \in m} \tilde{u}_d^{\text{VIX}}. \quad (7)$$

As a robustness check, I also construct a monthly global risk proxy using the simple sum of daily VIX forecast errors; the results remain robust (*see Figure 8 in Appendix B*).

3 Empirical validation of the global risk proxy

First, I establish that the daily and monthly VIX innovations satisfy the key properties required of a proxy for global risk shocks: they are unexpected at the daily frequency and remain unexpected once aggregated to the monthly frequency; they systematically capture information related to global risk sentiment; and they are empirically relevant. In particular, the series aligns closely with well-known episodes of heightened global risk and financial stress and, when used as an external instrument, generates impulse responses that are consistent with theoretical predictions and DSGE-based evidence for Canada. Second, I examine the orthogonality of the proxy with respect to other global structural shocks. Although VIX innovations are intended to capture GRS, a priori they may reflect a linear combination of other underlying shocks.

3.1 Unexpectedness and information content

Autocorrelation. A necessary condition for the validity of the proxy is the absence of serial dependence. I analyze this condition using the autocorrelation function (ACF) of the daily VIX innovations over 60 lags, corresponding to the horizon implied by the baseline proxy-SVAR specification. Under the null of no autocorrelation, about 5% of sample autocorrelations are expected to be statistically significant by chance. Consistent with this, only two coefficients exceed the significance threshold, as shown in *Figure 1*. When the proxy is aggregated to the monthly frequency, the ACF shows no clear evidence of serial correlation at the 5% level (*see Figure 9 in Appendix B*). Taken together, these results indicate that the global risk shock proxy exhibits no statistically meaningful serial dependence.

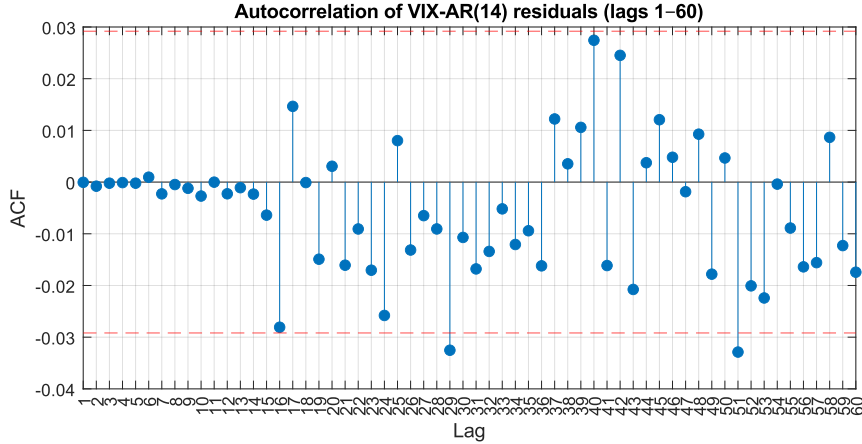


Figure 1: ACF VIX residuals of an AR(14) daily process. VIX is expressed as logarithmic differences.

Granger causality. To evaluate whether the proxy is unanticipated and relevant, I conduct Granger causality tests. Because daily data on the Toronto Stock Exchange (TSX) is available, the analysis is first performed using the proxy at the daily frequency. The results in *Figure 2* show that the proxy Granger-causes changes in TSX prices, while there is no evidence of causality in the reverse direction. This pattern is consistent with interpretation of the proxy as capturing exogenous shifts in global risk sentiment that affect domestic financial markets.

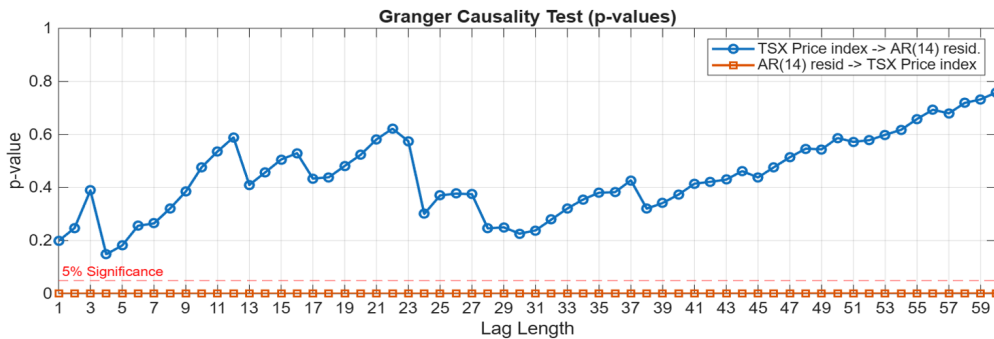


Figure 2: Results from Granger causality tests between a daily global risk proxy and the log-differenced Toronto Stock Exchange price index, based on matched daily data from 2002 to 2019.

To test whether the proxy is predictable from macroeconomic and financial conditions at the monthly frequency, I conduct Granger causality tests using the simple monthly sum of daily VIX innovations. This choice isolates the information content of the proxy at the monthly horizon and avoids mechanical predictability induced by smoothing. Table 1

reports the results. No variable Granger-causes the proxy at the 5% significance level. At very close the 10% level, the TSX exhibits Granger causality; however, this effect is absent at the daily frequency and is therefore likely driven by temporal aggregation rather than genuine predictability. Overall, neither individual variables nor their joint inclusion display systematic predictive power for the monthly proxy.

Table 1: Monthly Granger causality tests for the global risk proxy

Variable	p-value
Industrial Production (U.S.)	0.196
Economic Policy Uncertainty	0.657
Toronto Stock Exchange	0.099
BAA Credit Spread (U.S.)	0.111
1-Year Treasury Bill (U.S.)	0.402
1-Year Treasury Bill (Canada)	0.633
Excess Bond Premium (U.S.)	0.230
Unemployment Rate (U.S.)	0.408
VIX (U.S.)	0.650
VXO (U.S.)	0.365
Exchange Rate (CAD/USD)	0.275
Joint (All Controls)	0.228

Notes: The proxy is constructed as the monthly sum of daily VIX innovations. All variables are rendered stationary prior to testing: series are demeaned when stationary in levels and first-differenced otherwise. The tests include a constant as the only deterministic term and use 12 monthly lags.

Additionally, the Granger causality test in *Figure 3* shows that the CAD/USD exchange rate responds to the smoothed monthly proxy, while the proxy is not anticipated by exchange rate movements, supporting its interpretation as unanticipated.

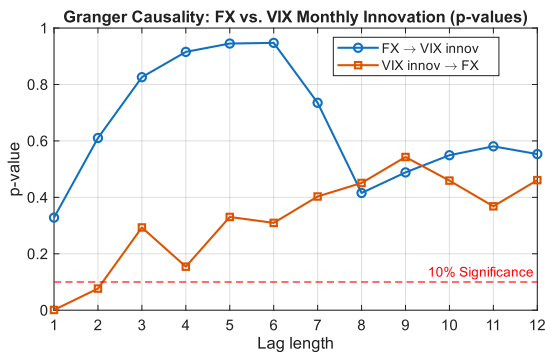


Figure 3: Granger causality test between daily VIX innovations aggregated to monthly frequency (smoothed) and the CAD/USD exchange rate (FX).

Relevance. To provide further evidence that this measure contains relevant information about GRS, I plot the time series in *Figure 4* and highlight its peaks alongside well-known episodes of heightened global risk. It aligns closely with these events, indicating that it captures major shifts in global risk sentiment. Importantly, it reflects not only U.S.-related shocks but also episodes originating in other countries. For this reason, it is interpreted as a proxy for GRS.

Monthly global risk proxy and major risk events

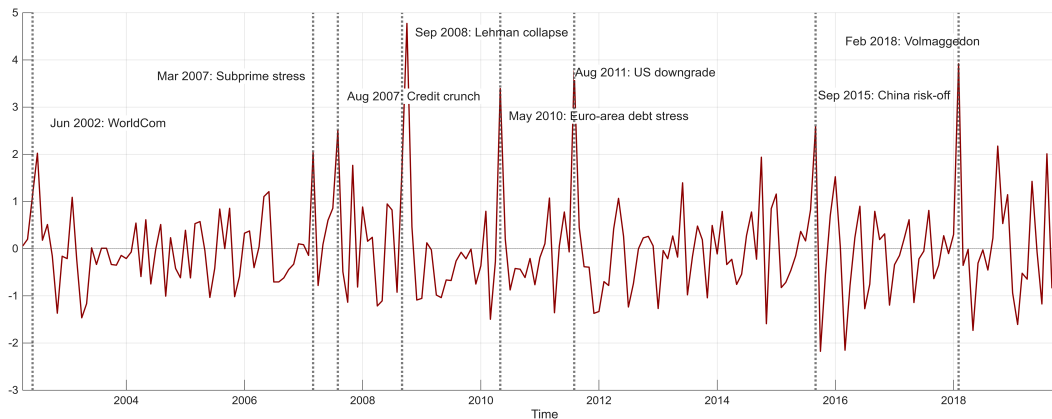


Figure 4: Vertical dashed lines indicate global financial stress events: WorldCom (June 2002), subprime mortgage stress (March 2007), credit crunch (August 2007), the Lehman Brothers (September 2008), euro-area debt stress (May 2010), the U.S. downgrade (August 2011), the China risk-off episode (September 2015), and Volmageddon (February 2018).

I then employ the proxy as an instrument under the proxy-SVAR framework. I target the residual from the exchange-rate equation in the first stage. The proposed instrument exhibits a strong correlation with this residual, yielding conventional first-stage F-statistics of 41^2 , well above the Stock and Yogo (2002) threshold of 10.

The set of variables follows standard monetary policy VAR specifications for the Canadian economy. Details on data sources, variable construction, and lag selection are provided in *Appendix A*. The baseline specification augments the system with the TSX, as stock exchange variables are commonly used in global risk analyses, and the Canadian Economic Policy

²In addition, I compute the implied first-stage F – statistic, based on the estimated signal-to-noise ratio of the proxy. This implied F – statistic equals 208, indicating that the instrument is far from weak. Together, these results provide strong evidence that the proposed proxy systematically captures information about global structural risk shocks.

Uncertainty (EPU) index. The inclusion of the EPU serves as a robustness check and does not affect the estimated impulse responses. For completeness, *Appendix B* reports impulse responses from specifications excluding the EPU in *Figure 14*, which remain nearly identical to the baseline, along with additional robustness exercises using alternative lag-lengths *Figures 10 to 13*. I now present the baseline results. *Figure 5* reports the Canadian impulse responses to a global risk shock, normalized to increase the CAD/USD exchange rate by 5 pp.

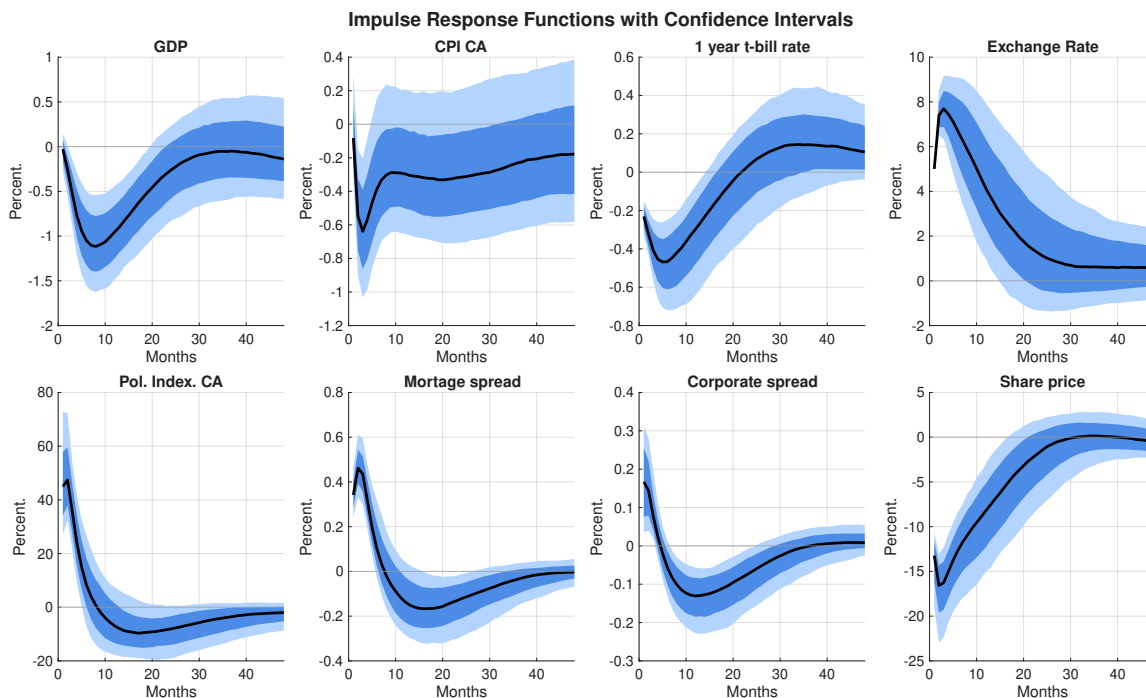


Figure 5: Baseline model. First stage regression: F : 41 and F -robust: 20.7. Percentage response to a global risk shock that increases the exchange rate $E_{CAD/USD}$ by 5% (depreciation of Canadian Dollar). Both 68 (dark blue) and 90% (light blue) confidence intervals are included using the moving block bootstrap (Jentsch and Lunsford, 2022) with 1000 replications. The black line represents the median response.

The resulting impulse responses behave as expected and are consistent with the predictions of the DSGE model calibrated to the Canadian economy by Mendicino and Zhang (2018). Output declines, prices fall, and monetary policy eases in response to the shock. Risk-sensitive financial variables display dynamics consistent with heightened global risk, while the TSX share price index experiences a sharp decline. Moreover, the historical decompositions reported in *Figure 19* in *Appendix C* show that the identified shock—captured by the proposed proxy—contributes meaningfully to observed fluctuations.

3.2 Exogeneity with respect to other global shocks

Formally, daily unexpected VIX innovations may reflect a linear combination of several structural global shocks. In particular,

$$u_d^{\text{VIX}} = \omega_1 \varepsilon_d^{\text{Risk}} + \omega_2 \varepsilon_d^{\text{U.S. MPS}} + \omega_3 \varepsilon_d^{\text{Demand}} + \omega_4 \varepsilon_d^{\text{Oil}} + \omega_5 \varepsilon_d^{\text{ECB MPS}} + \xi_d, \quad (8)$$

where $\varepsilon_d^{\text{Risk}}$ denotes the global risk shock, $\varepsilon_d^{\text{U.S. MPS}}$ captures U.S. monetary policy shocks, $\varepsilon_d^{\text{Demand}}$ represents global demand shocks, $\varepsilon_d^{\text{Oil}}$ denotes oil price shocks, $\varepsilon_d^{\text{ECB MPS}}$ captures euro area monetary policy shocks, and ξ_d is an idiosyncratic disturbance. Thus, a priori, daily VIX innovations—which form the building block of the GRS proxy—could systematically contain information about other standard global shocks. The objective of this section is to provide evidence that the contribution of these non-risk shocks is negligible, implying

$$u_d^{\text{VIX}} \approx \omega_1 \varepsilon_d^{\text{Risk}} + \xi_d.$$

Under this condition, daily VIX innovations and their monthly aggregation satisfy the defining property of a valid proxy for GRS. I begin by examining the correlation between the proposed GRS proxy and available proxies for U.S. and euro area monetary policy shocks, global demand shocks, and oil supply shocks. Results are reported in Table 2.

Table 2: **Correlation with other available global proxies**

Shock proxy	Coefficient	<i>p</i> -value
Oil supply news (Känzig, 2020)	0.0030	0.5767
U.S. monetary policy shock (Bauer and Swanson, 2023)	-0.0706	0.6815
ECB monetary policy shock (Jarocinski and Karadi, 2020)	-0.3052	0.1225

All *p*-values are above the 10 percent significance threshold, indicating that the GRS proxy does not systematically embed information from these alternative structural shocks. When $Z_t^{G.Risk}$ from equation (7) is regressed on the full set of available proxies, none of the coefficients is statistically significant, and the adjusted R^2 is -0.0004, indicating no explana-

tory power.

A remaining concern is potential contamination from aggregate demand shocks, for which no direct external proxy is available. To address this, I perform an exercise that conditions on proxies for global risk, oil supply, and monetary policy shocks, including the monetary policy proxy of Soosalu (2024).³ The residual variation in Canadian output that remains after conditioning on these controls is interpreted as capturing aggregate demand disturbances. Formally, I assume that the reduced-form Canadian GDP residual from the VAR satisfies

$$U_t^{GDP} = \beta_1 \varepsilon_t^{Demand} + \beta_2 \varepsilon_t^{Risk} + \beta_3 \varepsilon_t^{Oil} + \beta_4 \varepsilon_t^{U.S. MPS} + \beta_5 \varepsilon_t^{Can. MPS} + \beta_6 \varepsilon_t^{ECB MPS} + \eta_t^{GDP}, \quad (9)$$

where η_t^{GDP} is noise. For all shocks except demand, observable proxies are available and satisfy $z_t^j = c_j \varepsilon_t^j + \nu_t^j$, $j \in \{\text{Risk, Oil, U.S. MPS, Can. MPS, ECB MPS}\}$, with $c_j \neq 0$ and $\mathbb{E}[\nu_t^j] = 0$, where ν_t^j denotes measurement noise orthogonal to the structural shocks.

Substituting these proxy representations into the GDP residual yields the operational equation $U_t^{GDP} = \beta_1 \varepsilon_t^{Demand} + \sum_j \frac{\beta_j}{c_j} z_t^j + \tilde{\eta}_t^{GDP}$, where $\tilde{\eta}_t^{GDP} \equiv \eta_t^{GDP} - \sum_j \frac{\beta_j}{c_j} \nu_t^j$ collects the original residual and proxy-specific measurement error.

Since all proxies z_t^j are observed, this representation can be estimated by regressing U_t^{GDP} on the full set of observable proxies. Under the assumption that the shocks in the decomposition exhaust the relevant structural drivers of output, the component of U_t^{GDP} orthogonal to all observed proxies isolates aggregate demand innovations. Letting \hat{U}_t^{GDP} denote this regression residual, one can obtain

$$z_t^{Demand} \equiv \hat{U}_t^{GDP} = \beta_1 \varepsilon_t^{Demand} + \tilde{\eta}_t^{GDP}, \quad (10)$$

which serves as an external instrument for demand shocks in a proxy-SVAR.

Using z_t^{Demand} as an instrument for global demand shocks and targeting the reduced-

³Under the SOE assumption, monetary policy surprises in Canada cannot systematically generate GRS. Accordingly. Next section addresses this in detail.

form GDP residual generates statistically highly significant impulse responses that display textbook demand-shock dynamics (see *Figure 18 Appendix C*). In sharp contrast to the GRS responses, risk-sensitive financial variables react only weakly, and the exchange rate does not show a depreciation—exhibiting instead a mild appreciation of the CAD. *Figure 6* illustrates these systematically different transmission patterns by comparing the median impulse responses to the recovered demand shock and to the proposed global risk shock. Together, these results suggest that the global risk proxy is also orthogonal to aggregate demand shocks and captures a distinct, exogenous source of variation.

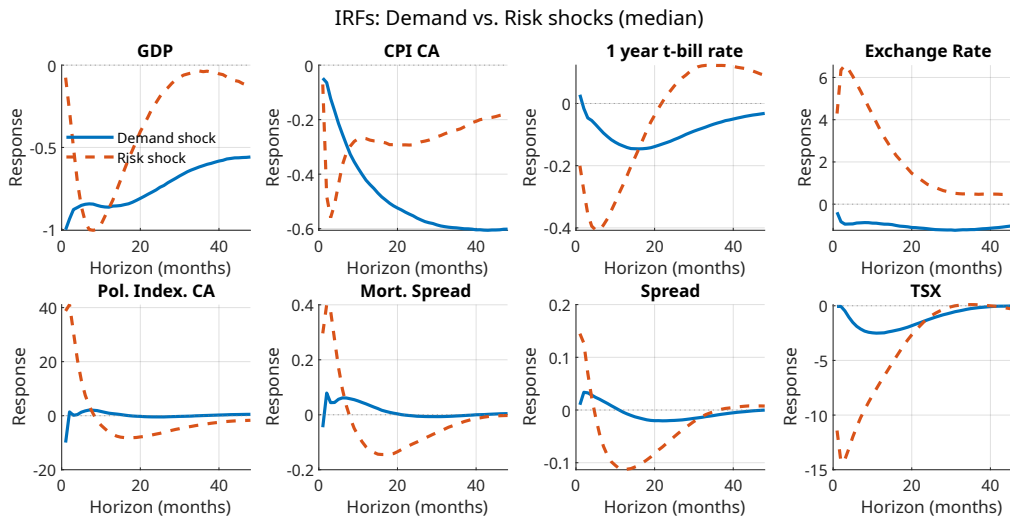


Figure 6: Median impulse responses to the recovered demand shock and the proposed global risk shock, based on 1000 *mbb* replications. Shocks are scaled so that the maximum decline in output equals 1 percent.

Strong exogeneity test. I test the exogeneity of the GRS proxy using the procedure developed by Bruns and Keweloh (2024) and implement the test using their publicly available code. The results, reported in *Table 4 in Appendix C*, indicate that the proxy satisfies the relevance and orthogonality conditions required for identification in a proxy-SVAR framework, providing further evidence that it captures exogenous GRS.

In conclusion, the results suggest that the proposed proxy is unexpected, relevant, and orthogonal to the main business-cycle driving forces⁴.

⁴Another concern is neutral TFP shocks. However, the literature finds that technological innovations are highly persistent and not the primary drivers of short-run output fluctuations (Basu et al., 2006).

4 Global risk and identification of monetary policy

In this section, I study how global risk shocks affect the identification of the effects of monetary policy shocks—by systematically influencing high-frequency (HF) monetary policy surprises (MPS). I argue that even at HF identification, MPS measures embed non-monetary components related to global risk.

I begin by showing that the impulse response functions of a restrictive monetary policy shock change substantially when the HF monetary policy shock proxy from Soosalu (2024)⁵ is orthogonalized with respect to a GRS proxy. The results indicate that this series contains global risk information and therefore does not isolate a pure monetary policy shock.

Then, using a similar framework as Jarocinski and Karadi (2020) and Soosalu (2025), I argue that global risk shocks affect MPS through imperfect market expectations of the central bank’s reaction to the accumulation of global risk shocks between policy announcements.

4.1 Global risk shock contamination

Identifying the causal effects of Canadian monetary policy requires purging high-frequency monetary policy shock proxies of global risk components. I do so by orthogonalizing the high-frequency monetary policy surprise series of Soosalu (2024) $-MP_t^{\text{Proxy}}$ with respect to the global risk proxy $-GR_t^{\text{Proxy}}$ using a single OLS regression estimated over the full sample period 2002–2019. Specifically, I estimate

$$MP_t^{\text{Proxy}} = \beta GR_t^{\text{Proxy}} + u_t, \tag{11}$$

⁵Soosalu (2024) constructs a high-frequency monetary policy shock using price changes in BAX2 futures—six-month Canadian Bankers’ Acceptance futures—measured within a narrow 30-minute window around Bank of Canada policy announcements.

where u_t is assumed to be i.i.d. I then define the global-risk-orthogonalized high-frequency monetary policy surprise as

$$MP_t^{\perp\text{Proxy}} = MP_t^{\text{Proxy}} - \hat{\beta}GR_t^{\text{Proxy}} = u_t. \quad (12)$$

This orthogonalized series is subsequently used as an external instrument in a proxy-SVAR targeting the one-year Canadian Treasury bill rate, following Soosalu (2024). Comparing impulse responses obtained with and without this orthogonalization allows me to quantify the extent to which global risk contaminates high-frequency monetary policy surprises.

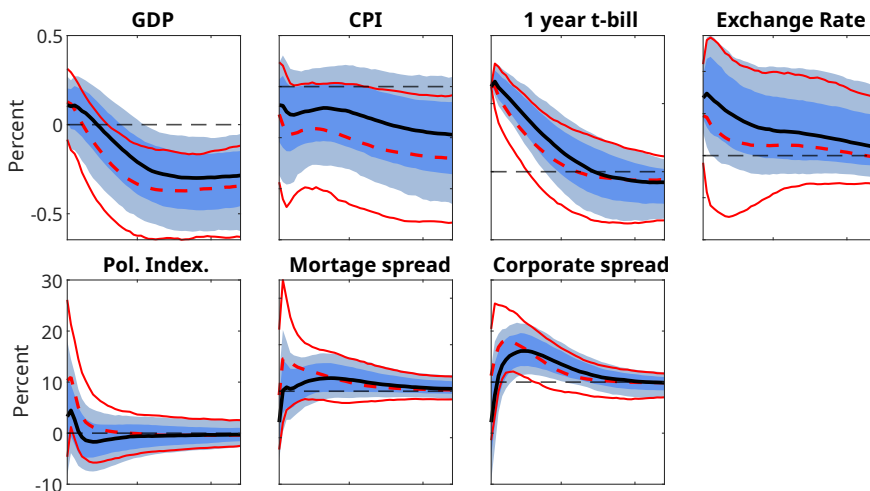


Figure 7: Percentage responses to a 25-basis-point contractionary monetary policy shock. The solid black line shows the median impulse response based on the risk-orthogonalized monetary policy shock proxy, with dark-blue and light-blue shaded areas denoting the 68% and 90% confidence intervals computed using a moving block bootstrap with 1000 replications. The red dashed line reports the median response obtained from the raw monetary policy shock proxy of Soosalu (2024), with red solid lines indicating its 90% confidence bands. The exchange rate is measured by the BIS effective exchange rate index, where an increase corresponds to an appreciation of the Canadian dollar. The sample period, variables, and lag structure follow Soosalu (2024), with two exceptions: the inclusion of the policy uncertainty index as a sanity check and the exclusion of the BAA spread, which a SOE such as Canada should not be able to systematically influence.

As shown in *Figure 7*, risk-sensitive variables such as spreads and uncertainty respond less once global risk innovations are purged from the monetary policy shock proxy. Notably, exchange rate effects become larger and statistically significant, indicating an appreciation of the Canadian dollar in line with standard SOE models. Overall, these results suggest that

conventional HF monetary policy surprises reflect a combination of monetary policy shocks and innovations to global risk conditions, thereby obscuring the transmission and strength of monetary policy. In specific, after this unexpected global risk innovations component is removed, the real effects of monetary policy become more modest: GDP and CPI responses are approximately 20% and 33% lower, respectively⁶.

4.2 Global risk shocks and monetary policy surprises

One central goal of monetary policy shock identification is to isolate *exogenous deviations from the policy rule* in order to recover the causal effects of monetary policy. A convenient way to formalize this idea is to view pure monetary policy shocks as deviations from a policy reaction function:

$$i_t = f(x_t, r_t) + \varepsilon_t^{\text{pure MP}}, \quad (13)$$

where i_t is the policy rate, $f(x_t, r_t)$ is the central bank's policy reaction function, r_t denotes global risk, x_t denotes information about the economic state excluding r_t , and $\varepsilon_t^{\text{pure MP}}$ is the pure monetary policy shock. Under HF-identification, the observed monetary policy surprise captures

$$\text{Surprise}_t = i_t - \mathbb{E}(i_t). \quad (14)$$

Market participants form expectations using a perceived policy rule $\hat{f}(\hat{x}_t, \hat{r}_t)$, where information about the state of the economy may differ from the central bank's information set ($\hat{x}_t \neq x_t$ and $\hat{r}_t \neq r_t$) and $\hat{f} \neq f$. Monetary policy surprises can therefore be written as

$$\text{Surprise}_t = \varepsilon_t^{\text{pure MP}} + f(x_t, r_t) - \hat{f}(\hat{x}_t, \hat{r}_t). \quad (15)$$

Thus, even under HF-identification, MPS may reflect a mixture of pure policy deviations and misperceptions of the central bank's policy reaction function.

⁶Soosalu (2024) reports impulse responses using 68% confidence intervals; under this criterion, CPI responses remain statistically significant.

Monetary policy decisions at time t respond to the information available at the announcement date. In particular, policy adjustments may reflect new state realizations that have emerged since the previous meeting. For global risk, this implies that the relevant object entering the reaction function is the accumulation of unexpected risk innovations during the inter-meeting period rather than the level of risk itself.

To capture this empirically, I construct an announcement-frequency global risk shock proxy (r_t^{Proxy}) as the cumulative sum of daily unexpected VIX innovations realized between consecutive monetary policy announcements, excluding the announcement day.⁷ By construction, r_t^{Proxy} measures global risk innovations that occur after the previous meeting and are fully observed prior to the next announcement, and therefore were not part of the information set underlying the policy rule or private-sector expectation formation at $t - 1$. I relate this proxy to the HF-MPS of Soosalu (2024), which captures unexpected changes in market expectations around policy announcements.

A key empirical consideration concerns the appropriate length of the accumulation window for r_t^{Proxy} . While daily unexpected VIX innovations follow an AR(14) process, the manner in which risk accumulates and influences expectations prior to policy announcements is not known *a priori*. For example, more recent innovations may play a larger role in shaping market participants' expectations than innovations that occurred earlier in the inter-meeting period. I therefore consider a range of accumulation windows between 16 and 22 trading days, which exceed the short-run dependence structure of the innovations while remaining plausibly relevant for pre-announcement information aggregation.

The empirical specification relates high-frequency monetary policy surprises to global risk innovations accumulated between consecutive policy announcements:

$$Surprise_t = \beta r_t^{Proxy} + u_t, \tag{16}$$

⁷Between 2003 and 2012, policy announcements were released at 9:00 a.m. Eastern Time; from 2013 onward, scheduled announcements were released at 10:00 a.m. Eastern Time.

where t stands for announcement frequency.

Table 3 reports estimation results for samples beginning in 2003 and 2008, for robustness. For each sample, results are shown for the full set of observations (*All periods*) as well as for subsamples that restrict attention to episodes of elevated accumulated risk, defined as periods in which r_t^{Proxy} exceeds one standard deviation from its mean ($\pm\sigma$). In addition, the table reports the results for alternative window lengths used to construct accumulated global risk innovations.

Table 3: Accumulated Global Risk and Monetary Policy Surprises

Start Year	Risk Regime	Accumulation Window	N	β	p -value	R^2
2003	All periods	16 days	136	0.105	0.017	0.023
2003	All periods	18 days	136	0.108	0.011	0.026
2003	All periods	22 days	136	0.090	0.012	0.025
2003	$\pm\sigma$ risk	16 days	43	0.132	0.014	0.061
2003	$\pm\sigma$ risk	18 days	42	0.132	0.013	0.084
2003	$\pm\sigma$ risk	22 days	35	0.093	0.014	0.052
2008	All periods	16 days	96	0.129	0.002	0.037
2008	All periods	18 days	96	0.138	0.000	0.046
2008	All periods	22 days	96	0.090	0.003	0.031
2008	$\pm\sigma$ risk	16 days	32	0.138	0.021	0.081
2008	$\pm\sigma$ risk	18 days	32	0.154	0.004	0.109
2008	$\pm\sigma$ risk	22 days	27	0.083	0.008	0.041

Notes: The table reports regressions of the HFI monetary policy surprise series on accumulated global risk shocks. Accumulated risk is measured as the sum of daily VIX innovations over the indicated number of trading days preceding each policy announcement. Regressions are estimated without an intercept and use robust standard errors. $\pm\sigma$ risk periods are defined as periods in which accumulated risk exceeds one standard deviation from its sample mean. Data is at announcement frequency. End year is 2019.

Across all specifications, accumulated global risk innovations r_t^{Proxy} are positively and statistically significantly associated with monetary policy surprises. Estimated coefficients are relatively stable across accumulation windows and subsamples, with all specifications yielding effects significant at conventional levels.

These findings indicate that high-frequency monetary policy surprises systematically co-move with global risk accumulated between announcements. Because r_t^{Proxy} captures innovations realized strictly after the previous policy decision yet publicly observed prior to the

announcement at t , the documented relationship cannot reflect informational asymmetries about realized risk. Instead, it suggests that markets misperceive how accumulated global risk enters the policy reaction function ($f \neq \hat{f}$).

4.3 Implications for identification of pure monetary policy shocks

Evidence from the literature and from this paper’s impulse responses indicates that the Bank of Canada systematically adopts a more accommodative monetary policy stance during periods of elevated global risk. However, when market participants overestimate the strength of the central bank’s response to global risk innovations accumulated between announcements, easing policy decisions may nevertheless be recorded as contractionary monetary policy surprises under HF-identification. In particular, attributing a depreciation of the Canadian dollar—driven by rising global risk between announcements and an easing monetary policy response—to a restrictive monetary policy shock is inconsistent with standard SOE models, especially when the underlying pure monetary policy innovation is negligible.

As a result, HF-MPS embed systematic global risk-related variation, contaminating the identification of the effects of monetary policy shocks. The same reasoning applies to other risk-sensitive variables, whose responses partly reflect global risk dynamics rather than the causal effects of monetary policy, thereby distorting the estimated impulse responses. This interpretation is supported by the regression results in *Table 3*, which document a positive relationship between accumulated global risk innovations and high-frequency monetary policy surprises, implying that higher accumulated risk is associated with more restrictive measured MPS. This explanation is also consistent with the differences in the impulse response functions shown in *Figure 7*.

5 Conclusion

This paper examines how global risk shapes macroeconomic dynamics and monetary policy identification in a small open economy, using Canada as a case study. I develop a global risk shock proxy that allows the effects of global risk to be identified using only domestic variables, without augmenting the VAR with global aggregates or imposing additional restrictions. Global risk shocks depreciate the Canadian dollar, tighten financial conditions, and reduce asset prices, output, and prices, eliciting an expansionary monetary policy response and accounting for a sizable share of fluctuations in key macro-financial variables.

I further provide evidence that global risk shocks systematically interact with high-frequency monetary policy surprises. The findings suggest that global risk accumulated between policy announcements affects measured surprises through misperceptions of the central bank's reaction function, leading standard high-frequency measures to embed endogenous, risk-driven variation. As a result, when global risk is not explicitly controlled for, the estimated real effects of monetary policy are overstated and the exchange rate response becomes difficult to reconcile with standard small open economy models.

Overall, the results identify global risk shocks as both an important driver of macro-financial fluctuations in Canada and a confounding factor in monetary policy identification. Accounting for unexpected global risk innovations accumulated between announcements is therefore crucial for correctly estimating the magnitude and transmission of monetary policy shocks. The proposed proxy and identification framework are readily applicable to other small open economies, providing a tractable approach to studying the interaction between global risk and monetary policy in comparable settings.

6 References

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7 Appendix

Appendix A: Model specification and data

The VAR is estimated using monthly data from January 2002 to December 2019. The lag length is selected according to the Akaike Information Criterion (AIC), which suggests the inclusion of two lags, coinciding with Soosalu (2024).

I select the following variables, as they are standard in the monetary policy transmission literature for Canada.: GDP, CPI, 1 year t-bill, exchange rate, mortgage spread and corporate spread. To enhance the analysis, I expand the set of variables by including the Canadian Economic Policy Uncertainty (EPU) Index as a robustness check—its inclusion does not alter the results⁸—and the Toronto Stock Exchange (TSX) price index, common variable included in risk shock studies. If the proposed global risk proxy indeed captures an external global risk shock, I would expect to observe a positive response in the EPU index following the shock, and a decrease in the TSX price index. This serves as a consistency check for the shock’s external nature, as it has been documented that risk shocks drive domestic economic policy uncertainty and decreases stock returns. Bartsch (2019) emphasizes that while risk merely shifts expected values and thus asset prices, ambiguity arises when agents face uncertainty about the quality or relevance of policy information and predictions⁹. In this sense, external risk shocks can translate into heightened domestic policy ambiguity, as agents become aware of imprecise policy outcome expectations or unknown outcome probabilities. Consistent with this mechanism, Bauer et al. (2023) decompose the VIX into risk and uncertainty components and show that innovations to the risk component causally increase the uncertainty component.

The variables are sourced and constructed as follows:

- **Gross Domestic Product (GDP):** Real GDP at basic prices, by industry, monthly (in millions), seasonally adjusted. Source: Statistics Canada, Table 36-10-0434-01. Normalized to 100 at its initial observation and then transformed using $\log(x) \times 100$.
- **Consumer Price Index (CPI):** Monthly CPI from Statistics Canada, Table 18-10-0004-01. Transformed using $\log(x) \times 100$. Not seasonally adjusted; base year is 2002 = 100.

⁸See *Appendix* for additional robustness checks.

⁹Especially when policymakers are untrustworthy, poor predictors of their own behavior, or ineffective communicators (Ellsberg, 1961)

- **Credit Spread:** Difference between the 3-month corporate credit rate and the 3-month Treasury bill rate. Source: Statistics Canada, Table 10-10-0122-01.
- **1-Year Treasury Bill Rate:** Daily rate, aggregated to monthly average. Source: Statistics Canada, Table 10-10-0139-01. Demeaned.
- **Mortgage Spread:** 5 year fixed mortgage rate minus 5 year government bond rate. Stats Canada table 3410014501 and 1010012201. Demeaned.
- **Economic Uncertainty:** Canadian policy uncertainty index from Baker (2016); data obtained from the authors' website. Normalized to 100 at its initial observation and then transformed using $\log(x) \times 100$.
- **Exchange Rate:** Canadian dollar/USD. Monthly averages. Bank of Canada. Transformed using $\log(x) \times 100$. Not seasonally adjusted; base year is normalized to 2002 = 100.
- **Short-Term Interest Rate:** 3-month corporate credit rate, Statistics Canada, Table 10-10-0122-01. The role of short-term interest rates in Canada for monetary policy transmission is highlighted in Ha & So (2023). All interest rate variables are demeaned before estimation.
- **VIX Index:** Retrieved from the Chicago Board Options Exchange (CBOE), via FRED (Federal Reserve Bank of St. Louis): <https://fred.stlouisfed.org/series/VIXCLS>, accessed July 21, 2025.
- **TSX Price Index:** Daily data, averaged to monthly frequency, normalized to 100 at the initial observation, and transformed as $\log(x) \times 100$. Data are retrieved from the Toronto Stock Exchange. accessed October 20, 2025 <https://www.tsx.com/>.

The VAR is estimated in levels, and all interest rate and spread series are demeaned prior to estimation. Inference is conducted using a *moving block bootstrap* (MBB) procedure, as proposed by Jentsch and Lunsford (2022). The block length is set to 20 months, and the results are robust to other reasonable choices of block length¹⁰.

¹⁰The MBB algorithm is applied to the proxy-SVAR using the authors' publicly available replication code.

Appendix B: Robustness

7.1 Alternative monthly aggregation for proxy

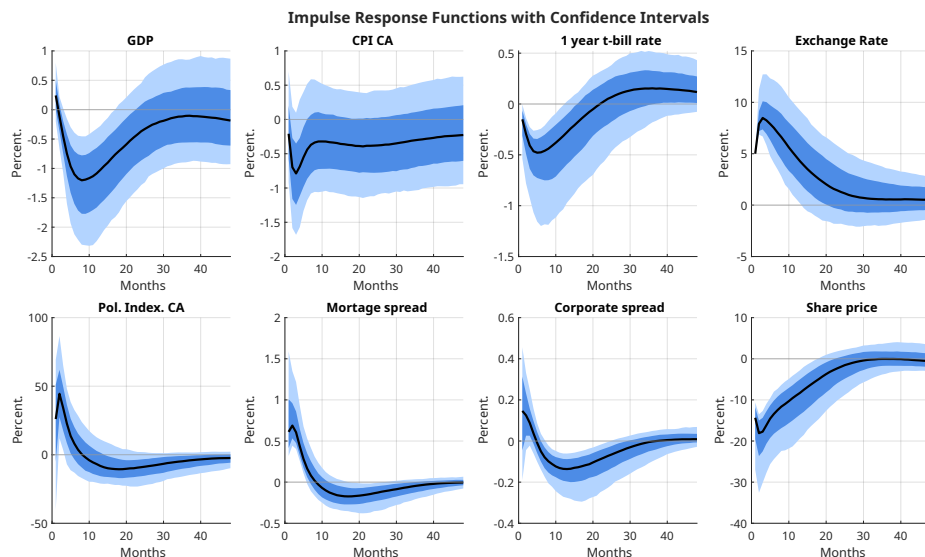


Figure 8: The proxy variable here is constructed by directly summing the daily VIX innovations within a month, i.e. there is no innovation smoothing. VAR(2). Moving blocks bootstrap, 1000 replications.

7.2 ACF proxy - monthly aggregation

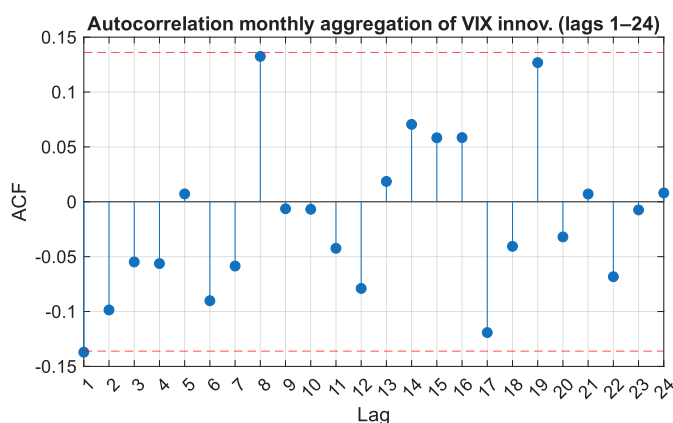


Figure 9: Autocorrelation function using the direct sum of daily VIX unexpected innovations. We do not use here the moving average aggregation of the daily proxy, as it by construction is likely to show some autocorrelation.

7.3 Alternative lag-length

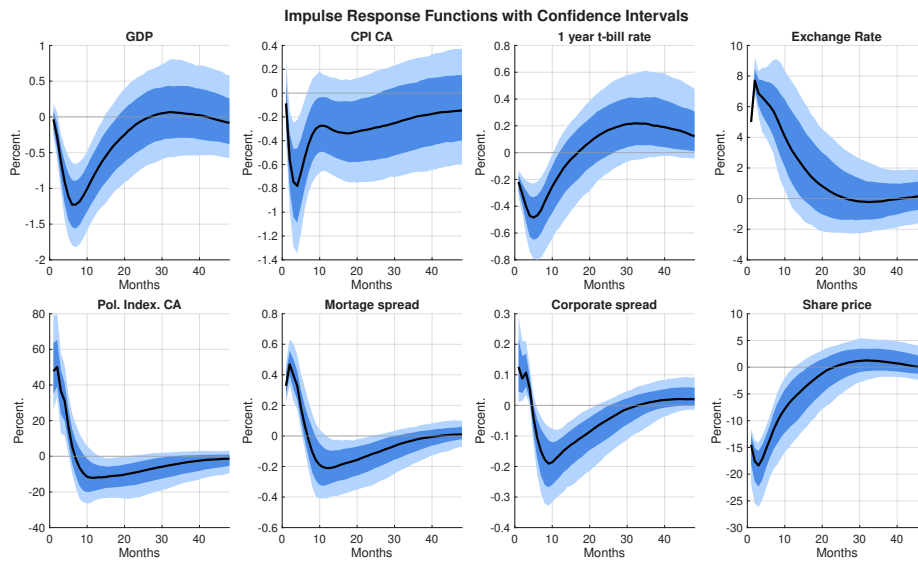


Figure 10: VAR(3). Moving blocks bootstrap, 1000 replications.

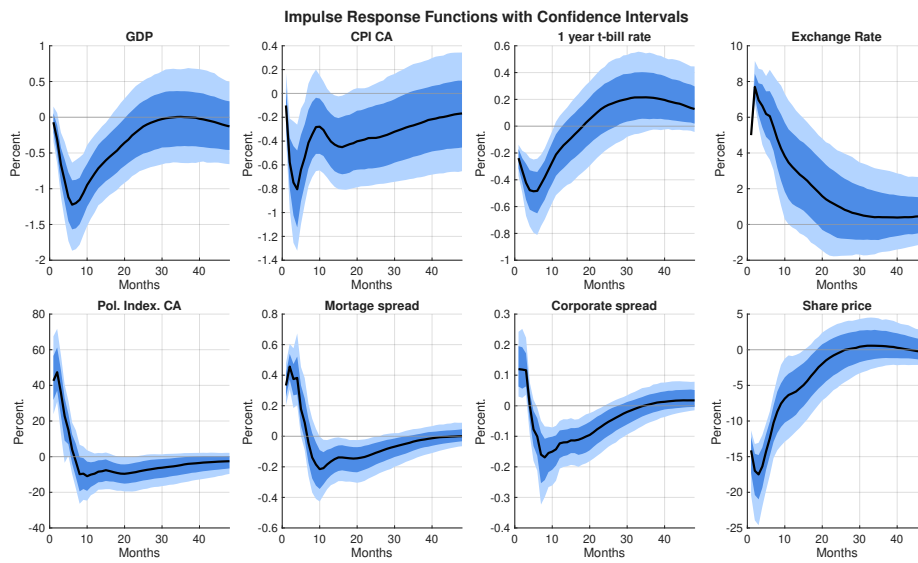


Figure 11: VAR(4). Moving blocks bootstrap, 1000 replications.

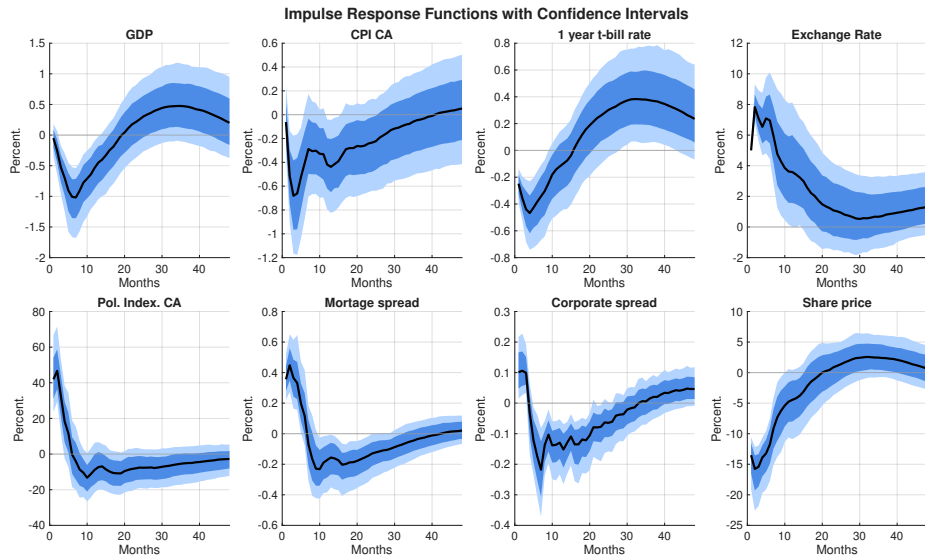


Figure 12: VAR(6). Moving blocks bootstrap, 1000 replications.

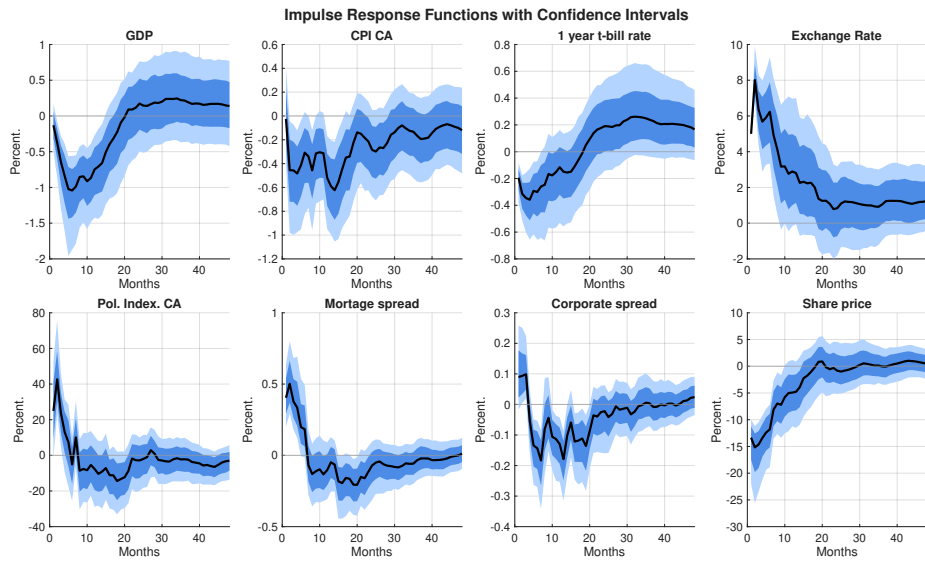


Figure 13: VAR(9). Moving blocks bootstrap, 1000 replications.

7.4 Exclusion of Economic Policy Uncertainty

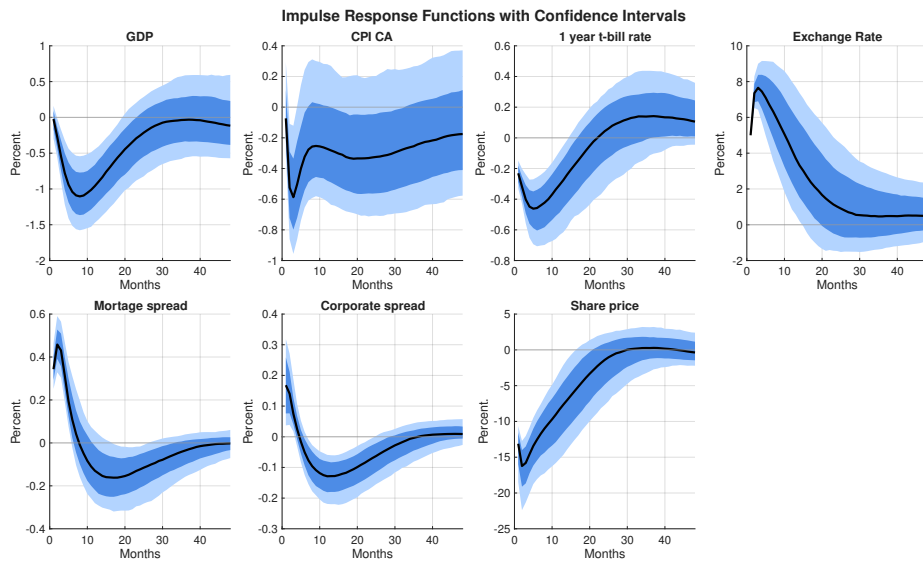


Figure 14: VAR(2). Moving blocks bootstrap, 1000 replications.

7.5 P&P global risk proxy for Canada

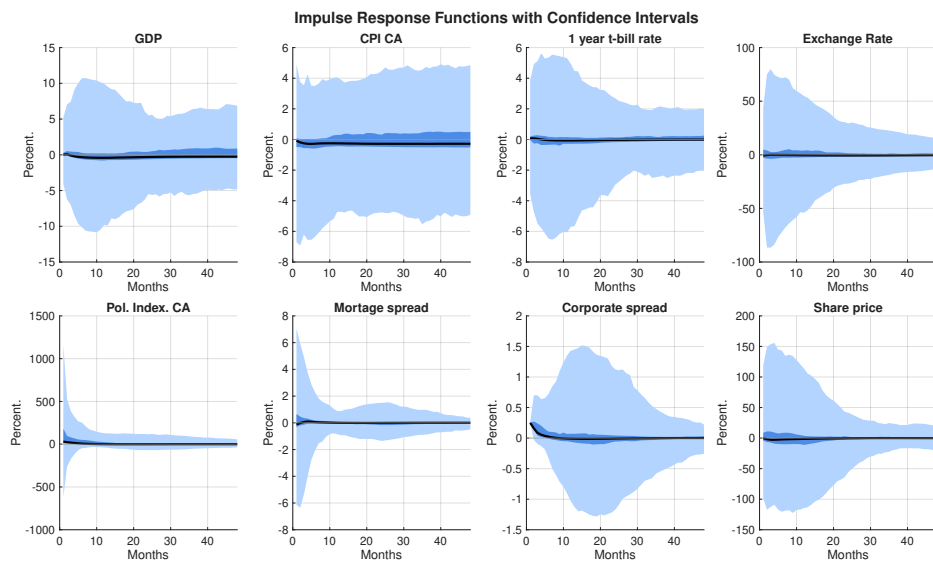


Figure 15: VAR(2). Moving blocks bootstrap, 1000 replications. First stage targets the credit spread residual, as it is the only residual with an F-test above the threshold, namely 15.9. Shock is normalized to increase the credit spread by 25 bp.

7.6 P&P uncertainty (risk) proxy for Canada, VXO target

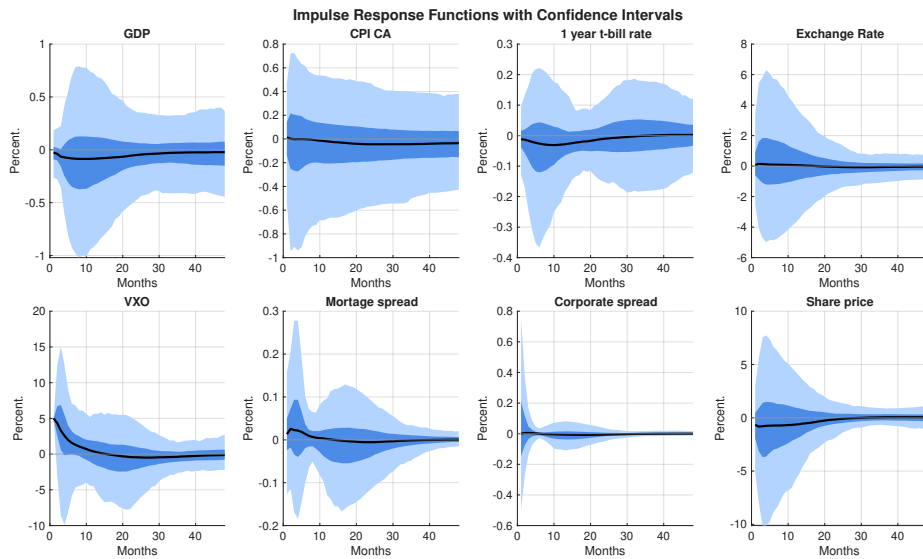


Figure 16: VAR(2). Piffer–Podstawski global risk proxy for Canada. The first-stage target is the VXO residual, as intended by the authors. Confidence intervals are computed using a moving block bootstrap (MBB) with 1000 replications.

7.7 P&P uncertainty (risk), TSX target

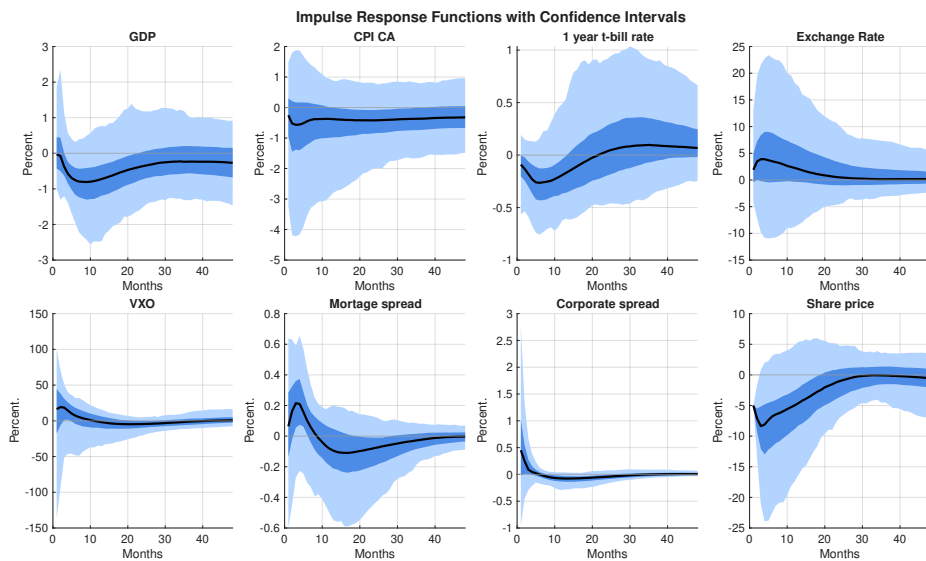


Figure 17: VAR(2). Piffer–Podstawski global risk proxy for Canada. The first-stage target is the TSX (Stock Exchange) residual, as it exhibits the highest correlation with the Piffer–Podstawski proxy. Confidence intervals are computed using a moving block bootstrap (MBB) with 1000 replications.

Appendix C: Proxy and structural shocks

7.8 Strong exogeneity test

Table 4: Strong Exogeneity Test Summary (Bruns & Keweloh, 2024)

Component	Test Type	Statistic	p-value	Reject H_0 at 10%
Target Residual (exchange rate)	F-stat (standard)	41.04	0.000	Yes
	F-stat (robust)	20.74	0.000	Yes
	R^2 / Adj. R^2	0.163 / 0.159	–	–
Global Risk Proxy (z^2)	F-stat (standard)	27.85	0.000	Yes
	F-stat (robust)	12.11	0.001	Yes
	R^2 / Adj. R^2	0.117 / 0.112	–	–
Number of observations		213	–	–
Adjusted R^2 (first stage)		0.112	–	–
Exogeneity J-test	Standard GMM	1.06	0.983	No
	CUE (Non-conservative)	1.07	0.983	No
	CUE (Conservative)	1.07	1.000	No
	GMM with Kurtosis	10.34	0.586	No
	CUE w/ Kurtosis (Non-cons.)	7.02	0.856	No
	CUE w/ Kurtosis (Conservative)	7.02	0.990	No

7.9 Recovered demand IRFs

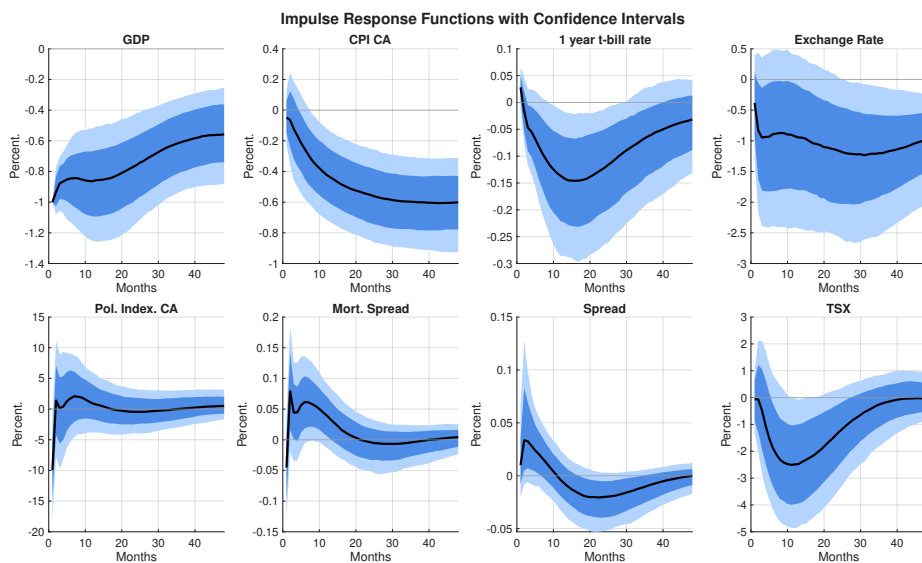


Figure 18: IRFs of recovered demand shock. MBB 1000 replications. 68 and 90% confidence bands. The shock is normalized to a 1 percent on-impact decline in output. The first-stage targets the reduced-form residual of output.

7.10 Historical decomposition

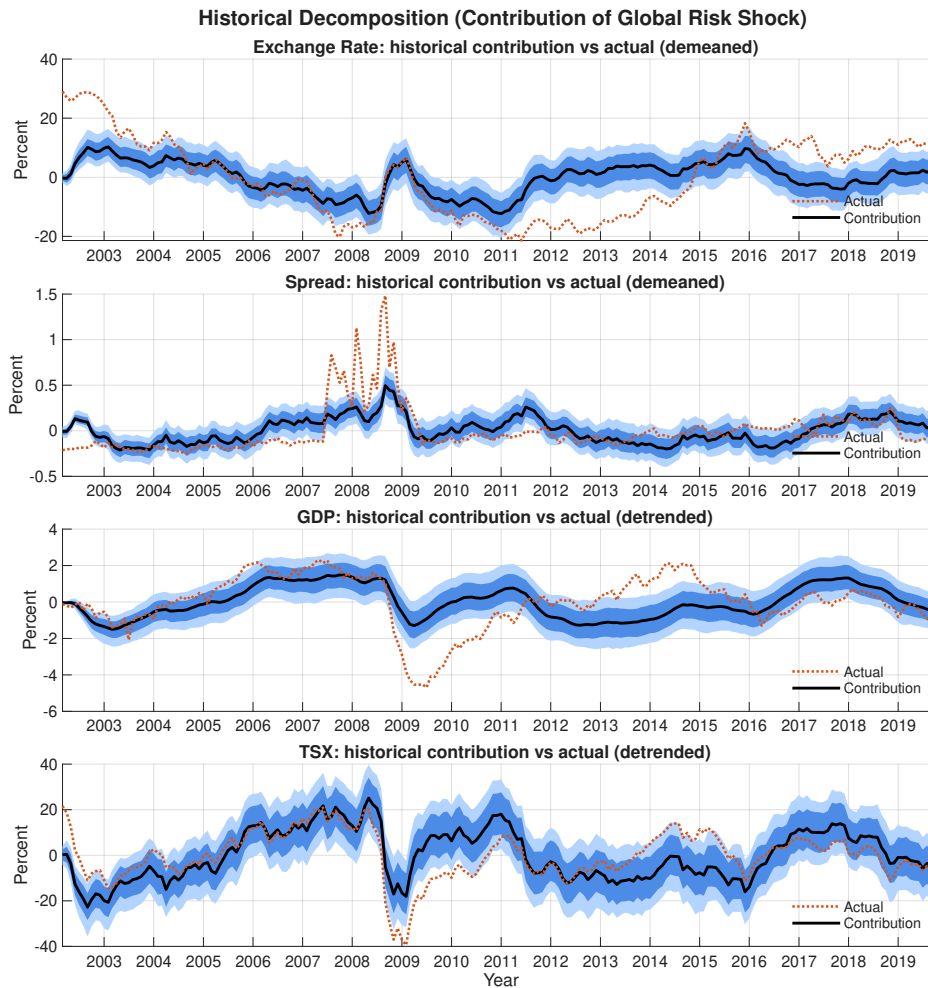


Figure 19: Baseline model. The table reports the cumulative historical contribution of global financial expectation shocks – global risk shock–, along with 68 and 90 percent confidence bands and the corresponding deviations of the actual variables. The spread and exchange rate are demeaned, while output and TSX are detrended using a third-degree polynomial (results are robust to using polynomials of degree 2 to 4. Here “contribution” is the cumulative effect of identified global-risk innovations on each variable.